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Abstract

The causes of and extent of network externalities in payment systems such as the ATM and the ACH-market have been analysed and tested in earlier studies. In this paper a similar study is made for the market for electronic card payments, i.e. the EFTPOS-market. A panel data set of variables relevant to the evolution of the EFTPOS market in the G-10 countries, Australia and the Nordic countries for the period 1988–1999 is gathered and used in a statistical description of the evolution of the market. Also the hypothesis regarding the positive effects of standardisation for the evolution of the market is tested. The results are highly significant and the coefficients have the expected signs. A model that describes the banks' adoption decision of EFTPOS technology is developed. It is assumed that if network externalities are present, the larger the use of common standards, the larger will be the transaction demand for this particular instrument. Within the specific context of the EFTPOS market, the model illustrates the trade off between network effects and competition effects often described in the literature. Existence of pure strategy equilibria requires that banks are not exceedingly asymmetric in terms of their relative sizes in the acquiring market. The full adoption with common standards outcome is more likely to result the smaller benefits banks derive from differentiation.

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1 Introduction

Positive network externalities or network effects are often claimed to be present in payment instruments and payment systems. Network effects are at work when an increase in the number of individuals consuming a certain product enhances the quality of the product for all consumers. Thus the consumers' utility and thereby their aggregate willingness to pay for the product increases directly with the size of the market. The telephone is a classical example of this type of externality as are other communication intensive industries such as the telefax or the internet. In some cases referred to in the literature as indirect network externalities, the beneficial size effects can also arise because of complementarities between markets. The larger size of a certain market benefits consumers in a complementary market through lower prices, an increased availability of products and technical service or even through an overall increase in "know-how" that facilitates the use of the product. The information technology sector is often characterised by these type of externalities. For example, when considering the purchase of a computer the consumer takes into account the market share of the specific hardware brand. This is because the supply of compatible software and technical support will be larger. Also, more users will know how to use the software.

However interesting this distinction may be, it may obscure the underlying source of network externalities. In both cases it is the existence of *complementarities* that gives rise to externalities. For indirect network externalities, the complementarities exist between products or services in different markets, e.g. hardware and software products. For direct externalities, the complementarities arise between different users of the same product or service, for example different users of a payment system. A user of a giro system derives no utility from participation in the system, if there is no other individual or enterprise participating and thus willing to accept payments through the system.

Complementarities between products or users may exist and give rise to network externalities, but for these complementarities to be exploited it is crucially important that the products or the users can interact. This is usually expressed in terms of products being compatible[1] with each other or sharing a common standard. For a payment card to be accepted by a retailer, it is necessary that the retailer's terminal can process the information imbedded in the card. Thus complementarities and compatibility together give rise to positive

[1] Compatibility may be achieved by the use of common technical standards and business standards. Technical standards establish rules for features of payment instruments or systems, for example rules for communication protocols. Business standards are agreements that stipulate procedures, legal interpretation and/or technical standards to be adopted in the processing of interbank payment transactions, for example requirements for security management in EFTPOS systems. (See BIS (2000).)

network externalities. Complementarity without compatibility creates an unexploited potential for network externalities. Payment systems such as ATMs, EFTPOS or ACHs[2] often require certain infrastructure, such as information routing switches and telecommunication lines. In this context, system compatibility is based largely on the adherence to common rules, operational standards, and formats. In this economically more relevant sense, a network is thus made up of the sum of all systems and/or individuals that through adherence to common standards can interact with each other, or in other words are compatible with each other.[3]

Several studies have examined the extent of and the effects of network externalities in payment systems such as the ATMs and the ACHs. This paper attempts a similar study of how the existence of network externalities and the extent to which these are exploited influence the evolution of the EFTPOS market. I use a modified version of the model developed by Gowrisankaran and Stavins (1999) to illustrate the crucial role played by standardisation and interoperability agreements between providers in the decisions to adopt and use the EFTPOS technology. In my model, adoption and usage decrease with the number of systems that are not compatible with each other. The conditions for equilibria associated with common and proprietary standards and for full, partial and non-adoption of the EFTPOS technology are derived. It is shown that the existence of pure strategy equilibria requires that banks are not exceedingly asymmetric in terms of merchant customers, that is in the number of locations where they can install acceptance terminals. Furthermore, equilibria with full adoption in common standards require that the benefits of differentiation are not too large. Firms' benefits of differentiation are modeled here as higher mark ups associated with the establishment of different standards. The less intensely banks compete with each other for customers the larger the parameter range for which the interoperability outcome results.

In Gowrisankaran and Stavins' paper it was shown that the degree of market concentration was positively correlated with the adoption and usage of the

[2] Automated teller machine (ATM) is an electro-mechanical device, that permits users, typically using machine-readable plastic cards, to withdraw cash from their accounts and/or access other services, such as balance inquiries, transfer of funds or acceptance of deposits (BIS, "Statistics on payment systems in the Group of Ten countries"). The ATM-system is the network of terminals interlinked by communication lines, switches and other data processing equipment that is required for the provision of these services.

Electronic funds transfer at the point of sale (EFTPOS) refer to the use of payment cards at a retail location where the payment information is captured and transmitted by electronic terminals.

Automated Clearing Houses (ACH) are electronic clearing systems in which payment orders are exchanged among financial institutions, primarily via magnetic media or telecommunication networks, and handled by a data processing centre. (BIS, "Statistics on payment systems in the Group of Ten countries")

[3] Katz and Shapiro (1985).

ACH-technology and thus to the extent to which network effects in this market were exploited. In contrast, the hypothesis in this study is that regardless of the fragmentation of the market in different proprietary systems, network externalities will be exploited if these systems are linked together through compatibility agreements. Compatibility is defined as the capacity of different proprietary systems to interact with each other through the use of common technical and business standards. In the specific EFTPOS market, compatibility means that the merchant's terminal can accept the card and process the payment regardless of what system the card issuer belongs to.

As an illustration of the importance of standardisation for the development of the EFTPOS-market, statistical evidence on the growth of the market in the G-10 countries, Australia and the Nordic countries was gathered for the period 1988–1999. The development of the EFTPOS-market itself, in particular all the aspects that are relevant in explaining the presence of network effects, is described and analysed. The data is also used in a test for the existence of network externalities, according to the hypothesis that—if externalities are present—the fewer the number of networks in the compatibility sense the larger the growth of EFTPOS-transactions that will be observed. Different functional forms are used in the regressions. The exponential form for the independent variable is shown to be a better specification of the relationship between the variables than the logarithmic form. The more concave the specification is the stronger these effects are. All coefficients are found to have the expected signs and the results are highly significant. I gather and analyse other data relevant to parameters in this as well as in Gowrisankaran and Stavins' (1999) model, such as the number of terminals installed and the degree of market concentration in the bank market. The degree of market concentration measured by the Herfindahl-Hirschman Index (HHI) data is also regressed on the growth of EFTPOS transactions as a separate test of the Gowrisankaran-Stavins hypothesis in this specific market. The results are highly significant and the sign of the coefficient consistent with their hypothesis. Furthermore, there is evidence of a strong positive correlation between the degree of market concentration and the use of common standards.

As in Gowrisankaran and Stavins (1999), the policy perspective is important for the study. If the efficiency of the payment system is the policy objective, one must ask how the existence of network externalities affects this goal. In Gowrisankaran and Stavins (1999) the focus is in the market failure aspect. They test for the existence and extent of network externalities in the ACH-market. If network effects exist and are large enough, the market outcome will result in underprovision of the technology. Under the assumption that the ACH system is a more efficient payment system than other paper based alternatives, one policy conclusion they point to is that the technology might need to be subsidised. The issue of which market structure leads to the best exploitation of network externalities is further investigated. This study compares different market outcomes without taking into account the problem of underprovision. As regards the exploitation of network externalities, standardisation instead of market concentration is singled out as the crucial variable. The conclusion is that the best strategy for policy makers interested in the efficiency of the payment market is to promote the use of common standards and to facilitate the co-ordination efforts of market players to this effect. Also the conditions for the interoperability outcome gives guidance on the issue of when more active standardisation efforts are required from policy makers. Everything else equal, the more decentralised and competitive the market is, the less likely it is that the market will achieve the interoperability outcome.

The model used is in line with the literature on network externalities. When network effects are large, it is necessary to achieve a certain level of expected market size to get the market established. The combination of economies of scale that are also present on the production side and the existence of network effects thus creates strong incentives towards market concentration at the infrastructure level through the creation of broad based payment networks, shared by otherwise competing providers.[4] Co-operative arrangements however also intensify competition among providers within the same network as their products become less distinguishable for consumers. These opposite effects have been described in the literature as the trade off between "competition effects" and "network effects".[5] The model illustrates how the trade off works in this specific market and describes how these opposite effects affect the conditions for the different outcomes.

Regarding the efficiency discussion, there is no formal analysis in this paper of the relative effects of different combinations of market structure and degrees of standardisation. Clearly, if one common technical standard in a network market is delivered through the market being completely monopolised, this outcome will give a less efficient result than if the market was divided by a large number of firms sharing the same standard. Mainly due to lack of relevant data, other factors relevant to market growth as for example pricing are not taken into account either. The price faced by users, both cardholders and merchants is naturally a very important factor in explaining market developments.[6]

In the next Section I present a review of related empirical research. In Section 3, I describe the main characteristics of the EFTPOS market, in particular those aspects that point to the existence of network effects. I also describe the

[4] See for example McAndrews (1991).
[5] See for example Economides (1996) and Katz and Shapiro (1985).
[6] See for example Humphrey, Kim and Vale (1998).

evolution of the market in the studied sample and give some statistical evidence of the importance of standardisation in the market. In Section 4, the model is developed. Section 5 presents the empirical results.

2 Related research

From a theoretical point of view, if network externalities are present in a certain market, then certain effects should be observable in terms of prices, market shares, standardisation incentives and technology adoption decisions. Empirical tests of network externalities in different markets are often based on the observation of these effects.

Regarding *prices*, the theory leads us to expect that if network externalities are present, the larger the network producing the network good, the larger willingness to pay it will elicit from consumers and thus the higher prices the network will be able to extract.

On the ATM market, McAndrews (1996) measures the effects of network size on prices. Incorporating network externalities in the retail demand for ATM services and assuming the fulfilled expectations Cournot outcome where banks compete in output, equilibrium output and prices are derived. The comparative statics show that the derivative of the equilibrium price with respect to network size is not clear cut. The sign depends on the relative strength of economies of scale in consumption, i.e. network externalities, and economies of scale in the production of these services. If network effects predominate, the effects of network size on prices are positive, reflecting the fact that larger networks give rise to higher aggregate utility. On the other hand if the effect of economies of scale in production is stronger, then larger networks will lead to lower prices. These hypotheses are tested by McAndrews (1996) against bank, network and price data. The results show that demand side effects are significant up to a certain network size, up to which prices charged are higher when the network becomes larger. This is explained by the fact that, up to a certain point, larger network sizes lead to better exploitation of network effects and thus to increasing willingness to pay for the service that the network provides. Beyond this size, the effects of network externalities are outweighed by the negative effects on prices from supply side economies of scale. In addition the effects of intersystem competition on prices are also tested by McAndrews (1996). The hypothesis tested is that competition between systems does not have the expected negative effect on prices. More competition does not automatically lead to lower prices, because of the existence of considerable costs to consumers of changing networks. Using an ATM-system instead of another competing system may for example imply that the customer has to change banks. The results give support to this hypothesis and suggest that competitive pressure between systems do not have any significant effect on prices.

Carlton and Frankel (1995) have also studied empirically the similar issue of the effects on ATM costs and volumes of mergers between competing systems. Their purpose was to look for evidence regarding the beneficial effects of network mergers against traditional anti-trust considerations. Their hypothesis is that intersystem competition does not have the expected efficiency gains in terms of costs and prices, but that those gains are more likely to be achieved by intra-system competition instead, i.e. by increasing the number of firms within the same network. The specific case studied is the effect of the merger in 1987 of the two by then competing shared ATM-networks in Chicago—Cash Station and Money Station. They show how after the merger, transaction volumes and the number of machines soared and how the costs per transaction declined in comparison with the corresponding total figures for the United States. These results can be interpreted in the light of the analysis done by Katz and Shapiro (1985) or more recently by Economides and Flyer (1997). The merger of the two systems is equivalent to a move towards full compatibility. The increase of the size of the network resulting from the merger leads to an increase in industry wide output and thereby to an increase in consumer surplus.

The theory of network externalities also predicts that the larger these effects are the stronger are also firms' incentives to adopt the technology that exhibits these effects. Saloner and Shepard (1995) tested for the existence and magnitude of network externalities in the *rate of adoption* of ATM technology. They modelled first the conditions for adoption of this technology in each period under the assumption of network externalities. Under this assumption, consumers' utility and willingness to pay for the ATM-services increase with the size of the network which in turn increases banks' revenues from the adoption of the technology. Also, the costs of adopting the technology decrease with time because of technological advances. As the McAndrews study, Saloner and Shepard take into account the effect of economies of scale in supply as well. In this context the signs of the effects of economies of scale in supply and in demand coincide. The larger the network of installed ATMs the larger is also the probability that more banks will adopt it. These are the demand side effects. Also, the larger the number of adopting banks, the lower are unit costs for the operation of the system. These are the supply side effects. Their empirical results give strong support to the theory. They find that increasing the expected network size by adding one more branch to the number of potential ATM-locations, increases the probability of a bank adopting the technology in the first nine years ATMs were available by between 5, 7 and 10 percent. Even though economies of scale in production also have a significant effect on adoption decisions, network effects appear to be stronger.

The issue of how the presence of network externalities influence firms' incentives towards the use of common standards has been the object of many studies after the seminal paper by Katz and Shapiro (1985). Economides and Flyer (1997) analyse firms' incentives to adhere to a certain standard considering the trade-off between the advantages of conforming to a technical platform, i.e. the increase in consumer surplus that results from the increase of the network size, against the advantages of product differentiation through the choice of non-compatibility. Using a two-stage model of Cournot competition—in the first stage firms choose the technical standard, in the second the firms play a Cournot game in quantities—they confirm the early results by Katz and Shapiro that showed that the highest welfare was achieved by full compatibility, i.e. all firms adopting the same standard. However they also showed that because of the opposing incentives present in network goods, such an equilibrium is not likely to arise. Instead the market will be dominated by a few firms showing large asymmetries in output and prices. These asymmetries are larger the stronger the network externalities are. Similarly to the analysis of Carlton and Frankel (1995) that shows that intersystem competition does not have the usual effects when network externalities are present, Economides and Flyer also show that these asymmetries do not diminish and that total welfare actually decreases with new entry under non-compatibility. The reason is that increasing the number of firms within one coalition, which would be equivalent to increasing the size of that particular network, increases consumer and total surplus. However allowing new entrants that do not—or are not allowed to—adhere to existing standards, results in standard fragmentation. This implies more networks of smaller size. When network externalities are very strong, that is for pure network goods, the total surplus is largest with a monopoly standard.

Gowrisankaran and Stavins (1999) model and test for network externalities in the ACH market. They also analyse the effects of market concentration on the adoption and use of this technology. Their model is a two-stage game that describes banks' decision to adopt the ACH technology and customers' decision to use the same technology. In the first stage banks make the adoption decision. In the second stage the customers of the banks that have adopted the technology decide whether or not to make use of the system. Assuming that network externalities are present, each customer's usage is an increasing function of other customers' usage. By construction, banks have captive markets, that is each bank has its own set of customers at the beginning of the game and they do not compete among themselves for customers. The issue of market power is disregarded and banks price ACH-transactions at cost. As in Saloner and Shepard (1995), it is shown that the profitability of adoption increases in other banks adoption, that is network effects apply even at the bank level. It is also shown that in terms of the internalisation of the network externalities, the more concentrated the banking market is, the more banks internalise the value of network effects. Both results have significant empirical support. In accordance with the literature on network externalities, this model has multiple Nash equilibria but one that is Pareto dominant. Comparing different possible equilibria with each other, it is shown that consumer usage and thereby consumer surplus are higher for strategies associated with higher level of adoption.

The conclusions regarding welfare effects appear to be counterintuitive. The more oligopolised the banking market is, the larger are the efficiency gains in terms of more adoption and usage. This is a result of the assumption that firms do make use of their market power and act as perfect agents for their customers. Without this assumption the welfare effects of market concentration would be the usual ones. In more concentrated markets firms will have larger market power. Profit maximising decisions will lead firms to reduce production and extract a larger share of consumer surplus through higher prices. The assumption used in this model contributes however to separate this effect from the positive effect that market concentration has on the internalisation of network effects. Furthermore, the testable implications of the model are robust to the assumption of market power. If market power was present and positive correlations could be observed between firms' adoption decisions on one hand and between usage and the degree of market power on the other, then these positive correlations could only be due to the existence of network externalities. Absent network externalities, the sign of the correlations would be reversed. If consumers decide simultaneously which bank to use and whether or not to use the ACH-system, the fact that one firm adopts the system reduces the residual demand for some other firm which would in turn reduce this other firm's incentives to adopt the system. Also, the smaller the number of firms the smaller would be the equilibrium quantity of ACH-usage. Thus even when firms enjoy market power, the fact that positive correlations are observed can only be attributed to the existence of network externalities.

The main results of the model were then tested against American data with two regression equations. One regressed the number of other banks that have adopted ACH and volume of usage on the individual banks adoption decision. The other test was based on an index of banking market concentration, a measure that is regressed on the fraction of customers at banks that have adopted the technology. The conclusion derived from the model is that the more oligopolised the market is, the larger is the adoption probability and thus the share of customers using the technology. All variables intended to test for network externalities showed strong and significant coefficient values.

3 A description of the market for electronic card payments

The market for electronic card payments (EFTPOS) has emerged in the majority of the industrialised countries in the last ten to fifteen years. It has evolved from paper based versions of the same type of payment instrument, the debit- or credit card[7] payment with vouchers for authorisation and verfication of payment.

EFTPOS are mostly used for face-to-face non-recurring transactions between a vendor and a cardholder and as such they are mostly substitutes for cash or cheques, the two other payment instruments used at point of sale transactions. They are however a more efficient means of payment than paper based non-cash payment instruments. The reason is that they lower both costs and risks associated with these payments. Because of the on-line authorisation procedure, the card issuing bank can avoid situations where payers' do not have enough funds and default on the payment. Also the costs associated with electronic payments lie usually between a third and a half of the costs posed by cheques or other paper based transactions.[8]

As compared to cash, consumers benefit by the use of card payment as the higher risks associated with cash are avoided. The major risk associated with cash is financial loss as a result of theft or loss and is equal to the total value of the banknotes involved. If a payment card is involved instead, the financial loss can be completely neutralised by the card holder complying with the rule that the loss of the card is communicated to the issuing bank immediately. Also, there are "shoe-leather" costs for cash users in accessing to cash through ATMs or bank branches that do not arise with the use of cards. However, cash benefits in most countries by a legal tender status. As such it is accepted as a means of payment everywhere, whereas the use of EFTPOS requires that the merchant has installed a terminal that accepts the instrument. Thus complementarities exist between the two ends of the transaction—the cardholder and the merchant. For these complementarities to be exploited, i.e. for the card payment to be accepted by the terminal there must exist compatible infrastructure arrangements described in next subsection.

For these reasons, the EFTPOS is a market that requires widespread acceptance and thus is a market where network externalities can be assumed to exist. Cardholders' benefit increases in the number of installed terminals—the larger the installed base the broader is the acceptance of the card as a means of

[7] The difference between debit and credit card transactions is that in the first case the transaction results in an immediate debit to the cardholder's account while in the second case the transaction amount is charged to the cardholder's credit line.

[8] See Humphrey, Pulley and Vesala (1996).

payment.

3.1 Infrastructure arrangements

Compared to cash payments that only require the exchange of banknotes between payer and payee for the payment to be finally settled, non-cash payment transactions are more complex. Settlement of non-cash transactions involves other parties than the direct counterparts to the transaction and requires different procedures and infrastructures for the exchange of payment information between all the parties involved.

There are a number of different non-cash payments and this diversity is also reflected in the details of how the payment transaction is processed and the type of infrastructure needed. In general in some way or another, all types of non-cash payments are based on the transfer of funds between accounts held at financial intermediaries. The final transfer of funds is preceded by an exchange of information between counterparts in the different steps of the payment process. When the payment instrument is delivered to the payee, the payment is usually authenticated and authorised. Authentication entails a control of the validity of the instrument used as well as of the identity of the counterparts involved. Authorisation of the transfer of funds by both the payer and the payer's financial institution requires the verification of the ability to pay. If the payer and the payee have accounts at different financial institutions, there is a need of further exchange of information for the clearing process between the two. The clearing process itself involves the exchange of relevant payment information and the calculation of claims for settlement between the financial intermediaries. In the settlement process, the funds are transferred between the parties through accounts held with a common third party, usually the central bank.

For EFTPOS the authorisation and authentication of payment is done at the moment of the transaction. The payee has a terminal that permits real time communication with the bank holding the payers transaction or credit account. The bank verifies that the cardholder has enough funds in his/her account to cover the transaction and authorises the payment. In most cases the cardholder is identified by the use of a unique digit string or Personal Identification Code (PIN). This type of payment system requires an infrastructure of telecommunications and computer routing or "switches" linking the merchant terminal with the card issuing bank and the merchant's bank, i.e. the acquirer. In some countries this switch infrastructure was already in place as it was first developed for the ATM-system, i.e. for the purpose of providing bank customers with the possibility of making cash withdrawals at automated teller machines. Switching services are often outsourced to third party providers that are not financial

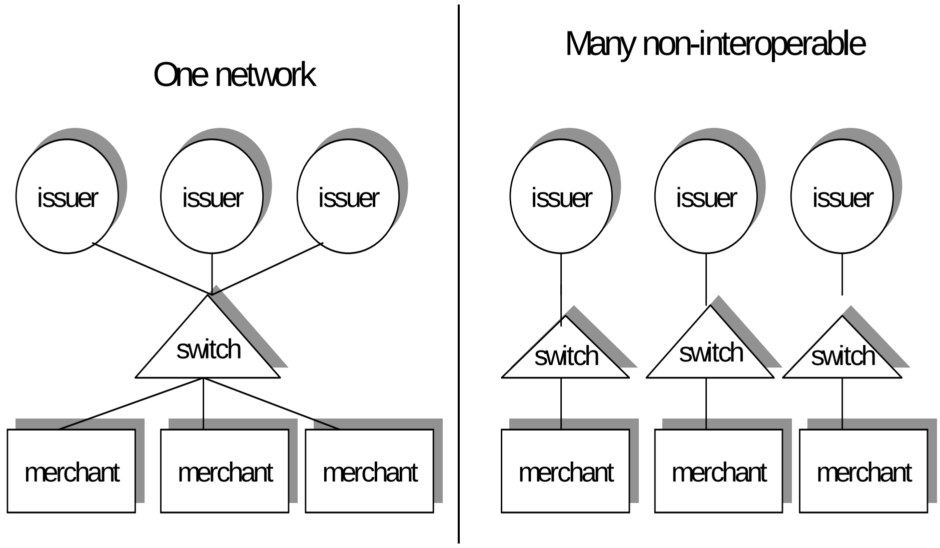

Figure 1: Different network arrangements

institutions.[9]

The way this network infrastructure is organised reflects the extent to which network externalities are exploited. It is possible for all card issuing banks to construct a shared switch network, as shown in the left hand side of Figure 1 illustrating the case of a completely centralised network. In this type of arrangement, all merchants are linked to the card issuing—and the merchant banks through a central switch. A cardholder can thus use the card as means of payment at all points of sale. Participating banks may be shareholders to the joint network or not. If not, the banks buy switching services from the network owners.

At the other extreme, the EFTPOS infrastructure may be organised in a completely decentralised way. Each card issuing bank has its own switch and communication links to its merchant customers, as illustrated in the right hand side of Figure 1. In this case customer utility derived by the use of a bank card diminishes considerably as the customer can only make card payments at a reduced number of points of sale.

In between these two extremes a number of hybrid solutions may arise. A number of banks, for example, may co-operate in the EFTPOS market through shared networks while others develop proprietary systems. As regards the exploitation of network externalities, what matters is the interoperability aspect and not the ownership aspect or the number of systems. From a customer per-

[9] See BIS (2000).

spective, the example illustrated in Figure 1 can also be seen as one centralised network if links are established between the systems. In that case, all participants in the system are interconnected and all merchants are able to accept all cards regardless of the identity of the issuing bank.

3.2 Market evolution in the studied sample

The sample covers the period between 1988 and 1999 in the Group of Ten countries,[10] Australia, Denmark, Finland and Norway. The data set is to a large extent provided by the Blue Book and the Red Book, i.e. the annual payment statistics published by the European Central Bank and the Bank of International Settlements respectively.[11] For Norway, the data are provided by the Bank of Norway's statistical publications.[12]

Some data, as for example information on the number of networks, was collected by direct contact with representatives of the payment systems departments of the central banks in the studied countries. This is because there is no common understanding regarding what figure should be reported as "number of EFTPOS networks" in the statistical publications mentioned. Some countries have reported the number of proprietary networks. Others, as is the case for Australia, report the number of networks from the consumer perspective. This is also the interpretation used in this paper: a network is defined as the sum of all systems that through linkages and interoperability agreements work together as one. The data on the number of networks according to this definition is naturally more difficult to obtain, especially if the number of networks is relatively large. It is thus a safe assumption that the information received is accurate when one or two networks were reported. The larger the number of networks reported, however, the less reliable this information becomes. The distinction between one, a few or many networks is thus more important than the exact number for the conclusions of the analysis. The Herfindahl-Hirschman Index on market concentration (HHI) was also provided directly by the central banks involved.

As can be seen in Figure 2, at the aggregate level, the growth rate of debit card payments—most of which are EFTPOS payments—surpasses by far the growth rate of the other non-cash payment instruments in the studied period. The Bank of International Settlements published a study of the retail payment market in the G-10 countries in 1999.[13] This report emphasised the rapid growth

[10] The G-10 countries are: Belgium, Canada, France, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom and United States.
[11] ECB, "Payment Systems in the European Union"; BIS, "Statistics on payment systems in the Group of Ten countries".
[12] Norges Bank (2000).
[13] BIS (1999b).

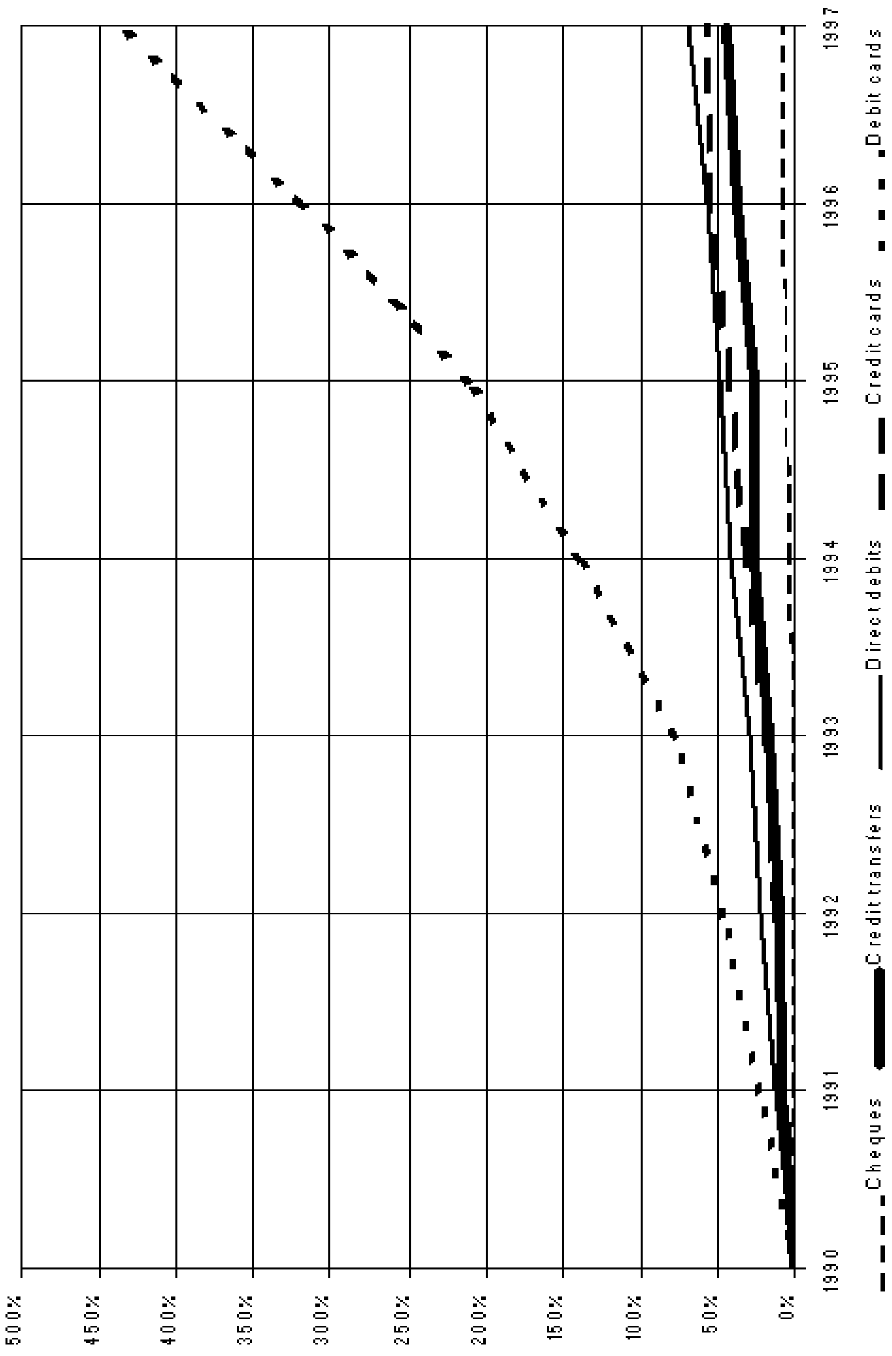

Figure 2: Aggregate growth of non-cash payment volume. G-10 and Australia. Source: BIS (1999b).

rate for card payments as one of the salient features of the recent evolution of the retail payment market. Both demand and supply factors are forces driving this development. From the demand side, there is a clear trend toward the substitution of card payments for both cheques and cash. From the supply side, this report also points to the development of interoperability standards among different card networks as one of the main driving forces for the rapid growth. This development has occurred through mergers and alliances among different systems. Most remarkable regarding the level of global acceptance achieved are the alliances between the large card associations such as Visa and MasterCard and the different local networks. As regards retail payments in general, there is no other payment instrument that has been nearly as successful as card payments in achieving global acceptance.

This trend of mergers and alliances between different proprietary systems is in itself a clear indication of the existence of network externalities in the market. The larger the number of acceptance points the more convenient is the use of payment cards and thus the larger is the number of consumers that will substitute card payments for cash and cheques. Merchants are interested in investing in the necessary equipment only if there is sufficient demand for this particular payment instrument. This demand increases in turn with the number of acceptance points. Card issuers, typically financial institutions, although competing with each other for customers, are aware of the fact that total utility—for both merchants and cardholders—is strongly correlated with the level of acceptance and thus co-operate with each other in enlarging the size of the network. This is clearly the case for the sample studied, where the average number of proprietary systems is much larger than the average number of networks from the interoperability perspective, as can be seen in Figure 3.

Figure 3 also shows that the driving forces for co-operation between systems have remained strong. While the average number of proprietary systems has increased, the average number of non-compatible systems has decreased. The latter category's share of the average number of proprietary systems decreased from 50 percent to 14 percent over the studied period. At the beginning of the period half of the countries in the sample started out with more than one network in the non-compatibility sense while only two countries had more than one network in 1999. This gives also some indications on the relative importance of network externalities and of economies of scale. The latter are also present in this type of payment system as the infrastructure used often involves large fixed costs of adoption and relative low variable costs. Thus, economies of scale can be exploited through consolidation at the infrastructure level and through the establishment of shared networks. According to Figure 3, economies of scale in production does not appear to be as strong as network effects are, as we observe

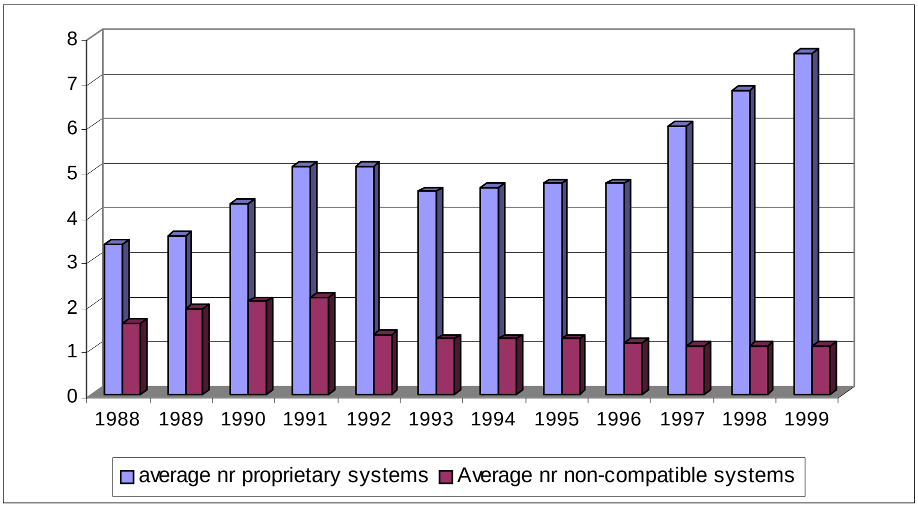

Figure 3: Proprietary versus non-compatible systems

more concentration on the "interoperability" side than on the ownership side.

As expected and shown in Figure 4 with values for 1999, there is also a positive correlation between the number of acceptance terminals and the volumes of card payments, this latter variable expressed as the number of EFTPOS transactions per capita. The correlation amounts to .79 and is strongly significant.

Although the aggregate growth rate for the EFTPOS market in the sample studied has been very rapid, there are large differences between countries. Institutional factors such as the degree of market concentration and different regulatory approaches may explain some of these differences. The regulatory policies in some countries have been tolerant of single nationwide network arrangements for EFTPOS or shared ATM systems in combination with close monitoring and consultation to preserve effective competition. Some have been less inclined to accept network alliances that could result in dominant systems.[14] In some countries such as France, the UK , Belgium and some of the Nordic countries the development of the EFTPOS market was already under way in the beginning of the studied period. In others the market began to develop some years later. Norway and Canada have the steepest growth rates in transactions, other countries as the US, Germany or Italy show very modest development. In the case of Japan, the EFTPOS market did not pick up at all during the studied period.

As expected and seen by comparison of Figures 5 and 6 there is a positive correlation between the number of terminals per million inhabitants and the

[14] BIS (1999b).

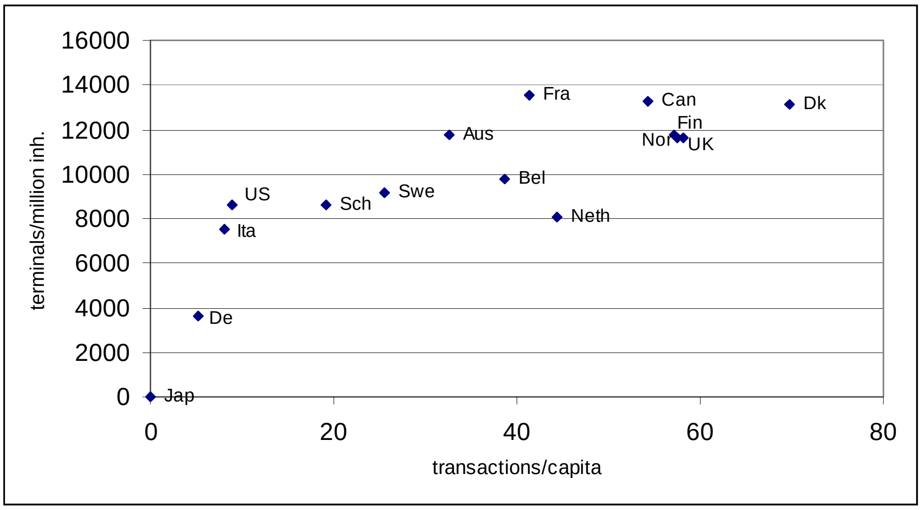

Figure 4: Terminals per million inhabitants and transactions per capita 1999.

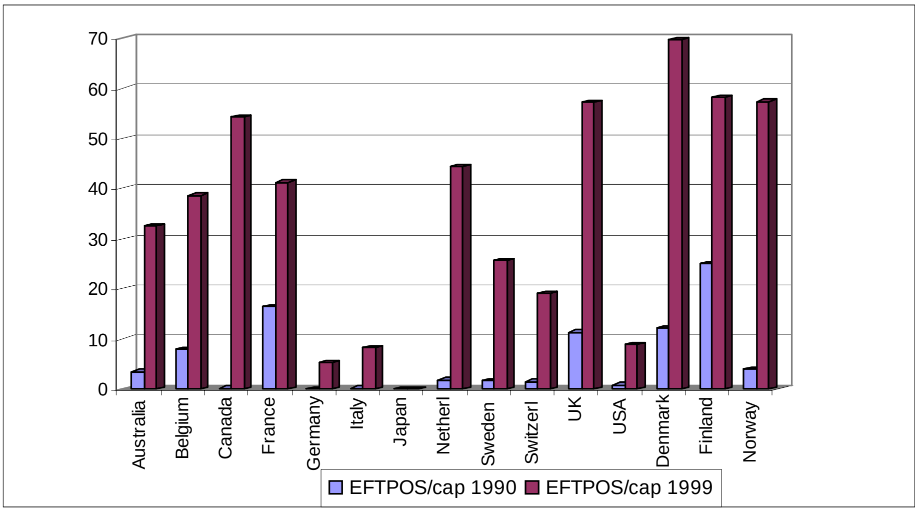

Figure 5: Number of EFTPOS transactions per capita 1990 and 1999.

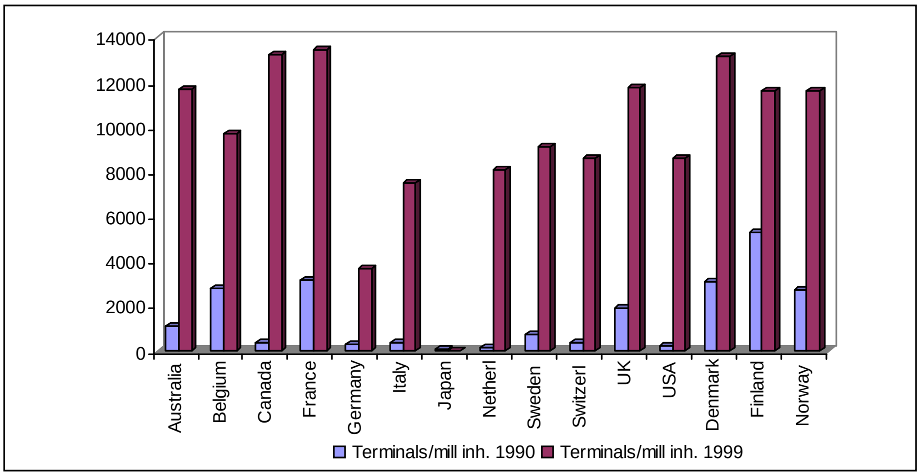

Figure 6: Terminals per million inhabitants, 1990 and 1999.

number of transactions per capita. However, this correlation although high and strongly significant in both years, decreased from .93 in 1990 to .79 in 1999. This may be an indication of a gradual wearing off of network effects, that is that the market could be moving towards a saturation point as regards the installed base of terminals.

The number of networks seen from the compatibility perspective, not the proprietorship aspect, appears however to have been pivotal for development of the EFTPOS markets. As shown in Figure 7, the average growth rate of transactions for countries with more than one network has been just a small share of the corresponding growth rate in countries with only one network. At the end of the period the number of transactions per capita in countries with only one network was on average tenfold larger than in the other group.[15] Lack of interoperability between systems may also contribute to explain the somewhat lower correlation observed at the end of the period between the number of transactions per capita and the number of terminals. The US and Germany are among the countries that experienced a larger growth in number of terminals than in number of transactions and these two are at the same time countries with more than one network.

The importance of interoperability for the growth of the market can also be seen at the country level. There are only three countries in the group of countries with several networks over the whole period—the US, Germany and Japan. However, as can be seen in Figure 8, the US has experienced a clear ten-

[15] Some countries with large growth in per capita transactions had two networks, and in the case of Canada more than two, during the first years of the studied sample. This is the case of Canada and Netherlands until 1992, of Norway until 1995 and Switzerland until 1996.

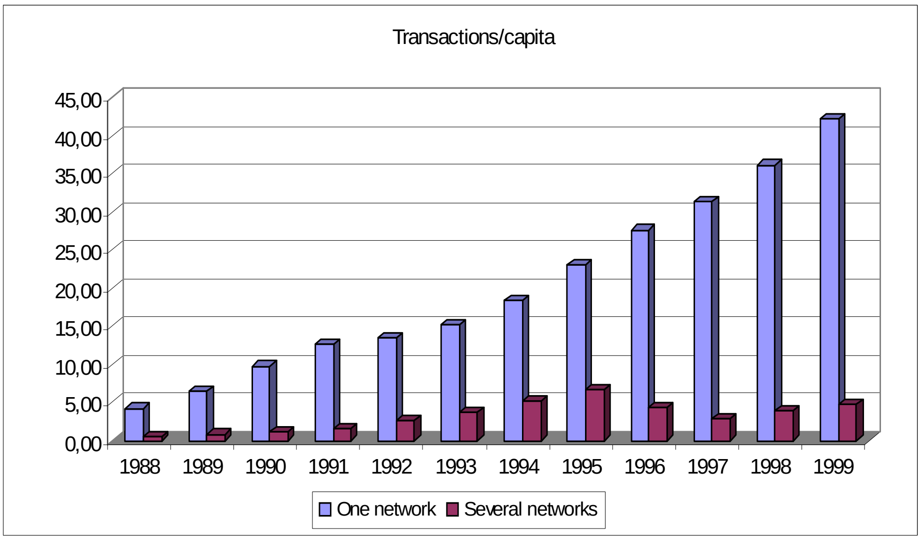

Figure 7: Transactions per capita. Average for countries having one or several networks.

dency toward network consolidation and the number of transactions per capita increases towards the end of the period.

Canada is one of the countries with the most rapid increase in EFTPOS transactions. In the first years of the studied period, however a number of different proprietary systems were in place and there was no growth in transactions per capita. It was first after 1992, when the different systems merged into one nationwide network, that the number of transactions per capita began to soar.

Japan is a clear example of a market in which large fragmentation hindered market development completely. While the number of networks oscillated around two hundred, the number of transactions per capita stayed around zero for the whole period. In the case of Japan, the lack of interoperability was the result of the regulatory environment. When EFTPOS were introduced the Ministry of Finance imposed several restrictions on, for example, the number of locations where terminals could be installed. Also users were required to make a separate deposit contract with each bank to use debit cards. These regulations were abolished in 1997 and this has created incentives to develop the EFTPOS system. In particular, a nationwide service, sharing a network of compatible terminals and a common clearing center was launched.[16] The effect as regards volume of transactions appears to have been almost immediate. Compared to 1999, the number of transactions increased eight times in 2000.[17]

[16] Direct information from Mr. Januchi Iwabuchi from the Bank of Japan.
[17] *Electronic Payments International* (2001).

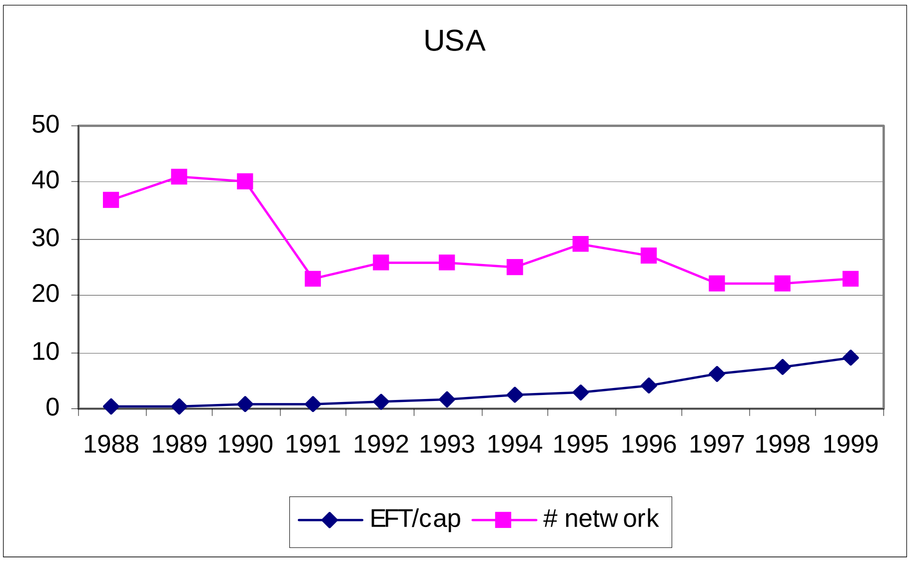

Figure 8: Transactions per capita in the US and number of networks. 1988–1999.

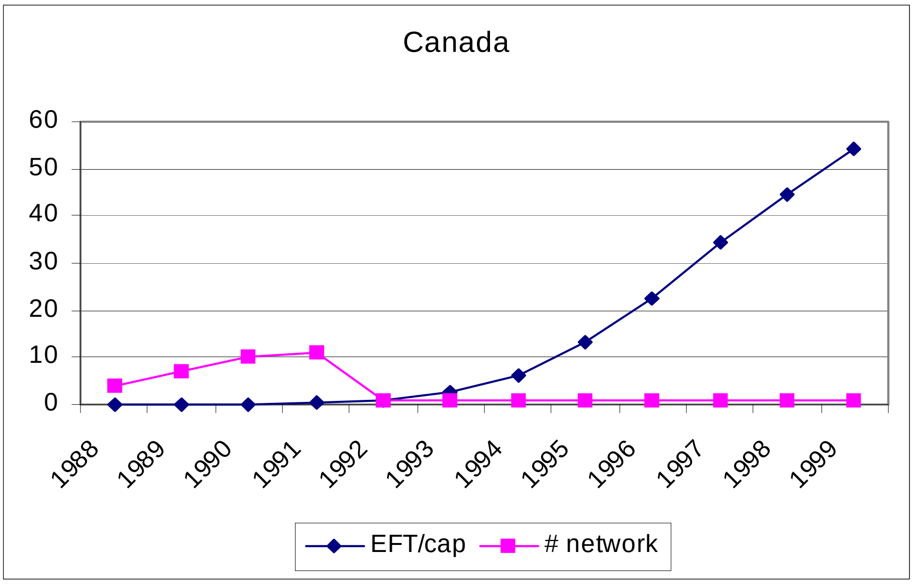

Figure 9: Transactions per capita in Canada and number of networks 1988–1999.

In the case of Germany, the number of networks in the interoperability sense is not clear. There are two systems, one on-line and one off-line, although both offer full interoperability. The off-line feature of the system implies that no control of availability of funds is done when the transaction is completed. Furthermore, in Germany the banks behind the off-line system do not guarantee payment, i.e. payment risk is borne solely by the retailer. This feature has had negative effects on merchant acceptance. Furthermore, there are a number of non-interoperable proprietary systems that offer debit card service to those customers that do not qualify for the Eurocard system which is the largest card system in Germany. However there is no data on neither the number of systems nor the transactions volumes through those. These systems are believed to comprise very small shares of the market. In order to solve the data problem, two networks are reported for Germany. This is not the real figure, but it serves the purpose of distinguishing Germany from the group of countries with only one network.

Although the issue of interoperability, as shown in Figure 7, is clearly crucial for the development of the EFTPOS market, other factors may also have influenced the differences in growth rates between countries. Pricing is a natural candidate for such a factor. Unfortunately, no conclusions can be drawn on the importance of different price structures as detailed information on each country's pricing policy could not be gathered. Regarding fees towards merchants, these should influence their willingness to install the equipment and accept EFTPOS payments. No data on merchant fees was available. In general fixed transaction fees apply for debit card transactions and turnover fees for credit cards. It can be inferred from the information received that there are at present two main pricing strategies towards cardholders. EFTPOS transactions are either completely free of charges or cardholders pay a fixed annual (or in some cases monthly) fee for the use of the card.

The degree of market concentration is also a variable influencing the growth of the market. In Gowrisankaran and Stavins (1999), the internalisation of network externalities and thus the growth of the ACH-market are positively correlated with the degree of market concentration. In terms of the exploitation of network externalities, the same effect is achieved through interoperability agreements between different firms as through having one firm monopolising the market. Naturally, both explanations of how network externalities are best exploited—the degree of standardisation and the degree of market concentration—might be related to each other. For example, it is possible that it is easier for market players to agree on the use of common standards and links between systems the more concentrated the market is.

Consolidation at the infrastructure level may foster market growth through

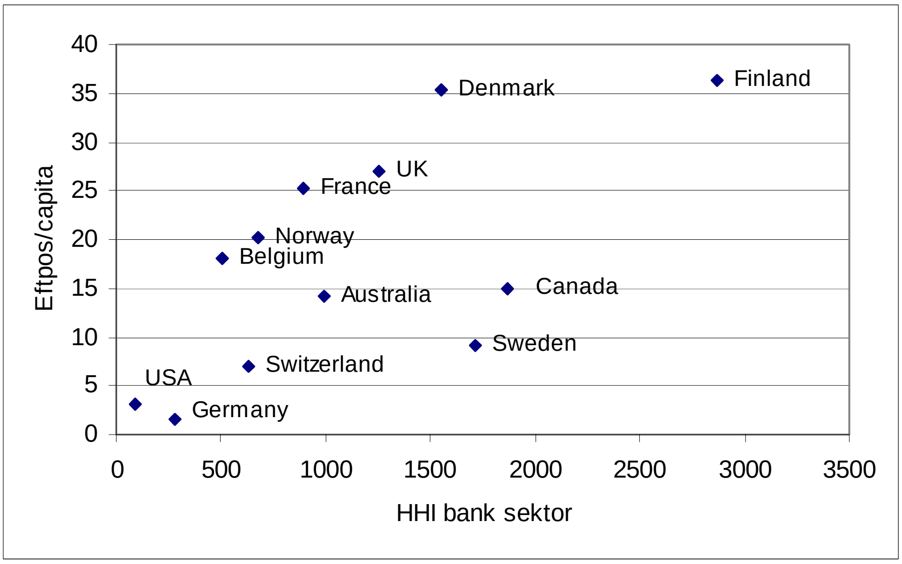

Figure 10: Transactions per capita and concentration in the bank market.

other channels than the exploitation of network effects. The more concentrated the market is the more exploited are economies of scale often present in payment systems. This has a positive effect in market growth through lower prices to users. As shown in the overview of related empirical research, both effects—network effects and economies of scale—and the relative strength of these effects are relevant to the study of the efficiency of payment systems.

Comparison of Herfindahl-Hirschman Index[18] of market concentration (HHI) in the deposit market with figures on average EFTPOS-transactions per capita as shown in Figure 10 supports the existence of such a correlation in a subset of the studied sample.[19] The correlation between these variables is .65 and highly significant.

4 The model

An important difference between the ACH-market analysed by Gowrisankaran and Stavins and the EFTPOS market is that in the former, users' utility of the system increases directly in the usage of the system by other users. The larger the number of individuals to whom the potential consumer can effectuate payments through the ACH-system, the more the consumer would benefit by

[18] The Herfindahl-Hirschman Index is calculated as the sum of banks' squared market shares in the deposit market.

[19] Data used in the construction of HHI was not available for three of the countries in the sample.

using the system—a case similar to the telephone. For card payments, however, the potential user does not directly benefit by the number of other cardholders. In this case, the cardholder benefits by the spread of acceptance of the card as means of payment, that is by the size of the installed base of terminals. Naturally, the number of terminals installed increases in the number of card users as the gains of adoption to banks and merchants increase in this number. Thus, indirectly users benefit by other users adopting the technology. There is a snow ball effect that is typical of network goods.

There are three types of players in the EFTPOS market described in this model: banks, merchants and consumers. Consumers have identical preferences and banks have perfect information on their willingness to pay for card payment services. The alternative to electronic card payments is cash, accepted as means of payment by all merchants. Cash has thus the advantage of fully exploiting the positive externalities present in payment instruments. Nevertheless, everything else equal, in the choice between cash and card payments, consumers prefer cards because cash involves "shoe-leather" costs—the time and effort devoted to withdraw cash from the bank account—that vanishes with the use of payment cards. Also there is the benefit of the risk reduction that results from carrying smaller amounts of cash. Thus, given that banks have chosen to adopt the technology and offer card payment services to their customers, card payments are preferred to cash. However in the introductory stage of the technology, card payments will not be as widely accepted by merchants as cash. The utility of using card payments increases in the degree of acceptance, that is in the number of terminals installed that can process electronic card payments.

Merchants need a certain technology in order to be able to accept card payments. They need also an agreement with their acquiring bank, i.e. the bank that installs the terminal at the merchant's point of sale and that holds the merchant's account. Merchants benefit from the adoption of the technology as it makes it possible to offer alternative means of payment which potentially can increase sales. Merchants bear the fixed costs of adoption associated with the installation of terminals. However, it is assumed that these costs are lower than the benefits that merchants derive from the adoption of the technology. Thus, if the merchant's bank decides to adopt, the merchant will install the technology, as it implies positive profits. The marginal costs of transactions are assumed to be zero. By these assumptions, both the merchant's and the consumers' decisions can be ignored in this model.

There are two variations to the basic model. In the first case, banks have completely captive markets in relation to merchants and private customers. The rationale for this is that there are very large switching costs for both groups. Once they have chosen a bank, they stick to their choice. Also, as in Gowrisankaran and Stavins' model, banks act as perfect agents for their private customers and want to maximise their customers' consumer surplus. This is explained by the assumption that banks do not exploit their market power in the payment market. Instead they take their mark-ups in the complementary deposit—and saving markets by offering lower interest rates for these accounts, i.e. a kind of two-part tariff arrangement. In this sense, the larger their customers' valuation of the service is, the larger the share of surplus that banks can extract in the complementary market. In the other version of the model, switching costs are high but not infinite. If the quality of payment services offered to bank customers is widely inferior to that offered by other banks, customers might choose to incur these switching costs. In this sense, the model describes a situation of "almost" captive markets, where the potential of loosing customers does not completely vanish.

There are two stages in the model. In the first stage banks make their technology adoption decision. They decide both on adoption and on the choice of technology standard. If they adopt, they install acceptance terminals at all their merchant customers' points of sale. In the second stage, customers decide on usage. The utility that customers derive from card payments determines the level of usage. However, the set up of the model is such that both the merchants' and the private customers' usage and acceptance decisions are given by the banks' adoption decision. Regarding the decision on technology standard, there are two choices. Banks can either adopt a common standard or a proprietary standard. It follows from the basic assumption regarding the existence of network externalities that usage and consumer surplus is lower with fragmentation in different standards.

In real life, given that banks offer their customers card payments services, customers usually acquire cards. Card holders are usually not explicitly charged for the use of the card, or are charged low annual fees. Thus, the fact that in the model, consumer usage decision is given by the bank decision is not a problem. However, modelling merchants' adoption decision as given by banks adoption is a simplification of the real world. Merchants incur the costs of adoption and pay either turnover or transactions fees. The higher the costs for merchants, the lower the incentives for adoption. The case of relatively slower terminal adoption in Germany is a good example of this. Merchants participating in the off-line system incur higher payment risks which is equivalent to say that they have higher costs. Despite the fact that merchant costs are important in merchant adoption decision, these are not taken into account in this model. Data on charges to merchants were not available and the benefits of adoption to merchants are difficult to estimate. Moreover, the primary focus of this study is the interoperability aspect and the effect that the choice of standards may have on usage decisions.

4.1 The second stage: consumers' choices

There are two banks in the market and each bank has a fixed number of customers equal to $C/2$, where C is the total number of customers in the market that is divided equally between banks. Customers may be private customers or merchant customers and the relative importance of these two categories in the composition of a bank's customer base differs. However, it is assumed that the share of merchant customers of the total number of bank customers is very small. Thus, the effect of differences in number of merchant customers between the two banks on the total number of customers can be disregarded and the assumption of symmetry still holds.

Each customer decides whether or not to use payment cards as an alternative to cash. The use of payment cards is thus a 0–1 choice. Each customer decides simultaneously on usage conditional on his or her bank's adoption decision. There are two technology standards for terminals available A and B which are equivalent to each other in terms of quality. Thus a bank may decide to adopt or not to adopt, and if adoption is decided there is also a choice between two technologies.

Network externalities appear indirectly at the users' level. The more terminals installed—expressed by t_j—the larger the benefit from the use of card payments. Thus, consumers benefit directly from the number of terminals installed with the technology standard chosen by the customer's bank. The subindex j denotes the technology in question. Each bank has N_b merchants, i.e. points of sale where terminals can be installed. The subindex b denotes the bank in question. Banks are completely symmetric in the number of private customers but they may differ in the number of merchant customers, that is in N_b. If differences in the number of merchant customer exist, then it is assumed that bank 2 is larger than bank 1, that is $N_2 \geq N_1$. If a bank decides on adoption, then terminals are installed at all N_b possible places. $N = N_1 + N_2$ is the total number of merchant customers in the market and is thus non-negative, i.e. $N_1, N_2 \geq 0$. The number of terminals installed in each standard is a function of the adoption decisions, namely:

$$t_j = N_1 + N_2 \text{ if same standard,} \tag{1}$$

$$t_j = N_b \text{ if partial adoption or different standards,} \tag{2}$$

$$t_j = 0 \text{ if non-adoption.} \tag{3}$$

Bank customers conform a completely homogenous group in the EFTPOS market, i.e. all customers derive the same utility from the adoption of the technology. The price of the card payment service does not enter the utility function. Card payments are priced through annual fees which cover banks' fixed costs of adoption. These are fees taken for the package of bank services associated with the provision of bank accounts. From the consumer perspective, the cost of acquiring and using a payment card is thus equal to zero. Then a customer belonging to bank b derives the following utility from the usage of card payments:

$$u_b = \gamma t_j \geq 0. \tag{4}$$

With $t_j \geq 0$, the assumption of network externalities is given by the marginal utility of adoption γ being non-negative. As t_j is a function of the adoption decision of both banks, this means that if the consumer belongs to a bank that has adopted a certain technology, then his or her utility of card payments increases if the other bank adopts the same technology. If the banks choose different standards, the consumer benefits in the bank size in the merchant market, i.e. N_b. The transaction demand for card payments for the customers of each bank is a function of the utility derived by the use of payment cards. For simplicity, the transaction demand function is assumed to be equal to expression (4), i.e. $d_b = u_b$:

$$d_b = \begin{cases} \gamma t_j & \text{if adoption,} \\ 0 & \text{otherwise,} \end{cases} \tag{5}$$

where d_b denotes bank b's representative customer's transaction demand for card payments, i.e. how much any customer will use EFTPOS as means of payment. As the use of payment cards is not priced then individual utility equals consumer surplus of usage for a customer of bank b and can be expressed as

$$CS_{i,b} = \gamma t_j. \tag{6}$$

Given the choice of standard and that each bank has $C/2$ customers, bank b's aggregate consumer surplus is given by

$$CS_b = (C/2)\gamma t_j. \tag{7}$$

Formally in the second stage of the game consumers make their choices, however as expression (5) shows, the equilibrium is already determined at the first stage. By construction, market demand for card payments equals aggregate consumer surplus. However, both aggregate demand and consumer surplus will be divided between the two technologies as will bank customers:

$$CS_b = (C/2)\gamma N \text{ if same standard} \Rightarrow CS = D = \quad (8)$$

$$CS_b = (C/2)\gamma N_b \text{ if partial adoption/different standards}$$
$$\Rightarrow CS = D = (C/2)\gamma N. \quad (9)$$

It follows directly that as consumer surplus and demand are additive, aggregate consumer surplus and demand will be larger if both banks adopt the same standard.

4.2 The first stage: banks' choices

Banks maximise their share of customers' consumer surplus, as given by expression (7), net of a fixed cost of technology installation K that is common to the whole branch and to the two technology standards. Fixed costs of installation are related to each bank's share of the acquiring market, i.e. to N_b and thus the larger the number of terminals that each bank can potentially install, the larger these costs are. However, these costs have been absorbed by the merchants and can thus be disregarded.

4.3 Nash equilibria with captive markets

By the assumption of captive markets, mark ups are constant for all banks and equal to $\alpha = 1$. Assuming first completely captive markets, and given the assumption of identical customers, this means that banks can extract all consumer surplus. Thus,

$$\alpha = 1 \Rightarrow$$
$$CS_{i,b} = \gamma t_j - \alpha\gamma t_j = 0.$$

Banks pay off functions can be expressed by

$$\pi_b = \begin{cases} \gamma(C/2)t_j - K & \text{for adoption,} \\ 0 & \text{otherwise.} \end{cases} \quad (10)$$

It will be assumed that whenever banks are indifferent between adoption and non-adoption, i.e. when the pay off function (10) is not strictly greater than zero, adoption will result. By the same token, for outcomes in which banks are indifferent between adoption in common standards or adoption with different standards, the banks will choose common standards. Letting S_b express bank

b's technology choice of standard A or B or 0 for non-adoption and defining $\theta = \gamma C/2$,the possible strategy combinations and related pay-off functions can be described in the following matrix:

	$S_2 = A$	$S_2 = B$	$S_2 = 0$
$S_1 = A$	$\theta N - K, \theta N - K$	$\theta N_1 - K, \theta N_2 - K$	$\theta N_1 - K, 0$
$S_1 = B$	$\theta N_1 - K, \theta N_2 - K$	$\theta N - K, \theta N - K$	$\theta N_1 - K, 0$
$S_1 = 0$	$0, \theta N_2 - K$	$0, \theta N_2 - K$	$0, 0$

Banks are assumed to have perfect information on each others' pay-off functions. Although nine strategy combinations are possible, only three of these—$(A, A), (B, B)$ and $(0, 0)$ on one diagonal of the matrix—represent equilibrium outcomes.

Partial adoption is not possible with this set up. Outcomes where bank 1 adopts when bank 2 abstains, i.e. $(A, 0)$ or $(B, 0)$, are not equilibrium outcomes as the conditions for these outcomes—$\theta N - K < 0$ and $\theta N_1 - K \geq 0$—contradict the assumptions of the model. Given the assumptions of the relative sizes of each bank's terminals, if the larger bank has negative profits of adoption, the loss of adoption is even larger for the smaller bank and it will also abstain from adoption. Nor is partial adoption by the largest bank possible. Outcomes $(0, A)$ and $(0, B)$ are not equilibria as these outcomes would require that conditions $\theta N_1 - K < 0$ and $\theta N_2 - K \geq 0$ are both satisfied. However $\theta N - K \geq 0$ is then also satisfied and bank 1 would choose adoption using the same standard as bank 2.

Full adoption with different standards, i.e. (A, B), or (B, A), are not equilibrium outcomes either. The conditions for these outcomes are $\theta N_b - K \geq \theta N - K$ and $\theta N_b - K \geq 0$ for $b = 1, 2$. This would require $N_b \geq N$ which is impossible since N_1 and N_2 are non-negative numbers.

Full adoption with common standards, i.e. (A, A) or (B, B) are equilibria. The conditions for these outcomes are:

$$\begin{aligned} &\text{bank 1:} \quad \theta N - K \geq \theta N_1 - K; \theta N \geq K, \\ &\text{bank 2:} \quad \theta N - K \geq \theta N_2 - K; \theta N \geq K. \end{aligned} \tag{11}$$

The first line of this condition can be expressed as $N \geq N_1$ which is always satisfied as N_2 is non negative. This means that full adoption with common standards will always result if $\theta N \geq K$ and thus adoption is an equilibrium outcome. However, even if this condition is satisfied, *non-adoption* may result if $\theta N_2 < K$, that is for certain parameter values, multiplicity of equilibria exists. The largest bank's profits of adoption are non-negative if the smaller bank also adopts, but negative if the smaller bank abstains. For small enough values of K only the full adoption with common standards type of equilibrium is possible. The multiplicity of equilibria vanishes as does the trivial *non-adoption* outcome when the condition $\theta N < K$ is satisfied.

4.4 Non-captive markets: network effects versus competition effects

Within the previous set up, whenever "adoption" is the preferred strategy, both banks will choose the same standard in equilibrium. This result follows from the assumption of captive markets according to which banks do not compete with each other for customers. Both banks have the same customer base and symmetric mark ups. Assuming instead that banks have "almost" captive markets for private customers, different results may arise. The assumption of "almost" captive markets reflects a situation in which banks face a risk of losing customers to other banks. Banks that adopt the common standards increase their customers' surplus. However, as a consequence, bank services become less distinguishable from each other and switching costs are reduced. As a result of this, the risk of losing customers to other banks in the same network reduces mark-ups. Banks must then choose between belonging to a larger network where consumer surplus is high, but mark-ups are low or differentiating their card technology from other banks through proprietary standards which increases mark-ups at the cost of lower consumer surplus. In this way the trade off between "competition effects" and "network effects" described in the literature are introduced.

The choice of a proprietary standard is a strategy that banks follow to increase switching costs. Here, the choice of a proprietary standard is modelled as the choice of a technology different than the one chosen by the other bank and can be interpreted as a decision not to enter into interoperability agreements with the other bank. When considering whether to change banks, customers to a bank that has chosen a proprietary standard have to take into account the cost of losing the possibility of making card payments at all points of sale belonging to this bank's merchants. The larger the bank's merchant base is, the larger are also these costs for private customers.

However, the larger the other banks' shares of the total merchant base are, the larger are the bank's costs for adopting a proprietary standard in terms of forgone consumer surplus. Alternatively, the mark-up can be seen as the non-explicit price private customers pay for payment services. Proprietary standards make the customer base more captive, the market less competitive and the demand for each bank's card payments system more inelastic. Thus, proprietary standards are associated with higher mark-ups $(\hat{\alpha})$,than open standards $(\check{\alpha})$.

Actually, different switching costs for customers of each bank and thus different mark ups $\hat{\alpha}$ could also be assumed to exist. Differences in sizes in the acquiring market—that is in the relation between N_1 and N_2—should be reflected in differences in mark ups across banks. The same argument applies for situations where a bank is the only one adopting the technology which should give it more market power. However, as a simplifying assumption, switching costs will be assumed to be determined mostly by factors other than these and only one $\hat{\alpha}$ will exist. A bank would prefer to be alone in its choice of standard if

$$\hat{\alpha}\theta N_b - K \geq \check{\alpha}\theta N - K, \hat{\alpha} \geq \check{\alpha}. \tag{12}$$

The condition (12) is satisfied for small ratios of N/N_b. Thus proprietary standards and the corresponding higher mark-ups $\hat{\alpha}$ are the preferred choices for banks having a large share of the total installed base of terminals. Those are also the banks for which the incentives towards differentiation are stronger as they have the capacity to impose large switching costs on their customers. In the terms used in the network literature, these are the banks for which competition effects outweigh network effects.

How does the existence of a trade off between network effects and competition effects affect the strategy space and the equilibrium outcomes? As before, there are nine strategy combinations and two technology choices if adoption is chosen. The profit functions are

$$\pi_b = \begin{cases} \theta\check{\alpha}N - K & \text{if the same standard,} \\ \theta\hat{\alpha}N_b - K & \text{if different standards or partial adoption,} \\ 0 & \text{if non adoption.} \end{cases} \tag{13}$$

The possible strategy combinations and corresponding pay-off functions are described in the following matrix:

	$S_2 = A$	$S_2 = B$	$S_2 = 0$
$S_1 = A$	$\theta\check{\alpha}N - K, \theta\check{\alpha}N - K$	$\theta\hat{\alpha}N_1 - K, \theta\hat{\alpha}N_2 - K$	$\theta\hat{\alpha}N_1 - K, 0$
$S_1 = B$	$\theta\hat{\alpha}N_1 - K, \theta\hat{\alpha}N_2 - K$	$\theta\check{\alpha}N - K, \theta\check{\alpha}N - K$	$\theta\hat{\alpha}N_1 - K, 0$
$S_1 = 0$	$0, \theta\hat{\alpha}N_2 - K$	$0, \theta\hat{\alpha}N_2 - K$	$0, 0$

Given the assumptions of banks' relative market shares, outcomes where bank 1 adopts when bank 2 abstains are not equilibrium outcomes.Thus, neither $(A, 0)$ nor $(B, 0)$ are equilibria. All the other strategy combinations are however equilibrium outcomes. Depending on parameter values the equilibrium outcomes are:

1. *Full adoption with common standards* (A, A) *or* (B, B) are the outcomes

described in the first column, first row and second column, second row. For this to be an equilibrium outcome, the following conditions have to be satisfied:

$$\theta\check{\alpha}N - K \geq \hat{\alpha}N_2 - K; \theta\check{\alpha}N - K \geq 0. \tag{14}$$

From expression (14) we get that:

$$N_2 \leq N_1 \frac{\check{\alpha}}{\hat{\alpha} - \check{\alpha}}.$$

Given the assumption that $N_2 \geq N_1$, this condition can only be satisfied if $\hat{\alpha} \leq 2\ \check{\alpha}$. Small differences between $\hat{\alpha}$ and $\check{\alpha}$ imply that competition effects are small relative to network effects, and thus banks have stronger incentives to exploit these through the choice of common standards. Given the differences between mark ups, the outcome with full adoption in common standards results if market shares in the acquiring market N_1 and N_2 are not exceedingly asymmetric, as represented by the shaded area in Figure 11. The more symmetric the market is in this sense, the more likely it is that the both banks will choose adoption with the same standard. If instead N_2 is large relative to N_1, this means that differentiation is the better option for the largest bank. The number of terminals that the smaller bank can add to the network is not large enough and thus network effects are outweighed by competition effects. Given each bank's size in the acquiring market, the full adoption outcome with common standards would arise for small differences between mark ups. In terms of Figure 11, small differences between $\hat{\alpha}_2$ and $\check{\alpha}$ imply a larger slope for the $N_1\frac{\check{\alpha}}{\hat{\alpha}-\check{\alpha}}$ line which, for larger asymmetries between banks, increases the area for which the interoperability outcome results. The situation of completely captive markets with the same mark up regardless of the choice of technology can be described as a special case for which $\hat{\alpha} = \check{\alpha}$ applies. In that case, as long as adoption yields positive profits for the largest bank, full adoption with common standards is the only equilibrium outcome regardless of the extent of asymmetries between banks. Also considering the assumptions of the model regarding the number of terminals for each bank, outcomes below the 45-degree line are not possible. Below this line the relative sizes of banks in the merchant market is reversed, which is ruled out by assumption. See Figure 11[20]:

2. *Full adoption with different standards* (A, B) or (B, A) are the outcomes

[20] In Figure 11, it has been assumed that $\theta\hat{\alpha}_1 N_1 \geq K$,which means that outcomes with partial adoption are not described.

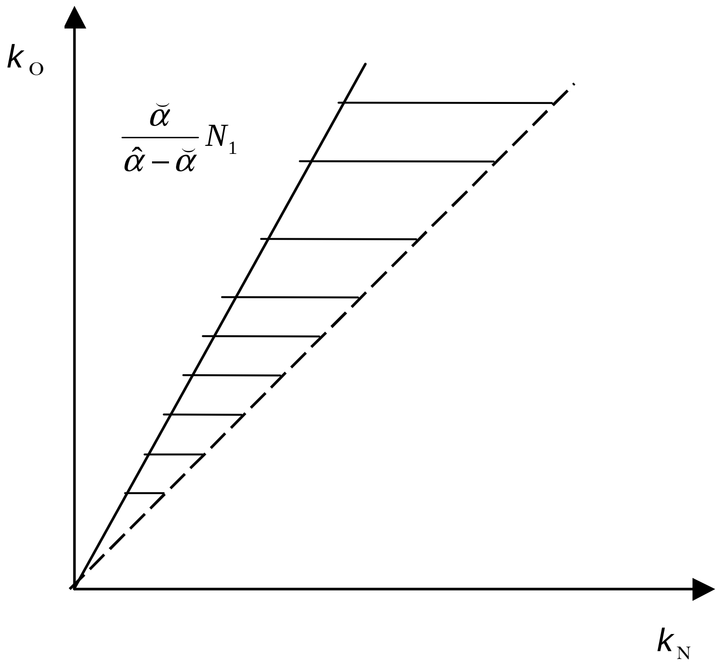

Figure 11: Market shares in the acquiring market with full adoption in common standards

described in the first column, second row and in the second column, second row. Conditions for this equilibrium are:

$$\theta\hat{\alpha}_1 N_1 \geq K; \theta\hat{\alpha}N_1 - K > \theta\breve{\alpha}N - K. \tag{15}$$

From expression (15) we get that:

$$N_2 < N_1 \frac{\hat{\alpha} - \breve{\alpha}}{\breve{\alpha}}.$$

With reference to Figure 11, if the slope of the $N_1 \frac{\breve{\alpha}}{\hat{\alpha}-\breve{\alpha}}$ line is given by its inverse, the same shaded area would denote outcomes of full adoption in different standards instead. As in the previous case, for this outcome to result, the $N_1 \frac{\hat{\alpha}-\breve{\alpha}}{\breve{\alpha}}$ line must lie above the 45-degree as outcomes below this line are ruled out by assumption. Thus equilibrium outcomes of full adoption in different standards require that:

$$\begin{aligned} \frac{\hat{\alpha} - \breve{\alpha}}{\breve{\alpha}} &> 1 \\ &\Rightarrow \hat{\alpha} > 2\breve{\alpha}, \end{aligned}$$

which means that the mark ups that apply when different standards are chosen are at least twice as large as the ones that result from the use of common standards, i.e. that competition effects are large. Analogously to the previous case, given that the condition $\hat{\alpha} > 2\check{\alpha}$ is satisfied, the full adoption with different standards outcome is more likely to result if the banks' sizes in the acquiring market are not exceedingly asymmetric.

3. *Non-existence of pure strategy equilibria* arises when asymmetries between N_1 and N_2 are large enough, that is for outcomes outside the shaded area in terms of Figure 11. For large differences in size in the acquiring market, the largest bank wants to be alone in its choice of standard. However the smaller bank prefers to choose the same standard. Assuming small enough costs of installation, i.e. excluding the non-adoption outcome, the game is thus similar to the "matching pennies" example whose only Nash equilibrium is in mixed strategies.[21]

4. *Partial adoption:* These are the outcomes for which only the largest bank adopts, i.e. strategy combinations $(0, A)$ or $(0, B)$. Conditions for this outcome to result are given by

$$\begin{aligned} \theta\hat{\alpha}N_1 &< K; \theta\check{\alpha}N < K, \\ \theta\hat{\alpha}N_2 &\geq K. \end{aligned} \tag{16}$$

   This is the case for which the differences between common standards and proprietary mark ups respectively, are large as in the case with full adoption with proprietary standards. Furthermore, the costs of installation exceed the smaller bank's profits of installing its own set of terminals. For given costs of installation K and for given differences in market shares and thus in proprietary mark ups , the parameter θ is important in discriminating between the partial adoption and the adoption with proprietary standards. For small values of θ, which means that the network externalities γ and/or the total number of bank customers C are not large enough partial adoption instead of adoption with different standards results.

5. *Non adoption:* is the equilibrium outcome that results if

$$\begin{aligned} \theta\check{\alpha}N &< K. \\ \theta\hat{\alpha}_2 N_2 &< K. \end{aligned}$$

   This outcome results if the costs of installation are too high, or both banks' potential number of terminals too small, i.e. the number of possible

[21] Fudenberg and Tirole (1991).

vendors accepting card payments is not sufficiently large. Given K, this result obtains also for small θ.

For a certain parameter range given by

$$\theta\hat{\alpha}_2 N_2 < K \leq \theta\breve{\alpha} N, \tag{17}$$

the outcomes $(0,0),(A,A)$ or (B,B) are all possible. Installation of its own terminals does not yield positive profits for the largest bank. However, positive profits are obtained if the smaller bank also adopts. Similarly, the smaller bank has positive profits of adoption—albeit smaller—if the larger bank adopts, but larger losses if it abstains. Adoption or non adoption decisions are contingent on prevailing expectations on the other bank's decision. The trivial case with no adoption at all can be eliminated by assuming that technology costs are accessible for at least the largest bank, that is that $K \leq \theta\hat{\alpha} N_2$. Also, in that case, the multiple equilibria outcome vanishes. In that case, depending on the parameter values only three types of equilibria are possible—full adoption with common standards, full adoption with proprietary standards or partial adoption. The gains from differentiation as expressed by the difference between mark ups is important in discriminating between different outcomes. For very large differences in mark ups either partial adoption or full adoption with proprietary standards are the outcomes, depending on the size of N_1.For large market shares of the smaller bank, full adoption with proprietary standards will arise.

Summarising: when the choice of standards exists, equilibrium outcomes give rise to different degrees of exploitation of externalities and thus to different levels of consumer surplus and of demand for the technology. As shown by expression (8):

- *Full adoption with common standards* gives the highest level of consumer surplus and demand. The common standards equilibrium is more likely to result for small differences between the mark ups that are associated to the differentiation and interoperability cases respectively:

$$CS = D = 2\theta N. \tag{18}$$

- *Full adoption with proprietary standards* results in lower consumer surplus and demand. This outcome will result for large differences between mark ups:

$$\begin{aligned} CS &= D = \theta N_1 + \theta N_2 && (19) \\ &= \theta N. && (20) \end{aligned}$$

- *Partial adoption:* This outcome is more likely for large differences between mark ups and large costs of installation in relation the smaller bank's profits of adoption. This type of equilibrium results in the lowest level of consumer surplus and demand, how much lower depends on the degree of market concentration in the acquiring market. If the largest bank has the lion share of the acquiring market, the increase in demand that results from the move from partial adoption to full adoption with proprietary standards is moderate:

$$CS = D = \theta N_2. \tag{21}$$

5 Empirical results

Although it is not possible to test the theoretical implications of the model given my data set, the basic assumptions of the model can be tested. According to the assumptions of the model, if network externalities are present, then the highest level of demand and consumer surplus will be observed for markets having only one standard or system. The hypothesis is that interoperability between different systems allows for better exploitation of network effects. In a dynamic perspective, the highest growth for the EFTPOS market should be observed in countries having one network in the interoperability sense. Such an effect is seen already in Figure 7 showing average transactions per capita for countries having one system and for countries having more than one. I test this hypothesis regressing the number of networks in the interoperability sense to the volumes of transactions with payment cards per capita. I use the same panel data that was used in the description of the evolution of the EFTPOS market.

I also test for the Gowrisankaran and Stavins hypothesis regarding the effect of the degree of concentration in the bank market on data from the EFTPOS market. Market concentration is measured by HHI-data for a subset of the sample. Higher HHI should have a positive effect on the growth of EFTPOS transactions according to Gowrisankaran and Stavins.

The growth of EFTPOS transactions is measured as the annual change in the ratio of the number of card payments to the total number of non-cash transactions:

$$\Delta CARDSHARE_{t,i} = \frac{cardnumber_{t,i}}{noncash_{t,i}} - \frac{cardnumber_{t-1,i}}{noncash_{t-1,i}}.$$

By taking the share of the total number of transactions the differences between countries regarding economic activity is taken into account. The number of networks variable SYS is expressed in logarithmic form. This seems to be a more reasonable specification than assuming a linear relationship between the two variables. The positive growth effect of going from for example four to one network is thus assumed to be larger than the effects obtained when going from 400 to 397 networks.

I use the panel data described in Section 3.2. The effect of interoperability on EFTPOS transactions is captured by the regression equation

$$\Delta CARDSHARE_{t,i} = \alpha + \beta \log(SYS_{t,i}). \tag{22}$$

The result of the regression—shown in Table 1—is highly significant. The sign of the β coefficient is, as anticipated, negative although the value .58 is fairly low. The explanatory value is high, adjusted R^2 is .403. I then add another explanatory variable to the regression equation, namely the logarithmic form of the number of proprietary systems $PROP$—see Table 2. This does not follow from any prediction from the model. However, the number of proprietary systems can gauge the positive effect on growth that obtains through the exploitation of economies of scale in the production of card payment services. The results of the test adding this effect are still highly significant for both variables. The coefficients have the correct negative sign, and approximately the same strength—the coefficients are $-.38$ and $-.34$ for SYS and for $PROP$ respectively. The adjusted R^2 value is approximately the same (.426), suggesting a fairly high degree of multicollinearity between the two independent variables. Due to this high correlation between the number of proprietary systems and the number of non-compatible systems, the separate effects of these two variables can not be estimated accurately.

Also, according to the model, the number of installed terminals should be included as an explanatory variable and the coefficient for this variable can be expected to be positive. Including the variable ΔTER = number of terminals/million inhabitants $(t, i)-$number of terminals/million inhabitants $(t-1, i)$ in Table 3 adds to the explanatory power of the equation as seen by the increase in adjusted R^2 (.470). All the coefficients are highly significant and have the expected sign.

I repeat the regression using an exponential specification instead. The goal is to obtain an indication of the strength of the externalities by trying a more concave functional form. The larger the degree of concavity, the larger are network externalities reflected by the regression. For example, with a logarithmic form the underlying assumption is that there is a positive effect on transactions, albeit small, when going from 400 to 397 networks. With more concavity, there is no effect, the degree of fragmentation is too large for the market to establish at all (as the case has been in Japan). However for markets having just a few networks, the positive effect of diminishing the number of networks is larger with the exponential specification. The regression equation is

$$\Delta CARDSHARE_{t,i} = \alpha + \beta \exp^{-(SYS_{t,i})}. \tag{23}$$

With this specification the result of the regression is still highly significant (see Table 4), the value of the coefficient β is higher, 5.38 but the adjusted R^2 is somewhat lower, .34. However, adding also the SYS variable in logarithmic form to expression (23) in Table 5 shows that the t-ratio for the exponential specification is still significant, but not for the logarithmic form. From this, we can conclude that the exponential form is a better description of the strength of the externalities. Adding then the $PROP$ variable (Table 6), also in exponential form does not change the value of the adjusted R^2 noticeably (.35). As before, we can conclude that there is a high degree of multicollinearity between the two variables and thus that their separate effects can not be estimated accurately. The coefficients have the expected signs, although the coefficient for SYS is somewhat larger (4.8 and 2.9 respectively). Also similar to the earlier results, adding the variable ΔTER in Table 7 adds to the explanatory power of the equation, seen in the increase in R^2 from .34 to .45.

In order to test for the effect of market concentration, I add the variable HHI to regression equation (23)—see Table 8. According to Figure 10, a linear specification seems to be reasonable in this case. The regression equation is now

$$\Delta CARDSHARE_{t,i} = \alpha + \beta \exp^{-(SYS_{t,i})} + \gamma(HHI_{t,i}). \tag{24}$$

The coefficients for the SYS and HHI variables have the correct signs. Both are statistically significant, although the HHI variable, only at the lower 10 per cent level. Again, the adjusted R^2 is almost unchanged compared to (23), suggesting a high degree of multicollinearity between SYS and HHI. Estimating the sole effect of HHI on $\Delta CARDSHARE$ in Table 9, as in Gowrisankaran and Stavins, the coefficient for HHI becomes highly significant and the explanatory value as shown by the adjusted R^2 increases. Finally, the test of multicollinearity between SYS and HHI in Table 10 shows a very large negative correlation between the two, with highly significant t-ratios and a R^2 value of .88. A tentative explanation for this negative correlation could be that normally, a high degree of market concentration implies a few number of market players, or at least of large players. The smaller the number of players, the lower are the costs of co-ordination and thus standardisation efforts can be facilitated.

6 Summary and conclusions

This paper describes and analyses the evolution of the EFTPOS market and shows how the existence of network externalities affect market developments. Relevant data for the G-10 countries, Australia and the Nordic countries and comprising the period 1988–1999 has been gathered and presented. The section presenting the descriptive statistics emphasizes the main hypothesis of the study, namely that—apart from the degree of market concentration that has been pointed out as an important explanatory variable in earlier studies—it is the degree of interoperability and the use of common standards that is the crucial variable in the exploitation of network externalities. Thus the degree of interoperability—measured as the number of networks in the market that are non-compatible with each other—can be used in a test of network externalities. The hypothesis is that the larger the degree of interoperability, that is the fewer the number of networks, the larger the growth we will observe in EFTPOS transactions. A model is also developed that illustrates the main hypothesis of the study and how the trade off between competition effects and network effects affect the outcome. It is shown that the more symmetric banks are in terms of their size in the acquiring market, the more likely it is that the common standards outcome will result. On the other hand, the larger the gains of differentiation, that is the stronger the competition effects in relation to network effects, the more likely is the adoption of different standards. The data gathered is used in several tests of network externalities in line with the main hypothesis. The results are highly significant and the coefficients have all the correct sign. A similar test of the Gowrisankaran and Stavins' hypothesis is conducted using data on market concentration as the explanatory variable in the regression which also shows highly significant results.

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Table 1

Dependent Variable: TRPROC?-TRPROC?(-1)
Method: GLS (Cross Section Weights)
Date: 06/28/01 Time: 16:57
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 14
Total panel (unbalanced) observations: 140
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.061957	0.105268	19.58761	0.0000
LOG(SYS?)	-0.576014	0.054936	-10.48517	0.0000
Weighted Statistics				
R-squared	0.407686	Mean dependent var		2.676144
Adjusted R-squared	0.403393	S.D. dependent var		2.394128
S.E. of regression	1.849232	Sum squared resid		471.9130
F-statistic	94.98435	Durbin-Watson stat		1.049685
Prob(F-statistic)	0.000000			

Table 2

Dependent Variable: TRPROC?-TRPROC?(-1)
Method: GLS (Cross Section Weights)
Date: 06/28/01 Time: 17:23
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 13
Total panel (unbalanced) observations: 126
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.487670	0.186142	13.36434	0.0000
LOG(SYS?)	-0.375921	0.125457	-2.996402	0.0033
LOG(PROP?)	-0.338689	0.155412	-2.179295	0.0312
Weighted Statistics				
R-squared	0.434892	Mean dependent var		2.747941
Adjusted R-squared	0.425703	S.D. dependent var		2.320784
S.E. of regression	1.758745	Sum squared resid		380.4615
F-statistic	47.32876	Durbin-Watson stat		1.045808
Prob(F-statistic)	0.000000			

Table 3

Dependent Variable: TRPROC?-TRPROC?(-1)
Method: GLS (Cross Section Weights)
Date: 07/04/01 Time: 17:08
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 14
Total panel (unbalanced) observations: 137
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.552487	0.146557	10.59305	0.0000
LOG(SYS?)	-0.550456	0.056107	-9.810818	0.0000
TER?-TER?(-1)	0.000584	0.000124	4.694625	0.0000
Weighted Statistics				
R-squared	0.478063	Mean dependent var		2.853670
Adjusted R-squared	0.470273	S.D. dependent var		2.555402
S.E. of regression	1.859881	Sum squared resid		463.5273
F-statistic	61.36801	Durbin-Watson stat		1.122474
Prob(F-statistic)	0.000000			

Table 4

Dependent Variable: TRPROC?-TRPROC?(-1)
Method: GLS (Cross Section Weights)
Date: 07/05/01 Time: 13:32
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 14
Total panel (unbalanced) observations: 140
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.203669	0.043180	4.716781	0.0000
1/EXP(SYS?)	5.378111	0.344454	15.61344	0.0000
Weighted Statistics				
R-squared	0.345884	Mean dependent var		2.717689
Adjusted R-squared	0.341144	S.D. dependent var		2.288274
S.E. of regression	1.857391	Sum squared resid		476.0861
F-statistic	72.97171	Durbin-Watson stat		1.020998
Prob(F-statistic)	0.000000			

Table 5

Dependent Variable: TRPROC?-TRPROC?(-1)
Method: GLS (Cross Section Weights)
Date: 07/05/01 Time: 13:41
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 14
Total panel (unbalanced) observations: 140
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.434874	0.375967	1.156683	0.2494
1/EXP(SYS?)	4.719268	1.130672	4.173863	0.0001
LOG(SYS?)	-0.070788	0.114875	-0.616216	0.5388
Weighted Statistics				
R-squared	0.348766	Mean dependent var		2.726013
Adjusted R-squared	0.339259	S.D. dependent var		2.294322
S.E. of regression	1.864962	Sum squared resid		476.4976
F-statistic	36.68491	Durbin-Watson stat		1.018313
Prob(F-statistic)	0.000000			

Table 6

Dependent Variable: (TRPROC?-TRPROC?(-1))
Method: GLS (Cross Section Weights)
Date: 07/05/01 Time: 13:44
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 13
Total panel (unbalanced) observations: 126
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.193552	0.048801	3.966150	0.0001
1/EXP(SYS?)	4.841206	0.460311	10.51724	0.0000
1/EXP(PROP?)	2.895420	1.062711	2.724560	0.0074
Weighted Statistics				
R-squared	0.365655	Mean dependent var		2.806124
Adjusted R-squared	0.355340	S.D. dependent var		2.165276
S.E. of regression	1.738515	Sum squared resid		371.7596
F-statistic	35.45038	Durbin-Watson stat		1.092867
Prob(F-statistic)	0.000000			

Table 7

Dependent Variable: (TRPROC?-TRPROC?(-1))
Method: GLS (Cross Section Weights)
Date: 07/05/01 Time: 13:48
Sample: 1989 1999
Included observations: 11
Number of cross-sections used: 13
Total panel (unbalanced) observations: 123
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.024575	0.073543	-0.334160	0.7388
1/EXP(SYS?)	4.735025	0.430157	11.00767	0.0000
1/EXP(PROP?)	2.759071	1.012491	2.725032	0.0074
(TER?-TER?(-1))	0.000279	6.73E-05	4.142742	0.0001

Weighted Statistics			
R-squared	0.460933	Mean dependent var	2.980740
Adjusted R-squared	0.447343	S.D. dependent var	2.325716
S.E. of regression	1.728958	Sum squared resid	355.7261
F-statistic	33.91730	Durbin-Watson stat	1.205948
Prob(F-statistic)	0.000000		

Table 8

Dependent Variable: (TRPROC?-TRPROC?(-1))
Method: GLS (Cross Section Weights)
Date: 07/17/01 Time: 11:42
Sample: 1989 1997
Included observations: 9
Number of cross-sections used: 11
Total panel (unbalanced) observations: 89
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.213659	0.099495	2.147434	0.0346
1/EXP(SYS?)	4.249523	0.784252	5.418566	0.0000
HHI?	0.000418	0.000230	1.817942	0.0726

Weighted Statistics			
R-squared	0.373460	Mean dependent var	3.118604
Adjusted R-squared	0.358889	S.D. dependent var	2.354274
S.E. of regression	1.885053	Sum squared resid	305.5945
F-statistic	25.63088	Durbin-Watson stat	0.999052
Prob(F-statistic)	0.000000		

Table 9

Dependent Variable: (TRPROC?-TRPROC?(-1))
Method: GLS (Cross Section Weights)
Date: 07/17/01 Time: 11:42
Sample: 1989 1997
Included observations: 9
Number of cross-sections used: 11
Total panel (unbalanced) observations: 89
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.298913	0.175548	7.399200	0.0000
HHI?	0.000594	0.000193	3.074338	0.0028
Weighted Statistics				
R-squared	0.538952	Mean dependent var		3.588620
Adjusted R-squared	0.533652	S.D. dependent var		3.076065
S.E. of regression	2.100634	Sum squared resid		383.9019
F-statistic	101.7004	Durbin-Watson stat		0.982605
Prob(F-statistic)	0.000000			

Table 10

Dependent Variable: 1/EXP(SYS?)
Method: GLS (Cross Section Weights)
Date: 07/17/01 Time: 11:48
Sample: 1988 1997
Included observations: 10
Number of cross-sections used: 11
Total panel (balanced) observations: 110
One-step weighting matrix
Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.270646	0.016060	16.85219	0.0000
HHI?	4.35E-05	8.81E-06	4.940672	0.0000
Weighted Statistics				
R-squared	0.877491	Mean dependent var		0.447048
Adjusted R-squared	0.876356	S.D. dependent var		0.318077
S.E. of regression	0.111845	Sum squared resid		1.351011
F-statistic	773.5656	Durbin-Watson stat		0.160183
Prob(F-statistic)	0.000000			