HHL LEIPZIG GRADUATE SCHOOL OF MANAGEMENT

Dissertation

European Payment Instruments

Institutional Determinants of an Efficient POS Payment Mix

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Abstract:
This thesis sheds light on the functioning and characteristics of payment systems to serve as a foundation for understanding the drivers for higher payment system efficiency. Its central goal is to develop insights into the determinants of collective payment choice suitable to lower payment costs to society. So far, the institutional environment, as potential important influence on the payment instrument mix, has not been focused on in the literature. Therefore, particular emphasis is laid on the empirical analysis of the impact of institutional factors on the share of card payments on consumer spending at the point of sale (POS). For this, a unique panel data set is constructed covering the eight most important European payment markets ranked by non-cash transaction volumes. The empirical results allow formulating conditions necessary to achieve a more efficient payment mix. They also form a basis for the assessment of related policy measures with a focus on the SEPA project in terms of their efficiency enhancing effect. Future research could possibly build upon the panel data collected.

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European Payment Instruments – Institutional Determinants of an Efficient POS Payment Mix

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List of abbreviations

ACH	Automated clearing house
ATM	Automated teller machine
AUD	Australian dollar
BIS	Bank for International Settlements
bn	Billion
CAD	Canadian dollar
CPSS	Committee on Payment and Settlement Systems
CSM	Clearing and settlement mechanism
DNS	Designated-time net settlement
e.g.	exempli gratia (for example)
EAPS	European Alliance of Payment Schemes
ECB	European Central Bank
EEA	European Economic Area
EPC	European Payments Council
ESCB	European System of Central Banks
et al.	et alii (and others)
EU	European Union
EU27	European Union consisting of 27 countries
EUR	Euro
GBP	Pound sterling
GDP	Gross domestic product
i.e.	id est (that is)
ICS	International card scheme
ICT	Information and communication technology
IFTS	Interbank funds transfer system
ISO 20022	Universal financial industry message scheme (UNIFI) issued by the International Organization for Standardization
LVPS	Large-value payment system
m	Million
NOK	Norwegian krone
OECD	Organisation for Economic Co-operation and Development
p. (pp.)	page(s)
p.a.	per annum
PE-ACH	Pan-European automated clearing house
PIN	Personal Identification Number
POS	Point of sale
PSD	Payment Services Directive
PSDG	Payment Systems Development Group

PSP	Payment service provider
RPS	Retail payment system
RTGS	Real-time gross settlement
SCC	SEPA Card Clearing Framework
SCF	SEPA Cards Framework
SCS	SEPA Cards Standardisation "Volume"
SCT	SEPA Credit Transfer
SDD	SEPA Direct Debit
SDD B2B	SEPA Business-to-Business Direct Debit
SDD Core	SEPA Core Direct Debit
SDW	Statistical Data Warehouse maintained by the ECB
SEK	Swedish krona
SEPA	Single Euro Payments Area
TARGET/ TARGET2	Trans-European Automated Real-time Gross settlement Express Transfer system
USD	US dollar
XML	eXtensible Mark-up Language

List of variables employed in chapter 5 and 6

ACH	Domestic central ACH that processes card payments exists
ATM	Number of automated teller machines with a cash function
ATM18*	= ATM / INH18, number per m inhabitants > 18
ATMNW	Number of ATM networks
ATMVOL / ATMVAL	Volume / value of ATM withdrawals in m / m EUR
ATMVAL18*	= ATMVAL / INH18, EUR per inhabitant > 18
$BANK_{dom}$	Number of domestic banks
$BANK_{dom}$18*	= $BANK_{dom}$ / INH18, number per m inhabitants > 18
CARDNB	Number of payment cards in m
CARDNB18*	= CARDNB / INH18, number per inhabitant > 18
CARDATMFRQ*	= ATMVOL / CARDNB, withdrawals per card
CARDPOSFRQ*	= CARDVOL / CARDNB, payments per card
CARDVOL / CARDVAL	Volume / value of POS card payments in m / m EUR
CARDVALCONS*	= CARDVAL / CONS x 100, share in %
CHVOL	Volume of cheque payments in m
CHVOL18*	= CHVOL / INH18, number per m inhabitants > 18
CONS	Final consumption expenditure of domestic households at current market prices in m EUR
CONS18*	= CONS / INH18, EUR per inhabitant > 18
CR5	Asset value market share of five largest banks in %
DEBITNB	Number of debit cards in m
DEBITNB18*	= DEBITNB / INH18, number per inhabitant > 18
EUR	EUR is legal tender
GDP	Nominal gross domestic product at current market prices in m EUR
GDP18*	= GDP / INH18, EUR per inhabitant > 18
INH18	Number of individuals older than 18 in m
INTEGR	Degree of vertical integration of the predominant domestic payment card scheme as described in chapter 2.1
NCB	National central bank operates and/or owns domestic ACH
PATENT	Patent applications to the European Patent Office
PATENT18*	= PATENT / INH18, number per m inhabitants > 18
POS	Number of POS terminals
POS18*	= POS / INH18, number per m inhabitants > 18
POSNW	Number of POS terminal networks
RDEXP	Expenditures for research and development in m EUR
RDEXPGDP*	= RDEXP / GDP x 100, share in %

UNEMPL	Unemployment rate in a country in %
X_{it}	Observation of variable X in country i and year t
ΔX_{it}	First difference of variable X ($\Delta X_{it} = X_{it} - X_{it-1}$)

* own calculation, **bold** variables are employed for modelling purposes

More details available at Table 5–1 (pp. 162-163) and accompanying explanations in chapter 5.2.

1 Introduction

Any trade of goods, as well as the exchange of services and financial assets between economic agents, critically depend on the existence of well-functioning payment systems. They are the bloodstreams of the economy. Consequently, the economic growth of the last decades has been supported and facilitated by the remarkable rise of electronic payments.[1] According to the World Payments Report (Capgemini & RBS, 2012) the total number of non-cash payments worldwide has experienced a sustained 7% annual growth since 2001, reaching 306 bn in 2011. Of these transactions, 28% took place in Europe,[2] 40% in North America and 13% cumulated in Brazil, Russia, India and China. Among non-cash payments, card transactions have been the fastest growing segment. In Europe, they make up 40% of non-cash transaction volumes. Yet, payment behaviour differs widely across countries. In Finland for example, consumers use their payment cards five days a week, in Italy it is only 32 times a year.

Given the importance of payments for the settlement of economic transactions between individuals, firms and public authorities, this market has begun to receive increased attention from central banks and regulators like the European Commission. In addition, empirical research point to societal costs for the initiation, processing, clearing and settlement of payment transactions of up to 0.77% of GDP (see Table 3–5, p. 117). In 2011, this amounted to EUR 97 bn in the European Union (EU27).[3] Thus, lowering the costs e.g. by using more efficient payment instruments and systems could contribute significantly to economic wealth.

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1 Millard and Willison (2006) for example model how a reliable payment system contributes – in contrast to a barter economy – to social welfare by fostering trade.

2 In the study, Europe refers to the euro area, Denmark, Poland, Sweden and the UK.

3 The EU27 countries are (year of entry in parentheses): Austria (1995), Belgium (1952), Bulgaria (2007), Cyprus (2004), Czech Republic (2004), Denmark (1973), Estonia (2004), Finland (1995), France (1952), Germany (1952), Greece (1981), Hungary (2004), Ireland (1973), Italy (1952), Latvia (2004), Lithuania (2004), Luxembourg (1952), Malta (2004), the Netherlands (1952), Poland (2004), Portugal (1986), Romania (2007), Slovenia (2004), Slovakia (2004), Spain (1986), Sweden (1995), the UK (1973) according to http://europa.eu/about-eu/countries/index_en.htm (retrieved 2013, February 14). 2011 GDP obtained from Eurostat at http://epp.eurostat.ec.europa.eu/ (retrieved 2012, November 8). Croatia joined the EU on 2013, July 1 (http://europa.eu/newsroom/calendar/mobile/event/292084 (retrieved 2014, January 10). As data collection for this thesis was concluded by this time, subsequent analysis refers to EU27 if not stated otherwise.

Therefore, a number of policy measures have been initiated in the field of payments in order to raise the efficiency of payment systems with the aim of promoting economic growth. Such measures have been geared towards overcoming national fragmentation, fostering competition, increasing the resilience against shocks and reducing the use of cash. One paramount example is the establishment of the Single Euro Payments Area (SEPA) by the European banking and payment services industry. The creation of such a harmonised market for credit transfers, direct debits and card payments has been stipulated, guided and enabled by the European Commission and European Central Bank (ECB).

Despite its economic relevance, research in the field of retail payments has just grown out of its infancy. In particular, empirical research is scarce because reliable longitudinal data have been only available since the early 90s. Still, more work needs to be done to grasp the underlying mechanisms of payment markets. Yet, "mere mention of the words 'payment systems' to an economist tends to conjure up images of an obscure and rather technical sub-discipline" (Haldane, Millard, & Saporta, 2008, p. 1).

Against this background, this thesis will shed light on the functioning and characteristics of payment systems to serve as a foundation for understanding the drivers for higher payment system efficiency. Its central goal is to develop insights into the determinants of collective payment choice suitable to lower payment costs to society. So far, the institutional environment, as potential important influence on the payment instrument mix, has not been focused on in the literature (Humphrey, 2010, p. 1733). Therefore, particular emphasis is laid on the empirical analysis of the impact of institutional factors on the share of card payments on consumer spending at the point of sale (POS).

Because Europe is one of the most important economic regions worldwide, and is characterised by a diverse range of different payment system's set ups, it has appeared promising to concentrate on the developments in this market. For this reason, a unique panel data set is constructed covering the eight most important European payment markets ranked by non-cash transaction volumes.

The empirical results allow formulating conditions necessary to achieve a more efficient payment mix. They also form a basis for the assessment of related policy measures in terms of their efficiency enhancing effect. Further, future research can possibly build upon the panel data collected.

Subsequently, an overview about payment habits across Europe is provided in chapter 1.1. Chapter 1.2 highlights the research question and approach guiding this thesis, as well as provides an outline of its structure.

1.1 Payment behaviour in selected European countries

In the following, the stage for this thesis is set by visualising the development of retail payments in the eight largest European markets. These are, based on 2011 non-cash transaction volume, the United Kingdom (UK), followed by Germany (DE), France (FR), the Netherlands (NL), Spain (ES), Italy (IT), Belgium (BE) and Finland (FI). Together, they account for 80% of the total volume of all non-cash transactions in the EU27. Three groups of figures are presented covering the

(i) total volume of non-cash transactions and the payment mix for the four largest markets in Figure 1–1 (p. 14) and for the remaining countries in Figure 1–2 (p. 15) , both arranged by size;

(ii) payment card use at the POS and at automated teller machines (ATMs) in terms of volume per inhabitant over 18 years of age[4] (Figure 1–3, p. 16) and average value of transactions (Figure 1–4, p. 17);

(iii) size of the payment card and POS terminal networks in relation to the population older than 18 years is combined with the share of card payment value on household consumption – the central variable of the empirical analysis in chapter 5 (see chapter 5.2.2, Figure 1–5, p.19).

For each figure, the observations for the start and the end year – 1990 and 2011 – are displayed, if not indicated otherwise.

[4] This denominator was chosen instead of total population as a full choice of payment instruments is only available when the consumer reaches full legal capacity (see chapter 5.2.1).

Non-cash transactions and payment mix

In Figure 1–1 and 1–2 below, payments with cheques, payment cards as well as via credit transfers and direct debits are depicted. The fifth bucket is filled by either paper-based credit transfers (1990) or e-money payments (2011). All payment instruments are defined and the underlying infrastructure is explored in chapter 2.1.2 and 2.1.3. Astonishing is the largely diverging payment mix among the eight countries in question, as well as across time. This observation will be further explained below.

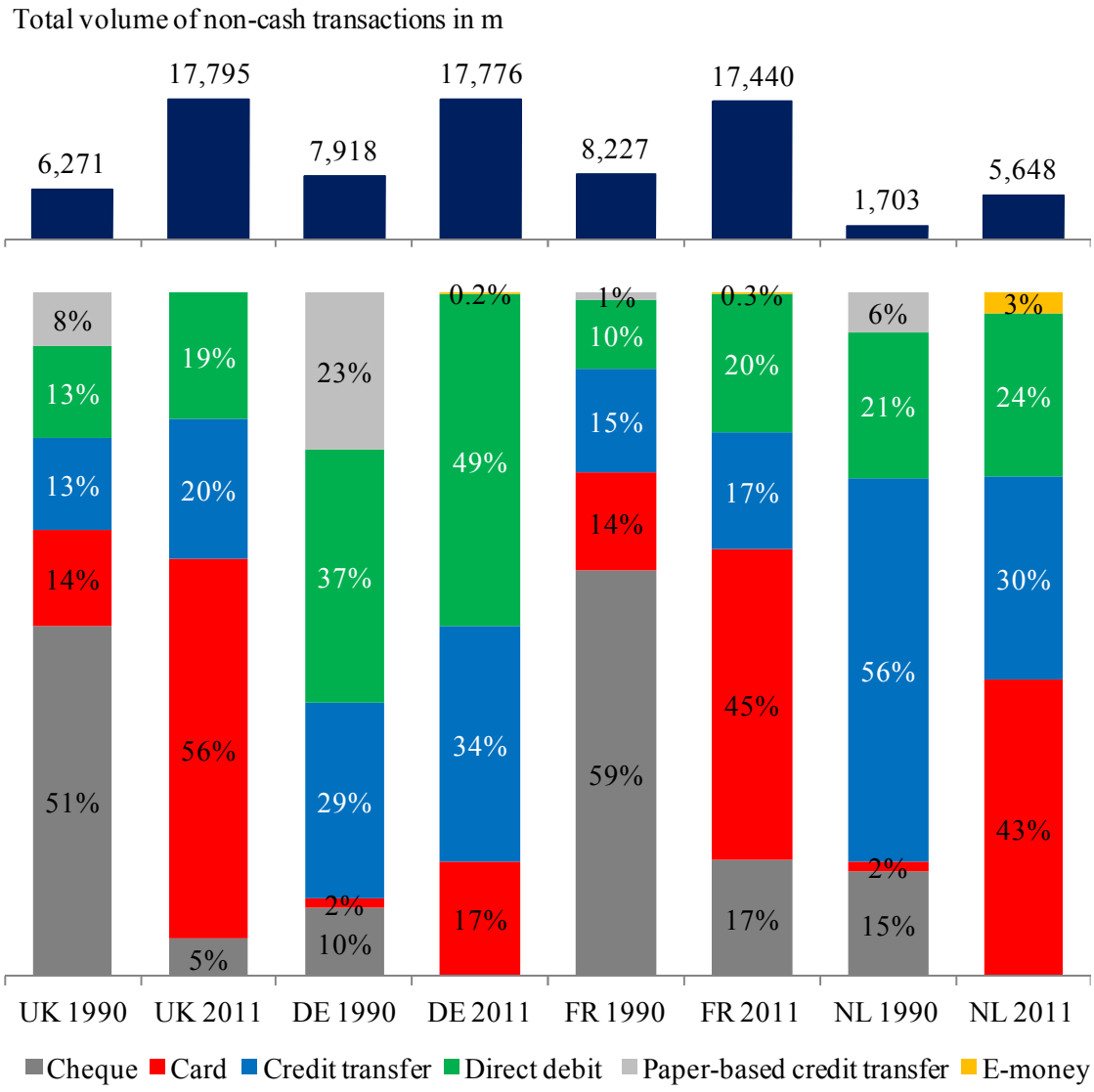

FIGURE 1-1: Non-cash transactions and payment mix in UK, DE, FR and NL[5]

[5] Own illustration based on data published in European Monetary Institute (EMI, 1996) and in ECB's Statistical Data Warehouse (SDW) accessible at http://sdw.ecb.europa.eu/ (data retrieved 2013, February 7).

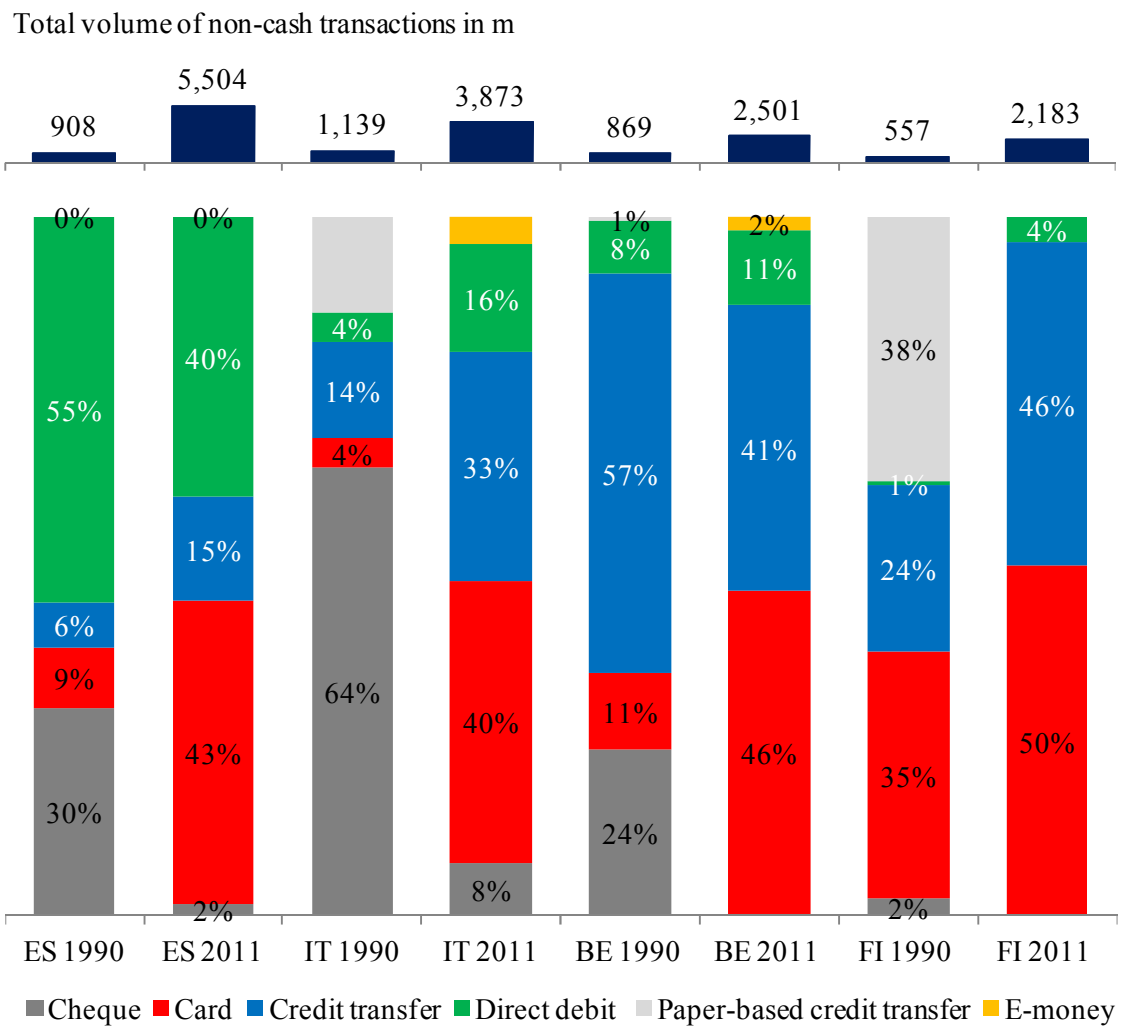

FIGURE 1-2: Non-cash transactions and payment mix in ES, IT, BE and FI[6]

As will be shown in chapter 3.2, paper-based payments such as cheques and paper-based credit transfers are expensive to process. In contrast, electronic transfers using payment cards, credit transfers or direct debits are to be preferred from a cost efficiency point of view. Across all countries, a respective shift is noted – the share of paper-based payments dropped from 48% in 1990 to 6% in 2011. In this process, cheques dramatically lost relevance, but they are still written in France and the UK. On the other hand, electronic transactions gained ground. Card payments in particular spread considerably. Across all countries, their volume increased fastest at 12% p.a., which compares to 5% annual growth for the sum of non-cash transactions. This resulted in a widening of the portion of cards in the payment mix from not even 10% in 1990 to more than 40% in 2011. In contrast, the share of electronic credit transfers and direct debits only im-

[6] Own illustration based on data from EMI (1996) and SDW (data retrieved 2013, February 7).

proved by 10 %-points to 53%. Lastly, e-money was designed to decrease societal payment expenditures by especially targeting the replacement of cash. But only in the Netherlands, Italy and Belgium has e-money gained some popularity (2-4% of transaction volume).

Considering the European countries separately, it is noticed that overall non-cash payment volume advanced most notably in Spain, at 9% p.a., followed by Finland at 7% annually. Other markets showed lower growth rates between 6% p.a. on the higher end (Italy and the Netherlands), and 4% on the lower (Germany and France). Largest progress in the field of card payments was made in the Netherlands, with a 24% continuous growth per year, followed by Italy and Spain (18% p.a. each). However, starting levels were only moderate in these countries. Germany is the only market where the share of card payments on total non-cash transaction volumes remained subdued, in comparison to all others.

Card payments and withdrawals

Figure 1–3 below displays the number of card payments per inhabitant aged 18 in the upper part of the chart, and of ATM withdrawals in the lower part.

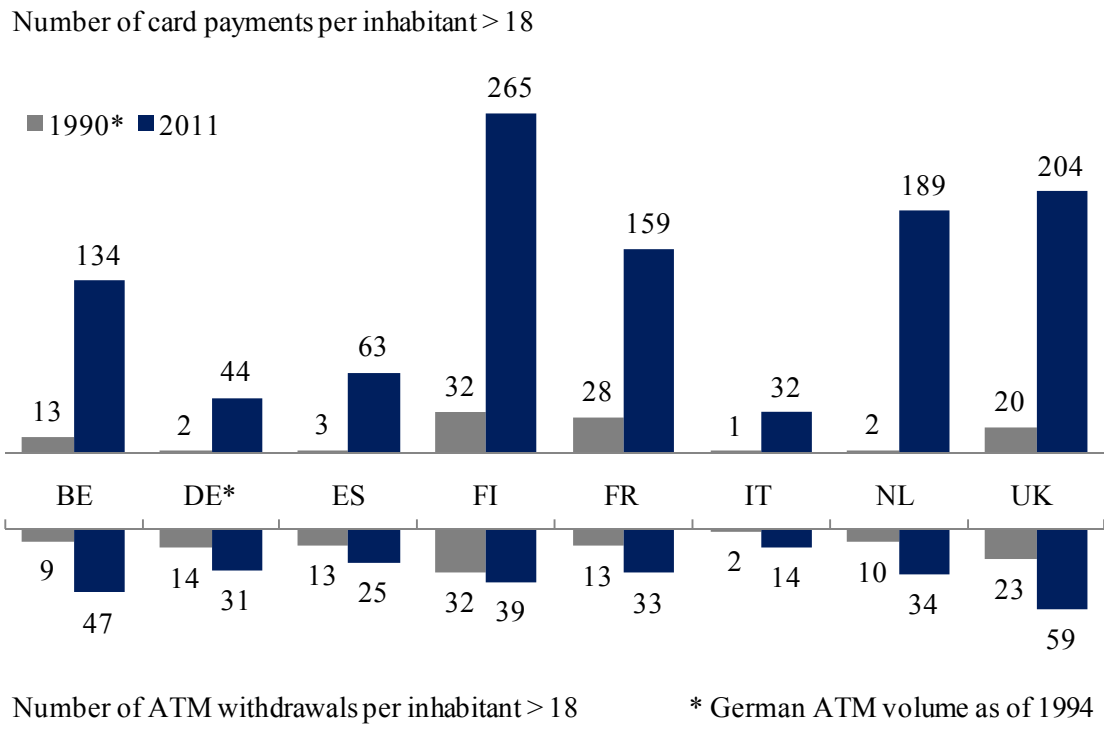

FIGURE 1-3: Number of card payments and ATM withdrawals[7]

[7] Own illustration based on panel data collection and calculation as described in chapter 5.2.1.

While across all countries analysed, the number of card payments per inhabitant increased from a mere 13 transactions a year in 1990 to 136 in 2011, the development of ATM withdrawals was markedly slower. Here, an average of 15 transactions a year in 1990 doubled to 35 in 2011. In contrast, throughout the period examined, there was hardly any change in the average card payment or withdrawal values. Overall, EUR 53 was spent per purchase in 2011, 1% less than 22 years ago. A similar situation is found in the ATM space, on average EUR 117 was withdrawn in 2011, 1% more than 1990.

Figure 1–4 shows the average value of card payments in the upper part of the figure and of ATM withdrawals in the lower part respectively.

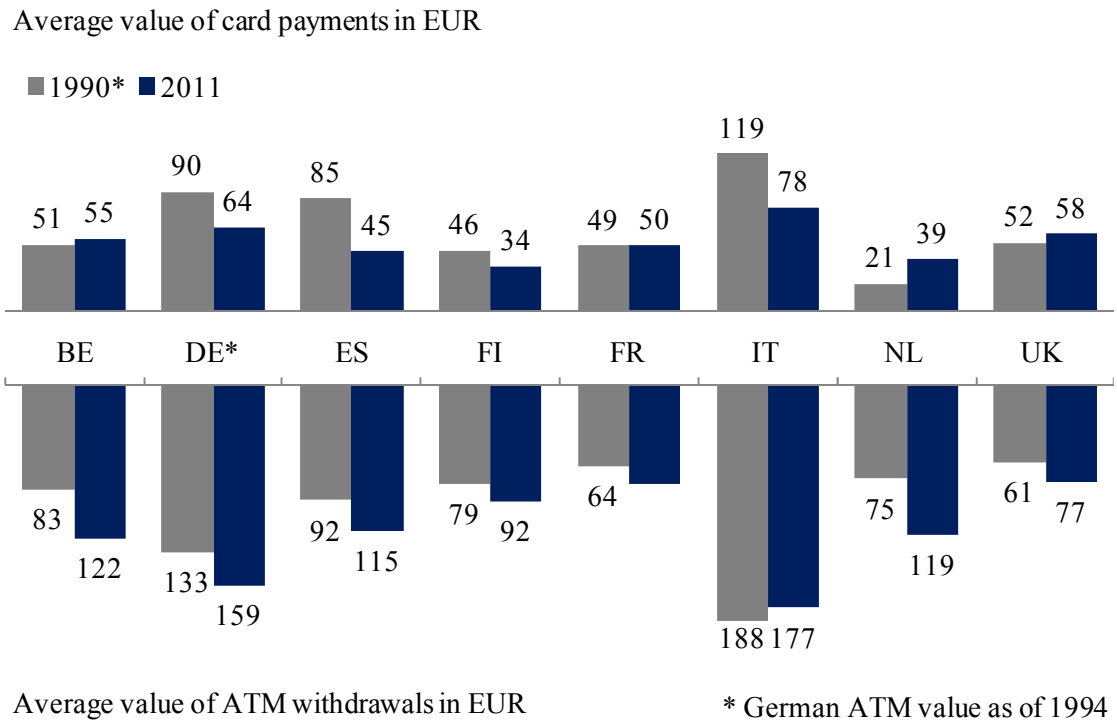

FIGURE 1-4: Average value of card payments and ATM withdrawals[8]

Examining single markets separately, three groups of countries are distinguished (see also chapter 5.2.2 and Figure 5–2 on p. 166 for this categorisation):

(i) those with a long-lived affinity to card payments characterised by high numbers in 1990 as well as in 2011 – notably France, Finland, and the UK – the "card enthusiasts";

[8] Own illustration based on panel data collection and calculation as described in chapter 5.2.1.

(ii) those experiencing a behavioural shift from a cautious approach to card payments at the beginning of the 90s to a warm embrace in later years as observed in the Netherlands and Belgium – the "card adopters" and

(iii) those who have been and still are reluctant to use their cards for payments – namely Spain, Germany and Italy – the "traditionalists".

The latter group on average spends the most per purchase at the POS. This observation supports the idea that these cardholders are particularly prone to use cash for every day shopping, and only employ their cards for exceptionally high amounts. Consequently, Spanish, German and Italian consumers need to withdraw more money at ATMs than those in the other markets. Moreover, they visit ATMs rather infrequently, compared to particularly British, Belgian or Finnish consumers. Indeed, it could be argued that they are less comfortable overall with the handling of their payment cards.

Network size and share of card payments on consumption

Finally, Figure 1–5 below examines the relationship of payment card diffusion (number of cards per inhabitant older than 18) and POS terminal density (number of POS terminals per inhabitant older than 18) to the portion payment cards capture on all purchases which is identified by the size of the bubbles.

From Figure 1–5, a number of very preliminary inferences can be drawn. Markets with either a high payment card diffusion (UK) or high POS terminal density (Finland) – the other value being at a medium level – seem particularly successful in convincing consumers to pay by card. This pattern was already apparent at the beginning of the observation period and has continued since then. The Netherlands and Belgium could probably raise their card consumption share, particularly based on the expansion of the POS acceptance network, while they did not slow down the distribution of payment cards. Both dimensions developed rather slowly in Germany which could be one reason for the exceptionally low payment card usage for purchases in line with low transaction volumes, pointed to in the previous sections.

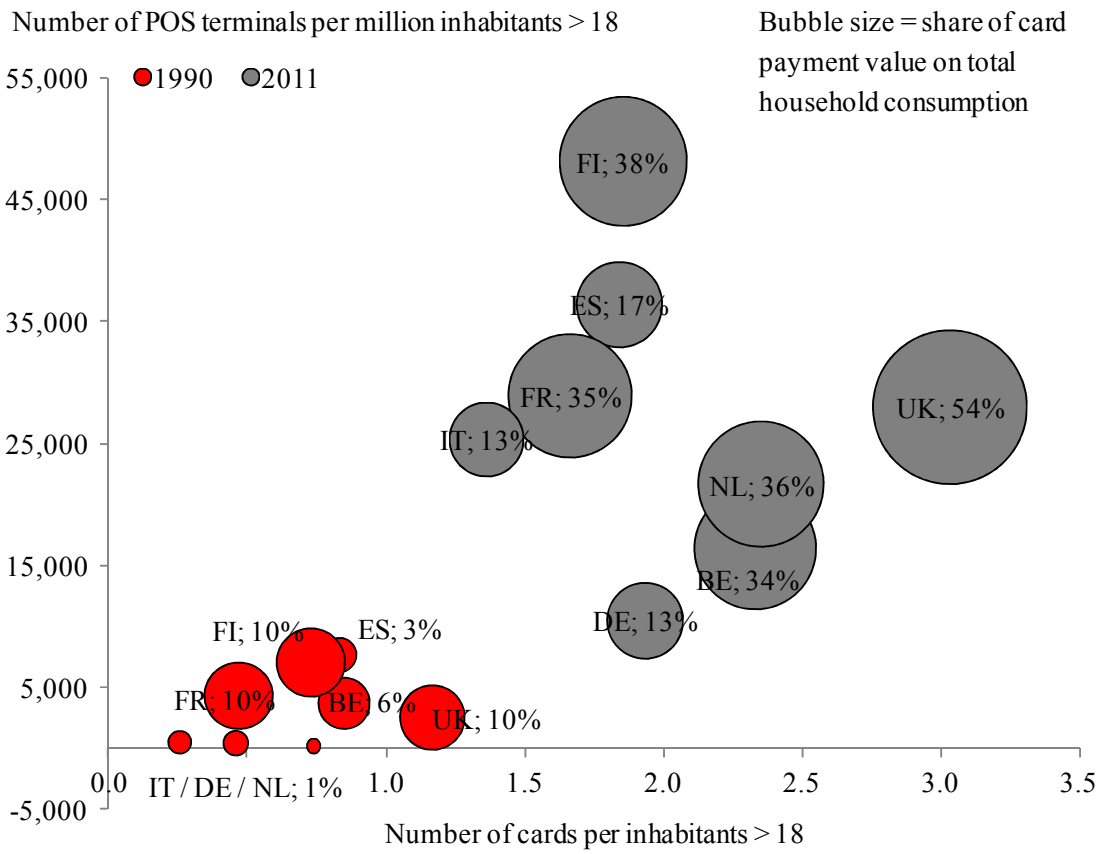

FIGURE 1-5: Size of POS terminal and card network to card payment value[9]

France, Italy and Spain pose a conundrum. All three are characterised by a combination of low card diffusion with medium POS terminal density. Yet, France has been successful in continuously expanding card payment purchases, while the other two markets have not. One main divide between them is that, in France, card payments were already well accepted by consumers in 1990 ("card enthusiasts"), while this was not the case in Spain or Italy. Still, other influencing factors are likely to play an important role as well in determining payment choice.

Overall, the diverse development in the European payment markets and their varying success in turning to cost efficient payment means, notably cards, at the POS is worth to be studied in more depth. In the following, the respective research question and approach are introduced.

1.2 Research question and approach

The starting point of the subsequent discussion is provided by three observations. First, the organisation of domestic payment systems, as well as the payment mix

[9] Own illustration based on panel data collection and calculation as described in chapter 5.2.1.

including the utilisation of cards, varies widely throughout Europe. Second, national payment markets are characterised by particular features that not only distinguish them from other markets, but also require the establishment of certain institutions to ensure their smooth functioning. Each country has found a distinct set up for these institutions, although a number of similarities may exist. Third, the social costs for payment instruments differ. Thus, if an efficient mix is encouraged, participants in the payment system could benefit from lower payment expenditure.

At the heart of this thesis, therefore, lies the question: "To what extent do institutional determinants contribute to differences in the payment mix, in particular in the use of payment cards?" This question shall be empirically examined based on the example of the eight most important European payment markets, as identified above. A period of 22 years spanning from 1990 to 2011 is analysed. Emphasis is laid on purchases at the POS with payment cards, cash and – as a legacy instrument – cheques. In terms of the underlying infrastructure, this dissertation focuses on retail payment systems (RPS), in contrast to large-value payment systems (LVPS), as defined in chapter 2.1.3.

The empirical results form the foundation for an appraisal of the SEPA initiative with respect to its capacity to (i) alter the institutional environment in a way that payment card use is encouraged and (ii) consequently to contribute to a more efficient payment mix. Figure 1–6 (next page) illustrates the structure of this dissertation.

It is organised as follows: In chapter 2, basic concepts regarding the functioning of payment systems with a focus on European arrangements are presented. Also, the network characteristics of payment markets and their two-sidedness are explored in order to enable identification of institutional variables for further analysis.

Chapter 3 contains a review of the literature on costs of payments to society, emerging from certain patterns of payment instrument use at the point of sale, as well as from the respective retail payment systems necessary to process these transactions. Socially preferable arrangements are highlighted.

This is followed by a study of the existing literature intended to explain payment instrument use, which is appraised in chapter 4. In particular, research on determinants of collective and individual payment behaviour based on aggregated as well as micro data is appraised. Moreover, based on the findings of the previous chapters, a framework for the subsequent empirical analysis is developed.

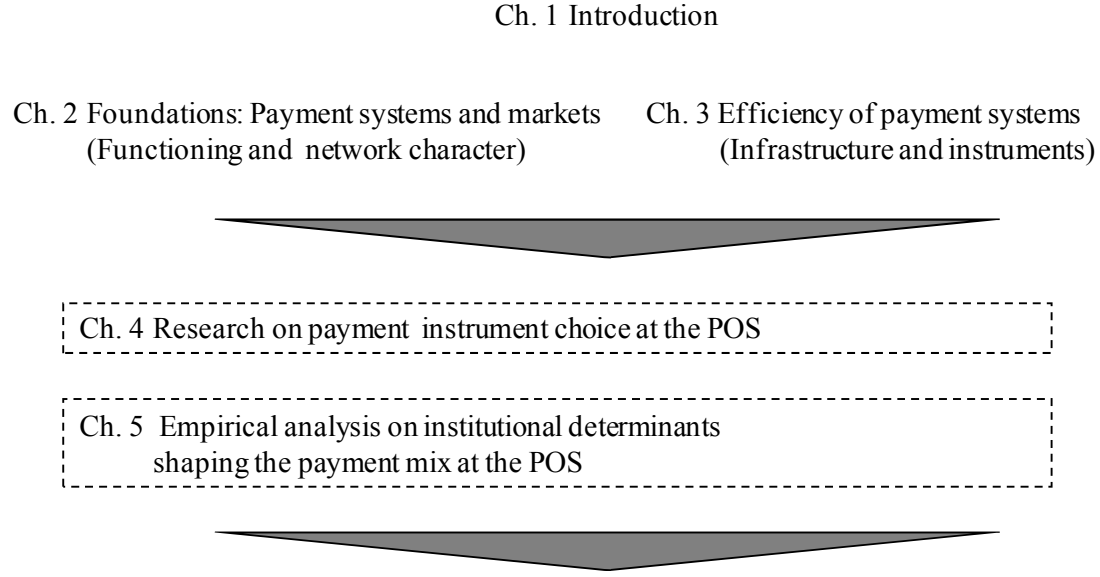

FIGURE 1-6: Dissertation structure[10]

Chapter 5 empirically addresses the research question using panel data as described above. Prior to that, an analysis of the payment systems' set up in the eight European countries considered in this thesis was undertaken to obtain observations on the institutional variables, since these were not readily available. Also, the process followed to construct the panel data is made transparent. Ideas for further research are presented as well.

In chapter 6, based on the empirical results, conclusions are drawn on whether the mechanisms introduced to create the SEPA could possibly pave the way to a more cost efficient payment instrument mix at the point of sale.

In this way, this thesis contributes to the field of retail payments research by

– filling a research gap as it includes institutional variables into the empirical analysis of payment choice leading to a specific payment mix at the POS,

[10] Own illustration.

– constructing a new data set, spanning an extended period of time for a wide range of countries, while collecting observations on institutional variables, and
– developing a better understanding on the possible impact of specific (self-) regulatory measures on the efficiency of European payment markets.

2 Foundations: Payment systems and markets

Hereafter, the foundations are laid for the understanding of the functioning of payment systems in chapter 2.1, and of the characteristics of payment markets in chapter 2.2. Besides creating a common terminology for this dissertation, first insights are developed with respect to potential obstacles to payment system development towards a more efficient payment instrument use.

2.1 Functioning of payment systems

The aim of this chapter is to lift some of the opaqueness weighing on payment systems research. Chapter 2.1.1 answers the following questions: What is a payment? How is a payment processed and who is involved? What is a payment system? Payment instruments (payment means) are introduced in chapter 2.1.2. Further, new payment methods – in essence being "access" products for payment instruments – are briefly characterised. Clearing and settlement arrangements are covered in chapter 2.1.3. Here, especially multilateral arrangements, i.e. inter-bank funds transfer systems (IFTSs), are of interest. A brief conclusion in chapter 2.1.4 offers preliminary inferences on potential sources of inertia inherent in the payment system. These inferences are further solidified in chapter 2.2.

2.1.1 Payments, market participants and payment system

This chapter consist of three parts. At the beginning, payments are characterised and the generic payment process designed to facilitate trade is presented. In the second section, the major market participants are introduced. In particular, card schemes are focused on. In the last part, a payment system definition is carved out and its main components are identified.

Payments and the payment process

A payment is a transfer of funds to discharge an obligation on the part of a payer vis-à-vis a payee (beneficiary) (Kokkola, 2010, p. 25). There are two ways of exchanging funds: (i) spending cash or e-money, or (ii) using deposits held in accounts with banks,[11] called non-cash transactions (Kahn & Roberds, 2009, p. 6). Kahn and Roberds (2009, p. 5) specify that payments enable trade in an environment that is characterised by a time mismatch of trading demands, and limited enforcement of obligations. A time mismatch occurs because goods and services cannot be exchanged instantaneously, owing to an inadequate supply of liquid, desirable assets. The enforcement of obligations might be limited by a number of factors, such as an inadequate legal system, or informational frictions.

Informational frictions could arise, for example, if payment accounts are used to transfer funds. Should the identity of payer and payee remain vague, and the ability of the former to meet his/her obligations is uncertain, trade will most likely not take place. Therefore, insufficient enforcement requires ensuring the identity and credit history of trading partners. Besides, Chiu and Lai (2007, p. 31) note that liabilities should be offset at regular intervals. Such periodic settlement helps to limit the obligations a payer accumulates over time, and thus reduces his/her net gain from default (see Appendix A–2, third section for a brief discussion on deferred versus continuous settlement).

The generic payment process is designed to tackle time mismatch and limited enforcement. It is briefly outlined by Guibourg and Segendorf (2004, p. 4) who draw on Committee on Payment and Settlement Systems (CPSS, 2000, p. 3) and involves

(i) authentication of the involved parties,
(ii) validation of the payment instrument,
(iii) verification of the payer's ability to pay,
(iv) authorisation of the funds transfer,
(v) transmission of the respective transfer information,

[11] Banks are credit institutions in the meaning of Article 4(1)(a) Credit Institutions Directive 2006/48/EC. Credit institutions pursue inter alia following activities: "money transmission services", i.e. payment services and "issuing and administering means of payment (e.g. credit cards [...])" according to Annex I Credit Institutions Directive 2006/48/EC.

(vi) clearing and settlement.

For cash payments, validation only is needed, while knowledge on the trading partners' identity and credit history is not essential to instantly settle trades. Validation ensures that the payment instrument presented is suitable for universally transferring a certain amount, not only between a specific payer and payee, but to any other trading partner as well.

Following, the other five steps are clarified with reference to non-cash transactions. The payment process is started by placing a transfer order (transfer instruction). Through the authentication of payer and payee as account holders, their identity and the payer's right to transfer funds from his/her bank account is confirmed (European Central Bank [ECB], 2009a). CPSS (2000, p. 3) comments that authentication is carried out by the payer's and payee's bank respectively, based on a pre-agreed security mechanism, such as a signature or PIN[12], or a mandate in the case of a direct debit. Further, verification is conducted by the payer's bank, by checking whether enough funds are available in the payer's account. The payer's bank also authorises the transaction, i.e. gives consent to the transfer of funds on behalf of the payer (ECB, 2009a). Finally, the payer's bank submits the transfer information (transfer message) into a clearing and settlement arrangement to complete the payment process. The transfer message contains the transfer instruction and additional routing information.

With respect to the last step, CPSS (2003a) defines: clearing means "the process of transmitting, reconciling and, in some cases, confirming transfer instructions prior to settlement, possibly including the netting[13] of instructions and the establishment of final positions for settlement". In the simplest case without netting, the final position is a claim by the payee's bank on the payer's bank. By ways of settlement, the interbank (net) obligations are discharged. It takes place

[12] The PIN (Personal Identification Number) is a personal and confidential numerical code which the user of a payment instrument may need to verify his/her identity. It is equivalent to a signature in paper-based transactions, such as cheques (Mai, 2005).

[13] Netting is the "agreed offsetting of mutual obligations by participants in a [clearing and settlement] system. This process involves the calculation of net settlement positions and their legal reduction to a (bilateral or multilateral) net amount" (ECB, 2009a). By multilateral netting, the difference between the amount that one participant owes to all other participants, and the amount that others owe that participant, is calculated (CPSS, 2000, p. 5).

when the settlement agent transfers the net amounts between the settlement accounts of banks (Rambure & Nacamuli, 2008, p. 5). Settlement agents are central banks, or those commercial banks that maintain settlement accounts on behalf of other banks and across whose books fund transfers take place (ECB, 2009a). Finally, banks debit or credit the payment accounts of payer and payee with the amount stated in the transfer instruction.

Based on the generic payment process, two different basic payment mechanisms were developed. According to Kokkola (2010, p. 30), a transfer order is either placed by the payer, who authorises his/her bank to send funds (credit-based "push"-transaction). Or the payee instructs his/her bank to collect funds (debit-based "pull"-transaction). The credit-based payment mechanism is typically initiated through a credit transfer or by using e-money, two of the five non-cash payment instruments illustrated in chapter 2.1.2. In contrast, the debit-based payment mechanism is used to handle direct debits, payment cards and cheques. Both processes are schematically depicted and linked to the generic payment process in Appendix A–1.

Market participants

Based on the description of the generic payment process, the main participants active in payment markets were introduced: payer, payee and their banks as well as the settlement agent who is part of the clearing and settlement arrangement. All are depicted in Figure 2–1 on the next page, thereby drawing on standard four-party models applied to describe payment markets (see for instance Leinonen, 2008a, p. 45). Other actors are payment service providers (PSPs) and card schemes whose roles are identified as well. A detailed assessment of their functions in European and US retail payments processing and the risks involved is conducted by Bradford et al. (2009).

Payers and payees are subsequently referred to as users, while banks, PSPs and card schemes are providers in the payment market. In the context of POS transactions, the merchant[14] (payee) delivers goods or services to the consumer

[14] The majority of authors refer to "merchants" to categorise payees that accept payment cards as a means to discharge obligations. However, it has to be kept in mind that, besides retailers, other payees such as hotels, restaurants, airlines, public authorities etc. accept cards as

(payer), who in turn pays the invoiced amount. Both, merchants and consumers, conclude contracts with their respective banks to set up payment accounts. Banks offer payment instruments suitable for transferring funds between these accounts.

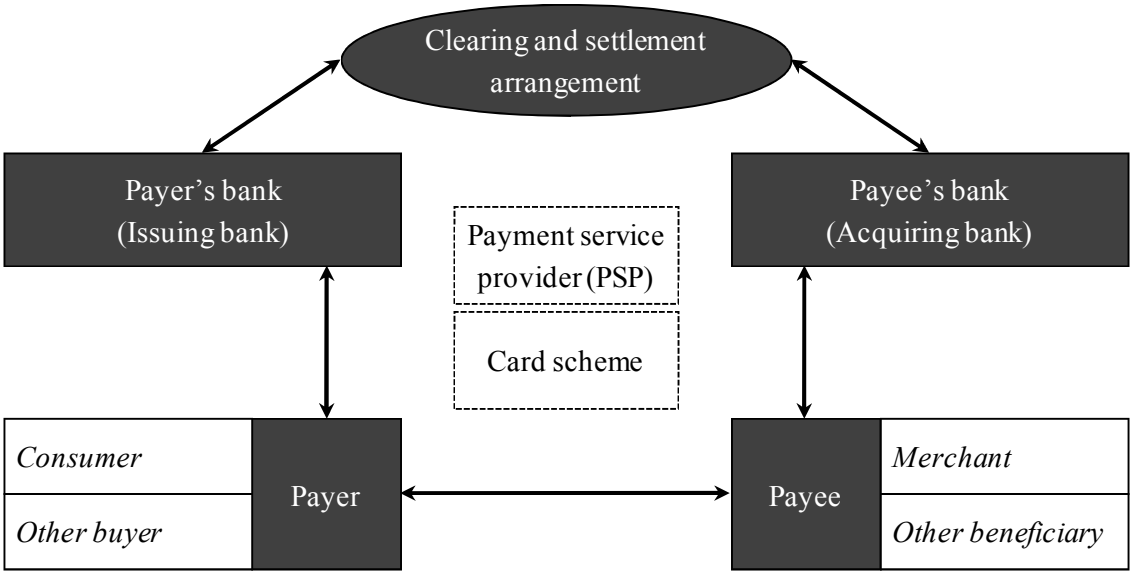

FIGURE 2-1: Participants in payment markets[15]

With respect to card payments, the payer's bank is called the issuing bank, while the bank serving the payee is called the acquiring bank.[16] Issuing banks distribute payment cards to their customers based on the understanding that merchants acquired (signed-up) by acquiring banks will honour these cards (Rambure & Nacamuli, 2008, p. 32). Moreover, the issuing bank ensures that the acquiring bank receives the payment for transactions made, in accordance with pre-agreed (card scheme) rules (Kokkola, 2010, p. 55). As a prerequisite, the issuing bank authenticates the cardholder and verifies that enough funds or sufficient credit lines are available.

Merchants willing to accept payment cards conclude a contract with an acquiring bank, which guarantees that the purchase amount is reimbursed (European Commission, 2006a, p. 90). The acquiring bank processes the merchant's transaction and obtains the purchase value from the issuing bank (European Commis-

payment instruments. Acceptance points may be "offline" ("brick-and-morter" POS) or "online" including mobile or telephone orders (card-not-present transactions).

15 Own illustration, adapted from Boer et al. (2010, p. 59) and extended.

16 Issuing and acquiring banks might be identical or belong to the same group with the result that transactions can be handled in-house (see chapter 2.1.3 for an explanation).

sion, 2006a, Glossary). This often requires the installation of so-called acceptance points, such as physical or virtual POS terminals.

Issuing and acquiring roles are also observable for the sending and receiving of electronic or mobile payments (see Box 1–1, p. 33) as Boer, Hensen, and Screpnic (2010, p. 60) notice. Both payment methods are "access products" to existing payment instruments, and are explained in chapter 2.1.2.

Increasingly, PSPs take over some of the issuing and acquiring tasks traditionally provided by banks (Weiner et al., 2007, p. 3). In the past, PSPs were often controlled by banks, but are now, to an increasing extent, nonbank undertakings. One example is First Data, a privately held PSP that is worldwide active in merchant acquiring and processing of card transactions, validating and guaranteeing cheques, as well as issuing and processing prepaid cards on behalf of merchants. In 2006, First Data bought the Gesellschaft für Zahlungssysteme (GZS), until then the monopoly MasterCard acquirer in Germany, which was jointly held by savings, cooperative and commercial banks.[17] Another example is ClickandBuy, which handles electronic payments as a 100% subsidiary of Deutsche Telekom.[18]

With the opening up of the European payment markets through the Payment Services Directive (PSD, Directive 2007/64/EC), especially nonbank PSPs are enabled to leave their niches, take on broader roles and directly compete with banks. The impact of such a deconstruction of the value chain is addressed in chapter 6.

A further condition to facilitate card transactions is that the issuing and acquiring banks, as well as PSPs, conform to a common set of rules. These are laid down through card schemes. Card schemes are usually owned by banks or their associations. In particular, this is the case with domestic debit card schemes, which are often jointly owned by the respective national banking community. In Europe, for example, this holds true for Dankort (Denmark), Carte Bancaires CB (France), girocard (Germany), PagoBancomat (Italy), BankAxept (Norway), Multibanco (Portugal) as well as for Sistema 4B, ServiRed and Euro6000

[17] See http://www.firstdata.com and Annual reports of 2011 and 2006 stored there for details (retrieved 2012, June 11).
[18] See http://www.clickandbuy.com for details (retrieved 2012, June 11).

(Spain).[19] In contrast to Visa Inc., Visa Europe Limited remained a member organisation with European banks as shareholders. MasterCard and Visa Inc. turned away from their member-owned model to become publicly listed in 2006 and 2008 (Rambure & Nacamuli, 2008, p. 36).

Card schemes are technical and commercial arrangements that establish the organisational, legal and operational framework necessary for the functioning of the schemes' payment cards (Kokkola, 2010, p. 55). Among other tasks, a card scheme grants licenses and membership status to banks, and certifies third-party providers (PSPs). It establishes network rules and technical standards, and observes compliance to these (European Commission, 2006a, p. 2). Card schemes may also be involved in processing or the acquiring business. For instance, some operate payment card processing centres (switches). Switches, according to the Payment Systems Development Group (PSDG, 2011, p. 56), provide a mechanism that connects issuing and acquiring banks to facilitate payment card transactions that cardholders initiate at POS terminals, ATMs or other acceptance points, as well as through the Internet or mobile phones.

The degree of vertical integration describes the extent to which card schemes not only provide the framework for, but are also involved in the cards business. In its report, the European Commission (2006a, p. 88) has investigated the varying degree of integration card schemes can display. At the lowest level (1), scheme ownership is legally separated from the network ownership, and the scheme does not engage in issuing and acquiring. Hence, the scheme solely owns the brand and sets parameters for access to the network and technical standards. At higher levels, the scheme might (2) switch the authorisation requests, (3) authorise and process as well as (4) clear and/or settle the transactions. A fully integrated scheme would also (5) acquire merchants and (6) even distribute POS terminals.

[19] More information on these card schemes are available at http://www.nets.eu (BankAxept, Dankord), http://www.cartes-bancaires.com, http://www.electronic-cash.de (girocard), http://www.bancomat.it/ (PagoBancomat), http://www.sibs.pt (Multibanco), http://www.4b.es (Sistema 4B), http://www.servired.es and http://www.euro6000.com; information on Multibanco and Euro6000 were also obtained from http://www.die-deutsche-kreditwirtschaft.de/uploads/media/170506_ZKA-press-finaldoc.pdf (all retrieved 2012, June 12).

The degree of integration may have implications for the intensity of competition between providers in the card payments market, and create entry barriers. Examples of varying degrees of integration are: German girocard (level 1), French Carte Bleue (level 2), Visa and Mastercard (level 3), Spanish ServiRed (level 4), Amex (level 5) and Belgian Bancontact/MisterCash (level 6), according to the European Commission (2006, pp. 88-89) and ServiRed (footnote 19).

Payment systems and components

Based on the explanations given with respect to payments, their processing, and the market participants involved, a payment system definition is derived. For this purpose, two complementary ones are consulted.

The first ties in to the role of payments in facilitating trade. It states: "a payment system is any arrangement that enables exchange by overcoming the paired frictions of time mismatch and limited enforcement" (Kahn & Roberds, 2009, p. 5). Alternatively, a payment system can also be defined through its constituting elements. Accordingly, CPSS (2003a) states: "a payment system consists of a set of instruments, banking procedures and, typically, interbank funds transfer systems that ensure the circulation of money".

Throughout this thesis, "instruments" refers to payment instruments available to payers and payees as introduced in chapter 2.1.2. From the discussion of the generic payment process, the widening role of PSPs as well as the tasks performed by card schemes, it appears that the term "banking procedures" might be too restrictive. Hence, the technical and administrative procedures from the moment a payment is initiated until the transfer message enters a clearing and settlement arrangement are called "processing". Finally, besides IFTSs, other clearing and settlement arrangements exist, as chapter 2.1.3 demonstrates.

Summing up, a "payment system" is defined as any arrangement that facilitates the transfer of funds to discharge obligations arising between payer and payee from the trade of goods and services. Through this arrangement, banks and other providers, notably PSPs and card schemes, are enabled to provide payment services. These include offering payment instruments and methods that allow

payers and payees to initiate funds transfers, processing the respective transfer instructions and carrying out clearing and final settlement of the payments.

A payment is final when (i) the settlement account of the bank managing the payee's account has been credited and (ii) the settlement is irrevocable by the payer and unconditional (CPSS, 2003a in conjunction with CPSS, 2001, p. 30).

2.1.2 Payment instruments and methods

A payment instrument is "a tool or a set of procedures enabling the transfer of funds from a payer to a payee" (ECB, 2009a). Following, the six generic payment instruments are examined whereby cash and non-cash payment instruments are distinguished. At the end of this chapter, payment methods are introduced.

Cash payment instruments and e-money

Cash payment instruments, e.g. banknotes and coins, are usually used in face-to-face transactions of low-value. Since payer and payee do not need to exchange information on their identity, they can transact funds anonymously.[20] With its status of being legal tender, notes and coins are to be accepted for all types of payments (Kokkola, 2010, p. 28). In contrast to non-cash payment instruments, cash provides instant finality and discharge of debt (Rambure & Nacamuli, 2008, p. 25). In the absence of authentication and verification options for small transactions, validation is essential to counteract counterfeiting, and thus to ensure the payer's ability to pay. While cash might be convenient, it is expensive to distribute, handle and process, makes taxation less transparent and is subject to fraud and theft. In the euro area, the cost of cash amounted to 0.3-0.4% of GDP in 2008, which justifies why public authorities are seeking to limit cash usage (Capgemini & RBS, 2011, p. 12).

E-money stored on multi-purpose prepaid cards (e-purses) exhibit characteristics similar to cash, especially in regards to anonymity and validation needs, but processing is less costly. E-purses are accepted as a means of payment by undertakings other than the issuer[21] (Kokkola, 2010, p. 30). First, a monetary value is

[20] Nevertheless, authentication is often required for large-value payments to prevent money laundering and terrorism financing (Kokkola, 2010, p. 28).

[21] In contrast, single-purpose prepaid cards are used in closed systems where issuer and accep-

uploaded and subsequently reduced by each purchase. E-purses were designed for small (micro-) payments at retailers, car parks, vending machines, public transport and the like, with the aim to replace cash. Nevertheless, results were mixed. While, for example, Chipknip (Netherlands) and Proton (Belgium) became widely used, the attractiveness of Moneo (France) remained limited (Rambure & Nacamuli, 2008, p. 29). The latter holds true for the German GeldKarte as well.[22] Further information is provided in Box 1–1 (p. 33). The development (and failure) of several e-purses is documented in van Hove (2004).

Non-cash payment instruments

Non-cash payment instruments enable the transfer of funds between payment accounts which are maintained by banks in the name of payer and payee. Following, the core characteristics of non-cash payment instruments are explained. The varying usage patterns across European countries were explored in chapter 1.1. A detailed comparison regarding the efficiency of instruments employed at the POS is conducted in chapter 3.2.

– Credit transfers (direct credit, wire transfer) are instructions by the payer to his/her bank requesting to transfer a defined amount to the payee's account. Processing occurs by ways of the credit-based payment mechanism (see Appendix A–1 for a detailed description). For recurrent payments, the payer can arrange a "standing order". Credit transfers may be initiated in paper or electronic from, but as a rule, processing occurs electronically (Kokkola, 2010, p. 31). According to Rambure and Nacamuli (2008, p. 29) this contributes to low handling costs. Moreover, reconciliation is good, especially if the payment reference is provided by the payee, instead of the payer.

– Direct debits are initiated by the payee through his/her bank, which collects the funds from the payer's bank, given the payer's prior authorisation by a legally binding mandate. The debit-based payment mechanism is employed (as explained in Appendix A–1). Depending on national rules, the mandate is

tor are identical such as in public transport systems (Rambure & Nacamuli, 2008, p. 34).

[22] Between 2003 and 2011, the number of uploads grew by 3% p.a., the volume of transactions by 1.2% p.a. https://www.geldkarte.de/_www/en/pub/geldkarte/press/facts_and_figures/transaction_numbers.php (retrieved 2012, June 12).

either deposited at the payer's or the payee's bank. In the event of insufficient funds, the payer's bank has usually no obligation to honour the payment possibly leading to a credit risk for the payee (Kokkola, 2010, p. 31). For recurrent payments, direct debits offer more flexibility then credit transfers, as the amount to be debited can vary. Once the mandate is set up, payment initiation, processing, clearing and settlement, as well as reconciliation on the part of the payee, are completely automated, keeping costs low (Rambure & Nacamuli, 2008, pp. 31-32).

– Payment cards, as described by Kokkola (2010, p. 31), enable the holder to purchase goods and services from merchants, or to withdraw money at ATMs. Commonly, both functions are combined on a single card. Payment cards are used to authorise a debit from the payer's account within a few days (debit card) or at a pre-determined monthly date (delayed or deferred debit card[23]). Credit cards allow the cardholder to draw on a line of credit granted by the issuer. The outstanding balance is to be repaid either in full or part, depending on the agreement with the issuer. In general, interest is charged. Since payment card processing is fully automated, costs are low and driven by economies of scale. However, high merchant service charges and interest payments make credit cards less desirable from a society's point of view (see chapter 3.2 on the cost of payment cards). Processing is done by utilising the debit-based payment mechanism.

– Cheques are signed written transfer orders drawn by the payer on his/her bank, and presented to the payee, who submits it to his/her bank. Although processing (via debit-based payment mechanism), clearing and settlement of cheques is widely automated, decreasing economies of scale, due to declining volumes, manual handling on the part of payers and payees, as well as reconciliation needs and security issues contribute inter alia to the high costs of cheque use (Rambure & Nacamuli, 2008, p. 26-27). Despite these drawbacks, cheques are advantageous from the payer's point of view, due to the delay between the drawing of the cheque and the debiting of his/her account. On the other hand, the payee bears a credit risk at the time of accepting the cheque until his/her

[23] In the public commonly referred to as charge cards as well.

account is credited. Although declining in use, cheques are still common in a few European countries, such as the UK and France (Kokkola, 2010, p. 32).

New payment methods and e-money

Besides the payment instruments described, a multitude of electronic and mobile payment methods, as well as e-money products, emerged in recent years (see Box 1–1 below). While e-money itself is a payment instrument, the new payment methods build upon existing payment instruments and infrastructure. They offer alternative technical channels to initiate and authenticate transactions via Internet or mobile networks (Kokkola, 2010, p. 33). For this reason they are considered "access products" for payment instruments, rather than being an actual alternative to them (Weiner et al., 2007, p. 10).

This view is supported by Bleyen, van Hove, & Hartmann (2010, p. 83), who develop a sophisticated five-layer model in an attempt to classify payment instruments and methods. The authors aim at delivering a "helpful tool" for proper classification. Besides its drawbacks – for example, payment instruments and methods that require authentication and the authentication procedure itself are not accurately distinguished – it provides a solid overview on developing the landscape of payment methods and products.

Box 1–1: E-money, electronic and mobile payments

Electronic or e-money is "a stored value or prepaid product in which a record of the funds or value available to the consumer for multipurpose use is stored on an electronic device in the consumer's possession. This definition includes both prepaid cards (sometimes called electronic purses [or e-purses]) and prepaid software products that use computer networks" (CPSS, 2004, p. 2). The E-Money Directive 2009/110/EC further clarifies that e-money is "a claim on the issuer which is issued on receipt of funds [at par value] for the purpose of making payment transactions […] and which is accepted by a natural or legal person other than the electronic money issuer" (Article 2(2) in conjunction with Article 11(1)). Creation and reimbursement of e-money is effected by one of the core payment instruments – cash, credit transfer, direct debit or payment cards (Kokkola, 2010, p. 30). Issuers of e-money are electronic money institutions who also provide related services. Electronic money institutions are governed by the E-Money Directive and, compared to banks, subject to a simplified regulatory regime due to a limited area

of activity (ECB, 2009a). Examples include Google Checkout or multipurpose prepaid cards such as Hong Kong Octopus Card and e-purses in Europe mentioned above on pages 30 to 31.

Electronic or e-payments are made over the internet using either a (i) payment card, (ii) online-banking based credit transfers or direct debits or (iii) transactions enabled by e-payment providers with which consumers set up individual accounts funded through a credit transfer, direct debit or credit card (European Commission, 2012a, p. 4). Examples for method (ii) include "sofortüberweisung" (Germany, rolled out under the label "sofortbanking" in other European countries)[24] and iDEAL (Netherlands)[25]; for method (iii) ClickandBuy and Twitpay. Boer et al. (2010, p. 35) illustrate the functioning of TwitPay: Twitpay links Twitter and PayPal user accounts. A transaction is initiated by sending a Twitter message and routed through PayPal payments infrastructure. The PayPal account is linked to the user's credit card and/or payment account, such that the funding and receiving of payments is done by credit card transactions, direct debit or credit transfer. The Twitpay example shows how payment methods are "stacked" upon existing payment instruments and infrastructure.[26]

Mobile or m-payments are transactions for which the transfer order is initiated, transmitted or authorised via a mobile phone or other mobile device. Two categories are distinguished: (i) remote m-payments take place through the internet (often funded via payment card) or through sms-services where billing occurs through a mobile network operator, (ii) proximity payments employing Near Field Communication (NFC) technology. The latter requires specifically equipped phones that can be recognised by compatible merchant acceptance interfaces when put near to them (European Commission, 2012a, p. 5). Obopay for example, a privately held company funded inter alia by Nokia, delivers a wide range of mobile payment solutions.[27] However, the boundaries between e- and m-payments become blurred (European Commission, 2012a, p. 5). This is due to the rise of smartphones supporting mobile Internet and payment-apps through which payments can be initiated (de Bel & Gâza, 2011, p. 23-24).[28]

[24] See https://www.payment-network.com/pnag_en for details (retrieved 2012, June 14).

[25] See http://www.ideal.nl for details (retrieved 2012, June 14).

[26] Boer et al. (2010) describe the e-payments market in detail. Updates on new developments and e-payment methods are given by de Bel, Boersma, and Screpnic (2011) and de Lange, Longoni, and Screpnic (2012). All of these studies were edited by Innopay, a specialised consultancy firm. Despite a growing body of literature on e-payments, e.g. on consumer adoption and security issues, no literature review seems to exist on this field of research.

[27] See https://www.obopay.com/corporate_website/index.php for company information (retrieved 2012, June 15).

[28] The m-payments market and selected methods are covered in de Bel and Gâza (2011). For an elaborate report on the evolution of e- and m-payments including behavioural, technical, legal and political aspects refer to Lammer (2006). The compilation also records a number of existing payment method solutions. A current literature review on the emerging field of m-payments research is delivered by Dahlberg, Mallat, Ondrus, & Zwijewska (2008).

2.1.3 Clearing and settlement arrangements

This chapter is organised as follows.[29] Owing to their importance, predominantly IFTSs being multilateral clearing and settlement arrangements are analysed in the first section of this chapter. A distinction is made between large-value and retail payment systems. Details on access criteria to IFTSs and resulting participation levels, the choice of a settlement asset (central bank vs. commercial bank money) and different settlement methods (designated-time vs. real-time and gross vs. net settlement) are given in Appendix A–2. The second section of this chapter describes other types of clearing and settlement arrangements and how these might be interlinked to IFTSs.

Interbank funds transfer systems[30]

ECB (2009a) explains that IFTSs are "based on a private contract or legislation, with multiple membership, common rules and standardised arrangements, for the transmission, clearing, netting and/or settlement of monetary obligations arising between its members." Two types of IFTSs are distinguished, those handling predominantly large-value transactions and those specialising in retail payments.

Large-value payments, as indicated by Humphrey (2010, p. 1732), are primarily made between banks for their own accounts, or on behalf of their customers including other banks, as well as nonbanks and participants in the financial markets. These large-value payments include business transfers, securities transactions and foreign exchange trades, and usually require urgent and timely settlement. For the most part, large-value payment systems (LVPSs) settle continuously and without prior netting[31] of transfer instruction – called real time gross settlement (RTGS). This procedure results in high liquidity demands of systems' participants as they must be able to meet obligations at any time during operating hours. Due to their systemic importance, LVPSs are, as a rule, operated by central banks acting as settlement agents and providers of collateralised liquidity.

Although, only 1% of a country's transactions are of large value, they make up

[29] Before continuing, it might be sensible to recall the terms: "clearing", "settlement", "settlement agent" and "settlement account" as clarified in chapter 2.1.1.
[30] This section draws on Appendix A–2 including its the sources if not indicated otherwise.
[31] Netting is explained in footnote 13.

over 90% of the value of aggregated payments, as Humphrey (2010, p. 1732) has calculated. Therefore, the author concludes that well-functioning LVPSs are a prerequisite for the smooth operation of a country's financial system. The three most important LVPSs by transaction value are CLS for worldwide foreign exchange transactions, TARGET2[32] (euro area) and Fedwire (USA), all listed in Table 2–1 below. It shows a selection of significant LVPSs together with their defining characteristics: currency area, settlement method and arrangement (who settles the transaction?), operator of the system as well as the number and value of transactions. Settlement always occurs in central bank money.

LVPS *(data for 2010)*	Currency area	Settlement		Operator	Transaction	
		method*	arrangement		volume (in m)	value (in EUR bn)
Large-value payment systems						
CLS	Foreign exchange	RTGS	National central banks	CLS Bank(1)	198	816,769
TARGET2	EUR	RTGS	National central banks	Eurosystem(2)	87	633,826
Fedwire	USD	RTGS	Fed. Reserve	Federal Reserve	125	458,871
CHIPS	USD	MN/BN/G	CHIPS (liquidity by Fed. Reserve)	CHIPCo(1)	91	275,399
CHAPS	GBP	RTGS	Bank of England	CHAPS Clearing Company(1)	32	66,124
EURO1/ STEP1	EUR	MN	TARGET2	EBA Clearing(1)	59	62,208

Values for CLS (USD) and USD/GBP converted to EUR (1 EUR = GBP 0.8578 / USD 1.3257 annual average reference exchange rate for 2010 according to SDW[33]).
* MN: multilateral netting, BN: bilateral netting, G: gross settlement.
(1) Founded and privately owned by a consortium of banks.
(2) Technical infrastructure provided by Banca d'Italia, Banque de France and Deutsche Bundesbank.

TABLE 2-1: Overview of major large-value payment systems[34]

[32] TARGET abbreviates the term Trans-European Automated Real-time Gross settlement Express Transfer system; TARGET2 has replaced TARGET by May 2008 after a phased migration (http://www.ecb.int/paym/t2/html/index.en.html, retrieved 2013, February 24).

[33] http://sdw.ecb.europa.eu/ (data retrieved 2012, May 15).

[34] Own illustration adapted from Kokkola (2010, p. 49) and updated based on CPSS (2012a) for currency, volume, value and settlement method; supplemented by
- CLS Bank International (2009, p. 3–4) for CLS (continuous linked settlement),
- ECB (2009b, p. 2 and 7) for TARGET2,
- CPSS (2003b, p. 442–444) for Fedwire, CHIPS, FedACH,
- Rambure and Nacamuli (2008, p. 96-97) and http://www.chapsco.co.uk/chaps_company/about_chapsco/-/page/1968/ (retrieved 2012, May 15) for CHAPS,
- ECB (2008a, p. 14–15) for EURO1/STEP1.

In general, there is no lower boundary set for the value of transactions handled through LVPSs. For instance, the average value of a TARGET2 transaction was EUR 6.8 m in 2011. Yet, 67% of the payments settled in TARGET2 had a value of EUR 50,000 or lower in the same year.[35]

Retail payment systems (RPS) handle a large number of relative low value and non-urgent payments originating mainly from consumers and other nonbank payers who employ non-cash payment instruments (CPSS, 2003a). Hence, in contrast to large-value payments, retail transactions usually relate directly to the purchase of goods and services rather than to transfers between banks according to Kemppainen (2003, p. 24). Moreover, retail payments are initiated through the different non-cash payment instruments available to a vast number of users, while large-value payments in general take the form of credit transfers made between banks and other institutions eligible to directly connect to LVPSs. In RPSs, designated-time net settlement (DNS) is prevalent: Obligations of the system's participants are accumulated throughout a predetermined period (settlement cycle), netted on a bi- or multilateral basis, and settled at the end of that period. In general, LVPSs are entrusted with the settlement of the net obligations arising between the RPSs' participants.

Kokkola (2010, p. 50) notices that the netting service is typically provided by a clearing house or a clearing association, but may also be organised in other ways. Clearing houses provide the rules for the clearing process, as well as the necessary operational functions such as (i) centralised clearing facilities, (ii) interbank communication networks for presenting and exchanging transfer messages and (iii) possibly bi- or multilateral netting arrangements (CPSS, 2000, pp. 5-6 in conjunction with Kokkola, 2010, p. 10). In contrast to clearing houses, clearing associations do not operate central processing facilities, but merely establish common rules for bilateral clearing among participants (CPSS, 2000, p. 5).

According to PSDG (2011, section III) three types of clearing houses prevail, notably (i) cheque clearing houses, (ii) automated clearing houses (ACHs) mainly specialising in the handling of credit transfers, direct debits and card transac-

[35] See http://www.ecb.int/paym/t2/about/figures/html/index.en.html and http://www.ecb.int/paym/t2/html/index.en.html (retrieved 2012, July 3).

tions as well as (iii) payment card processing centres (switches). The central banks' role as systems' operator and supplier of settlement asset is not as pronounced as in LVPSs. This holds true in particular for card processing centres; to a lesser extent for ACHs and cheque clearing centres.[36]

Retail payments typically account for 99% of a country's non-cash payment transactions, but not even 10% of the value (Humphrey, 2010, p. 1732). Examples for RPSs are recorded in Table 2–2 below and include CORE (France), FedACH (USA), BACS (UK) and STEP2 (euro area). The columns are arranged as in Table 2–1 on LVPSs.

RPS *(data for 2010)*	Currency area	Settlement		Operator	Transaction	
		method*	arrangement		volume (in m)	value (in EUR bn)
CORE	EUR	MN	TARGET2	STET(1)	12,817	5,120
FedACH(2)	USD	BA	Fed. Reserve	Federal Reserve	11,563	16,173
BACS	GBP	MN	CHAPS	VocaLink(1)	5,673	4,732
Equens	EUR	MN/BA	TARGET2 MC/V(4)	Equens SE(1)	4,449	2,005
RPS	EUR	BA	Bundesbank STEP2 and other ACHs	Deutsche Bundesbank	2,663	2,300
STEP2(3)	EUR	BA	EURO1	EBA Clearing(1)	525	2,379

Values for USD/GBP converted to EUR (1 EUR = GBP 0.8578 / USD 1.3257 annual average reference exchange rate for 2010 according to SDW[37]).

* MN: multilateral netting, BA: batch settlement: a number of transfer orders are combined in one file and processed together (Kokkola, 2010, pp. 34 and 332).

(1) Founded and privately owned by a consortium of a number of banks.

(2) Includes transactions sent by private ACHs to FedACH.

(3) Includes STEP2 XCT, ICT and SCT service.

(4) MC/V: Card transactions are settled via MasterCard and Visa.

TABLE 2-2: Overview of major retail payment systems[38]

[36] In the EU, 5 of 17 cheque clearing houses and 9 of 23 ACHs are operated by national central banks, but only 6 of 34 card processing centres (PSDG, 2011, pp. 46-47, 51, and 62-63).

[37] http://sdw.ecb.europa.eu/ (data retrieved 2012, May 15).

[38] Own illustration adapted from Kokkola (2010, p. 49) and updated based on CPSS (2012a) for currency, volume, value and settlement method; supplemented by
- Rambure and Nacamuli (2008, p. 96-97) for BACS,
- ECB (2008a, p. 14-15) for STEP2,
- http://www.banque-france.fr/en/financial-stability/payment-systems-and-market-infrastructure/infrastructure/retail-payment-system.html (retrieved 2012, May 15) for CORE,
- De Nederlandsche Bank (2012) and http://www.equens.com/cards/issuing/payment_clearing_services.jsp (retrieved 2012, May 15) for Equens,
- Deutsche Bundesbank (n.d., p. 3) for RPS.

Other clearing and settlement arrangements and linkages

In order to obtain a full view of the clearing and settlement arrangements available, and how they might interact, Figure 2–2 below was developed. It exemplifies the possible links between the four types distinguished by CPSS (2000, p. 5) and explored hereafter: in-house transactions, bilateral agreements, correspondent banking and multilateral arrangements (IFTSs). The numbers in parentheses correspond to these explanations: (1) and (2) depict in-house transactions and bilateral agreements while (3a) and (3b) refer to correspondent banking; (4), (5a) and (5b) concern IFTSs. Also, the type of settlement asset used is exhibited.

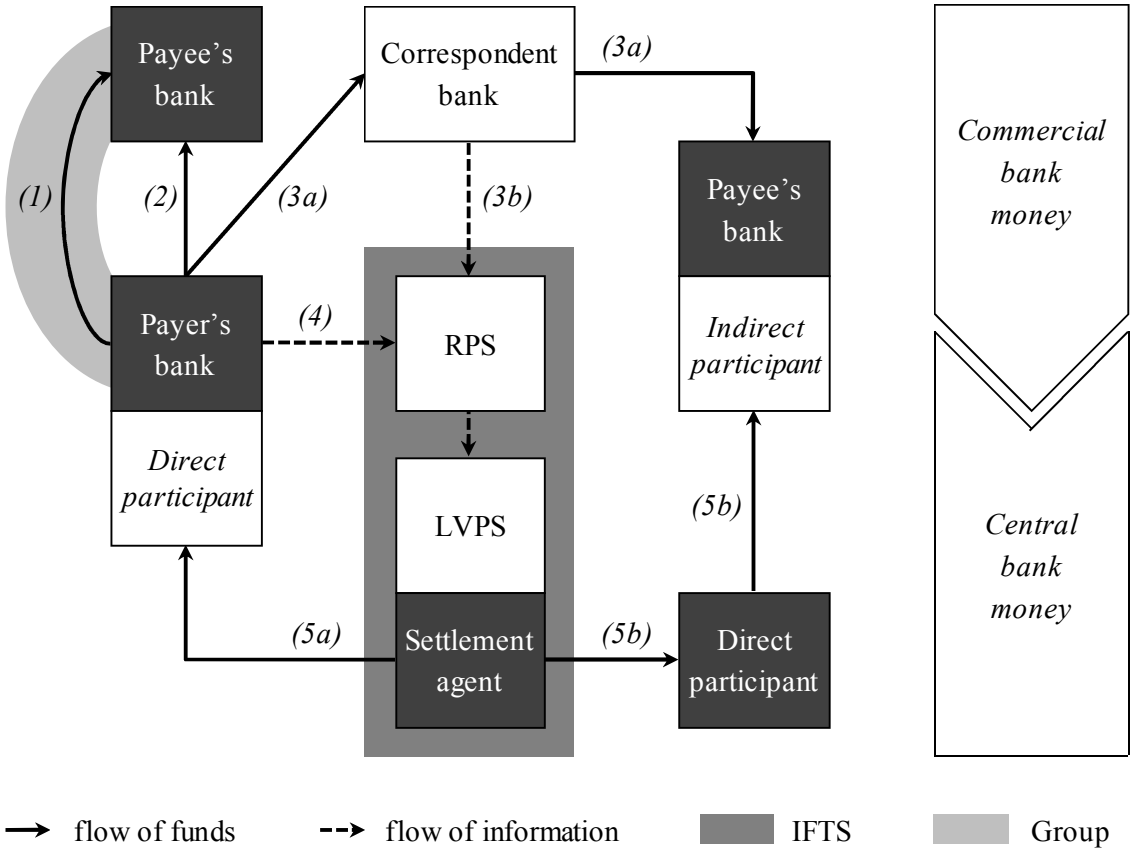

FIGURE 2-2: Clearing and settlement arrangements[39]

(1) In-house transactions occur if payer and payee hold their payment accounts at the same bank or group. Thus, clearing the transfer instructions and settling the corresponding claims and liabilities, i.e. crediting and debiting of the payment accounts, can be performed within the same bank in commercial bank money. Subject to appropriate internal account structures and networks, even cross-border transactions can be handled in-house. However,

[39] Own illustration.

banks may choose to process such payments via an IFTS. Bank mergers and acquisitions, as well as the expansion of banks' branch networks broaden the scope for in-house transactions (Kokkola, 2010, p. 38).

(2) Bilateral agreements are concluded between the payer's and the payee's bank. These agreements provide a basis to exchange transaction information, calculate balances for settlement in commercial bank money, and transfer funds accordingly, using the settlement accounts mutually maintained by both banks. Bilateral solutions tend to be rather inefficient when large payment volumes are processed for a large number of beneficiaries (CPSS, 2000, p. 5).[40] Complexity arises from the need for every bank involved to set up bilateral contracts, transmission channels and settlement accounts with all others, as well as from managing liquidity and credit risks.

(3a) In correspondent banking, the banks of payer and payee (customer banks) entrust the correspondent bank (service-providing bank) to make and receive payments on their behalf (ECB, 2009a). Balances calculated during clearing are settled in commercial bank money via correspondent, i.e. settlement accounts. These have been mutually established between customer banks on the one hand, and correspondent banks on the other, and are governed by bilateral contracts (CPSS, 2000, p. 6). There is no direct account relation between the payer's and payee's bank. (3a) illustrates the correspondent bank debiting the payer's bank account and crediting the payee's bank account during settlement.

(3b) However, especially in cross-border trades, (domestic) correspondent banks may not have established account relationships with both the (foreign) payer's and the (domestic) payee's bank. Consider a French payer (F) wishing to transfer funds to a Japanese payee (J). F's bank is not a direct participant in a (domestic) Japanese IFTS. Nevertheless, F's bank maintains an account with a correspondent bank in Japan. But, the latter might not hold a

[40] This holds except for the experience of Germany. Here, three clearing organisations (giro networks) serve different categories of banks, i.e. commercial, savings and cooperative banks. These are interconnected through bilateral clearing arrangements. Settlement is effected in central bank money via the RTGS system (CPSS, 2000, p. 7 in conjunction with CPSS, 2012b, p. 181).

settlement account with J's bank. Hence, the correspondent bank being a direct participant clears and settles the payment through the (domestic) Japanese IFTS. As J's bank in this example is only an indirect participant, another directly participating bank that maintains a settlement account for J's bank needs to be involved. The direct participant receives the funds and credits J's bank's account accordingly.

As indicated, correspondent banking is well-established to effect cross-border payments involving different currencies to finance international trade, where settlement directly via a (domestic) IFTS is not possible. Moreover, correspondent relationships are important for banks to access IFTSs as indirect participants while the correspondent bank being a direct participant acts on their behalf (Kokkola, 2010, pp. 38 and 40).

It is worth noting that with greater consolidation in the financial sector and consequently growing payment values, correspondent banking could possess some characteristics of IFTSs. Thus, overseers should assess whether such arrangements are systemically important (see Appendix A–2 for a definition), and regulate the choice of settlement asset accordingly (CPSS, 2001, paragraph 6.10).

The multilateral agreements touched upon hereafter are only a small extract of the vast range of possible links. IFTSs, together with other types of clearing and settlement arrangements, form a complex payment network. A report by CPSS (2008) thoroughly analyses the situation, and the growing interdependencies leading to a concentration of liquidity and operational risks in a number of critical IFTSs, banks and other service providers. This enhances the potential for disruptions to spread quickly and widely throughout the payment system, adversely effecting welfare.

(4) assumes that the payer's bank is a direct participant in both IFTSs, namely the RPS and LVPS. Therefore, it sends the transaction instruction directly to the RSP without involving an intermediary. Within the RPS, all incoming transfer instructions are cleared and sent for settlement to a LVPS. The LVPS prepares the settlement, which is finally performed by the settlement

agent. However, in some constellations, settlement can be effected by the RPS itself, via a settlement agent.

(5a) displays the debiting of the settlement account of the direct participating payer's bank, while (5b) assumes that the payee's bank is an indirect LVPS participant. Crediting, therefore, necessitates involving a direct participating bank, which sustains a correspondent relationship with the payee's bank.

2.1.4 First observations on obstacles to payment systems development

From the explanations given throughout chapter 2.1 so far, three issues emerged. First, payments are complementary goods. Users' demand is fixed to the level of economic activities, and is, ceteris paribus, hardly influenced by the efficiency of the payment system. Hence, initiatives to enhance efficiency must be most likely provider driven. Second, for users to send and receive funds and for providers (banks, PSPs, card schemes) to process respective transfer instructions, they must cooperate and develop common rules and standards for payment instruments and processing. Third, IFTSs are the supporting pillars of payment systems and at the core of the web of different clearing and settlement arrangements. Prerequisite for establishing IFTSs are substantial investments that are shouldered by central banks or large bank consortia. Taken together, the three issues mentioned might create inertia, thereby hindering the advancement of payment systems towards higher efficiency. This notion, among other themes, is further explored below.

2.2 Network character of payment markets

This chapter aims at linking some essential findings from the literature on network industries and two-sided markets with important characteristics of payment systems. It starts with a brief introduction of the two disparate strands of economic theory applied to analyse networks in chapter 2.2.1. In chapter 2.2.2 payment systems are characterised as physical networks, and demand-side network effects are identified. Chapter 2.2.3 explores some aspects of two-sided markets and their application to the cards market. The central role of interchange fees is also discussed. In chapter 2.2.4 the economies of scale inherent in providing payment services are revealed. Multilateral clearing and settlement arrangements in particular benefit from these. The underlying question throughout

these last three chapters is: What drives efficiency in payment systems? Chapter 2.2.5 outlines some answers based on the preceding analysis and gives indications on obstacles hindering to reach higher efficiency levels in payment systems.

2.2.1 Theories of networks

Following Cohendet, Llerena, Stahn, & Umbhauer (1998, p. 1), networks can be viewed from two different angles, by inspecting (i) the structure of the agents' interactions or (ii) the impact of positive network effects. The first approach draws on network analysis techniques, which have been widely applied in a number of fields, most notably in the study of social groups.[41] The basic idea is that networks consist of a set of vertices (nodes) and edges connecting the nodes. The topology of a network can be investigated along a range of properties, such as distance and clustering of nodes, as well as number and direction of linkages.[42]

In research on payment systems, this view is inter alia adopted to analyse systemic risks in IFTSs. Questions regarding the systems' resilience to contagion from credit, funding (liquidity) or other shocks, as well as respective transmission channels are answered. ECB (2010a), for instance, provides an excellent summary on recent papers. These also draw on other techniques such as game theory, agent-based modelling and simulations, to capture dynamic developments, as well as the behaviour and interdependencies of participants. Studies based on the Payment and Settlement System Simulator BoF-PSS2, provided by the Bank of Finland, are prime examples, a selection is published in Leinonen (2007, 2009a).

The second, industrial organisations view is concerned with the impact of network effects on market structure, conduct and performance. Katz and Shapiro (1985, 1986 and 1994), Farrell and Saloner (1985, 1987a, 1987b), as well as Economides (1996), Economides and Salop (1992), Economides and White (1994) laid the very foundations for understanding the economic implications.

In short, network effects imply that the users' utility and related willingness to pay depends on the size of the network, i.e. the number of possibilities to interact

[41] For an introduction to network analysis based on graph theory refer to Brandes and Erlebach (2005); for application in social science, see for example Jansen (2006).
[42] Refer to Newman (2003) for first insights.

as defined by Endres and Martiensen (2007, p. 604). The authors further suggest that network effects are predominantly positive; hence, the utility for all users of a network increases with each new user joining. Moreover, network markets are characterised by increasing production economies of scale, and complementarity of compatible network goods (Endres & Martiensen, 2007, pp. 607 and 609, and Shy, 2001, pp. 2 and 5). Payment cards, for example, adhere to common standards, and are thus compatible with POS terminals or ATMs, in order to generate the complementary network good, i.e. a card payment or cash withdrawal. Network effects and economies of scale entail monopolistic tendencies, and obstruct switching to a new technology, i.e. a new compatibility standard (Shy, 2001, pp. 2 and 7-8).

Typically, the industrial organisations inspired literature has focused on network industries, e.g. transport or telecommunications. It explored options to enhance performance by breaking up (national) monopolies and allowing more competition through regulating access to existing essential infrastructure.[43] Moreover, the introduction and diffusion of new technologies, for example in information and communication technology, were extensively researched.[44] However, the application to payment markets has been limited and confined to singular aspects. The next chapters aim at narrowing this gap.

2.2.2 Demand-side network effects in payment markets

Figure 2–3 (next page) shows a stylised example of a payment system's network, which will also be referred to throughout the further discussion. It consists of three banks which are connected through two IFTSs for retail and large-value payments. Other clearing and settlement arrangements exists, but are not displayed. The banks have established relations with three merchants (M) and four consumers (C). Also, the banks operate three ATMs (A). All together, banks, IFTSs, consumers, merchants and their POS terminals, as well as ATMs, form the nodes

[43] See Laffont and Tirole (2001) for a theoretical discussion of these issues in the telecommunications market. For a comprehensive treatment of the economic and judicial reasoning for the deregulation of the telecommunications, postal services, electricity and transport sector confer to Klaus (2009).

[44] Weitzel (2004) explains uptake and diffusion of new technical standards in information networks. Thereby, he conceptualises an interdisciplinary network theory, and develops a standardisation model to simulate different standardisation scenarios.

in the payment network. Their role and the links between them are revealed hereafter. PSPs and card schemes are not displayed, but accounted for if appropriate.

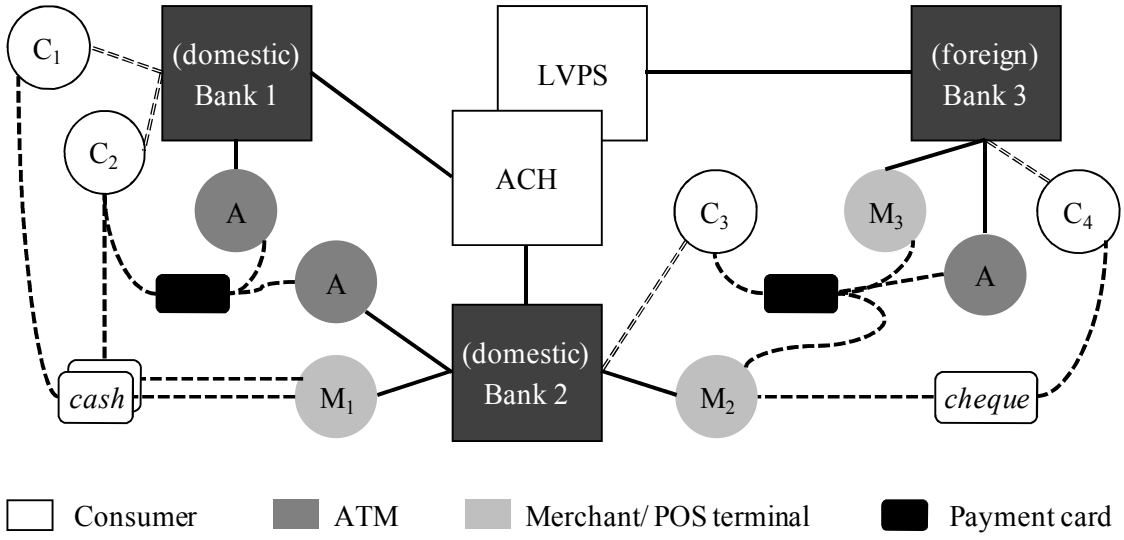

FIGURE 2-3: Stylised payment network[45]

The remainder of this chapter unfolds as follows: As a starting point, the payment system's physical network consisting of IFTSs, and other infrastructure is described in the first section. Also, the implications of the decision to adopt a specific payment instrument (irreversible investments, switching costs) are demonstrated. Further, the network good property of payment means is noted. The second section is concerned with the implications of network effects on the uptake of new (more efficient) payment technology and the structure of payment markets. Third, some examples (IFTSs, ATM and POS networks) for direct and indirect network effects are proposed.

Payment systems as networks and network good characteristics

Endres and Martiensen (2007, p. 602) describe networks as consisting of real (physical) or imaginary links between their nodes, allowing them to interact. In a payment system, physical links are decisive for its functioning.

At provider level, banks and IFTSs are linked through data processing and communication networks depicted by straight lines in Figure 2–3 above. Banks and other providers manage physical links to ATMs and merchant POS terminals (so-called acceptance network). Additionally, banks maintain payment accounts

[45] Own illustration.

which connect them to their customers. The account relationships between banks and consumers are illustrated as double dotted lines in Figure 2–3; those between banks and merchants, as well as between banks and IFTSs, are not shown. At user level, the links between consumers and merchants or ATMs are formed by deploying a payment instrument, such as payment card, cash or cheque. They are depicted as dotted lines.

The central node of the European payment system, measured by value of transactions handled, is TARGET2 (see Table 2–1, p. 36). It connects almost 1,000 direct participants (banks), more than 16,000 indirect participants and correspondents as well as 80 ancillary systems[46] such as ACHs, and handles 91% of euro large value payments in value terms.[47] To send and receive transfer instructions, banks and IFTSs make use of the SWIFT communication network. SWIFT is a member-owned cooperative that operates a world-leading proprietary platform through which transfer and other financial messages are transmitted.[48] SWIFT also facilitates the setting of respective standards. POS and ATM networks also belong to a payment system's infrastructure. In the EU, more than 430,000 ATMs and almost 9 m POS terminals were installed in 2010; the number of ATM and POS terminals per million inhabitants grew by 3.1% p.a. and 4.3% p.a. respectively since 2000.[49]

IFTSs, communication and acceptance networks build the fundamental infrastructure of a payment system. Related supply-side economies of scale are discussed in chapter 2.2.4. The literature on infrastructure efficiency is reviewed in chapter 3.1.1 and 3.1.2.

At user level, payers and payees are connected through payment instruments and acceptance networks, if required – examples in Figure 2–3 above are cheque and payment card. First, both groups need to adopt a certain payment instrument or

[46] In ancillary systems, payments are cleared while the "ensuing monetary obligations are settled in another system, typically an RTGS system" (ECB, 2009a).
[47] See http://www.ecb.europa.eu/paym/t2/html/index.en.html (retrieved 2012, May 25).
[48] For company information see www.swift.com. In 2011, SWIFT transmitted on average 18m messages per day between its 2,334 members (supervised financial institutions) and 7,784 other participants (http://www.swift.com/about_swift/company_information/swift_in_figures/archive/2011/SIF_2011_12.pdf (retrieved 2012, May 25).
[49] Own calculation based on SDW data (http://sdw.ecb.europa.eu, retrieved 2012, May 26).

acceptance infrastructure. Determinants for adoption and usage of payment means are identified in chapter 4 and 5; related network effects are dealt with in the next section. This might require irreversible investments. Merchants for example must install POS terminals; consumers in turn, might apply for a specific payment card. If payment instruments would only differ in their penetration rate, users would adopt the one more widely spread (Guibourg, 1998, p. 6). That is because users want to avoid becoming locked-in to a means of payment that is hardly accepted by merchants or held by consumers, since switching to an alternative could be costly. Such switching costs (Shapiro & Varian, 2008, pp. 111 and 117) are entailed inter alia in

- contractual commitments between issuing and acquiring banks and users,
- durable purchases such as acceptance infrastructure or software and
- data conversion needs for example for merchants' databases.

Second, in the actual payment situation, payers and payees agree to use a specific payment instrument like a payment card. Besides connecting cardholder and POS terminal, a payment card also links its holder to ATMs for cash withdrawals. It becomes evident that a payment card does not possess any inherent value on a stand-alone base. Instead, its value rises with any additional user. This holds true for other payment instruments as well. In Figure 2–3 (p. 45), cheque or cash link consumers and merchants to allow for a payment; they are worthless to their holder if the payee does not accept them. Therefore, payment instruments are pure network goods (Endres & Martiensen, 2007, p. 602).

In order to produce such network goods, network components must be able to operate together, i.e. be complementary like ATMs or POS terminals and payment cards or bank-internal and IFTSs' processing technology. Complementarity of the various nodes and links is even a "crucial defining characteristic of networks" (Economides, 2004, p. 4). This requires compatible network components that adhere to common standards (Guibourg, 1998, p. 6). The conditions influencing standardisation, i.e. the adoption of a new technology, are examined in the following section. Compatibility and complementarity are prerequisites for the emergence of positive network effects in information and communications

technology (ICT) networks (Weitzel, Wendt, & von Westarp, 1999, p. 2). Since payment systems heavily rely on ICT that provide for payment processing (Leinonen, 2008a, p. 27, and Weinberg, 1997, p. 34), insights on ICT network effects are applied to an analysis of network effects in payment systems.

Implications of network effects on network size and market structure

Formally, positive network effects (demand-side economies of scale, usage externalities) occur if the "utility that a user derives from consumption of the [network] good increases with the number of other actors consuming the good" and "depend[.] upon the number of other users who are in the same 'network' as is he or she" (Katz & Shapiro, 1985, p. 424). Weitzel (2004, p. 32) as well as Liebowitz and Margolis (1994, p. 135) clarify, that network externalities are a specific kind of network effect, and only exist if market participants fail to internalise the impact of a new network user on the others. Throughout this thesis, the term "network effects" is preferred to "network externalities", since market participants might be able to internalise, but the extent to which this occurs is not always clearly identifiable.

As a consequence of network externalities, a new user is not adequately rewarded for the benefit he/she adds to the other network users (Economides, 2004, p. 11). For example, a merchant who previously only accepted cash (M_1 in Figure 2–3, p. 45) considers accepting payment cards. If he/she would install a POS terminal, cardholders (C_2 and C_3) appreciate generally that another link to a merchant is available. Also, higher acceptance could encourage them to use their cards more often. Consumers that do not hold a payment card (C_1 and C_4) might be induced to obtain one as acceptance increases. This would enable them to shop, even if they are cash constrained (see review of Bolt & Chakravorti, 2008a in chapter 2.2.3), which benefits all merchants. Therefore, utility of consumers and merchants could improve if M_1 joins the network, but he/she is not compensated for the value added, since no compensating payments are foreseen in card networks.

Particularly for ICT networks, Katz and Shapiro (1994, p. 96) derive that, resulting from the social marginal benefit exceeding the private marginal benefit, the emerging network remains smaller and less efficient than the socially optimal

network, indicating market failure. The authors refer to this phenomenon as adoption externalities. These could be at least partly internalised if a network sponsor (owner), a single firm or joint venture that controls the property rights of a given technology, would initially post prices below marginal costs, and thus support early network growth.

Nevertheless, this strategy is unlikely to completely resolve adoption externalities, as consumers fear becoming locked-in to a proprietary network (Katz & Shapiro, 1986, p. 825, and Katz & Shapiro, 1994, pp. 101-102). Adoption externalities impede a rapid diffusion of new payment instruments such as e-money stored on multipurpose prepaid cards (Organisation for Economic Co-operation and Development [OECD], 2007, p. 30, and van Hove, 2004). Another example is the rather slow uptake of new SEPA payment instruments. More than four years after its launch at the beginning of 2008, only 28% of credit transfers make use of the new SEPA formats.[50] Also, entry of new undertakings competing with already existing large networks might prove very difficult – even if cost differentials from economies of scale are not considered.

The effects of adoption externalities on the diffusion of new payment technologies are amplified by the so-called start-up problem. Guibourg (1998, pp. 9-10) comments, that for the decision to join a network, not only the actual number of users, but also the potential users' expectations about the future size of a network are decisive for the decision to join and the actual size the network can reach. Also, the author explains that a critical mass of users is a prerequisite for network existence. As a result, the demand for a network good is – among others – a function of the expected network size (Katz & Shapiro, 1994, p. 96, and Economides, 1996, p. 678). For example, merchants will not invest in POS terminal upgrades to accept contactless payment cards[51] if they expect that only a very few cardholders will adopt and use such cards, the start-up-problem of a new technology.

[50] According to the SEPA SCT indicator retrieved from http://www.ecb.int/paym/sepa/about/indicators/html/index.en.html (retrieved 2012, June 21).

[51] Contactless (multipurpose prepaid) cards use NFC technology. Once the card is placed near to the POS terminal, the purchase amount is deducted from the value stored on the card prior to the purchase. A large scale field trial, for example, is currently undertaken in Germany (http://girogo.sparkasse.de and http://www.girogo.de, retrieved 2012, June 15). Visa pushes contactless payments in UK on the back of the Olympic Games in London (http://www.

New payment services, for example, have difficulties overcoming the initial hurdle of achieving a critical mass of users, since they strongly depend on ICT networks and legacy infrastructure (Leinonen, 2008a, p. 27). Two reasons are cited by Milne (2006, p. 1618): switching costs and installed base. Users have already invested in a given standard, such as an acceptance network, and might find it expensive to switch to a new technology. At the same time, once the existing standard, like a certain payment instrument, has been adopted by a large number of users, they benefit from network effects. Whether such critical mass is reached for a new payment instrument, so that users can enjoy similar network effects, is unknown.

Therefore, according to Leinonen (2008a, p. 27), changing to a new technology requires coordination on the side of both, providers and users. The author suggests that coordination becomes challenging when numerous stakeholders are involved, and the user base is highly dispersed in a large economy. As a consequence, even networks with superior products might not emerge at all, as no potential user is willing to bear the risk of being the first adopter of the new standard and thereby potentially becoming locked-in with a network of suboptimal size (Weitzel, 2004, pp. 25-26). For the establishment of SEPA, start-up and coordination problems are among the biggest hurdles that market participants need to tackle, as examined in chapter 6.

There is no known empirical study that deals with coordination problems associated with the adoption of new payment technologies on the side of users. As far as providers are concerned, Milne (2006) has modelled reasons for reluctance to introduce new technologies, and enhance the payment system's performance. His results closely mirror the above discussion. Milne (2006, pp. 1613-1615) observes that the payment industry exhibits low rates of technological adoption and diffusion. Potential cost savings from more efficient payment service provision are not exploited, leading to unnecessarily high costs for society. However, the author found that payment innovation has typically gone furthest in smaller economies, with a concentrated banking system.

guardian.co.uk/ money/2012/jan/19/contactless-wave-pay-revolution and http://www.visaeurope.com/en/ newsroom/news/articles/2012/usain_bolt_in_2012_ad_campaign.aspx (retrieved 2012, June 15).

With regards to investments required to improve shared infrastructure, such as IFTSs, Milne (2006, pp. 1627-1628) concludes that relatively concentrated (but not monopoly) banking systems achieve the greatest reductions in marginal cost of payment services. At the same time, incentives for individual banks to invest are higher, compared to fragmented banking systems, as individual banks can better internalise the benefits of an improved payment system.[52] Joint ventures might overcome incentive constraints, but benefits must be sufficiently large to outweigh bargaining and coordination costs. This delivers a further explanation of why more fragmented banking systems exhibit slower rates of technology adoption. Milne (2006, p. 1629) recommends inter alia reducing the role of shared infrastructure in order to increase incentives for innovation adoption.

Having illustrated the impact of network effects on the diffusion of new payment technologies, their influence on market structure will now be explored. Weitzel (2004, pp. 37-38 and 47-48) summarises that, in the field's fundamental literature, one major assumption prevails: positive network effects are indefinitely increasing. If one followed this assumption, the optimal, efficient network would involve the whole population, which would result in the formation of a natural monopoly (see chapter 2.2.4 for implications). But, the author replies that network effects may indeed diminish, and even become negative, with a growing number of users, since organisational and managerial complexity rise.

Weitzel concludes that a natural monopoly is not a compulsory social optimum. Instead, optimum network sizes could be smaller than the entire population, and multiple (incompatible) networks could coexist. Further, heterogeneous user preferences support the emergence of the efficient coexistence of networks, and help to overcome natural monopoly tendencies. Economides (2004, pp. 12-14) confirms this finding in principle. His model indicates that, although different networks exist, the leading one covers most of the market, while competitors

[52] According to Milne (2006), this reasoning is based on the assumption that higher quality and lower costs of payment services from technology improvements contribute to more economic activity, and thus higher bank profits. Enhancements of the shared infrastructure do not offer competitive advantages, thus incentives for individual banks to invest are limited. Nevertheless, in a banking system dominated by a few large banks with high market shares, it is more likely that individual banks can recoup investments and earn their share on the enlarged profit pool, i.e. internalise social benefits from higher economic activity.

yield much smaller market shares. Entry after the third firm has practically no influence on the output, prices and profits of the Top 3 firms, nor on consumers' and producers' surplus.

The card payments market exhibits the "winner-take-most" characteristic just described. Table 2–3 compares model predictions and actual shares on total volume of purchases with payment cards of the four biggest schemes per market (worldwide, USA and Europe). Cash withdrawals are excluded.

Market share	Model findings	Share on total volume of purchase transactions					
		Worldwide *(data for 2011)*		USA *(data for 2010)*		Europe *(data for 2009)*	
Largest firm	*63.4%*	Visa	64.7%	Visa	68.0%	Visa	72.2%
2nd firm	*23.2%*	MasterCard	25.6%	MasterCard	25.7%	MasterCard	26.0%
3rd firm	*8.5%*	UnionPay	4.7%	Am. Express	3.3%	Am. Express	1.7%
4th firm	*3.3%*	Am. Express	3.9%	Diners Club	3.1%	Diners Club	0.2%

TABLE 2-3: Predicted market shares vs. card schemes' market shares[53]

Some biases have to be borne in mind when interpreting the figures. First, card transaction numbers include (deferred) debit and credit card payments. However, American Express and Diners Club only offer credit cards. Second, for Europe, payments with Maestro cards (MasterCard's debit card brand) are not stated, while Visa debit card transactions are reported. Third, the European market is not yet fully integrated, but rather fragmented along country borders (see chapter 5.3.2 for details). In some countries, one domestic debit card scheme leads the market, while in others Visa debit or Maestro dominate. So, it would have been interesting to see detailed country figures, but those cannot be obtained. Similarly, an integrated worldwide card market does not exist. UnionPay for example is the monopoly card scheme in China. Within the country, merchants only accept and cardholders only hold UnionPay cards (HSN Consultants, 2010). Nevertheless, the scheme is continuously expanding its acceptance network abroad. Moreover, cardholders inter alia in Japan, Korea and Singapore can obtain local currency UnionPay credit cards issued by domestic banks.[54]

[53] Own illustration based on Economides (2004, p. 13) for modelling results and data published in HSN Consultants (2010, 2011 and 2012).

[54] See http://en.unionpay.com/comInstr/aboutUs/file_4912292.html (retrieved 2012, June 17).

Examples of direct and indirect network effects

Network effects can be direct and indirect. Katz and Shapiro (1985, p. 424) in conjunction with Klaus (2009, p. 237) point out that direct network effects are generated if the utility of the network good depends on the number of its users (nodes). If effects are positive, the utility of the network good rises with more users, since the number of possible connections between nodes increases. Indirect network effects influence the number and variety of complementary products available when the network expands, according to the authors. Klaus notes that indirect effects are positive if additional providers are motivated to offer complementary products and services once the installed base (number of users) is enlarging.

Direct network effects are observable at supplier level when participating in IFTSs and among banks offering ATM services. Both are explained hereafter.

Economides (2004, p. 3) suggests that clearing houses are networks, but explains direct network effects only with reference to exchanges. Nevertheless, his argument is conferrable to IFTSs in general: With each bank or ancillary system joining a system, the utility of all participants is enhanced as the number of possible connections between participants and their customers surge. It can be reasonably assumed that banks aim at optimising reachability between their customers. Against this background, banks would opt for joining an IFTS in which already a larger number of other banks participate. In Figure 2–3 (p. 45), a fourth bank entering the market would rather connect to the ACH than to the LVPS even if transaction costs would be equal.

The benefits are twofold. First, participating in a highly connected ACH, banks do not need to maintain a wide range of other clearing and settlement arrangements. Hence, complexity of and expenditure for bank-internal processing systems are lower. Second, clearing and settlement speed might be higher, raising customer satisfaction and possibly bank profits. Empirical studies are rare, but Gowrisankaran and Stavins (2004), for example, found evidence for network effects in their study on FedACH, according to which banks connect to the system when neighbouring banks also adopt ACH payments. Another aspect

is added by Guibourg (1998, p. 9) who notices that, especially in multilateral netting systems, costly liquidity holdings are reduced because "the need for settlement funds does not rise as fast as the value of payments processed" (see also Appendix A–2 on this).

At bank level, ATM networks also display direct network affects. Guibourg (1998, p. 8) notes, that every new bank joining and making its terminals available to the ATM network raises its value to cardholders, thereby benefitting the banks that joined earlier. Considering the earlier literature on the topic, Snellman (2006, pp. 13-14) supports the existence of network effects in ATM markets with respect to the adoption of ATM technology. In the previous section, it was pointed out that network effects might imply the emergence of monopoly structures. The question arises how monopolistic tendencies in mature ATM networks affect consumers. The studies reviewed by Snellman (2006, p. 16) come to mixed results. Nevertheless, she shows empirically for 20 European countries that mergers between incompatible ATM networks led to a decline in the number of ATMs resulting in decreased service levels and lower network value for cardholders (Snellman, 2006, p. 69). Unfortunately, countervailing effects, such as the extent to which banks pass on reduced bank operating expenses to consumers, were not analysed.

Indirect network effects are accepted at user level for ATM and POS networks and subsequently analysed.

ATMs generate a network of users enabling them to withdraw cash (Shy, 2001, pp. 187-188). Users are not necessarily customers of the same issuing bank, and the issuing bank might not be identical with the ATM acquiring bank, which is indicated in Figure 2–3 (p. 45). Guibourg (1998, p. 8) notes that cardholders' utility crucially depends on the number of ATMs available, not on the number of cardholders. The market is two-sided, a characteristic that is explained in the next section. A prerequisite for indirect network effects to arise is that ATMs and payment cards are compatible – despite being provided by different banks; otherwise the complementary product – cash withdrawal – cannot be generated (Economides & Salop, 1992, p. 105). As outlined in the previous section, to

achieve complementarity and compatibility, payment providers must cooperate and develop industry standards.

Like cash withdrawals, card payments are typical network goods whose production requires compatible network components. However, in contrast to ATMs, Guibourg (1998, p. 8) reasons that, in POS networks, direct externalities are more important. Her argument is based on the observation that the more merchants and cardholders are connected, the greater the utility for new users to join. However, she fails to recognise that the pure combined number of users is not as relevant as the number of possible card transactions between merchants on the one hand, and cardholders on the other. Such mutual dependency is an important feature of two-sided markets as explored below.

2.2.3 Two-sided markets and payment cards

This chapter deals with the application of the theory of two-sided markets on payment markets. First, the main characteristics of two-sided markets are mentioned. Based on that, three examples demonstrate the asymmetric prices charged to the two sides of the network. Thereby, fixed fees for adoption and variable fees for usage are distinguished. Regarding the latter, the interchange fee imposed by a card scheme on each payment is the most prominent example and is therefore examined in more detail.

Rochet and Tirole (2003, 2006) were among the first to research two-sided markets and singled out two decisive features: the existence of two distinct user groups, and the non-neutrality of the price structure on transaction volumes.

The authors documented that in two-sided markets, indirect network effects exist between two groups of users. Adoption and usage decisions of these two groups are interdependent. For example, Verdier (2006, p. 8) acknowledges that in payment card markets, indirect network effects arise between cardholders and merchants. Their demand for payment cards and POS terminals respectively are closely dependent on each other. For cardholders, it is beneficial if their cards are honoured by a large number of merchants. Merchants in turn will only invest in

acceptance infrastructure if they expect that many consumers wish to pay by card, or will otherwise abstain from the purchase.

According to Rochet and Tirole (2006, p. 2), platforms such as card schemes enable transactions between users, e.g. pairs of merchants and cardholders. A platform sets incentives to "get the two [...] sides 'on board'" by determining an adequate price structure. Thereby it establishes fixed charges for joining the platform (adoption charges) and variable fees for interactions on that platform (usage charges) for each side of the market separately. In two-sided markets, the overall volume of transactions depends on the price structure, i.e. the allocation of prices between the two market sides, rather than the overall price level. In order to maximise transaction volumes on the platform, the price allocation between user groups should reflect their respective elasticity of demand (Rochet & Tirole, 2006, p. 24). Actually, the market side with the lower price elasticity appears to subsidise the other side exhibiting a higher price elasticity. Consequently, Verdier (2006, pp. 5-6) notes that card schemes and their member banks set prices such that

- merchants and cardholders are incentivised to adopt and use the scheme cards,
- demands of the two groups are balanced and
- indirect network externalities are internalised.

While cheque payments also show characteristics of a two-sided market, this is not the case for cash, credit transfer and direct debit transactions. Here, merchants do not need to install a specialised acceptance network, and the demands of payers and payees are not distinct (Verdier, 2006, p. 9).

At the core of the debate on the two-sidedness of payment markets lies the question of how to lower payment system costs to society by encouraging the uptake and use of more electronic payment instruments, such as payment cards, to the detriment of expensive cash and cheques. As payment demand is exogenously given by economic activity, such strategies would change the payment mix, making it more efficient.

Subsequently, three examples demonstrate how the price structure is skewed to one side of the market, thus designed to encourage transactions with more

efficient payment instruments. Thereby, a distinction is drawn between (i) fixed fees for adoption of a certain payment instrument reflecting "adoption externalities" and (ii) variable fees per transaction reflecting "usage externalities". Both specifications of network externalities were defined above in chapter 2.2.2. Based on the results of this chapter, it seems advisable to distinguish the two. Yet, much of the payment literature is concerned with the influence of variable fees on usage, but hardly pays attention to fees for adoption or even ignores the differences (Chakravorti, 2009, p. 16).

Supporting adoption through subsidisation

Only a few studies are concerned with fixed charges for adoption of a certain payment instrument; these assume a fixed fee on one side of the market, the payers'. Two examples are cited hereafter. Research on payment systems that explicitly considers pricing for membership on both market sides is not known.

Ackerberg and Gowrisankaran (2006) analyse payers' decisions to adopt electronic ACH payments[55] (in essence credit transfers and direct debits) instead of continuing to rely on cheque transactions. For ACH payments to occur, the payers' and payees' banks need to be connected to FedACH (Table 2–2, p. 38). Moreover, payers must actively implement ACH technology to originate a transaction. This requires investments, for example, in specific software and the training of personnel. Payees, on the other hand, can receive transactions anyway, as long as their bank is linked to the ACH. The authors found that ACH technology is almost exclusively adopted by big companies, such as employers that originate a large number of transactions. Obviously for smaller firms the fixed costs of adoption are higher than the perceived benefit from switching to ACH payments. Their demand is perfectly inelastic. Hence, the authors argue that implementation costs should be subsidised, in order to encourage the adoption of the more efficient ACH payments, thereby raising transaction volumes.

[55] ACH is an electronic payment system operated by the Federal Reserve and used by banks and their customers to substitute paper cheques. Typically, ACH payments are deployed for recurring transactions such as direct deposit paycheques and automated utility bill payments (Ackerberg & Gowrisankaran, 2006, p. 3).

Bolt and Chakravorti (2008a) model the acceptance of debit or credit cards by merchants based on their costs per transaction, and the opportunity to increase sales. Purchases rise if

(i) consumers can spend their whole income by carrying a payment card instead of cash, which may be stolen before arriving at the shop and

(ii) liquidity-constrained consumers can borrow through their credit cards.

Merchants' transaction fees are a function of bank processing costs including default losses. Consumers pay a fixed fee per payment card, but can withdraw cash at no cost. Their utility is only positive if they can make purchases. It improves with higher consumption resulting from (i) greater security and (ii) access to credit. The profit-maximising, monopolistic bank performs issuing and acquiring tasks in one entity, no interchange fees apply. Bank processing costs can be low or high.

From the calibrated model[56] and under the assumption that consumers either utilise a debit or credit card or revert to cash, the following insights can be derived based on Bolt and Chakravorti (2008a):

– The maximum payment card fixed fee is inversely related to the merchant transaction fee. Consumers are willing to pay more for credit than for debit cards, since the former allows consumption even if income arrives later (see also chapter 4.2 for additional research confirming this notion).[57] Consumers' willingness to pay increases with higher merchant acceptance which confirms existence of indirect network effects.

– Banks will fully extract surplus from consumers before capturing surplus from merchants. Therefore, the bank sets fixed fees, such that consumers' utility from using a payment card just equals the utility from paying with cash. The authors attribute this to the two-sided nature of the market: If transaction fees

[56] The respective modelling results and parameter settings are displayed in Table 2 and 3 of Bolt and Chakravorti (2008a).

[57] The model by Rochet and Wright (2010) justifies differences of interchange fees in debit vs. credit card networks with the provision of credit to cardholders by banks instead of the merchant. The authors calculate the optimal interchange fee as a weighted average of merchants' net avoided cost from not having to accept cash, and not having to provide credit; the weights would be the proportion of each type of transaction (purchases where debit cards can be used vs. purchases where credit is required).

are low, more merchants will accept payment cards; this increases the willingness of consumers to pay for obtaining them.

– Merchant transaction fees differ according to bank processing costs. If processing is efficient, merchant fees are low resulting in high acceptance rates and welfare. Otherwise acceptance and welfare are low, the differences are especially pronounced in the case of debit cards. Nevertheless, merchants' profits are highest when they decline payment cards and only accept cash, which explains why payment cards are not universally honoured.

– Looking at social welfare, payment cards generate, in most cases, higher welfare than cash. Therefore, from a social planner's point of view, if processing costs are sufficiently low, it seems sensible to subsidise merchant acceptance (e.g. investments for POS terminals) or force their variable fees (further) down in order to encourage efficient card payments. It should be borne in mind that this could negatively impact cardholder fixed fees, and the number of transactions. In addition, rising default costs from more widespread use of credit cards need to be taken into account when optimising welfare.

Some weaknesses of the model should be noted. First, cash is assumed to be free, although handling costs can be substantial, as indicated in chapter 2.1.2 and substantiated in chapter 3.2. If merchants and consumers could take into account their cost of cash, they would probably more often turn to card payments. As a consequence, from a more efficient payment mix, welfare effects could be more pronounced. Second, the inverse relationship between cardholder fixed fees and merchant transaction charges might not hold in practice. In their survey on European retail payments, the European Commission (2007a, p. 100) found no strong correlation between cardholder fees and interchange fees. Since interchange fees account for a substantial part of merchant service charges (European Commission, 2006a, p. 34), which correspond to the merchant transaction fees in the model, other factors might play a role in determining the allocation of prices to cardholders and merchants. Despite its drawbacks, the study valuably contributes to the two-sided markets literature, as it pays attention to the setting of fixed fees as part of the asymmetric price structure, which is otherwise often ignored.

Overall, for emerging payment networks to reach an efficient size, it seems advisable to encourage (subsidise) fixed adoption charges, in order to correct market failure from adoption externalities. However, in mature networks, like existing payment card schemes that already serve a large fraction of the population, usage externalities play a larger role as Rochet (2007) argues. This means, even if all consumers hold payment cards, they still need incentives to actually use them. Issuing banks spend a lot of time to design loyalty schemes that include, for example, airline miles to reward usage. The associated costs are – at least partly – recovered through interchange fees.[58] Their role in the card market is explored hereafter.

Promoting cardholders' demand through interchange fee

Interchange fees are levied on merchants as part of the merchant service charge for each transaction. They are frequently quoted to demonstrate the rebalancing needs between the two sides of the payment card market.[59] Interchange fees are distributed from the acquiring to the issuing bank. This is mediated by the card scheme in which both banks are members. If issuing and acquiring banks have not agreed on an interchange fee, a multilateral interchange fee set by the card scheme is applied. Issuing and acquiring banks are involved in establishing its level via the board of jointly owned card schemes, or via special committees (Börestam & Schmiedel, 2011, p. 13).

Because interchange fees are agreed among competitors, they have been subject to a number of rulings by competition authorities. A fairly complete list on investigations initiated and actions taken by public authorities is provided in Bradfield and Hayashi (2008), more detailed assessments are available in OECD (2007, pp. 40-43) as well as in Abele, Berger and Schäfer (2007, pp. 49-67).

[58] No empirical evidence on the level of pass-through to consumers is available. In the case of Australia, Bolt and Chakravorti (2011, pp. 15-16) report that the interchange fee cap imposed by the Reserve Bank led to higher annual card fees for consumers and less rewards.

[59] Interchange fees may also be agreed bi- or multilaterally for other non-cash payment means. EU market practices were surveyed by European Commission (2006b, pp. 133-135 and 139), with the result that multilateral agreements by a countries' banking associations may distort competition between banks for the provision of payment services. Moreover, the existence of interchange fees might be socially undesirable, as consumer prices become non-transparent, and banks might promote less efficient payment instruments.

Authorities such as the European Commission (2007a, pp. 116 and 168) and OECD (2007, pp. 7-9 and 310) argue that multilateral interchange fees inter alia

- might extract rents from merchants who are relatively price inelastic as they want to avoid losing customers by declining payment cards,
- may create market entry barriers to foreign banks if domestic banks bilaterally agree on interchange fees lower than the fallback multilateral ones.
- give rise to an implicit subsidy (i) from payment card shoppers to cash users and (ii) from debit to credit card payers as interchange fees for debit cards are lower than for credit cards – provided that merchants are not allowed to differentiate prices according to the payment instrument utilised, and
- could result in a socially inefficient payment mix, since (i) issuing banks tend to incentivise consumers to employ payment instruments that carry high interchange fees (such as credit cards) and (ii) consumers choose payment means based on private benefit (such as loyalty rewards), not based on full marginal costs, as the latter are unknown to them.

In contrast to the undesirable effects listed above are arguments that highlight the beneficial role interchange fees can play in two-sided card markets. The European Commission (2006a, pp. 18-19) states two reasons cited by payment providers for the existence of interchange fees. These are necessary

(i) to attract an optimal number of card network users, encourage exchange between them and thus contribute to the efficiency of retail payments and
(ii) to share costs and compensate issuing banks for services provided.

In addition, the process of setting interchange fees helps to save bargaining costs. All three points are now illustrated.

First, the nature of interchange fees as a tool to increase usage of payment cards is further explored. In her recent review of the literature on interchange fees,[60] Verdier (2011) summarises that these are necessary to correct the market failure, i.e. less than efficient usage caused by indirect network externalities arising bet-

[60] Several other literature reviews exists on the topic. For an introductory view see Bolt and Chakravorti (2008a), more detailed assessments are given by Rochet (2003) and Abele et al. (2007, pp. 72-83). The reviews by Schmalensee and Evans (2005) as well as Bolt and Chakravorti (2011) concentrate on the effects of regulatory interventions. A short synthesis on optimality and neutrality of interchange fees is provided by Verdier (2006, pp. 12-15).

ween consumers and merchants. The interchange fee that maximises transaction volumes should reflect the elasticities of demand of (heterogeneous) cardholders and merchants (Verdier, 2011, p. 280). There is a broad empirical consensus, that the consumer side should be subsidised to encourage card transactions (Verdier, 2011, p. 277). And Börestam and Schmiedel (2011, p. 13) affirm that, normally, merchants pay the largest share of aggregate transaction prices, whilst cardholders are occasionally even rewarded for initiating card payments. This market practice is justified by assuming lower price elasticity on the merchants' side, compared to the cardholders'. According to the authors, merchants' elasticity of demand has not so far been studied. Nevertheless, Rochet (2007, p. 12) suggests that merchants internalise some fraction of consumers' benefit arising from being able to pay by card, and therefore tolerate higher fees more easily than cardholders. Research on the price reactions of consumers is reviewed in chapter 4.2.

The interchange fee that maximises card payment volumes might be higher or lower than the welfare maximising interchange fee, indicating a socially undesirable under- or overuse of payment cards (Verdier, 2011, pp. 283-284). This finding can be illustrated by comparing payment costs to society (as shown in Table 3–5, p. 117) and payment card use. In Portugal, for example, payment costs amounted to 0.8% of GDP in 2005, the highest among the countries listed in Table 3–5; the average resident used his payment card 80 times in this year. On the other hand, Finland's citizens initiated on average 128 card transactions, and payment costs were as low as 0.3% of GDP, the lowest figure among the countries compared.[61] Although these numbers do not go beyond anecdotal evidence, they might arguably point to payment card underuse in Portugal, while Finland may exhibit an efficient payment mix.

The second reason offered for the existence of interchange fees is that acquiring banks reimburse issuing banks for the provisioning of a number of processing services, such as authentication, verification and authorisation (chapter 2.1.1). According to Verdier (2011, p. 281), the volume maximising interchange fee equalises the issuing and acquiring bank's perceived marginal costs. Such redis-

[61] Number of card transactions for all cards issued in the country except e-money function per million inhabitants according to SDW (http://sdw.ecb.europa.eu, data retrieved 2012, June 21). All figures as of 2005.

tribution would result in identical transaction costs borne by either bank – provided that consumers' and merchants' demand and price elasticity are identical. Unfortunately no public data are available to underline these findings. Nevertheless, some German and French banks analysed the card business' economic situation in both markets and uncovered a substantial reallocation from acquirers to issuers for POS card payments (Capgemini Consulting, 2008, pp. 32-33).

Third, the interchange fee setting process is a coordinated way of collectively agreeing on a distribution mechanism, which market participants deem necessary to ensure the proper functioning of two-sided card payment markets. The alternative would be "a chaotic system involving literally thousands of bilateral negotiations among issuing and acquiring banks, with the viability of the system in question" (OECD, 2007, p. 39). Indeed, the low extent of about 10% of transactions, in which banks revert to bilateral fees, confirms this view (OECD, 2007, p. 25).

The final outcome of this bargaining process is influenced by a number of factors which Börestam and Schmiedel (2011, pp. 12-14) collected:

- mutual usage externalities of both market sides,
- diffusion of the card scheme in question (growing or mature platform),
- price elasticity of issuing banks because interchange fees constitute an important part of issuing revenues,
- intensity of competition in the issuing and acquiring market,
- bargaining power of issuing and acquiring banks in the fee setting process.

Moreover, fee levels could be set such as to steer consumers towards more efficient payment cards (Börestam & Schmiedel, 2011, p. 17) which will be further discussed in chapter 3.2.

Once all these aspects are taken into account, interchange fee levels can vary widely across different markets. For the EU, these were surveyed by the European Commission (2006a, p. 30). For example, no such fee is applied in the Finish and Danish debit card schemes, Pankkikortti and Dankort, while in other European debit card schemes the interchange fee can make up to 0.8% of the payment value (European Commission, 2006a, p. 30).[62] In Germany, merchants

[62] The highest fee of 1.34% of debit card payment value is excluded, since the card scheme in

bear 0.3% of the value paid with girocards, but at least EUR 0.08 per transaction.[63] Credit card transactions entail even higher interchange fees ranging from about 0.6% to almost 2.4% of the payment value (European Commission, 2006a, p. 25). Reflecting the interchange fee variances, merchant service charges range from 0.3% to 3.0% in domestic debit card schemes and between 0.4% (0.9%) and 3.3% (3.0%) of MasterCard (Visa) credit card transaction values (European Commission, 2006a, p. 40).

Until now, no consensus among academics and regulators has emerged on how to determine interchange fees in a way that is welfare-maximising. Bolt and Chakravorti (2011, p. 24) state: "While the theoretical literature on the economics of payment cards is growing, the empirical literature is too limited to provide much guidance to public authorities." Overall, a balance needs to be achieved between raising merchant acceptance by demanding lower interchange fees on the one hand, and securing sufficient revenues for issuing banks, necessary to provide adequate incentives for payment card usage, and reliable payment networks operations on the other.

2.2.4 Supply-side economies of scale and open access to infrastructure

This chapter is concerned with economies of scale in (payment) networks. The concepts of natural monopoly and monopolistic bottlenecks are introduced and applied to payment systems. Second, the necessity for open access to essential facilities, such as IFTSs, as one measure to ensure efficient clearing and settlement, is emphasised. Finally, ways to exercise monopoly power in national debit card schemes are summarised.

A payment systems' infrastructure is characterised by strong economies of scale (Bolt & Humphrey, 2005, p. 6). According to Khiaonarong (2003, p. 31), appro-

question only processes low domestic volumes. Note that owing to complex tariffs, which are combinations of flat-rate and ad valorem fee, the European Commission simulated interchange fees based on a payment of EUR 50. The 0.8% and 1.34% mentioned refer to a fee of EUR 0.40 and EUR 0.67 per EUR 50 payment respectively as presented by the European Commission (2006a, p. 30). Data were collected over a period of 2000 to 2004 (European Commission, 2006a, p. 13).

[63] If merchants are part of the petrol sector, they pay preferential rates of at least EUR 0.04 per transaction and 0.2% of its value (see http://www.electronic-cash.de/en/contractual-basis/payment-system-fees.html, retrieved 2012, June 19). Besides, kick backs paid by acquirers to merchants lowering merchant charges are not uncommon.

ximately 50-80% of infrastructure costs in large value and retail payment systems are fixed. High initial investments and low marginal costs lead to declining average costs when volumes transacted increase (Shy, 2001, p. 5). OECD (2007, p. 28) draws the example of payment card networks, which bear large fixed costs for processing and ICT infrastructure at card processing centres, banks and merchants. Yet, variable costs are comparably minor and include manual authorisations or oversight of evolving fraud risks. Chapter 3.1.1 provides a literature review on economies of scale in IFTSs.

Economies of scale imply that the cost function is subadditive for the relevant range of demand. This means it is less costly for a single firm to produce a certain output instead of two or more firms (Klaus, 2009, pp. 178 and 180). Klaus (2009, p. 177) remarks that subadditivity in relation to the infrastructure is in fact network immanent, and a source of concentration tendencies. The author continues that, in conjunction with irreversibility of investments, natural monopolies might emerge. Investments are irreversible if the resources or production factors acquired can hardly be used for alternative purposes, or only with excessive loss of productivity (Klaus, 2009, pp. 170 and 186-187). Such sinking costs create entry barriers, which then limit the threat of potential competitors to a monopolistic supplier (Klaus, 2009, p. 200).

Refining the concept of natural monopoly, Knieps (2004, p. 8) determines that within a network, a monopolistic bottleneck is

(i) a facility essential to provide services to network users – no substitute exists due to subadditivity – and
(ii) it is economically infeasible to duplicate the facility as the investment costs for establishing it are irreversible.

It can be owned and operated by a single firm or a joint venture of firms which otherwise compete. As a consequence, Guibourg (1998, pp. 18-19) notes that such a monopolistic bottleneck exclusively controls a vital production factor in one, typically intermediary, segment of the network, but might compete in other complementary – often, user facing – market segments. The monopolist could limit competition in these parts of the market, for example, by impeding access to

the essential facility it operates.[64] The author refers to the so-called essential facility doctrine designed to mitigate bottleneck monopoly power: Firms that control essential facilities should offer non-discriminatory access to all active and potential suppliers. Knieps (2004, pp. 11-12) emphasises three dimensions in this regard: symmetrical access pricing, equal quality of operational services and no delay in granting access.

Within the payment system, a number of monopolistic bottlenecks can be identified: IFTSs and card schemes. Arising from network effects, a common determinant for the development of payment systems is that users prefer to easily and unrestrictedly transfer funds to other users, even if these are affiliated with another bank as touched upon in Leinonen (2008a, p. 26). Further, the author observes that users favour only a limited number of payment instruments, given that these are incompatible. Cardholders, for example, would find it difficult to manage and fund a large number of payment cards in parallel. And merchants would bear additional costs for acceptance if different POS terminals and processing routines would be required for each card brand. Network effects, monopolistic tendencies and the call for efficient service provisioning, i.e. exploiting economies of scale and avoiding costly duplication of payment infrastructure, are responsible for interbank cooperation being common in large parts of payment systems' networks (Guibourg, 1998, p. 9 and Milne, 2006, p. 1621).

As a result, monopolistic interbank payment infrastructures emerge (Leinonen 2008a, p. 26). In the EU, for example, until recently, national banking communities tended to jointly own and operate essential facilities, such as the domestic ACH, as well as the debit card scheme and the associated processing centre. All of which are frequently confined to the national market without cross-border or within-country competition. The extent to which this could be abused to obstruct competition and the entry of foreign banks or nonbank PSPs into the domestic payment market is explored below. For a comprehensive report on the development and current state of the eight European payment systems analysed in this dissertation refer to chapter 5.3.2.

[64] Besides, the company can leverage its monopoly position across markets through exerting incompatible technical standards, bundling of products and other pricing strategies, as well as non-price discriminatory strategies (Economides, 2004, p. 22).

In Figure 2–3 (p. 45), it is assumed that the domestic banks (Bank 1 and 2) manage the national ACH, and set access criteria that de-facto prevent (foreign) Bank 3 from processing its customers' payments through the same infrastructure. One alternative is to connect to Bank 1 or 2 and become an indirect ACH participant. However, such agreements could be unfavourable to Bank 3 (such as slow processing, high transaction prices) and impede its opportunity to compete in the market. Instead, Bank 3 decides to become a direct participant of the LVPS. Generally, such a strategy entails higher costs (Khiaonarong, 2003, p. 28) when compared to transmitting funds via an ACH. Among other cost determinants are the more sophisticated security measures and advanced requirements, in terms of operational abilities and liquidity holdings imposed by LVPSs. Moreover, Rambure and Nacamuli (2008, p. 10) mention that LVPSs' charges likely disadvantage banks that transfer only low volumes, which might be the case with a foreign bank trying to enter a new market. As a result, Bank 3 is hindered from competing on an equal footing with the other banks in acquiring merchants, and delivering payment services to consumers, including ATM withdrawals.

Surveying the retail payment markets in the EU, the European Commission (2007a, p. 149) found a number of possibly discriminating ACH access criteria that could impede competition, such as

- being a bank or nonbank financial institution (e.g. payment card scheme) which excludes nonbank PSPs,
- transmit minimum payment volumes,
- become a shareholder of the infrastructure owner,
- being a member of the national banking association, and
- operating in the country for a certain period or maintain physical premises.

Against this backdrop, inter alia Leinonen (2008a, p. 240) pushes for equal and open access rights to (domestic) ACHs for all licensed payment providers, including foreign banks and nonbank PSPs. According to Guibourg (1998, p. 21) ensuring broad, non-discriminatory access to and efficient utilisation of a

payment system's infrastructure, is often cited as an argument supporting the involvement of public authorities and the central bank.[65]

Holthausen and Ronde (2000, p. 33) also link access regulation to the issue of systemic risk prevention, pointing to the advantages of settlement in central bank money, as discussed in chapter 2.1.3 and Appendix A–2. They find that private access regulation (e.g. private operating IFTSs) "does especially well in terms of welfare if the systemic impact of failure is low, as the private banks internalise most of the costs of net settlement. On the other hand, when failures propagate through the system, the customers bear most of the cost of systemic crisis. Then the case for public regulation is stronger."

However, Guibourg (1998, p. 21) points out that the goal of promoting efficiency should not be misunderstood as to allow evermore new participants to join when economies of scale and network effects are already fully exploited. Newcomers should rather start a competing venture, instead of free riding on investments already made. Here, the factors restraining network size (organisational and managerial complexity) come into play. The extent to which the central bank should be involved in the provision of payment services was also recently discussed by Khiaonarong (2003), Bolt and Humphrey (2005) as well as Beijnen and Bolt (2009). Results are reported in chapter 3.1.1.

As far as national debit card schemes are concerned, three areas emerge where monopolistic market power persists. First, signs materialise that domestic interchange fees are set in a way to discourage foreign banks from entering the acquiring market (European Commission, 2006a, p. 31). Second, the Commission found that higher vertical integration of schemes, as described in chapter 2.1.1, comes at the cost of muting competition between issuing and acquiring banks. It suggests the separation of scheme ownership from network operation and the issuing / acquiring business (European Commission, 2007a, p. 92).

Third, national debit card schemes are not yet fully interoperable. Therefore, entry by foreign schemes, for example, through affiliating domestic issuing, and acquiring banks, has proved, until recently, problematic. With rare exceptions,

[65] Other reasons such as risk considerations are disregarded.

incumbent providers decided to divide the market into domestic and cross-border debit card payments. While the former are solely handled by the national scheme, the latter are transmitted through the processing centres of MasterCard or Visa.

In Germany for example, the girocard is co-branded with Maestro, thus enabling cardholders to pay and withdraw money within and outside the country. This practice seems to have precluded entry by a competing debit card scheme. Moreover, it leads to higher merchant prices since, on average, the interchange fees imposed for payments, based on the international debit card brands, are higher than those set by domestic debit card schemes (European Commission, 2006a, p. v and 32). How far the recent Commission's ruling on MasterCard and Visa interchange fees[66], as well as interoperability agreements between domestic card schemes, such as the establishment of the European Alliance of Payment Schemes (EAPS),[67] will contribute to lower interchange fees, remains subject to further analysis beyond this thesis.

2.2.5 Obstacles to payment system development

Throughout chapter 2.2 payment markets were identified as two-sided networks

- in which direct and indirect network effects determine the size of a single network (monopolistic tendencies) and the market structure, hence the number and size of competing networks (platforms) given access to essential facilities such as IFTSs and
- in which two interdependent user groups exist, whose adoption and usage decisions, and consequently transaction volumes, depend on the allocation of prices between them which is ruled by the respective network platform

Based on this, a deeper understanding of obstacles to payment system enhancements towards more efficiency emerged and is detailed below.

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[66] For a first insight see http://ec.europa.eu/competition/sectors/financial_services/enforcement_en.html (retrieved 2012, June 1). For an account of all interchange fee related investigations run by the European Commission and national competition authorities refer to European Competition Network (2012).

[67] The EAPS establishes bilateral connections between European national debit card schemes to allow cross-border card payments and money withdrawals. Until now, only a few agreements are already implemented, notably between Germany's girocard and three ATM networks, LINK (UK) as well as BANCOMAT (Italy) and EUFISERV (Switzerland, Austria). Also, some Italian POS terminals support girocard transactions. For more information on EAPS refer to http://www.card-alliance.eu (retrieved 2012, June 3).

The functioning and characteristics of payment systems directly and indirectly impact the adoption and usage of payment instruments on the consumers' side, and their acceptance by merchants (Verdier, 2006, p. 6). Since payment demand is largely fixed, moving to a more efficient payment mix requires, on the one hand, a change in consumer habits, and on the other, a coordinated effort by providers. Payment habits are difficult to alter, as chapter 4 will show, and, subject to the right incentives given adoption externalities and start-up problems; providers are reluctant to invest in new technology and infrastructure (Leinonen, 2008a, p. 27) inter alia, due to difficulties recouping contributions made to update a payment systems' shared infrastructure (Manning, Nier, & Schanz, 2009, p. 142). At the same time, competition between providers is subdued, due to the collaboration required for developing payment infrastructure and instruments (Leinonen, 2008b, pp. 142-145).

Moreover, network effects and economies of scale entail monopolistic tendencies that may hinder competition and efficiency gains in the provisioning of payment services due to entry barriers and the need to access to essential facilities. Leinonen (2008c, p. 206) summarises that "the current payment industry and services structures contain a massive barrier against change." In two-sided card markets, subsidisation for one side might be required to achieve optimal network size and welfare-maximising number of transactions. However, if not combined with transparent pricing of payment instruments, based on (marginal) costs, users are not able to distinguish efficient payment means from more costly ones. As a result of the barriers to change, a countries' payment system might cause high resource costs to society. In the subsequent chapter 3 the efficiency of payments is examined.

3 Efficiency of payment systems

In this chapter, the body of literature related to the determination of payment systems' efficiency is explored. Two principle levels of analysis are distinguished, as shown in Figure 3–1 below.

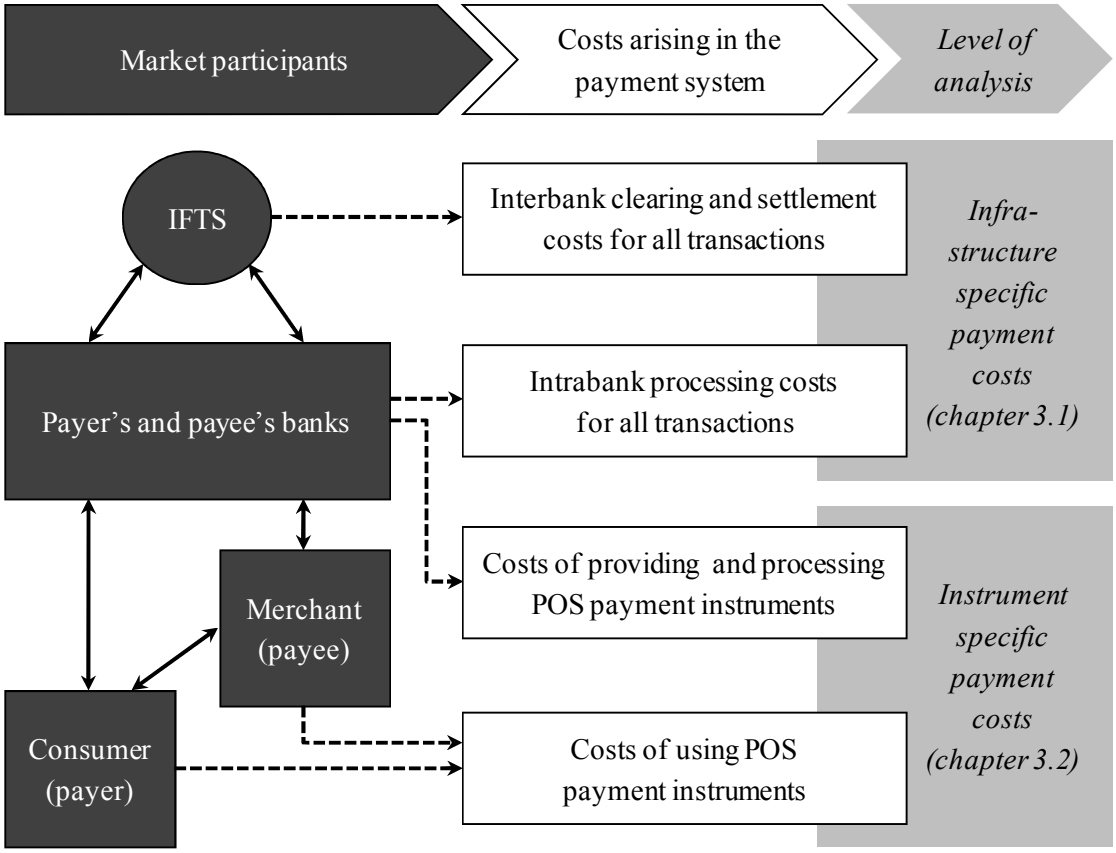

FIGURE 3-1: Efficiency of payment systems: Two levels of analysis[68]

First, infrastructure specific payment costs are incurred by IFTSs and banks for the processing of all types of payment transactions. Chapter 3.1 assesses the respective research, with an emphasis on RPSs and bank processing costs, as well as potential efficiency enhancing effects. Second, the expenses borne by banks for providing and processing payment cards, cash and cheques, as well as the costs (and benefits) of their usage at the POS assumed by consumers and merchants are of interest. Chapter 3.2 takes up this issue, and reviews related studies. Based on these results, payment instruments can be ranked based on their (cost) efficiency.

[68] Own illustration.

A first overview of the topic is offered by Bolt and Humphrey (2008), who review a selection of studies on payment costs concerned with both levels of analysis. The authors include research on intrabank processing expenditures and on payment instrument specific costs. For the former, they draw on Bolt and Humphrey (2007) and data included in a 2007 working paper from the Florida State University which has been later published at Bolt and Humphrey (2009), both studies are accounted for in chapter 3.1. For the second level, Bolt and Humphrey (2008) selected three studies: Gresvik and Øwre (2002) for Norway, Brits and Winder (2005) for the Netherlands, and Quaden (2005) for Belgium – all of which are examined in chapter 3.2. Bolt and Humphrey (2008) place their discussion of the research results within the context of establishing SEPA. This is underlined by the belief that SEPA will facilitate cross-border consolidation of inter- and intrabanking processing centres. The authors found large economies of scale associated with payment processing, and conclude that, if RPSs were to merge or banks were to unite their processing centres, unit costs per transaction would substantially fall. In this case, doubling transactions could entail over 30% cost savings. Users would also benefit, as these cost reductions are likely, at least partially, to be passed on to them.

In contrast to Bolt and Humphrey (2008), the following chapters entail an in-depth analysis of all relevant published work concerned with payment systems' efficiency starting as early as 1999 and including systems also outside of Europe. Emphasis is laid on a critical review of the assumptions made by the reviewed studies as well as on drawing links between their main findings including the resulting efficiency ranking between payment instruments as indicated in chapter 3.2.3. This specific approach was taken to reveal the complications involved with empirical payment markets research. It serves as a basis for choosing the key independent variable as well as a number of dependent variables for modelling purposes in chapter 5.

3.1 Research on payment infrastructure costs

Recent empirical literature[69] on the efficiency of payment infrastructure is very sparse because detailed, sufficient cost data are difficult to obtain, and in general confidential (Khiaonarong, 2003, p. 13). Moreover, costing methodologies vary widely, for example, in the choice of which items to include. Even basic information, like the – at least annual – volume and value of transactions with different payment instruments became available only about 20 years ago (Humphrey, Willesson, Lindblom, & Bergendahl, 2003, p. 160).

The existing publications focus on economies of scale and technological progress, while economies of scope and other possible efficiency enhancing factors, such as risk-mitigating measures, or governance arrangements, are less frequently investigated. With respect to RPSs, research on ACHs and cheque processing is analysed in chapter 3.1.1. Where applicable, costs of LVPSs transactions are included. A review of bank payment processing costs is given in chapter 3.1.2. Chapter 3.1.3 contains some concluding remarks on factors likely to influence inter- and intrabank efficiency. Throughout this chapter, the terms "electronic transactions" or "electronic transfers" refer to both, direct debit and credit transfers initiated electronically.

3.1.1 Efficiency of interbank retail payment systems

Subsequently, four studies on interbank clearing and settlement costs are reviewed: Hancock, Humphrey, and Wilcox (1999) as well as Adams, Bauer, and Sickles (2004) look at IFTSs operated by the Federal Reserve while Khiaonarong (2003) examines 31 IFTSs in Europe, North America and East Asia Pacific; Beijnen and Bolt (2009) concentrate on European ACHs.

Systems operated by the Federal Reserve

Hancock et al. (1999) estimate reductions in average Fedwire funds transfer costs associated with consolidation of payment processing centres, scale economies and technological change. During the time span under consideration (1979-

[69] A summary on the earlier literature from 1982-1997, which is almost entirely concerned with Federal Reserve operations (Fedwire, ACH, cheque and cash processing), is presented by Hancock, Humphrey, and Wilcox (1999) in Table 1.

1996), the number of Fedwire processing sites fell from 12 to 1, whilst the number of customer services offices was reduced to one-third. At the same time, transaction volumes quadrupled and prices for data processing and ICT declined substantially. Consolidation of operations appeared beneficial due to

- greatly increased data processing speeds and ICT security allowing for cheaper, safer and more reliable transmission and processing of transfer orders over longer distances,
- consolidation among suboptimal small processing centres which reduced total costs and facilitated enhancements to and standardisation of operations and networks (prior to this, each site had established its own standards and network), and
- expansion of banks' activities beyond the operating area of a single processing centre; banks pushed for reorganisation to limit number of standards/networks.

Hancock et al. (1999) specify a translog cost function, in which the total costs of Fedwire operations are regressed against (i) Fedwire transfer volumes, (ii) a range of input prices for data processing/ICT, labour, buildings and materials/other inputs, (iii) a dummy variable accounting for technological advance and the number (iv) of processing sites and (v) customer service offices. The authors test three approaches to capture technological change: Two simply assume that it is linked to the elapse of time, while their preferred approach relates technological progress to five major initiatives that upgraded Fedwire operations.

Average costs per Fedwire transfer excluding restructuring expenses dropped by 24% from USD 0.34 in 1979, to USD 0.26 in 1996 in nominal terms. Hancock et al. (1999) find that this decrease is to one-fourth attributable to the consolidation of processing centres and customer service offices. The impact of upgrading Fedwire operations on costs appears to be rather small, at about 1% p.a. Nevertheless, industry-wide technological advances substantially lowered data processing and ICT input prices. Economies of scale are identified as the largest source of average cost reduction. Moreover, the results indicate that scale economies have not yet been exhausted, despite high volumes already handled.

Adams et al. (2004) extend the investigation in two directions. First, besides Fedwire transfers[70], ACH transactions are included. Second, in addition to the effect of scale economies and technological progress on transaction costs, the impact of scope economies is derived, which earlier studies have largely ignored. Here, the authors argue that expenditures for installing and maintaining processing centres and ICT networks, as well as for support staff and backup facilities, could be shared among Fedwire and ACH services provided by the Federal Reserve.

Adams et al. (2004) derive total costs for Fedwire and FedACH transactions (see Table 2–1 and 2–2, pp. 36 and 38, for details on both systems) based on the respective output volumes, and four input prices as in Hancock et al. (1999). A time dummy is included to mirror technological progress. No event-specific approach as in Hancock et al. (1999) is applied. The authors test a translog and separable quadratic cost function; data range from 1990 to 2000.

Across all specifications, Adams et al. (2004) find no robust evidence for the existence of economies of scope. This not only justifies the current practice of the Federal Reserve to manage each type of transaction service as a separate business. It also explains why other providers, such as CHIPS, Visa or MasterCard, do not attempt to enter the ACH market. At the same time, strong support for economies of scale in payment processing is displayed across all models. Consistent with the results of Hancock et al. (1999), the cost-saving effect of technological change seems to be rather small, and remains fairly constant, around 1% annually. This is in line with the yearly average, private-sector productivity growth in the USA at this time.

Finally, Adams et al. (2004) calculate marginal costs. Depending on the model, they report a range from around US cent 2.7-4.4 for each ACH payment in 1990, dropping to around US cent 0.5-1.4 in 2000. For Fedwire transfers, marginal costs declined from US cent 28-40 in 1990 to US cent 5-22 in 2000. The authors

[70] In their study, Adams et al. (2004, pp. 12-13) aggregate Fedwire and Book-entry transactions to yield a model with two, instead of three, outputs. This appears sensible, given the close link between the two. A securities transfer consists of two "legs", the payment for the security and the delivery of it, only if the former occurs (delivery versus payment) according to Rambure and Nacamuli (2008, p. 148). While the payment is made through Fedwire, the delivery is a book-entry transaction (Adams et al., 2004, p. 4).

do not explain the apparent large dispersion of ACH versus Fedwire payment costs. One reason is offered by Khiaonarong (2003, pp. 14-16). He states that the costs for providing large-value payment services are comparably higher than for retail transactions, since the former involve higher real resource costs for investments and operations, combined with higher liquidity and risk costs. Another reason could be that economies of scale are less exploited in Fedwire compared to FedACH. While the number of FedACH payments more than tripled between 1990 and 2000 to 4.7 bn,[71] Fedwire volumes increased only by 42% to 108.3 m.[72]

Both, Hancock et al. (1999) and Adams et al. (2004) note that their results allow inferences on the cost structure of private payment processing providers, such as banks' back offices, as well as CHIPS or credit card processing centres. This notion seems sensible, as the Federal Reserve runs its operations as if it were a private competitor. Thereby, it aims at full recovery of operating expenses and imputed costs, which serve as the "profit element" to create a level playing field (Khiaonarong, 2003, p. 47).

Cross-country and European studies

The first (and only known) comprehensive assessment of scale and scope economies in IFTSs in Europe, North America and East Asia Pacific was undertaken by Khiaonarong (2003). In contrast to earlier reports, the author does not control for the influence of technological advance on payment costs. But he considers the role of the central bank in providing interbank funds transfer services. Khiaonarong (2003, p. 30) differentiates three policy arrangements:

(i) Minimalist approach: Central bank owns and operates only core IFTSs and does not compete with the private sector; central bank pricing is based on full cost recovery.

[71] Figure for 2000 as of CPSS (2003c, p. 159); for 1990 derived from CPSS (1991, p. 47): 941 m ACH credit transfers excluding ATM withdrawals plus 494 m direct debits times 0.88 market share as in 2000 (CPSS, 2003c, p. 159).

[72] Figure for 2000 as of CPSS (2003c, p. 159). Adams et al. (2004, p. 4) report 223 m Fedwire transactions in 2000, which could not be confirmed by CPSS data. In 1990, Fedwire processed 62 m payments (CPSS, 1991, p. 47). In addition, book-entries amounted to 14 m in 2000 according to CPSS (2003c, p. 159) while Adams et al. (2004, p. 4) states 29 m, the difference cannot be explained. One reason could be that Adams et al. (2004) sums up incoming and outgoing payments that essentially belong to the same transaction.

(ii) Competitive approach: Central bank and private sector compete in the provision of IFTS services under a level playing field principle. This requires full cost recovery, including imputed costs, e.g. costs that would have been incurred if services had been produced by a private processor.

(iii) Public service approach: Central bank owns and operates a majority of a country's IFTSs. The private sector does not compete and central bank pricing policy is directed to variable cost recovery and subsidisation of fixed costs.

Khiaonarong (2003) uses a log-linear model to derive unit costs as a function of (i) the number and average value of transactions, (ii) GDP per capita and (iii) two dummy variables accounting for the three policy approaches taken by the central bank. Data for the 21 LVPSs and 10 RPSs under consideration are mostly as of 2001. Operating costs and revenues were obtained through a common survey questionnaire. Still, they are not unambiguously comparable as pricing policies (degree of cost recovery), and costing methods (internal accounting methodologies) differ widely (Khiaonarong, 2003, p. 18).

Khiaonarong (2003, pp. 31 and 36-37) concludes that economies of scale are relatively strong. If the payment volume increases by 1%, unit costs are reduced by 0.49% to 0.68%, depending on model specifications. Scale economies are more pronounced in RPSs, due to higher volumes compared to LVPSs. Unit costs are positively correlated to GDP and average payment value. Here, rising general cost level in a country, and increasing expenditures to implement risk-mitigation are reflected. Scope economies are verified especially in ACH systems. Unit costs are lower if a number of different payment instruments are handled within a single facility such that fixed costs can be spread over a large number of transactions.

This result is in contrast to Adams et al. (2004). However, it appears more robust, since Khiaonarong (2003) examines a wide range of IFTSs, while Adams et al. (2004) only consider Federal Reserve systems. Scale and scope economies, as well as the level of risk, explain the large differences in unit costs reported by Khiaonarong (2003, p. 29): Average LVPS unit cost per transaction in the EU is

calculated at USD 1.54, in North America at USD 0.84. The average unit cost for ACHs in the EU is US cent 0.6, in North America US cent 0.8. Cheque processing in North America is more expensive, at USD 0.45.

As far as the role of the central bank is concerned, the model points to higher unit cost reductions under the minimalist, compared to the competitive and the public service approach. This implies a higher payment systems' efficiency, if the central bank's role is limited to own and operate only core IFTSs, without competing with private providers. A qualitative country analysis supports this finding.

Thereby, Khiaonarong (2003, p. 54) observes three other reasons why the minimalist approach is associated with higher payment systems' efficiency. First, the stronger involvement of the private sector in owning and operating IFTSs is mentioned. Unfortunately, the author does not substantiate this argument. But, it could be inferred that, since investment and operating costs are fully shared among the respective IFTS member banks, these have a strong interest in keeping expenses low. Second, in contrast to the competitive approach, the perceived conflict of interest stemming from the role of the central bank as provider of payment services on the one hand, and as regulator on the other, is avoided. Third, potential market failure due to subsidisation is circumvented. If central banks – as under the public service approach – absorb some of the payment costs on welfare grounds, so as to encourage an efficient payment mix, prices do not reflect real resource costs. Hence, private and social costs differ, which could lead to a socially undesirable over- or underuse of certain payment instruments.

Khiaonarong (2003, pp. 27-28) argues that the extent to which costs are recovered should be made contingent to the systems' stage of development. Further, transactions should be priced such that exploitation of economies of scale is encouraged. Under full cost recovery, this means applying a fixed adoption (membership) fee to recover fixed costs, and a per item usage charge that decreases with higher volumes, to reflect variable costs (Khiaonarong, 2003, pp. 51 and 57). The logic behind charging adoption and usage separately was outlined in chapter 2.2.3. In chapter 3.2, the problem of diverging social and private costs of payment instruments is discussed.

Based inter alia on the results of the three reports above, Bolt and Humphrey (2005) examine the TARGET system to deduce some policy recommendations on the design of its successor TARGET2. They propose consolidating the 17 TARGET[73] processing sites operated separately by national central banks, so as to take advantage of economies of scale and lower costs. In the year 2000, the average cost per transaction was around EUR 1.8. Only the two central banks with the highest payment volumes seem to reach the average level of transaction costs mentioned by Khiaonarong (2003, p. 29) of about USD 1.3[74] or EUR 1.15 (Bolt & Humphrey, 2005, p. 12).

Further, Bolt and Humphrey (2005) consider TARGET as a natural monopoly (see chapter 2.2.2 for details). On these grounds, the authors propose a temporary partial or full subsidy, until optimal network size is reached, i.e. full-scale benefits are realised, and unit costs decrease. After this initial period, prices should reflect full costs. In addition, it is suggested that pricing should consist of a fixed and a variable component, so as to encourage usage, and reward high volume members. This guidance is in line with Khiaonarong (2003, pp. 57 and 59). Bolt and Humphrey (2005) also look at economies of scope, but find very little if any evidence for their existence.

Finally, Beijnen and Bolt (2009) focus on economies of scale in eight European ACHs. Data from a variety of publicly available sources were collected, but the number of observations differs considerably between countries – from 2 in the UK (Voca/BACS) for the years 2004 and 2005, 5 in Belgium (CEC) from 1990-1994 to 16 in the Netherlands (Interpay) ranging from 1990 to 2005. The report also aims at capturing the effect of technological change and ownership structure on payment costs. Scope economies are not studied.

A translog cost model is employed that links operating costs to payment volume and two input prices, i.e. cost of labour and capital. Two dummy variables representing ownership structure and technological progress are added. Regarding the first dummy, the authors assume that, compared to private providers, national

[73] See "About TARGET" at http://www.ecb.int/paym/t2/target/html/index.en.html (retrieved 2013, February 24).

[74] Average transaction costs of the 21 LVPSs studied by Khiaonarong (2003).

central banks are more likely to subsidise the ACHs they own. Hence, reported cost data would only partially reflect the true processing costs, resulting in higher cost levels of privately owned ACHs, than of those owned by the central bank. Concerning the second dummy, technological change is associated with the passage of time.

Just as the aforementioned researchers did, Beijnen and Bolt (2009) also discovered large economies of scale. If the number of transactions would double, total operating costs would only increase by 23-30%, depending on the model specification. This effect is more pronounced in smaller ACHs. Yet, even the largest investigated processing centres exhibit scale economies. Against this background, the authors conclude that if European ACHs consolidate, average transaction costs would substantially decline. Further, they presume that the creation of SEPA will facilitate such mergers and thus contribute to raising European payment systems' efficiency. Beijnen and Bolt (2009) illustrate their findings: The merger of Interpay (Netherlands) and Transaktionsinstitut für Zahlungsdienstleistungen (Germany) to Equens could lead to a 35-40% reduction in average costs since transaction volumes would double.

According to the study, the ownership structure also explains cost differences between ACHs. Central bank owned ACHs show much lower average costs than privately owned ones, indicating that subsidisation is stronger in the former than in privately owned processing centres. The adverse consequences of this practice are emphasised by Khiaonarong (2003) as mentioned above.

Beijnen and Bolt (2009) also found that technological advance leads to an annual drop in operating costs of 5%. Compared to Hancock et al. (1999) and Adams et al. (2004) this figure appears quite high. However, Beijnen and Bolt (2009) relate it to the 6% yearly decrease in Fedwire payment costs determined by Bauer and Ferrier (1996). The noticeable divergence could be attributed to the fact that data processing and ICT input prices – being responsible for a large part of average cost reduction judging from Hancock et al. (1999) – are not represented in the models specified by Beijnen and Bolt (2009) and Bauer and Ferrier (1996).

In the next step, Beijnen and Bolt (2009) extend the model by establishing a two output case. More specifically, they distinguish two payment categories, i.e. bill payments (credit transfers and direct debits) and POS transactions (card payments, ATM withdrawals and cheques), regardless of whether these were initiated electronically or paper-based. The authors note that a more obvious split between paper-based (cheques and paper-based credit transfers) and electronic transactions could not be pursued, due to insufficient data on hand.

Nevertheless, subsuming electronic and paper-based payment instruments in either payment category could have two problematic implications. One is that the adverse impact of scale economies can be seen in the decline of paper-based instruments leading to rising unit costs (see chapter 3.1.2). Table 3–1 below shows the share of paper-based credit transfers and cheques in four of the 12 EU countries studied by Beijnen and Bolt (2009). In sum (last row of Table 3–1), the share of cheques was almost three times as high as the share of paper-based credit transfers in 1990 and declined more slowly until 2004. As a consequence of this disparity, rising unit costs possibly weigh more heavily on the estimated POS versus bill payments' scale benefits.

Country	Paper-based credit transfers		Cheque transactions		Paper-based credit transfers		Cheque transactions	
	... in % of non-cash payment volume				... in % of non-cash payment value			
	1990	*2004*	1990	*2004*	1990	*2004*	1990	*2004*
France	1.1	--	59.3	*29.4*	58.6	--	29.6	*1.9*
Germany	24.7	*7.0*	9.9	*0.8*	59.1	*43.4*	15.8	*1.7*
Netherlands	36.7	*7.8*	15.2	--	3.6	*8.2*	0.2	--
UK[(1)]	7.9	*2.8*	51.0	*16.2*	2.5	*0.2*	5.7	*2.2*
∑	15.1	*3.7*	41.4	*13.9*				

(1) In 1990, "Town" cheques used primarily in financial transactions are excluded (volume share <1%, but value share 53% on national non-cash payments). No such transactions were made in 2004.

TABLE 3-1: Share of paper-based credit transfers and cheques[75]

The second implication arises from an inappropriate classification of cheques as means of payment at the POS in some countries. From Table 3–1, it can be inferred that in France, the Netherlands and the UK, it is mainly consumers who have used cheques, given the apparently low average values. In Germany, however,

[75] Own illustration based on data in CPSS (1991) and CPSS (2006).

cheques are more often initiated by businesses, as their average value is higher. Thus, placing them into the POS category further distorts unit cost assessment.

Overall, Beijnen and Bolt (2009) establish that modifying the cost function by introducing two outputs has not substantially altered the results reported above. Scale economies appear to be slightly smaller with POS versus bill payments. This outcome is to be seen in the light of the implications of payment instrument categorisation just outlined. The authors attribute the lower POS scale economies to the need to install and maintain a costly acceptance network, which appears plausible.

Nevertheless, the two scale economy estimates are somewhat in contrast to Bolt and Humphrey (2007) (see review in chapter 3.1.2). Besides a deviating methodology, the reason could lie in the different level of data (ACH versus country level data) and in the time span considered. Bolt and Humphrey (2007) included the years 1987 to 1990, in which paper-based credit transfers and cheques were still popular. Judging from data published in Group of Experts on Payment Systems (1989, pp. 305, 311, 329 and 347), 1987 usage patterns were similar to the ones shown for 1990 in Table 3–1 (p. 81), although a slight decline in most categories is observable.

Further, Beijnen and Bolt (2009) present an inconsistent data set. For example, UK data include only two observations for the years 2004 and 2005. Yet, the UK has, besides France, been the only country among the ones researched in which cheques are heavily relied upon. Taken together – including earlier years especially in the UK – this could shift the picture in favour of POS scale economies and hence be more consistent with Bolt and Humphrey (2007).

3.1.2 Efficiency of intrabank payment processing

While in chapter 3.1.1 interbank clearing and settlement costs were investigated, this chapter is dedicated to the literature on intrabank processing costs. The availability of data is equally problematic, which limits the research published so far. In what follows, three studies based on individually collected data of banks in three countries are reviewed. Humphrey and Vale (2004) look at Norwegian

banks; banks domiciled in Spain are covered by Carbó-Valverde, Humphrey, and del Paso (2006)[76] and those in the Netherlands by Bolt and Humphrey (2009). After that, two cross-country studies that rely on publicly available information are analysed. Humphrey, Willesson, Bergendahl, and Lindblom (2006) consider 12 European banking sectors during 1987 to 1999 while Bolt and Humphrey (2007) build on this report and extend the data to 2004, but omit one country.

Throughout all these studies, nothing is said about whether operating costs include interbank expenses as well. If this were the case, not only the banks' efficiency in processing payments would be measured, but implicitly the efficiency of a country's clearing and settlement arrangements. While this observation is not problematic per se, some more transparency would be beneficial, for example in order to distinguish social and private costs of payments. If, for instance, IFTSs are owned and operated by a central bank, services could be subsidised, resulting in higher social than private costs, which in turn might have adverse implications on payment systems' efficiency overall. This problem is addressed at the end of this chapter, and again more specifically in chapter 3.2.

Studies on Norwegian, Spanish and Dutch banks

Humphrey and Vale (2004) compare the influence of bank mergers and advances in payment technology on the operating costs of 131 Norwegian banks, between 1987 and 1998. On the one hand, economies of scale are estimated to determine pre- and post merger cost effects, which are contrasted with those actually achieved. On the other hand, the savings from (i) reduced intrabank processing costs and (ii) service delivery expenses (smaller number and size of branches), both associated with the ongoing shift from paper-based to electronic payment instruments, are evaluated. During the 12 years investigated, the share of electronic on all non-cash payments surged from 15.6% to 74.1%.

Humphrey and Vale (2004) apply a Fourier and a linear spline specification, with seven size-classes to estimate total costs, which contain operating expenses, funding and the opportunity costs of financial and physical capital. The models accommodate two outputs, i.e. the value of consumer and business loans, as well

[76] Also published in almost identical form under Valverde, Humphrey, & del Paso (2004).

as four input prices (funding, labour, material and purchased services, opportunity costs for financial and physical capital). In contrast to other studies reviewed in the previous chapter, Humphrey and Vale (2004) do not use a time dummy to control for technological progress but the ratio of electronic payments to total non-cash transactions.

From the 26 mergers observed, the Fourier and the spline function predict ex-ante a 2-3% reduction of average (unit) costs, i.e. total costs to total loan values due to scale economies. Ex-post, the actual decline in average costs fits within this range and is computed at 2.8%. Thereafter, Humphrey and Vale (2004) assess the cost effects associated with the shift from cheques and paper-based credit transfers to debit card and other electronic transactions. They find a 13% decline in average costs over the whole period, which by far exceeds the cost savings accomplished through bank mergers. Hence, the authors conclude that encouraging the efficiency of payment systems should be preferred over policies that facilitate consolidation among banks.

Carbó-Valverde et al. (2006) establish the influence of advances in payment technology, and changes in service delivery, via branches or ATMs, on operating costs of 93 Spanish savings and commercial banks, between 1992 and 2000. Analogous to Humphrey and Vale (2004), improvements in payment technology are measured based on the substitution of paper-based by electronic transactions. While cheque use declined by 17%, card payments and other electronic transactions increased by 85% and 81% respectively. With regards to service delivery, the number of ATMs grew by 142%, the number of branches by 22%. Hence, the ATM/branch ratio rose from 0.6 to 1.2. The ratio of operating costs of the Spanish banks to total assets, i.e. unit costs, fell over the 9-year period by 37% – which corresponds to a saving of 0.7% of GDP in 2000.

Carbó-Valverde et al. (2006) employ a non-linear composite cost function to reveal the sources of this decline. Operating expenses (sum of labour, capital and material costs) are modelled using five output characteristics, i.e. the number of (i) ATMs and (ii) branches, the volume of (iii) payment card and (iv) cheque

transactions as well as (v) electronic transfers[77] and two input prices (labour, physical capital/ materials). The authors observe economies of scale as unit costs fall with rising asset value. In addition, as the payment mix becomes more efficient, predicted unit costs drop by 45% over the time span concerned. This result is in line with the values produced by the alternative translog and Fourier cost function, as well as with the actual figure of 37%.

Moreover, Carbó-Valverde et al. (2006) separate the effect of adjustments in service delivery from advances in payment technology. Holding the number of transactions and input prices constant at their mean value, the authors derive declining unit costs with increasing ATM/branch ratios up to 2.0. Given the actual ratio of 1.2, they conclude that further unit cost reductions can be achieved if ATMs expand relative to branches in the future. If ATM and branch numbers as well as input prices are held constant at their mean value, while overall payment volume grows, estimated unit costs decrease by 48% during the 9-year time period. However, separating the three payment instruments, cheque unit costs rise, while electronic transfers and card payments become cheaper. This observation is explained by the disparity in payment volume development disclosed above.

Bolt and Humphrey (2009) follow the path of Carbó-Valverde et al. (2006) and assess scale and scope economies for six major Dutch banks between 1997 and 2005, in the light of evolving payment technology, and service delivery practice. The authors believe that bank operations have become more efficient as banks

(i) realise greater scale benefits from expanding non-cash payment volumes – the number of card payments as well as other electronic transactions and paper-based credit transfer[78] increased by 67% – and

(ii) replace expensive branches with ATMs – the number of branches was cut by 51%, whilst that of newly installed ATMs increased by 37%.

They notice that actual unit costs – approximated by the ratio of operating costs to total asset value – declined by 38% during the time span surveyed. As the study by Beijnen and Bolt (2009) on European ACHs, Bolt and Humphrey

[77] According to Valverde et al. (2006, p. 15), these five banking outputs make up the bulk of bank operating costs.

[78] As cheque payments are close to zero, these are excluded (Bolt & Humphrey, 2009, p. 294).

(2009) relate their findings to possible cost savings possibly to be achieved once SEPA becomes a reality.

In their translog cost function, the authors link individual bank operating costs to two outputs, i.e. the (i) number of ATMs plus branches and (ii) total non-cash payment volume, and two input prices for labour and physical capital. Although they additionally include a time dummy, this turns out to be insignificant, as technological progress is already largely captured in the two outputs included. This confirms the observations made by Carbó-Valverde et al. (2006) and Humphrey and Vale (2004). As in these studies, the impact of lower ICT prices on unit costs is not controlled for.

Bolt and Humphrey (2009) obtain large-scale effects. Doubling the transaction volume would result in a 35% reduction of unit payment costs. Scale benefits from substituting ATMs for branches are slightly smaller. Overall, the weighted sum of both economies of scale estimates implies unit operating cost benefits of 38%[79] when outputs double, which is consistent with the actual data. The weights are the ratios of percentage change in the two outputs. It should be noted that the authors – unlike Carbó-Valverde et al. (2006) – include paper-based credit transfers in their model. If these were excluded, scale effects could have been even stronger, since processing electronic payments is more efficient than paper-based transactions, as suggested in chapter 3.1.2.[80] Economies of scope between processing of payments and maintaining ATMs and branches are found to be positive, but are insignificant. Bolt and Humphrey (2009) summarise that – given the possible savings in unit payment costs – realising SEPA could turn into 20% higher profits for banks. Due to competitive forces, this gain is expected to be shared, at least partly, with the users.

[79] The 38% is calculated from 0.24 weighted scale economies estimate. 38% = 100(1-1.24/2).

[80] In their survey on literature related to costs of specific payment instruments, Humphrey et al. (2003) report that an electronic transaction costs about one-third to one-half as much as a paper-based transaction.

European cross-country studies

Like Bolt and Humphrey (2009), Humphrey et al. (2006)[81] examine the advantages of a different payment mix and service delivery for the operating costs of banks. However, instead of individual (confidential) bank data, publicly available information on the entire banking sector of 12 European countries is analysed. Listed from the largest to the smallest amount of total bank assets, these countries are: Germany, France, UK, Italy, Switzerland, the Netherlands, Spain, Belgium, Sweden, Denmark, Norway and Finland. The rationale of the analysis is essentially the same as in Bolt and Humphrey (2009); the modelling approach is analogous to Carbó-Valverde et al. (2006).

During the period of 1987 to 1999, the share of electronic payments in the volume of non-cash payments surged from 43% to 79%. This development arose from a tremendous expansion in card payments (+671%) and other electronic transfers (+192%), while the use of cheques and paper-based credit transfers dropped by 10% and 79% respectively. At the same time, the ratio of ATMs to branches quadrupled from 0.3 to 1.2, which is almost entirely attributable to the rise of ATMs, as the number of branches remained stable.

A wider dissemination of electronic payments and of ATMs are believed to be responsible for the 24% reduction in unit costs measured. These are approximated – as in Bolt and Humphrey (2009) and Carbó-Valverde et al. (2006) – by the ratio of operating expenses to total asset value. Humphrey et al. (2006, pp. 1632-1633) note that, in the banking literature, this figure is generally accepted as a good proxy for unit costs. Moreover, the authors claim that operating costs consist to a large extent of

- expenditures for processing, debiting and crediting payments,
- delivering cash through ATMs and
- taking deposits and disbursing loans at branches – all of these activities are related to the ability to make or receive payments.

[81] From the information published, it can be inferred that Humphrey et al. (2003) (reviewed in chapter 3.2) use the same data and methodology, but report different outcomes. For instance, the decline in predicted unit costs is 45% (instead of 30%), which cannot be explained from the given information.

Using a non-linear composite cost function, Humphrey et al. (2006) link annual operating costs[82] to six outputs, i.e. transaction volumes initiated by (i) cheques, (ii) paper-based credit transfers, (iii) electronic credit transfers plus direct debits and (iv) payment cards as well as the number of (v) ATMs and (vi) standardised branches. The authors (p. 1636) describe the logic of choosing these parameters as follows: The volume of transactions processed on behalf of bank customers, along with the number of branches and ATMs, are directly associated with the bank's size and operating costs, from which scale economies can be determined.

Technological progress can be characterised more specifically by the change of the mix of electronic to paper-based transactions, and the ratio of ATMs to branches, than by alternative approaches, such as time dummies. Finally, input prices of labour and opportunity costs of physical capital and materials are integrated into the cost function. Humphrey et al. (2006) specify a translog and Fourier cost model, with four rather than six outputs. Here, cheques and paper-based credit transfers, as well as electronic transactions and card payments, are aggregated.

Humphrey et al. (2006) start by looking at the overall impact from a changing payment mix and service delivery practice on unit costs is looked at. Next, the cost effects of the two types of technological progress are considered separately.

With respect to the first approach, the authors detect over time a downward shift in estimated cost curves. This development has occurred out of three trends: (i) a rise of electronic payment instruments, (ii) accelerated distribution of ATMs and (iii) lower ICT prices. The impact of the latter remains unspecified here, but has been analysed by Hancock et al. (1999) and appear to be responsible for a 5% yearly reduction in average transaction costs (see chapter 3.1.1). Predicted unit costs, i.e. the ratio of predicted operating costs per dollar of actual assets, fall by 30% throughout the 13-year period. This figure is close to the 24% cut in unit costs seen in reality, which translates into total operating cost savings of 0.38% of the 12 countries' aggregated GDP in 1999.

[82] Total operating costs include labour, materials, outsourcing, capital consumption costs (but no interest expenses) and in some cases capital expenses of banks' ATMs – depending on country-specific arrangements. If costs incurred by banks' customers who use other banks' ATMs are included, these may lead to some double counting, since the revenue received does not reduce the reported cost of the other banks' ATMs (Humphrey et al., 2006).

As a result, bank prices could have fallen by almost 8%, if lower bank costs were fully passed on to users. Although economies of scale are observed along with expanding outputs, these have diminished in the largest countries by 1999 according to Humphrey et al. (2006). On the contrary, other studies such as Hancock et al. (1999) and Beijnen and Bolt (2009) still detect scale benefits, even if volumes are already large, as in Fedwire and European ACHs. The translog and Fourier models led to similar outcomes.

Humphrey et al. (2006) add a second dimension, by separating economies of scale associated with varying payment volumes on the one hand, and altering service delivery practice on the other. If variations in payment volumes are considered, while the number of ATMs and branches as well as input prices is held constant, strong scale economies are verified across all three models. A 10% rise in payment volumes result only in a 0.9% increase in operating costs, which implies falling unit costs. The authors then separate electronic from paper-based transactions. As expected, they determine a large reduction in unit costs for the former, while unit costs for the latter increase over time, which is associated with dramatic changes in usage patterns (see figures above).

In a next step, Humphrey et al. (2006) model variations in service delivery, while the other variables are held constant. Scale economies are identified, which are almost entirely attributed to the growth of ATMs, since hardly any new branch was opened. Hence, a 10% expansion in ATMs yields an 8.1% increase in operating expenses, indicating lower unit costs.

In their conclusion the authors suggest that transparent pricing of payment services based on variable or total average cost could induce users to turn to a more efficient payment mix, and service delivery. Such a shift could reinforce the exploitation of economies of scale and technological process, thus contributing to a further reduction in unit costs.

The study by Bolt and Humphrey (2007)[83] extends Humphrey et al. (2006) in two directions. It not only positions a European cross-country study, like the one just

[83] Bolt and Humphrey (2006) is based on the identical data and methodology. Results reported are the same, but here, some additional explanation on methodological choices are made.

discussed in the context of replacing cash and cheques with card payments. It also takes up the argument of a 2007 Florida State University working paper later published at Bolt and Humphrey (2009) that establishing SEPA will help better exploit economies of scale, because cross-border mergers of (card) processing centres are facilitated. Data were updated from Humphrey et al. (2006), as Bolt and Humphrey (2006) noted. Instead of 12, now 11 countries are covered (Switzerland is excluded); data range from 1987 to 2004.

In contrast to Humphrey et al. (2006), the analysed payment instruments are not grouped in electronic versus paper-based buckets, but whether they are used at the POS or to pay bills.[84] Bolt and Humphrey (2007, p. 460) affirm that this treatment is sensible, given that, between 2002 and 2004, debit cards accounted for 90% of non-cash transactions at the POS, and 86% of bill payments were initiated through electronic means. However, particularly in the earlier years of the period considered, this ratio was rather different (see Table 3–1, p. 81 and chapter 1.1 for details). Additionally, paper-based cheques and credit transfers exhibit higher unit costs in later years (Carbó-Valverde et al., 2006 and Humphrey et al., 2006), reducing the scale benefits of electronic payments, including cards. Resulting estimation biases were already uncovered at the end of chapter 3.1.1.

The decrease of actual operating costs even accelerated, and reached 34% in the 18-year period. As Bolt and Humphrey (2007) outline, bank cost savings materialised as the number of ATMs – being a more efficient way to deliver cash to payers – surged, while debit cards became more popular, reducing the need to provide cash in the first place.

Initially, the authors draw on three country cases, namely Norway, the Netherlands and Belgium, as studied by Gresvik and Øwre (2002), Brits and Winder

Thus, both reports should be viewed together.
Humphrey (2009) draws on this study, and places it into a wider context of competition among European banks and respective pricing of services. The author concludes that cross-country differences in banking market competition are not large, and that cost and productivity differences itself explain most of the variations in banking revenues. Further, bank prices are not closely linked to unit costs possibly resulting in misallocation of bank investments in more efficient payment technology, and difficulties experienced by users to choose efficient payment instruments. Users and banks would benefit from a per-transaction pricing, which closely mirrors unit costs of payment services (and thus changes in volumes).

[84] Bolt and Humphrey (2006) point to difficulties in data collection leading to this decision.

(2005) and Quaden (2005) respectively (see chapter 3.2 for a review). Bolt and Humphrey (2007) establish that strong scale economies for card payments exist, and are similar across the three studies. A 50% rise in transaction volumes would lead to more than 30% lower unit costs. However, it is noted that results may differ if larger countries such as Germany, France and the UK were examined. Given, for example, the results published by Humphrey et al. (2006), in these larger countries scale benefits could already be exploited.

In order to substantiate assessments of economies of scale, Bolt and Humphrey (2007) rely on two approaches, just as Humphrey et al. (2006). Besides overall scale benefits, those connected specifically to payment volume and service delivery are examined. Thus, Bolt and Humphrey (2007) relate bank operating costs to four outputs, i.e. volumes of (i) POS and (ii) bill payments and number of (iii) ATMs and (iv) branches as well as two input prices (labour, opportunity costs of physical capital/materials). Since the scale economies and unit operating costs derived from the translog and the Fourier cost functions turned out to be very similar, only the translog results are reported. The composite form is not tested.

First, Bolt and Humphrey (2007) display a downward shift in the cost function over time. Somewhat at odds with earlier literature, such as Humphrey et al. (2006), the authors claim that this originates – aside from lower ICT prices – mainly from the changes in service delivery, as the ATM numbers amplified by 434%, while branch numbers remained fairly stable. Conversely, the impact of extended payment volumes on the POS or by paying bills (+140% and +151% respectively) appears to be rather small. This finding is probably a consequence of grouping payment instruments with diverging cost and volume profiles in a POS and bill payment category, as explained in more detail above. Overall scale estimates point to a 60% reduction in predicted unit costs (operating costs to total asset value) once all four outputs double.[85] Yet, banks that reduce their branch network realise the highest gains, if the number of transactions and ATMs rise.

[85] Calculated according to Bolt and Humphrey (2007, pp. 465 and 469):
Output increase * (SCE-1) = reduction in unit costs if SCE<1.
SCE = estimated realised economies of scale. For all four outputs together, SCE is 0.4.

Second, Bolt and Humphrey (2007) assess scale benefits from payment processing and service delivery separately, while holding the other variables constant at their mean values. From the scale economy estimates provided, the following unit cost savings can be calculated. Consequently, doubling the number of payments or ATMs each would lead to a unit cost reduction of about 70%.[86]

The authors enrich their study and build on Brits and Winder (2005) and Quaden (2005) to discuss the issue of replacing cash at the POS by debit card payments. Using the scale economies derived in the three studies, Bolt and Humphrey (2007) calculate that, if payment volumes expand at 8% p.a., it could take 6 to 8 years until the average total costs for processing a debit card payment is as low as for a cash transaction. The process could even take a lot longer, if debit card growth is smaller than the projected annual 8%. Therefore, the authors argue that consolidating card processing centres across Europe could yield strong scale benefits, and consequently lower the cost of debit card use. This process should be fostered by establishing SEPA. US experiences of operating large card processing centres after a wave of mergers could be instructive for the assessment of SEPA benefits. Bolt and Humphrey (2007) add that prices for payers should reflect the relative costs of the different payment instruments, in order to induce users to replace cash by payment cards.

3.1.3 Factors influencing infrastructure efficiency

Throughout the studies reviewed, a number of factors emerged that contribute to lowering the costs of processing, as well as those of the clearing and settlement of payments. Regardless of the type of infrastructure (IFTSs or intrabank processing centres), evidence for the existence of economies of scale was found. Hence, high fixed infrastructure investment and maintenance costs can be spread over a larger number of transactions processed, leading to lower average or unit transaction costs. This effect is more pronounced for electronic rather than paper-based payments, because the latter often require manual handling. Therefore, expanding non-cash transaction volumes, as well as the share of electronic payments, will facilitate unit cost reductions. Overall, technological progress that

[86] Calculated according to footnote 85. SCE for POS and bill payments is 0.27, for ATMs 0.3.

lowers ICT input costs would amplify this development. Moreover, it is argued that transactions should be transparently priced, based on costs, in order to induce payers to choose the most efficient alternative. The issue of payment instrument prices will be dealt with in the next chapter.

With respect to RPSs in particular, economies of scope, i.e. the benefits of processing different payment instruments in one facility, could only be verified in one study. Overall, the evidence was inconsistent. The role of the central bank in clearing and settlement arrangements was hardly studied. Nevertheless, it surfaced that the central bank should avoid a conflicting responsibility as overseer and competitor. It seems advisable to even restrict its involvement to systemically important IFTSs. Here, it is recommended to phase-out potential subsidisation of services after an initial stage is passed, wherein a sufficient network size and respective transfer volumes have been achieved. Finally, pricing should be cost-based, so as to set proper incentives for IFTSs participants.

As far as banks' internal processing infrastructure is concerned, shifting service delivery practice towards more ATMs in comparison to branches also contributes to lower unit costs, e.g. a cheaper supply of cash.

3.2 Research on payment instrument costs at the POS

In this chapter an overview of the literature on private and social costs associated with POS payments via cash, cheque and payment cards is provided. The discussion will unfold as follows. In chapter 3.2.1, estimation methods used in the literature are analysed, and the body of research is classified. In line with this classification, the literature is reviewed in chapter 3.2.2. Conclusions are drawn in the last chapter 3.2.3. The most efficient payment instrument is identified and possible societal savings are estimated on the condition that the payment mix is shifted accordingly.

3.2.1 Methodology and classification of the literature

Current estimates for the total social costs of POS payments range from 0.30% to 0.77% of GDP (Table 3-5, p. 117), and are therefore not negligible. Still, the literature evaluating them is limited. Responsible are often severe data constraints,

since banks and end users do not generally register all payment-related costs in their internal accounting. Further, some cost items are common to several payment instruments, as well as other bank services, and fixed expenditures need to be distributed across transactions, and over time (Leinonen, 2008a, p. 114).

Moreover, a number of cost elements are difficult to quantify such as (i) merchants' expenditures for handling cash at the checkout, or time until a transaction is settled and (ii) consumer's effort for queuing at the checkout or acquiring cash at an ATM. In principle, these considerations also apply when determining the benefits of paying with certain instruments. To shed more light on the issue, central banks in particular have conducted comprehensive surveys to build a foundation for subsequent research.

Some of the studies explored hereafter not only concentrate on POS payment means, but also include instruments for bill and recurrent payments, such as credit transfers and direct debits. However, as this work focuses on POS transactions, the findings on the second category are not reported here. In those countries, in which cheques still circulated at the time of the survey, they served a hybrid function. They substituted for credit transfers and direct debits, but were also used at the POS. Cheques, therefore, are included in this analysis.

In the literature reviewed, a distinction is made between unit total and marginal variable costs on the one hand, and social and private costs on the other. Unit total costs are calculated by dividing the sum of fixed and variable costs for a specific payment instrument through the respective transaction volume. Through this approach, the overall resource costs to society arising from payments are captured. Marginal or incremental costs are derived by concentrating on the variable component occurring from one additional transaction of a certain size. This method is employed when the cost structure (ratio of fixed and variable components), is considered as given, and thus a more short-term perspective is adopted.

Leinonen (2008a, p. 120) notes that, focusing on marginal variable costs when establishing efficiency rankings between payment means could be misleading, and cites infrastructure costs, such as for clearing centres, as example. There, capacities are, to a large extent, fixed. Yet, the services provided are priced per

transaction, based on expected volumes, thus the fixed costs are possibly ignored. Such a situation hinders the establishment of new payment instruments, as high investment costs might be allocated to initially low transaction volumes, while for already operating payment instruments those are considered as sunk.

For the assessment of social costs, firstly the costs borne by all market participants are recorded, as set out in principle in Figure 3–2 below. Here, a payer's and payee's bank cost categories are identical and hence not depicted separately. The costs for tasks handled by PSPs and other service providers are contained in the expenditures allocated to the payer's and payee's bank (Leinonen, 2008a, p. 112). Expenditures of one party, which constitute revenues of another, such as consumers' annual card fees, or merchants' card processing fees, as well as interchange fees, are deducted, as explained inter alia in Brits and Winder (2005, p. 17) and Bergman, Guibourg, and Segendorf (2007, p. 5). Hence, only the incremental value added at each stage of the payment process is taken into account (Humphrey et al., 2003, p. 160). In contrast, for measuring the private costs of market participants, each group is considered individually, with the fee-revenue transfers included.

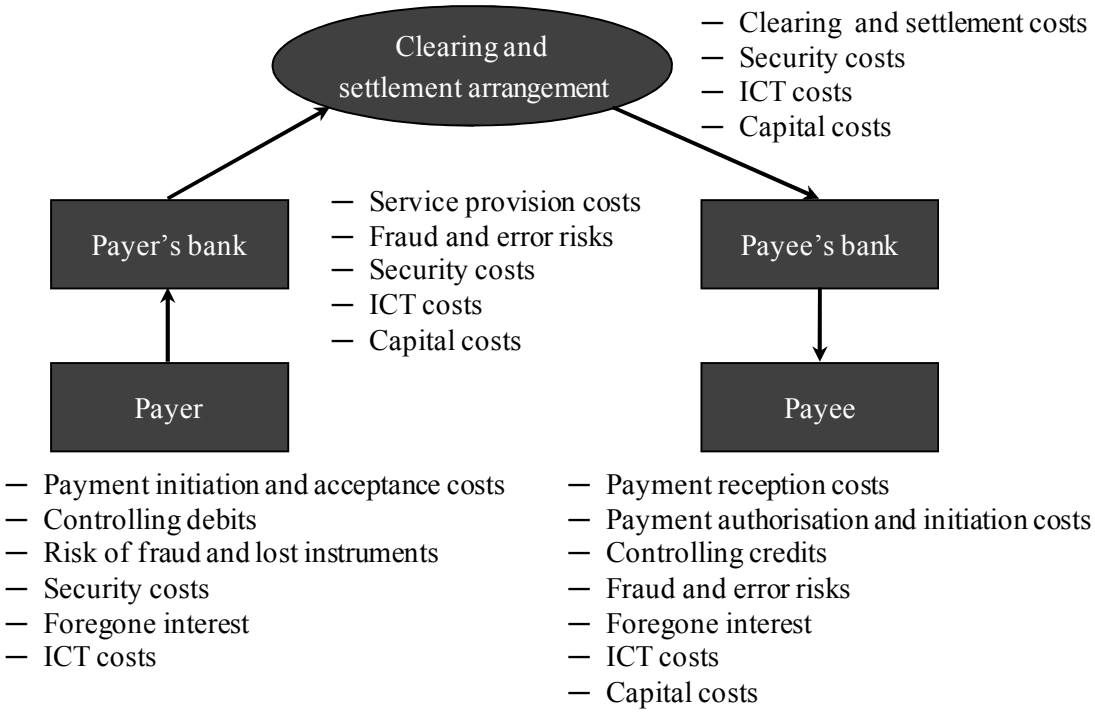

FIGURE 3-2: Payment market participants and their costs[87]

[87] Own illustration adapted from Leinonen (2008a, p. 112).

The framework depicted in Figure 3–2 covers all of the different payment instruments e.g. POS, as well as bill and recurrent payments. Although some of the cost categories are the same for all participants, differences occur with respect to the payment instruments assessed, the specific tasks carried out, and the magnitude of expenditures. In the following three sections, the above-mentioned cost items are exemplified with respect to POS payments and users.

Payment initiation, authorisation and acceptance involve expenditures for

(i) consumers, for acquiring cash at an ATM or branch (withdrawal fees, shoe leather costs) as well as queuing and processing time at the check-out;
(ii) merchants, for fees per transaction and POS terminal infrastructure, processing time and cash handling at the checkout, and in preparation for depositing.

Users also control debits and credits as part of their account and fund reconciliation. They rank cash and payment cards differently, when asked how comfortably this can be achieved, once these instruments are utilised or accepted. Foregone interests occur when funds are debited earlier and credited later than expected by users, which might result in float income for banks. Capital costs arise when funds are not available, for instance due to slow or erroneous processing. Here, merchants might prefer cash to card payments, as they receive funds with a delay, which gives rise to both foregone interest and capital costs. Fraud and error risks are mitigated by security measures. For users the magnitude of theft and counterfeiting of cash, as well as payment card fraud, can influence their perception of these payment instruments.

All parties considered bear costs for ICT ranging from bank-internal processing systems, ATM and POS networks to processing transactions. For consumers, ICT costs in respect to POS payments are negligible. Finally, for providing payment services, such as printing cheques, producing payment cards, clearing and settlement of transactions and supplying cash, banks bear service provision costs.

So far, this chapter has illustrated that varying methodologies, in terms of cost approach applied, as well as cost categories and number of market participants covered, can be utilised to assess the costs of paying. The research reports discussed hereafter are no exception. In addition, country specific technologies,

institutional arrangements and payment mix, which are investigated in chapter 5.3.2, determine payment system costs. Taken together, a comparison of the findings in the different studies should be carried out with these drawbacks in mind. Nevertheless, the available literature is clustered below, so as to illustrate similar approaches and allow a more focused appraisal.

As a starting point, a review of earlier research on private costs carried out by Humphrey et al. (2003) is examined. Since the paper looks into the private costs of banks and retailers, its findings are contrasted, on the one hand, with Gresvik and Øwre (2002), Guibourg and Segendorf (2004) and Banco de Portugal (2007), on the Norwegian, Swedish and Portuguese banking sector expenditures. On the other hand, analyses by ten Raa and Shestalova (2004) as well as Arango and Taylor (2008), concerned with Dutch and Canadian merchants, are dealt with.

Four research reports, namely Brits and Winder (2005), Quaden (2005), Bergman et al. (2007) as well as Takala and Virén (2008), cover social costs in the Netherlands, Belgium, Sweden and Finland respectively that accrue to the different participants in the payment value chain. While the Dutch and Belgium studies starts with marginal costs to derive social costs and disregards consumers, the Swedish and Finnish analyses draw on unit costs.

Expanding the methods applied so far, Garcia-Swartz, Hahn, and Layne-Farrar (2006) aspire to derive social net costs, e.g. to include as well social benefits assigned to market participants in the USA. Shampine (2007) thoroughly discusses the various assumptions underlying the calculation of social benefits.

3.2.2 Estimates of payment costs at the POS

This chapter is structured along the clusters outlined above, i.e. starts with private costs of banks and merchants, broadens the view to social costs of market participants and concludes by adding benefits to derive net social costs. Table 3–2 (next page) summarises the results of the literature analysed, as far as costs of individual payment instruments are concerned. While in the first column the report in question is shown, the next three contain a short description of the data sources, i.e. where and when the data were collected and what cost approach has

been used – unit total costs or marginal variable costs. In the last four columns the costs per payment instrument are enlisted as a central reference for the discussion in this chapter. Therefore, if payment instrument costs are compared, the respective values are found in this table, if not indicated otherwise.

Study	Country	Year	Scope*	Cheque	Cash	Credit card	Debit card
Private costs of banks							
Gresvik and Øwre (2002)	Norway	2001	UTC(1)	2.80	1.01(2)	--	0.31
Guibourg and Segendorf (2004)	Sweden	2002	UTC (VC)	2.20 (0.22)	0.50(2) (0.14)	0.51(3) (0.43)	0.20(3) (0.14)
Banco de Portugal (2007)	Portugal	2005	UTC	1.45	0.35(4)	2.44	0.23(4)
Private costs of merchants							
ten Raa and Shestalova (2004)	Nether-lands	1998	UTC	--	0.09	--	0.14
Arango and Taylor (2008)	Canada	2006	MVC	--	0.18	0.58	0.13
Social costs of market participants							
Brits and Winder (2005)	Nether-lands	2002	MVC	--	0.18	1.09	0.20
Quaden (2005)	Belgium	2003	MVC	--	0.27	0.65	0.21
Bergman et al. (2007)	Sweden	2002	UTC	--	0.52	0.50	0.34
Takala and Virén (2008)	Finland	2005	UTC	--	0.30	0.26(5)	0.26(5)
Net social costs of market participants							
Garcia-Swartz et al. (2006)	USA	1998	MVC(6)	0.78-0.89 (0.80-1.08)	0.72 (0.99)	0.72 (0.64)	0.63-0.68 (0.70-0.74)

All amounts for cheque, cash, credit and debit card transaction costs in EUR.
***** UTC: unit total (fixed + variable) costs, MVC: marginal variable costs, VC: variable costs
(1) Amounts differ slightly from those stated in Table 3–3 (p. 99) due to a deviating exchange rate applied by Humphrey et al. (2003).
(2) Volume weighted average of cash withdrawals at own/foreign ATMs; withdrawals at bank branches cost EUR 1.86 (Gresvik & Øwre, 2002, p. 130) and EUR 1.21 (Guibourg & Segendorf, 2004, p. 10).
(3) Sum of costs borne by card issuers and acquirers. Credit card figures include deferred debit cards.
(4) Cash withdrawals at ATMs included in debit card costs; cash withdrawals at bank branches cost EUR 1.85 (Banco de Portugal, 2007, p. 69)
(5) Private costs for users only, no distinction between credit/debit cards (Takala & Virén, 2008, p. 40).
(6) Costs per payment instrument according to transaction sizes of EUR 10.30 (EUR 48.49) and sub-categories: verified vs. non-verified cheque, PIN vs. signature debit card; the first (second) category relates to the lower (higher) costs calculated. Credit card figures include deferred debit cards (Garcia-Swartz et al., 2006, p. 188). No reference is made as to whether fixed costs are included, but judging from the cost items listed in Garcia-Swartz et al. (2006, pp. 184ff.), only variable costs are covered.

TABLE 3-2: Transaction costs per payment instrument[88]

[88] Own compilation. For Norway, Sweden and Canada, national currency converted into EUR;

Private costs of banks and retailers

Humphrey et al. (2003) deliver a comprehensive analysis of payment costs by summarising earlier literature, and developing insights into how efficiency could be raised in the payment system. According to the study, the costs of making payments depend on the type of instruments used (paper-based vs. electronic transactions), the transaction volume affecting economies of scale, technological advancement and pricing methodology. Table 3–3 below compiles the private unit costs borne by banks and retailers for POS payment instruments, derived from a number of country studies. The data reported remain fragmented, as relevant information is rarely made publicly available.

Country	Year	Cheque	Cash	Credit card	Debit card
Private bank costs					
Norway	2001	3.08	1.03-1.16(2)	--	0.34
Spain	2001	0.27	--	--	0.07
USA	1993	0.15-0.42(1)	--	--	--
Private retailer costs					
Australia	2001	0.27	0.07	0.57-1.11	0.10-0.22
Germany	1999	0.50-0.71	0.09-0.15	--	0.87
Netherlands	2002	--	0.15	3.40	0.27
Sweden	2001	--	--	1.54	0.23
USA	2000	0.35	0.12	0.70	0.33
USA	1993	1.22	--	--	--

All amounts for cheque, cash, credit and debit card transaction costs in EUR.
(1) Based on three different estimates, the dispersion arising from different economies of scale (Wells, 1996, pp. 9-10). Excludes EUR 0.09 float income for US banks. Float was eliminated in Norway starting in 2000 (Gresvik & Øwre, 2002, p. 125).
(2) Cash withdrawals at own and foreign ATMs; withdrawals at bank branches costs EUR 2.05 (Gresvik & Øwre 2002, p. 130).

TABLE 3-3: Private costs per payment instrument[89]

With respect to bank unit costs, the foundation for the Norwegian and USA data were established by Gresvik and Øwre (2002) and Wells (1996), while the

EUR 1 = NOK 8.0484 / SEK 9.1611 / CAD 1.4237 annual average reference exchange rate for 2001, 2002 and 2006 respectively according to SDW (http://sdw.ecb.europa.eu). For USA an exchange rate of USD 1 = EUR 0.894 for 1998 was applied according to OECD StatExtracts (http://stats.oecd.org/). SDW and OECD data retrieved 2011, April 14.

89 Own illustration adapted from Humphrey et al. (2003, p. 162). In the paper, reference is also made to paper-based giro payments (credit transfers) and electronic ACH payments (credit transfer and direct debit), both are omitted here due to being out of scope.
For USA/Australia, USD converted into EUR (EUR 1 = USD 1.027); for Norway exchange rate of NOK 1 = EUR 0.137 is applied as provided for by the authors.

Spanish data were derived from confidential sources (Humphrey et al., 2003, p. 162). This introduces a certain amount of fuzziness, in terms of comparability, as the methodology applied for collecting the latter is not disclosed, and differs for the calculation of the Norwegian and USA data. For example, branch costs are included for Norway, but not for Spain and the USA (Humphrey et al., 2003, p. 162). Clearing and settlement expenses are accounted for in the Norwegian case (Gresvik & Øwre, 2002, p. 127), but not in the USA case (Wells, 1996, pp. 9-10); neither can be verified for Spain.

Inspecting the data, the apparent high dispersion of bank costs is to a large extent explained by differing economies of scale depending on varying patterns of payment instrument use (Humphrey et al., 2003, p. 162). Enges and Øwre (2006, pp. 166-167) state that cheque use has declined since the '80s, and was virtually phased out in Norway by the end of the '90s. While in Spain and the US, 167 m and 41 bn transactions were conducted in 2001 respectively, according to ECB (2003, p. 96) and CPSS (2003c, p. 161). Another reason is offered by Leinonen (2008a, p. 118), who notices that the Activity Based Costing method used in the Norwegian study seems to distribute more overhead costs to the individual payment instruments than other approaches.

Nevertheless, Gresvik and Øwre (2002) remain a valuable source of insight into the development of payment costs. It provides the results of a cost survey conducted by Norges Bank in 2001, among a sample of seven banks, which is compared with information collected from earlier years. Between 1994 and 2001, the number of transactions for the payment services in question[90] more than doubled, while unit costs dropped by 55%. This efficiency gain is mainly attributable to a shift from manual services to electronic payment instruments, and higher economies of scale for the latter. Card payment transactions, for example, roughly quadrupled between 1994 and 2001, while unit costs dropped by 44%.

At the same time, prices charged to users increasingly reflect production costs, with the ratio rising from 39% in 1994 to 70% in 2000. However, this proportion

[90] This includes cheques, cash withdrawals and deposits (ATM and branch), card payments, direct debits, credit transfers initiated by mail, cash, phone, terminal and internet (Gresvik & Øwre, 2002, p. 130).

is not uniformly applied to all payment services. While cheque and card payment prices almost completely cover costs, with cost-coverage ratios of 94% and 90%, cash withdrawals at ATMs and branches evoke net unit costs[91] of EUR 0.64 and EUR 1.86 respectively. They are cross-subsidised with other payment services (Gresvik& Øwre, 2002). [92]

Humphrey et al. (2003) cite the Norwegian experience, to demonstrate that explicit pricing of payment instruments to cover their respective variable costs, instead of cross-subsidising and bundling, affects payment composition. They claim that the introduction of differentiated pricing led to a decline of the share of check and paper-based credit transfer on all non-cash transactions, from 90% to 40% within a decade until 1996, and a continued decay to less than 20%, until 2001. As electronic payments cost approximately one-third to one-half of paper-based payments, a complete shift towards the former could save 1% or more of national GDP annually, once transition costs have been covered.

The analysis by Guibourg and Segendorf (2004) is centred on the similar question of whether transaction fees equal variable costs, and whether relative prices reflect relative costs, for those payment services considered to be close substitutes. To tackle this question, fixed and variable costs of the four largest Swedish banks for each stage in the payment process, including clearing and settlement for a range of payment services[93], were collected in 2002.

Significant large disparities between variable costs and revenues for all payment services, except acquiring services for debit cards, were found (Guibourg & Segendorf, 2004). No fees are charged, for example, for cash withdrawals at ATM or branches, while merchants pay a variable fee of EUR 2.40 to the acquirer for each credit card transaction, which compares to EUR 0.12 acquiring variable costs. Overall, prices for consumers appear to be less cost reflecting than

[91] Net unit costs for ATM cash withdrawals were calculated from data given by Gresvik and Øwre (2002, p. 130) and comprise the volume weighted average of own and foreign ATM services costs net of consumers fees and converted (EUR 1 = NOK 8.0484). Withdrawals at branches are not priced; unit costs therefore equal net unit costs, as presented in Table 3–2.

[92] Enges and Øwre (2006) present the different stages of an intensive debate about whether to price payment services based on costs.

[93] This includes cheques, cash withdrawals, payment cards, acquiring services, direct debits/ credit transfers (paper-based, branch and electronic) (Guibourg & Segendorf, 2004, p. 8).

prices charged to corporate customers. Moreover, relative variable costs for close substitutes, such as debit and deferred debit card on the one hand, and payment card and ATM withdrawals on the other, are only mirrored to a low extent in the fees to either consumers or corporate customers. Considering the average bank's net result, a strong cross-subsidisation is visible where, basically, acquiring services for credit and debit card payments, achieving a surplus of EUR 39.7 m, subsidise cash withdrawals with a negative contribution of EUR 51.3 m.[94]

The authors further state that – given price elastic user demand – if pricing would have reflected more closely variable costs, debit cards were used more often than credit cards and cash (see Table 3–2, p. 98, for cost comparison). Such a development would have lowered the costs incurred by banks, but the efficiency gain to society, i.e. the reduction in social costs, needs to be further investigated. For this purpose, it would have been necessary to consider user costs and expenditures for infrastructure services, as well as market imperfections stemming from economies of scale, and the presence of network effects.[95] But no attempt was made in this regard.

In a later article, Guibourg and Segendorf (2007) assume – based on the same data and methodology as in Guibourg and Segendorf (2004) – that if a new price-setting strategy would result in payment patterns similar to that of Finland, the number of card transactions would increase by 80%. This is assumed to be attributable to debit card payments only. At the same time, the use of cash would decline by one half. Hence, the ATM-network could be reduced accordingly. Overall, the shift from cash to debit card payments would lead to a reduction of the banking sector's total costs by EUR 49 m[96] annually, and unit costs of debit card transactions would fall by 13%.

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[94] Amounts in SEK converted into EUR (1 EUR = SEK 9.1611), see footnote 88.

[95] In the case of mature markets, such as ATM services, network effects are likely exploited. Therefore, social costs should approximately equal private costs. In the case of card payments, the relationship is not as clear, as network externalities seem not yet fully exploited. Being a two-sided market with different price elasticities, a lower price – below marginal costs – should be charged from the group with the higher price elasticity, i.e. the consumers, in order to increase the size of this side of the market. In turn, higher fees are levied on merchants (Guibourg & Segendorf, 2004, p. 17).

[96] USD amounts converted (1 EUR = USD 0.9456 annual average reference exchange rate for 2002 according to SDW (http://sdw.ecb.europa.eu, data retrieved 2011, April 15).

Banco de Portugal (2007) provides, for the first time, a comprehensive survey on costs and benefits, characterising the Portuguese retail payment system.[97] In 2005, total costs incurred by the banking sector for providing payment services amounted to 0.77% of GDP, while respective revenues excluding float, inter-change fee and credit card interests accounted for 0.49% of GDP. This implies a cost-coverage ratio of 63.4%, a figure below the 70% already achieved in Norway, according to Gresvik and Øwre (2002).

Offering cash and cheque services induce the highest net unit costs for the banking sector, being estimated at EUR 1.77 for cash withdrawals at branches, and EUR 0.88 per presented cheque. This is cross-subsidised mainly with credit card services involving a net surplus of EUR 0.18 per transaction. A similar observation is made in Guibourg and Segendorf (2004) and Bergman et al. (2007). Debit card payments are supplied nearly cost neutral.

Banco de Portugal (2007) draws on the Activity Based Costing method, which was also employed in Gresvik and Øwre (2002). Direct and indirect (overhead) costs related to the provision of payment services[98] were collected among a representative sample of five Portuguese banks, and extrapolated to embody the whole banking sector. The costs borne by Unicre, the major acquirer for transactions with internationally-branded credit cards, were added. Costs for SIBS[99], the Portuguese payment processor, central bank and treasury (mint) costs are not included in the estimate. Revenues were obtained along the same lines.

Based on these data, Banco de Portugal (2007) undertakes a welfare analysis, and assesses the benefits for banks from the employment of more efficient payment instruments. Cash withdrawals, for instance, which are initiated at the branch counter, are compared with those initiated at an ATM. Completely switching to ATMs could save the banking sector EUR 14.9 m. Consumers would gain from

[97] Banco de Portugal (2007) draws on a thorough overview of the methodology of other central bank studies conducted for Norway, Sweden, the Netherlands and Belgium (Gresvik & Øwre, 2002; Guibourg & Segendorf, 2004; Brits & Winder 2005 and Quaden, 2005), all of which are reviewed in this chapter. Further, the key studies on payment costs as well as consumer choice of payment instruments are summarised, most of which are tackled here or in chapter 4.

[98] This includes cheques, cash withdrawals and deposits (ATM and branch), card payments and acquiring services, direct debits and credit transfers (Banco de Portugal, 2007, p. 58).

[99] Sociedade Interbancária de Serviços SA – Interbank Services Company.

less processing time, which could be translated into a benefit of EUR 3.6 m.[100] Based on unit costs referred to in Table 3–2 (p. 98), the authors determine that above a transaction value of EUR 8.00, paying by debit card would be more efficient than cash. If roughly half of the branch cash withdrawals would be replaced by debit card transactions, the respective cost-coverage ratio would rise from 63.4% to 64.7%. Unfortunately, the study fails to consistently estimate the social gain from replacing less efficient payment instruments.

Besides examining private bank costs, Humphrey et al. (2003) are also concerned with private retailer costs. However, from comparing the different studies on the latter cited in Table 3–3 (p. 99), generalisations are difficult to make, besides the observation that cash seems to be associated with the lowest unit cost, while credit card payments induce the highest. This is also confirmed by ten Raa and Shestalova (2004), according to Table 3–2 (p. 98).

The apparent high credit card payment costs correspond firmly to the considerations stated above for banking fees on these transactions, including acquiring services, which often cross-subsidise, especially cash provision. In addition, high interchange fees, which are part of the merchant service charge, are imposed on retailers. As these are passed on from the acquiring to the issuing bank, they are not counted towards unit costs for banks, but still constitute merchant costs. An appraisal of the function of interchange fees in a two-sided network market was made in chapter 2.2.3.

The picture changes if costs per sales are taken into account. In 2000, a cash payment of a USD 100 involves costs for the retailer of USD 0.90, a corresponding credit card payment USD 1.80 and a debit card transaction USD 0.80 (Humphrey et al., 2003, p. 163). Ten Raa and Shestalova (2004, p. 208) indicate retailer costs of EUR 0.90 for a EUR 100 cash payment, and EUR 0.53 for a respective debit card transaction.

This result is due to the deviating cost structures for the different payment instruments (ten Raa & Shestalova 2004). While cash handling is associated with

[100] Consumers save 575,000 hours in processing time, EUR 6.34 average gross hourly wage given by the Banco de Portugal (2007, pp. 109-110) is applied.

relatively low fixed costs, as there is no direct need to build up specialised infrastructure, the opposite holds true for electronic payments, e.g. initiated by cards or truncated cheques[101]. In contrast, variable expenditures for cash handling are high, as cost items such as counting, transport, depositing and theft/counterfeit are dependent on the amount handled. On the other hand, electronic processing of card payments involves the same variable costs independent of transaction value. At the same time, merchant service charges usually impose a value-dependent component, increasing variable costs for credit card transactions.

Therefore, a break-even analysis appears sensible, and is not only conducted by ten Raa and Shestalova (2004) or Arango and Taylor (2008) as outlined below, but also by Brits and Winder (2005), Quaden (2005) and Bergman et al. (2007) to determine the most efficient payment instrument, as demonstrated in the next section on social costs on pages 107 to 113. Table 3–5 (p. 117) gives an overview of the primary results.

Ten Raa and Shestalova (2004) aim at establishing the break-even point above which debit card payments are more cost efficient than cash. Data were collected from a representative sample of Dutch retailers for the year 1998. The paper determines the incremental costs of an additional payment, while costs occurring for the transaction itself and those relating to its value are accounted for. If only private costs incurred by retailers are taken into account, the incremental costs for a cash payment up to a value of EUR 30.00 is lower than for a corresponding debit card transaction.

In a second step, social costs are introduced and taken into account. Due to a lack of Dutch data, Norwegian ATM costs incurred by banks in 1994 were used as a proxy for the social costs of cash use. It remains questionable to what extent this is a robust approach, given that the number of ATM transactions in Norway rose by 33% from 1994 to 1998, probably involving a decline in marginal variable costs. In terms of distribution and usage of ATMs, Norway and the Netherlands appear roughly similar, with 440 and 419 ATMs per million inhabitants as well as 24 and 27 ATM cash withdrawals per inhabitant in 1998 (Norges Bank, 2001).

[101] Humphrey et al. (2003, p. 163) note the case of Germany, where basically all cheques are truncated and collected electronically.

Ten Raa and Shestalova (2004) notice that all POS fees imposed by the Dutch clearing house Interpay are cost neutral, and that consumers do not face additional costs, as banks fully subsidise cash withdrawals, and only a few retailers charge debit card payment fees. Here, inter alia consumer costs, such as from making trips to the ATM[102], as well as costs incurred by banks for cash depositing not fully charged to merchants, are disregarded. Thus, the only addition made to derive the social costs of cash handling, based on private retailer costs, is that of the Norwegian ATM expenditures. With these included, the switching point from which debit card payments are more efficient than cash transactions, drops to EUR 13 (ten Raa & Shestalova 2004, p. 211). If the limitations mentioned above would be considered, the break-even would probably be somewhat lower and closer to the results published by Brits and Winder (2005) and Quaden (2005) for the Netherlands and Belgium.

The only other survey known that is solely concerned with merchant costs associated with the acceptance of cash, payment cards and cheques was carried out by Arango and Taylor (2008) among Canadian retailers in 2006. Moreover, retailers' perception of these payment instruments is emphasised.

As indicated in Table 3–2 (p. 98), for a transaction amount of EUR 25.64, the median value in the survey, credit cards are more costly than cash, with debit cards being the cheapest payment instrument for merchants. A sensitivity analysis suggests that cash would be the least costly payment instrument below an amount of EUR 8.85 – for those merchants that pay the lowest debit card fee of EUR 0.05 per transaction. For retailers paying the highest debit card fee of EUR 0.18 per transaction, debit cards should be preferred for an amount above EUR 36.03 (Arango & Taylor, 2008).[103] For better understanding, it would have been useful if the authors had provided indications about the actual fee distribution.

With respect to the perception, merchants consider cash payments as the cheapest to accept. Arango and Taylor (2008) offer two explanations. First, retailers who view cash handling as a regular part of doing business might not include all

[102] See Garcia-Swartz et al. (2006), Shampine (2007), Bergman et al. (2007) and Takala and Virén (2008) for an estimate.
[103] CAD amounts converted (1 EUR = CAD 1.4237), see footnote 88.

relevant cost items in their internal calculations. Second, they might monitor total costs, while others control marginal costs per transaction. Both could have biased the studies' findings.

Besides the private costs to banks and retailers, Humphrey et al. (2003) are also concerned with social costs. For that reason, the authors report on a study by Wells (1996) that estimates 1993 cheque expenditures for the US market, with EUR 2.71-3.01 per transaction, the difference of EUR 1.34-1.37 to the sum of bank and retailer costs accruing to payers.[104] A direct comparison to other studies reviewed here is not possible, as unit costs of cheques for consumers are not assessed. However, Garcia-Swartz et al. (2006) calculate marginal private costs of cheques for consumers at EUR 0.78-1.08 (see Table 3–2, p. 98). Given that handling cheques involves – similar to cash – a high variable cost component, the conclusion drawn by Humphrey seems plausible.

Social costs of providing payment instruments

Brits and Winder (2005) report on a 2002 central bank inquiry into social costs of POS payments.[105] The data collected focus on the internal expenditures borne by all participants in the Dutch payment market, e.g. the central bank and Royal Dutch Mint, the four largest commercial banks, the Dutch central processor Interpay and credit card companies, as well as the retail sector. Consumer expenditures are not included. Overall, social costs amount to 0.65% of GDP.

To assess the efficiency of the different payment instruments, Brits and Winder (2005) refer to incremental variable costs, while transaction- and value-based expenditures are separated. If the choice is made between cash and debit card, the former is more efficient below an amount of EUR 11.63. The approach is similar to the one taken by ten Raa and Shestalova (2004), but the number derived is slightly below the EUR 13.00 established there. This may be attributable to the fact, that the more current study by Brits and Winder (2005) includes additional cost items, and covers almost the whole payment chain.

[104] USD amount converted (EUR 1 = USD 1.027 as provided for by the authors).
[105] This includes cash withdrawals / deposits (ATM and branch) and handling, card payments (debit and credit card, which are essentially deferred debit cards in The Netherlands) and e-purse (Chipknip) (Brits & Winder, 2005, pp. 10, 39-41).

Further, according to Brits and Winder (2005), e-purse payments are with EUR 0.033 variable cost per additional transaction cheaper than either of the payment instruments above. Credit cards are in any case more expensive, and should therefore not be used from a societal cost point of view. Consequently, if cash payments with an average value of between EUR 3.00 and EUR 20.00 would be substituted by 500 m e-purse and 1 bn debit card payments respectively, total variable cost savings of EUR 106 m p.a. could be achieved – about 7% of total variable payment costs. More substantial changes in payment behaviour possibly altering fixed costs structures are not considered.

Brits and Winder (2005) additionally determine total costs as a percentage of sales. Here, the debit card is the most economical means of payment, followed by credit cards and cash, while e-purse transactions are less efficient. Per euro of turnover, a debit card payment would cost approximately 1 cent, a corresponding credit card and cash transaction 3 cents each, and an e-purse payment 34 cents. The latter reflects a situation of very high fixed costs from infrastructure, while volumes are still limited, due to only very recent introduction of the e-purse. Once volumes ascend, the cost structure should change dramatically. Similar cost levels prevail in Belgium, as depicted by Quaden (2005), with the exception of the e-purse, evoking total costs of 10 cents per euro of sales.

The study by Quaden (2005) of the Belgian costs of payments at the POS[106] was conducted along the lines of Brits and Winder (2005). There, 2003 social fixed and variable costs, in relation to number and value of transactions along the payment chain, where identified. This included data collected from the central banks and the Royal Belgian Mint, 12 commercial banks, the operator of the electronic payment network Banksys and the Bank Card Company.[107] As consumers are said not to bear macroeconomic relevant internal costs, they are not considered.

In essence, the total costs to GDP from POS payments being estimated by Quaden (2005) at 0.74% for Belgium are rather similar to those computed for the Netherlands. The difference is mainly attributable to the total cost of cash making

[106] This includes cash, card payments and e-purse (Proton) (Quaden, 2005, p. 4).
[107] For details on the Banksys and BCC see chapter 5.3.2.

up 0.58% of GDP in Belgium, but 0.48% in the Netherlands largely due to longer processing times at the POS for merchants.

Judging from incremental variable transaction costs, e-purse usage involves the lowest costs with EUR 0.096 followed by debit card, cash and credit card as indicated in Table 3–2 (p. 98). The break-even analysis illustrates that for payments below EUR 10.24, cash is more efficient than a debit card transaction while deploying the e-purse is cheaper than both. This result is similar to the one for the Belgium market. In contrast to Brits and Winder (2005), the analysis was taken further: Only for transactions in excess of EUR 53.74, it is more efficient to pay by debit card rather than e-purse. Between cash and credit card, the switching point is at EUR 60.88 above which a credit card payment is less costly than cash while still being more expensive than debit card and e-purse (Quaden, 2005).

Quaden (2005) carries out a simulation to determine the efficiency effects of altering the payment mix. If 750m cash transactions with an average value of EUR 5.00 and EUR 20.00 were replaced by 250 m e-purse and 500 m debit card payments respectively, overall EUR 58 m could be saved. This corresponds to 6% of EUR 957 m variable costs for POS payments, similar to the Dutch results above.

A paper by de Grauwe, Rinaldi, and van Cayseele (2006) is concerned with the efficiency enhancing effect of cost-based pricing of payment instruments. The study is based on 2002 data from the Netherlands, which have been discussed in Brits and Winder (2005) as well as 1998 and 2003 data from Belgium, the former being taken from an earlier study by the authors, the latter from Quaden (2005).

Although the methodology is apparently the same, based on marginal social variable costs, the authors calculate a different switching point (de Grauwe et al., 2006). In regards to the Netherlands, cash is more cost efficient than debit cards below a transaction value of EUR 12.40 (instead of EUR 11.63), while in Belgium this is the case for a transaction value below EUR 8.70 (instead of EUR 10.24). Moreover, here cash is more efficient than e-purse for a value below EUR 4.50, while according to Quaden (2005, p. 29). e-purse is always cheaper than cash usage. Nevertheless, the overall efficiency ranking is not changed, but the subsequent analysis should be viewed with some caution.

If in both countries a price policy was adopted that more closely resembles the social costs of payment instruments, consumers would be induced to switch to the less costly alternative. De Grauwe et al. (2006) predict that for Belgium and the Netherlands, cost-based pricing could increase the share of debit card transactions on the sum of cash and debit card POS payments by 15 %-points. This would result in social costs savings of EUR 211 m or 11.80% and EUR 147 m or 5.60% respectively.

Extrapolating these results to a sample of 19 European countries, assuming the same cost structure as in Belgium and the Netherlands, savings in social costs of 0.14% of GDP are estimated to amount to a total of EUR 10 bn. This calculation assumes total social costs in these countries to a sum of up to 1.22% of GDP (de Grauwe et al., 2006). Judging from other studies reviewed in this chapter, the total social cost as a fraction of GDP seems to be quite high, and calls into question, therefore, the magnitude of potential savings to be achieved. In addition, it is disputable whether similar cost structures can be assumed, due to widely varying institutional arrangements in the countries in question, as shown in chapter 5.3.2.

Bergman et al. (2007) extend the earlier work of Guibourg and Segendorf (2004) by estimating total social costs for POS cash and card payments in Sweden, amounting to 0.40% of GDP. Although higher than the assessment by Takala and Virén (2008) on the Finnish payment system, reviewed below, this number is notably lower than those obtained for the Netherlands and Belgium. From the report itself, the reason for this disparity remains vague. Social costs for cash usage in relation to total costs for POS payments are similar, between 73% and 77%, while Swedish consumers pay less often with cash at the POS, as depicted in Table 3–4 (next page), pointing to higher unit costs (as noted in Table 3–2, p. 98). Institutional factors raising the costs of payments might play a role, but are not addressed by the authors.

Bergman et al. (2007) determine total social costs by calculating the internal private costs of each participant in the payment chain, e.g. the central bank, commercial banks and subcontractors such as cash deposits and transporters, switches and card clearing houses, as well as retailers and consumers. The authors base

their estimates on publicly available data, mainly from annual reports, as well as on the results of the data collection by Guibourg and Segendorf (2004).

Study	Country	Year	Payment volumes in m		Social costs in EUR m	
			Cash	POS	Cash	POS
Brits and Winder (2005, p. 23)	Nether-lands	2002	7,066	8,268	2,122	2,888
Quaden (2005, p. 27)	Belgium	2003	2,970	3,653	1,583	2,034
Bergman et al. (2007, p. 15)	Sweden	2002	1,424	1,989	6,560	8,470

TABLE 3-4: Cash vs. POS payments: Volume and social costs in NL, BE, SE[108]

In terms of total unit social costs, cash is the most expensive payment instrument, closely followed by credit card transactions; debit card payments are the least costly (Table 3–2, p. 98). For low value payments, cash is more efficient than debit cards. The break-even being calculated at EUR 7.80 is substantially below the calculations for the Netherlands and Belgium, which could be associated with the inclusion of consumer costs in the present study. With respect to credit cards, cash is to be preferred, up to a value of EUR 17.60 (Bergman et al., 2007).

Besides fees for ATM withdrawals, Bergman et al. (2007) determine private consumer cash costs based on expenditures for holding liquidity, shoe-leather cost, processing time for ATM withdrawals and POS transactions, as well as risk costs. In regards to card payments, consumers face annual fees as well as processing time costs at the cash register. With the exception of risk costs and annual card fees, Garcia-Swartz et al. (2006) have included the same cost items in their analysis, as remains to be discussed below.

Moreover, the authors introduce a new (negative) cost category – the value of interest-free credit for the time passing between the POS transaction itself, and its repayment or deduction from the current account, in case of deferred debit cards. This seems a valid consideration for the payment instrument choice at the POS. Consequently, Garcia-Swartz et al. (2006) included this item, as well as a benefit category. As a result, the private break-even value for consumers differs from the corresponding social switching point. Between cash and debit card the amount is

[108] Own compilation based on data given in the studies mentioned in the first column.

EUR 13.64, and therefore higher than the social break-even. Between cash and credit card it is EUR 4.37, i.e. substantially lower.[109] Thus, private consumer incentives lead to an underuse of debit cards, and an overuse of cash and credit cards, compared to the social optimum (Bergman et al., 2007).

As Swedish banks cross-subsidise cash handling with interchange fees, retailers have strong private incentives to discourage credit cards, and somewhat underuse debit cards. To come closer to a social optimum, the authors suggest introducing ATM withdrawal charges, and lowering interchange fees (Bergman et al., 2007).

Takala and Virén (2008) assess the total costs of POS payment media used in Finland to amount to roughly 0.30% of GDP, which is very low compared to the analyses reviewed above. According to the authors, this is due to the very efficient design of the Finnish payment system. However, the number derived could understate payment costs, since the true social costs are not calculated, which is explained in the following section.

The report by Takala and Virén (2008) evaluates the cost of cash handling data for 2000 to 2005 borne by the central bank and the Finnish mint, the banking sector, including the central ATM company Automatia, and retailers, subcontractors, e.g. cash depositors and transportation companies, as well as consumers. For the latter group, fees for ATM withdrawals, shoe-leather and liquidity costs are included. POS processing times are not accounted for, which could be the reason for the broadly deviating estimates for cash unit costs, as apparent in Table 3–2 (p. 98). Total cost of cash is calculated at 0.12% of GDP in 2005, down from 0.14% in 2000. This range is considerably below the result for Belgium and the Netherlands, although in both cases consumer costs were not even included.

In contrast, Takala and Virén (2008) measure 2002-2006 private costs for card payments, based on fees paid by consumers and retailers for the usage and acceptance of debit and credit cards. According to the study, total private costs of payment cards are 0.12% of GDP in 2005, up from 0.1% of GDP in 2002. During this time, transactions processed by merchants grew by 74%, indicating a decline in unit costs.

[109] SEK amounts converted (1 EUR = SEK 9.1611), see footnote 88.

The conclusion drawn by Takala and Virén (2008, p. 41), that per transaction costs are basically in line with the estimates produced by Bergman et al. (2007) is rather spurious, as cash unit costs in Sweden, for instance, are 73% higher, and the costs for card payments are derived utilising widely varying methodologies.

Net social costs of providing payment instruments

Garcia-Swartz et al. (2006) state that most studies, including those researched above, are incomplete, as they solely focus on the cost side, but hardly include the economic benefits of certain payment instruments. Thus, they present a cost-benefit framework in which they place the different payment means utilised at the POS.[110] The authors aim to take all parties of the payment chain into account, e.g. the central bank, commercial banks, merchants and consumers that were largely disregarded in the earlier studies referred to above, due to data constraints. While merchant cost information is substantiated in a 1998 survey among groceries by the Food Marketing Institute[111], other costs and benefits are subsequently added without clearly detailing underlying sources, or indicating the base year. In this way, marginal net social costs of the payment instruments under consideration are determined. Although it does not clearly distinguish between fixed and variable costs, the items listed suggest that only the latter have been included.

For transaction sizes of EUR 10.30, the average amount for cash transactions in groceries, debit card payments generate the lowest marginal net costs, followed by credit card and cash payments, while cheque transactions generate the highest costs. The picture changes when a value of EUR 48.49, the average transaction size for cheques in groceries, is applied. Then, non-verified cheques are placed before cash and verified cheques, followed by debit cards while credit card payments are cheapest (Garcia-Swartz et al., 2006) (see also Table 3–2, p. 98).

Given that the research analysed so far assigns high costs to credit card usage, as visible from Table 3–2 (p. 98), the placing of credit cards as having the lowest

[110] This includes cash, non-verified and verified cheques, credit and deferred debit cards, signature and PIN debit card (Garcia-Swartz et al., 2006, p. 184).

[111] For determining retailer costs, the authors also consult a second study on electronic speciality stores which is not reported here as data originate from 1995 while consumers and banking sector costs are identical for both cases. Further, the average transaction sizes of EUR 58.09 for cash and EUR 111.45 for cheque transactions (USD 1 = EUR 0.894) appear quite exaggerated compared to the other studies reviewed to draw generalised conclusions.

net social costs, in regards to the higher transaction size, is somewhat surprising. Although two studies, namely Quaden (2005) and Bergman et al. (2007), have determined a break-even between cash and credit card transactions, using a debit card is, in both cases, more efficient than paying with credit card. The deviating result produced by Garcia-Swartz et al. (2006) is mainly owing to the high value placed on consumer rewards for credit card payments. However, this calculation is, to a large extent, sensitive to the underlying assumptions, and thus associated with some uncertainty as outlined by Shampine (2007) and discussed below.

In addition, it is worth mentioning that the allocation of social payment costs to the different market participants allows a differentiated efficiency ranking. Netting social costs and benefits as indicated in Garcia-Swartz et al. (2006, pp. 187-188) per group, it becomes apparent that for the lower transaction size, cash and cheques are more efficient for merchants than payment cards, while the opposite holds true for consumers and commercial banks. With rising transaction sizes, the ranking changes as follows: credit card, signature debit and non-verified cheques are the most expensive instruments, while PIN debit, verified cheques and cash are the least expensive payment means for merchants. For consumers and banks, the general cost ranking does not change with higher transaction sizes, although credit cards become cheaper for banks than debit card payments.

The study concludes with the notion that, from a social point of view, a shift away from cash and cheques to cards is desirable, although the associated gains are distributed differently across the payment chain. Notably, such a change would benefit consumers, while merchants would not gain (Garcia-Swartz et al., 2006). Apparently, the conflicting private interests of consumers and merchants lead only to a socially suboptimal payment mix. To improve the situation, private incentives need to be altered by focusing on cost-based pricing and diminishing cross-subsidisation, as suggested in Humphrey et al. (2003), de Grauwe et al. (2006), Guibourg and Segendorf (2007) and Banco de Portugal (2007).

However, for banks it is often hardly feasible to introduce such a transparent price policy, as consumers who are used to “free” payment services will become dissatisfied if direct pricing is introduced (Enges and Øwre, 2006, pp. 162-163).

Indeed, the first bank to move in such a direction risks losing customers. In this situation, an industry-wide initiative could provide support in solving the issue. Yet, anti-trust restrictions and possible opportunistic non-compliance by individual banks, to attract customers from those banks that introduce differentiated pricing, are more likely to lead into a deadlock-situation.

Garcia-Swartz et al. (2006) is extensively discussed by Shampine (2007), who questions the underlying assumptions. One of the points made is the inconsistent inclusion of certain cost categories, such as for processing and equipment maintenance, as well as consideration and valuation of non-pecuniary costs and benefits. To deliver a more comprehensive estimate, Shampine (2007) proposes a flow of funds analysis, starting with the consumer paying at the POS, and including only incremental costs at each stage of the transaction process. Following this approach, annual credit card fees are to be excluded, as they are not incremental to a single POS transaction. Moreover, costs for obtaining cash are also considered irrelevant for the payment choice at the POS, and hence should be removed from the equation as well.

On the other hand, Takala and Virén (2008) and Bergman et al. (2007) account for these costs, as they indeed play a role for consumers' decisions at the POS. A solution to this apparent dilemma is to implement a two-step model where (i) adoption of a payment instrument and (ii) actual use at the POS are distinguished from each other. Models that employ such an approach are reviewed in chapter 4.

Shampine (2007) furthermore extends and refines the sensitivity analysis proposed by Garcia-Swartz et al. (2006). The paper concludes that the incremental net costs of cash to society at large, as well as to consumers, are significantly overstated, while the incremental net costs of credit card transactions are understated. Adjusting the results accordingly would decrease the cost difference between credit card and cash payments, as well as change their efficiency ranking.

It has to be borne in mind that the discussion in Shampine (2007) is limited to cash and credit card payments, resulting in somewhat preliminary conclusions. To arrive at a more complete assessment, cheques as well as debit card costs and benefits need to be included in a refined analysis.

3.2.3 Indicative efficiency ranking of payment instruments

From the overview on costs for certain payment instruments shown in Table 3–2 and 3–3 (pp. 98 and 99), and the related discussion of the literature, the following conclusions, with respect to payment instrument costs, can be drawn:

– Debit card transactions seem to be associated with the lowest social costs overall and private costs for banks. For retailers the picture is not as clear, although the review suggests that debit cards are, in principle, cheaper than credit cards and cheques.

– Retailers, in most cases, incur the lowest costs for cash payments, while for banks, cash services are more expensive than debit cards. To society as a whole, there is no unambiguous ranking of cash versus credit cards, but if consumer costs are taken into account, cash is more costly.

– Credit cards and cheques carry the highest private costs for banks and retailers. In terms of social costs, cheques are the most expensive payment means.

– Judging from marginal variable costs, the e-purse is the most economical payment instrument compared to all others. The opposite holds true if total costs are acknowledged, due to still low volumes processed against a background of high initial investments. Given the low number of studies in this regard, generalised conclusions cannot be made.

– Only a few studies have considered consumer expenditures and these estimates are associated with high uncertainties. It materialises that cash and cheque transactions are more expensive than card payments. Credit cards emerge to be less costly than debit cards, but this observation depends, to a large extent, on the value assigned to interest-free payback periods, and rewards linked to the transaction.

Yet, it should be considered that the estimations above rely on primary data collections based on different cost inquiry and analysis methodologies, owing inter alia to data restrictions and divergent institutional design. Moreover, not all studies cover the whole value chain. The majority of reports originate from small

countries with a manageable number of market participants, which immensely eases the collection of cost data. Therefore, the results might not be applicable to larger countries. Due to these limitations, cross-country studies are often not feasible, although they would contribute valuably to the understanding of efficient payment mix structures. Also, the extent to which cost differences stem from deviating economies of scale, as a result of varying payment mix and market size, could be explored in detail, if larger countries would be studied as well.

Table 3–5 below provides a comprehensive overview of the social optimal switching point between different payment instruments, and the costs to society as a fraction of GDP, as far as both have been evaluated by the studies reviewed.

Study	Country	Year	Payment costs in % of GDP	Break-even: Cash and ...	
				Debit card	Credit card
Private costs of banks					
Banco de Portugal (2007)	Portugal	2005	0.77	8.00	
Private costs of retailers					
ten Raa and Shestalova (2004)	Netherlands	1998		30.00 (13.00)[(1)]	
Arango and Taylor (2008)	Canada	2006		8.85-36.03	
Social costs of market participants					
Brits and Winder (2005)	Netherlands	2002	0.65	11.63	
Quaden (2005)	Belgium	2003	0.74	10.24	60.88
Bergman et al. (2007)	Sweden	2002	0.40	7.80 (13.64) [(2)]	17.60 (4.37) [(2)]
Takala and Virén (2008)	Finland	2005	0.30		

All amounts for transaction size that breaks even between cash and debit or credit card in EUR.
(1) Amount in () takes social costs into account.
(2) Amount in () indicates results for private consumer costs only.

TABLE 3-5: Payment costs and break-even between cash and cards[112]

It turns out that, for small transactions below roughly EUR 10, cash is more efficient than debit cards, regardless of whether private or social costs are considered.[113] The switching point between cash and credit cards, with respect to social costs, is higher, implying that the latter are more expensive than debit cards.

[112] Own compilation. For Sweden and Canada, national currency converted (EUR 1 = SEK 9.1611 / CAD 1.423), see footnote 88.

[113] Note, that Bolt, Jonker, & van Renselaar, 2008, p. 9 point to a lower switching point of about EUR 5. This indicative figure needs to be substantiated further. See also chapter 4.2.

However, as private and social cost ranks differ, a societal suboptimal payment mix might emerge. Non-transparent pricing and cross-subsidisation reinforce the situation. For example, banks are said to cross-subsidise cash services with credit card fees borne by merchants, with an unwanted consequence: Retailers apply a general mark-up, leading to higher consumer prices, according to Leinonen (2008a, p. 137), regardless of the payment instrument used. In addition, they favour cash, as they believe it is the most efficient payment instrument, but might not always be fully aware of its true costs. Moreover, consumers have strong private incentives to use credit cards (inter alia due to rewards and interest free periods) and perceive cash as a "free" service.

Overall, the cocktail of different private incentives might lead to a socially undesired overuse of cash and credit cards, while debit cards are inadequately employed. This result needed to be contrasted with related transaction figures to determine the extent of over- or underutilisation, and the inefficiencies the situation evokes. Neither has been attempted in the literature so far.

To promote change towards an efficient payment mix, some authors suggest introducing a pricing structure that reflects production costs. Applying differentiated pricing would reveal the actual costs associated with providing payment services, and incentivise end users to select the more efficient payment instrument. However, besides price, other factors also determine payment decisions at the POS. The impact of these forces is further explored in chapter 4.

The estimated savings to society from a more efficient payment mix differ widely, and range from small numbers up to 1% of GDP, depending on the assumptions and time-horizon chosen. Overall, the results achieved appear rather preliminary and not grounded in a well-established methodology. For instance, the questions on (i) how to determine the fraction of one payment instrument to be exchanged by another, (ii) what infrastructure investments are necessary to facilitate the shift and (iii) how consumers are induced to use more efficient payment means are not answered. In order to guide policy decisions, more effort would be required in this context.

4 Research on payment instrument choice at the POS

Throughout the previous discussion, it became apparent that some payment instruments are more efficient (payment cards) than others (paper-based cash and cheques) in terms of infrastructure and providers' processing expenditures, as well as users' costs for making and receiving payments. Therefore, persuading users to shift to less resource intensive payment instruments could generate social benefits. But, which characteristics drive users to prefer one payment instrument over the other? The main goal of this chapter is to answer this question, based on the empirical literature on this issue. In conjunction with the previous chapters 2 and 3, it forms the foundation for the subsequent empirical analysis in chapter 5.

In chapter 4.1 the principle two approaches to obtain data (micro- versus aggregated data) for empirical research are briefly reviewed. The central theme of this chapter, however, is the classification of the determinants of payment instrument use at the POS. This will then guide the further discussion throughout the chapters 4.2 and 4.3 on price and non-price characteristics of payment instruments as well as throughout chapters 4.4 and 4.5 on transaction attributes and constraints for payment choice. Finally, chapter 4.6 prepares the ground for the empirical analysis in chapter 5 by drawing preliminary conclusions on factors influencing the payment mix, with a focus on institutional aspects.

4.1 Data sources and categorisation of payment choice determinants

Empirical evidence on the factors influencing payment choices is rare: "on a microeconomic basis, little is known on how to encourage consumers to increase the use of debit and credit cards" (Carbó-Valverde & Liñares-Zegarra, 2009). One of the main reasons for this could be the lack of readily available and detailed enough data, especially regarding payment prices.

In a number of countries, consumer surveys on payment behaviour were conducted to overcome this problem. Often, these were supplemented with transaction information from payment diaries, which the respondents had been asked to complete. Another way of collecting transaction data was chosen by researchers who used POS scanners, or bank-internal processing data. This "micro-data"

approach has been applied in the majority of the literature, and it produces valuable insights into determinants of individual payment choices leading to a country's specific payment mix. It should be noted, however, that the literature focuses on consumers, while merchants receive much less attention. Besides, methodology and data coverage differ widely, making comparisons of the results over time and across countries somewhat unfeasible.

To allow for the latter, some researchers carry out econometric analyses based on (i) aggregated data from publicly available statistics and (ii) price data collected from private sources. Due to the low frequency of statistics publications, only a few observations are produced, which limit modelling choices. Nevertheless, besides allowing cross-country comparisons, this approach is also employed to study some of the institutional aspects of the payment system. These are deemed to contribute to the shaping of a countries' payment mix as well. Yet, qualitative assessments dominate this discussion.

The critical factors affecting consumers' payment choice at the POS can be grouped into four categories, exhibited in Figure 4–1: (1) price and (2) non-price characteristics of payment instruments, as perceived by payers as well as (3) transaction attributes and (4) constraints. These are dealt with in chapter 4.2 to 4.5.

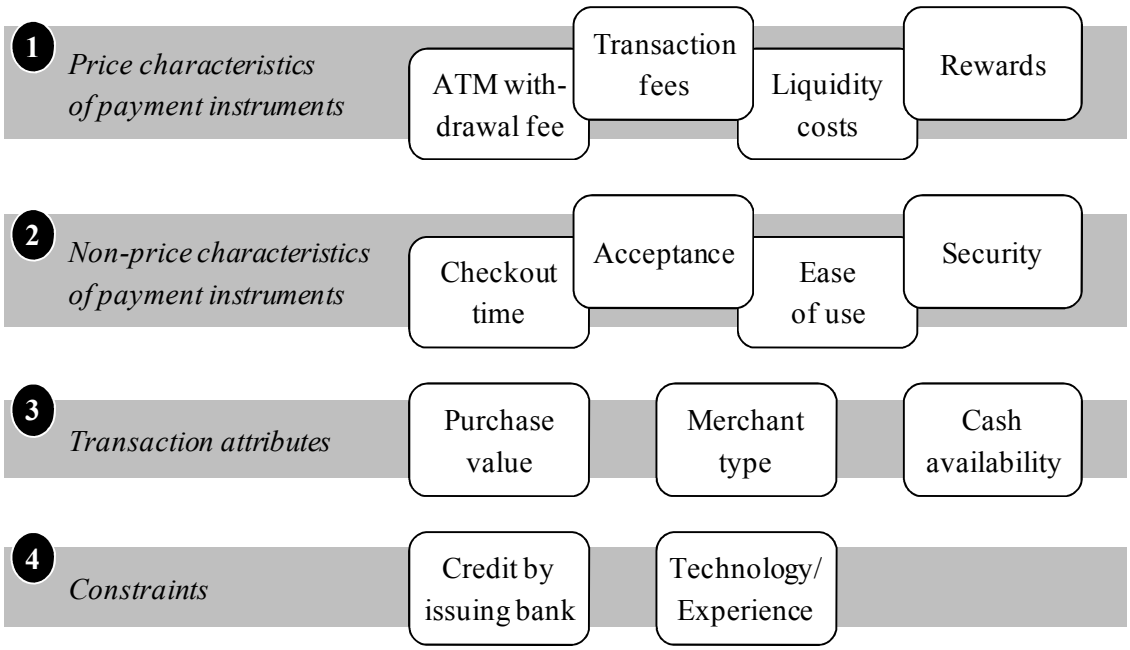

FIGURE 4-1: Determinants of consumers' payment instrument choice[114]

[114] Own illustration.

It is acknowledged that this display deviates from conventional classification, which rather distinguishes between socio-demographic and transaction characteristics, as well as consumers' perceptions of payment instruments. The following considerations led to this new approach, whilst the literature cited is exemplary, and further reviewed below.

Although all studies control for socio-demographic factors, the effect on payment instrument use is at least debatable. First, once additional explanatory variables are added, fewer socio-demographic characteristics turn out to be significant for payment choice. A direct comparison between Schuh and Stavins (2011) and the preceding paper Schuh and Stavins (2010), as well as between Arango, Huynh, and Sabetti (2011) and Arango and Taylor (2009) provide evidence for this view. Also, the effect of income seems limited due to collinearity to education (Klee, 2008) or other socio-demographic factors such as age and gender (Borzekowski & Kiser, 2008). Finally, behavioural differences between two segments of the population, such as older and younger individuals, may be better explained by the same underlying variables, including non-price characteristics, such as the frequency of ATM withdrawals, or demand for Internet purchases (von Kalckreuth, Schmidt, & Stix, 2009).

Studies such as Arango et al. (2011) and Schuh and Stavins (2011) dedicate a lot of effort to determine the influence of perception on a wide range of payment instrument features. Yet, only a few of these are researched widely enough to draw reliable conclusions on their importance for payment choice. Consequently, emphasis is laid on four selected non-price characteristics. It is especially worth noting that "acceptance" is intertwined with the transaction attributes of the third category. For example, some merchant types tend to honour payment cards (e.g. department stores), while others do not (e.g. small shops), based on costs incurred for acceptance (Bounie & Francois, 2006). Grocery stores, for example, predominantly handle small transactions for which cash seems the most efficient payment medium (see chapter 3.2). Therefore, perceived acceptance is associated with the merchant type dealing with "typical" ranges of sales values.

The constraints introduced here are not part of the conventional categories either, but may restrict or foster payment instrument adoption and/or use. For example, the proposed influence of income and education on credit card adoption appears to reflect credit limits imposed by the issuing bank (Simon, Smith, & West, 2010). And already Humphrey, Pulley, and Vesala (1996) ascertain the role of experience and technology affinity in shaping payment behaviour: "it is the youngest segment of the adult population that has the greatest adoption rate of new payment methods, since [...] [it] has the least experience with established methods, is more accepting of new technology, and thus more open to change given the incentives (including convenience) which may exist." Thereby, the authors support the hypothesis that behavioural differences between age groups can be attributed to some more rational factors.

4.2 Price characteristics of payment instruments

Determining the impact of pricing on consumers' payment choice is a complex task, due to a widespread lack of transparency. Starting in 2005, the European Commission undertook an extensive retail banking sector inquiry to shed more light on the issue. Three years later, a consultant firm was commissioned to explicitly obtain prices for current accounts, including payment cards and cheques. Overall, it emerged that pricing to consumers is highly opaque, given that payment services are often bundled together with account packages, while tariffs are complex and exceedingly detailed.[115]

Hence, consumers often perceive payments as "free" services, despite implicit charges arising from account package fees, foregone interests due to float (chapter 3.2.1), or low interests on transaction balances (Bolt, Humphrey, & Uittenbogaard, 2008)[116]. Leinonen (2009b, pp. 189-190) adds that, in fact, consumers absorb the merchant service charge (as other costs), which is uniformly passed on to them independent of the payment instrument used. On the other hand, issuing banks redistribute the interchange fee to cardholders in the form of rewards, or low adoption fees (see chapter 2.2.3 and footnote 120).

[115] For details refer to European Commission (2006a, pp. 13-16, and 2006b, pp. 15-17 and 44-46) as well as Van Dijk Management Consultants & Centre for European Policy Studies (Van Dijk & CEPS, 2009, pp. 37-73).

[116] Results published here are identical with those of Bolt, Humphrey, & Uittenbogaard (2005).

Against this background, only those price characteristics can be accounted for which consumers could reasonably observe. Still, they face a complex optimisation problem when deciding about the adoption and usage of the most suitable payment instrument. This is briefly outlined in the following.

In order to access and hold cash for transaction purposes, consumers may encounter ATM withdrawal fees.[117] These can be avoided, if cardholders obtain cash at the POS alongside paying for goods and services, called "cash back" (Humphrey, Kim, & Vale, 2001). Cash holdings give rise to foregone interests. For cheque payments, consumers first get a chequebook, and hence possibly pay a fixed fee; also charges for the drawing and bouncing of cheques may be made (Van Dijk & CEPS, 2009, p. 122). As reference made to cheque is sparse in the literature, it is only cursorily covered throughout this and the following chapters.

The decision function around payment card use is more complex.[118] First, monthly or annual fees apply for holding a debit or credit card respectively. At least in the case of debit cards, this fixed fee is often part of an account package, and thus difficult to evaluate. At the POS, payers optimise among transaction fees, costs of liquidity and rewards:

– Transaction fees can be imposed by issuing banks or merchants, in the form of a surcharge. Traditionally, banks have largely abstained from direct pricing of transactions, so as not to lose deposit market share, while anti-trust regulation hinders the sector-wide introduction of transaction pricing for consumers (Bolt, Humphrey et al., 2008). As described in chapter 3.2.2, Norway gradually introduced explicit pricing of payment services based on costs. PIN-debit card payments in the USA are another example. For these transactions, issuing banks impose a fee to steer consumers towards signature-based debit cards (Borzekowski, Kiser, & Ahmed, 2008). Surcharging is now permitted in a number of countries. Ideally, such mark-ups on transactions with certain pay-

[117] While cardholders who obtain cash at their own bank's ATM network are often exempt, customers of other banks, which are not member of the ATM network, are charged.

[118] In contrast, the theory on the economics of payment cards is widely researched, based on models nested in the two-sided market literature. A recent comprehensive review stems from Rysman and Wright (2012). See also Bolt and Chakravorti (2008b), Rochet and Tirole (2006) and Scholnick, Massoud, Saunders, Carbó-Valverde, & Rodríguez-Fernández (2008) for reports on the field.

ment instruments are based on costs, to induce payers to use more efficient payment means (Leinonen, 2010).[119]

– Liquidity costs underlie the substitution decisions between cash, debit and credit cards. If consumers draw from liquid accounts (through cash or debit card), they forego interest on transaction accounts. This is not the case when cardholders employ their credit card, and regularly repay the balance at the end of the grace period. These "convenience users" benefit from an interest-free short-term loan. However, if payers are liquidity constrained, they can borrow from their credit card, but then encounter interest ("revolver").

– Rewards are granted primarily for credit card transactions, but are also known for debit card transactions. They occur in various forms, such as airline miles, cash, discounts, loyalty points etc.[120]

From this discussion, four key pecuniary forces influencing payment decisions emerge: ATM withdrawal and transaction fees, as well as liquidity costs, and payment card rewards. Following an assessment of the impact of perceived costs in section one of this chapter, all four pecuniary forces are explored in the subsequent sections two to five.

Table 4–1 (next page) provides an overview of the literature surveyed. It informs about the country, time span and payment instruments (scope) covered in the respective data set. Further, the data collection methods (source), as well as key results, are highlighted. With respect to the former, "survey" and "diary" indicate that consumers were asked to answer a questionnaire and fill out a transaction log about all of their payments over a number of days. "Bank (transaction) data" and "price data" were supplied by providers of payment services, notably banks. "Aggregate data" is publicly available information; inter alia, on yearly transac-

[119] Bolt and Chakravorti (2011) study two cases, Australia and the Netherlands. But no clear answer can be given on whether abolishing the no-surcharge rule facilitates a more efficient payment mix. Most recently, Economides and Henriques (2011) have modelled this question. According to the paper, the no-surcharge rule results in reduced acceptance and higher market prices in equilibrium. However, it might still be socially desirable, depending on the merchants' market power and the network effect exerted on cardholders.

[120] According to Ching and Hayashi (2010), issuing banks often finance rewards out of interchange fee income. In countries in which public authorities are required to set interchange fees on cost-based benchmarks, excluding rewards, their value decreased significantly, as in the case of Australia (see Simon et al., 2010).

tion values, and volumes published by national central banks.

Methodological differences are also indicated: Some researchers examine adoption and use of payment instruments separately. Others exclude observations where consumers do not have a choice, due to restrictions imposed by the issuing bank (supply of a payment account/card) or by merchants (acceptance). Owing to the divergence in data coverage and methodology, direct comparisons between the studies reviewed are difficult. Still, some general conclusions can be drawn.

Study	Country	Year	Source/scope	Highlight
Perceived costs				
Schuh and Stavins (2011)[121(1)(2)(3)]	USA	2008	Survey: all instruments prepaid card	Perceived costs are important for payment card adoption and use
Arango et al. (2011)[(2)]	Canada	2009	Survey, diary: cash, debit and credit card	Payment choice is inter alia based on perceived costs, "avoid fees" and "delay payments" motives
ATM withdrawal fees				
Humphrey et al. (2001)[122]	Norway	1989-1995	Bank data: cash, cheque, debit card	Payers react to price changes by substituting cash and cheques, and replacing cheques by debit cards
de Grauwe et al. (2006)[123]	Cross-country	1998-2003	Aggregate and price data: cash, debit card	Cash replacement and debit card use is fostered if cash becomes relatively more expensive, given sufficient POS acceptance
Bolt, Humphrey et al. (2008)[122]	Netherlands Norway	1990-2004		
Scholnick et al. (2008)[124]	Spain	1997-2003	Bank data: cash, debit card	Higher withdrawal prices lead to more POS debit card payments (both are substitutes)
Per-transaction fees and surcharges				
Borzekowski et al. (2008)[(1)(2)]	USA	2004	Survey: debit card	Probability of debit card usage declines sharply when cardholders incur per-transaction fees

[121] Schuh and Stavins (2011) extend Schuh and Stavins (2010) based on newer and richer 2008 data. Both studies are based on the regular US Survey of Consumer Payment Choice, which is conducted on behalf of the Federal Reserve Bank of Boston. The complete data set for 2003, 2004, 2006, 2008 and 2009 is available at http://www.bos.frb.org/economic/cprc/scpc/index.htm (retrieved 2012, August 2). The 2010 data should be available soon. Besides the payment instruments mentioned, the study includes so-called "online banking bill payments", i.e. credit transfers and "bank account number payments", i.e. direct debits.

[122] In this paper, the determinants of replacing paper credit transfers with electronic credit transfers and direct debits are examined as well, but omitted here due to being out of scope.

[123] Countries covered are: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the UK, Czech Republic, Estonia, Hungary, Latvia, Slovenia, Poland, Romania, Switzerland, Norway and Iceland.

[124] For the largest part of their report, Scholnick et al. (2008) undertake a review of the literature on the economics of credit cards, the substituting relationship between debit cards and ATM withdrawals conditional to pricing as well as the characteristics of ATM networks.

Bolt, Jonker, and van Renselaar (2010)[3]	Netherlands	2006	Survey: cash, debit card	Lifting surcharges would result in higher debit card volume share
Carbó-Valverde et al. (2010)[1][3]	Spain	1997-2007	Bank data: debit and credit card	Lower interchange fees lead to rising acceptance which fosters payment card adoption and use
Interest rates				
Zinman (2009)[125][2]	USA	1995-2004	Survey: debit and credit card	Liquidity constrained consumers use debit cards more often than convenience user to save interests
Simon et al. (2010)[1][2]	Australia	2007	Diary: all instruments	Grace periods (rewards) induce replacement of debit cards (cash)
Payment card rewards				
Carbó-Valverde and Liñares-Zegarra (2009)[2]	Spain	2005	Survey: cash, debit and credit card	Rewards on debit and credit cards foster substitution from cash, the effect is larger for debit cards
Ching and Hayashi (2010)[126][2][3]	USA[2]	2005	Survey: all instruments	Cutting rewards would increase debit and reduce credit card usage, slightly more cash and cheque use

All instruments = four major payment instruments used at the POS (cash, cheque, debit and credit card)
[1] Adoption and use modelled separately. [3] Merchants excluded who accept only cash.
[2] Consumers without a payment account and/or payment card excluded.

TABLE 4-1: Price characteristics and payment choice at the POS[127]

Perceived costs

Schuh and Stavins (2011) and Arango et al. (2011) are based on comprehensive surveys of consumers' payment behaviour in the USA and Canada. While Schuh and Stavins (2011) asked payers to assess the overall net costs associated with payment instruments[128], Arango et al. (2011) differentiated between

(i) perceived costs, including inter alia withdrawal fees, account fees, and interest paid,

(ii) fixed annual credit card and monthly debit card fees which allow for free transactions as well as

(iii) rewards, tackled in the last section of this chapter.

According to Schuh and Stavins (2011), cash costs are ranked lowest, followed by debit card and cheque while credit cards are seen as the most expensive

[125] The study is based on the Federal Reserve's Survey of Consumer Finance (see footnote 135).
[126] The sample might be biased as income and education levels are higher compared to general U.S. population (Ching & Hayashi, 2010, p. 13).
[127] Own compilation.
[128] Costs include fees, penalties, postage, interest paid or lost, or subscriptions that raise costs as well as cash discounts and rewards that reduce costs (Schuh & Stavins, 2011, p. 31).

instrument. However, costs significantly affect only debit card adoption, as well as credit and debit card use. The cost ranks are identical to Arango et al. (2011). It materialises that consumers indeed replace cash or credit cards with debit cards at the POS, depending on their cost assessment Individuals that incur an annual credit card or monthly debit card fee while not being charged per transaction are more likely to employ their credit or debit card at the expense of the alternative instrument. In addition, the authors asked consumers about the three most important reasons for their particular payment choice at the POS. Besides ease of use, these were avoiding fees and delaying payments. The first motive favours debit cards and cash, while credit cards are used less. Adversely, the wish to delay payments significantly raises credit card use, to the detriment of the two other payment means. This finding fits with consumers' decision function, drafted above.

ATM withdrawal fees

Four studies are examined in this section. Humphrey et al. (2001) is concerned with the influence of relative prices on the substitution of debit card payments for cash, approximated by ATM withdrawals, and cheques at the POS. The authors use per transaction prices, as quoted by the surveyed Norwegian savings and commercial banks. In contrast to other jurisdictions, Norway gradually introduced direct (transaction) pricing, so as to better reflect at least the variable costs of providing payment services (see chapter 3.2.2 for details). De Grauwe et al. (2006, pp. 17-21) present a discrete choice model to determine the market share, in terms of debit card and cash transaction volume, conditional to debit card and ATM withdrawal fees. Bolt, Humphrey et al. (2008) compare the experiences of Norway (explicit pricing) and the Netherlands (non-transparent pricing as outlined above), to explain the shift from cash to debit cards at the POS. Scholnick et al. (2008) deliver, just as Humphrey et al. (2001), evidence on the substituting relationship between ATM withdrawals and debit card payments at the POS, conditional to withdrawal fees and cash back. While Humphrey et al. (2001) use a time-index and a cash back dummy to capture non-price influences, the other three studies directly control for cash availability (number of ATMs) and/or acceptance (number of POS terminals), investigated from a perception perspective in chapter 4.4.

Humphrey et al. (2001) find that higher prices evoke reduction in payment instrument use, as indicated by significant negative own price elasticities. The effect is strongest for cheques, followed by ATM withdrawals, and weakest for debit card payments. Reacting to price changes, consumers are willing to substitute ATM withdrawals and cheque transactions both ways, and to replace cheques by debit cards. In contrast to Bolt, Humphrey et al. (2008), de Grauwe et al. (2006, pp. 17-21) and Scholnick et al. (2008), no significant relationship appears to exist between ATM withdrawals and debit card use at the POS. The introduction of cash back significantly fosters debit card payments, while cheque use declines. More efficient payment technology associated with the passage of time has advantaged ATM withdrawals and debit card volumes, while cheques recede. Overall, the authors suggest that consumers quite sensitively react to relative price differences. Hence, they recommend adjusting payment prices such that cost differentials become visible in order to facilitate the transition to more efficient payment services. Such a policy has noticeably speeded up cash substitution in Norway compared to the Netherlands.

Bolt, Humphrey et al. (2008) conclude from their cross-country difference model that pricing indeed affects payment choice, i.e. lower prices for debit card transactions relative to ATM withdrawals result in higher debit card payment volumes. In the same vein, if ATM withdrawals become more expensive relative to debit card payments, cash is obtained less often. Yet, the impact of pricing is smaller than that of ATMs and POS terminal availability. This implies that non-price characteristics of payment instruments are more important to induce changes in payment behaviour than are price attributes. The authors even claim that the number of ATMs and POS terminals is a good proxy for "hard-to-specify/ hard-to-measure" non-price factors of POS debit card use. Nevertheless, Bolt, Humphrey et al. (2008) conclude that the shift towards a more intense use of debit cards could be speeded up with a combination of ensuring debit card acceptance, as well as setting direct price signals.[129]

[129] ATM withdrawals per capita reached a peak at 1998 and 2001 in Norway and the Netherlands respectively pointing to saturation.

In line with Bolt, Humphrey et al. (2008), de Grauwe et al. (2006, pp. 17-21) confirm that consumers respond to changes in payment prices. They turn away from cash as it becomes more expensive relative to debit card holding and use. Surprisingly, holders seem to employ their debit card more often, once the fixed annual fee is raised. In this way, consumers probably try to recover most value from the cards they have paid for anyway. Similarly, Borzekowski et al. (2008) (reviewed below) observe that debit card holding itself is an important determinant of its utilisation. Further, de Grauwe et al. (2006) show a small positive correlation between the number of POS terminals and debit card volumes, underlining the two-sided market nature of debit card payments. The number of ATMs indicating cash availability is not included in the model. Consistent with the conclusions of the other two papers, the authors state that if prices would more closely resemble payments cost, consumers could be induced to switch from cash. Debit card volumes would surge and the social costs of payments could be reduced.

Scholnick et al. (2008) confirm the previously mentioned results: The sum of debit card payments and cash back replace ATM cash withdrawals. Moreover, the higher the ATM fee, the greater the volume of transactions and withdrawals at the POS. Interestingly, the latter rises not only in line with the number of POS terminals, but also with the density of ATMs. One explanation is offered by the experience hypothesis, touched upon in chapter 4.5. Consumers being familiar with the handling of debit cards for cash withdrawals are more inclined to turn to card transactions at merchants' outlets.

Per-transaction fees and surcharges

The three studies analysed in this section look at payment prices from three different angles. While Borzekowski et al. (2008) are concerned with direct per-transaction fees imposed by issuing banks on cardholders, Bolt et al. (2010) are interested in the effect of surcharging by merchants. Both papers interpret consumer surveys conducted in the USA and the Netherlands respectively. Carbó-Valverde et al. (2010) rely on confidential Spanish bank data to explore the more complex relationship between interchange fees making up the biggest part of the merchant service charge, merchant acceptance and payment card adoption / use.

Borzekowski et al. (2008) show that explicitly charging for the use of those payment instruments perceived as close substitutes can have adverse consequences for payment efficiency. 15% of issuing banks in the USA set the median fee for PIN-based debit card payments to USD 0.75[130] in order to steer consumers to signature debit cards. In fact, consumers switch from PIN-based to signature debit card. The probability of paying with debit cards declines by 12%, despite the fact that the median fee only represents 1.8% of the average purchase amount. But overall, the likelihood of paying by debit card deteriorates as well, since some consumers seek other alternatives to signature debit cards. This finding might imply that cardholders cannot clearly distinguish between the card types. Finally, the authors suggest that surcharges would result in a sharp decline of transaction volumes. The effect might even be stronger than the one found for PIN debit cards, since surcharges are most likely visibly stated at the POS, while debit card transaction fees are not. Instead, these are published in the list of conditions, and appear on the account statement only after the payment has occurred.

Whether surcharging leads to a more efficient payment mix is examined by Bolt et al. (2010). They note that in the Netherlands, a large majority of small shop owners (i.e. 20% of all merchants) apply a fee for debit card payments below a purchase amount of EUR 10-15 (threshold). As expected, merchants who surcharge experience a significantly lower share of debit card payments, which are replaced by cash. In turn, if merchants stop surcharging, the share of debit card transactions at the POS increases from 36% to 44%. Moreover, the higher the fee, the less likely consumers are to pay by debit card – a 9 cent higher fee (up from EUR 0.23) is associated with 3%-points less debit card payments.

Against this background, Bolt et al. (2010) argue that surcharge and threshold with the social break-even point needs to be aligned, in order to avoid over- or underuse of debit cards. Judging from the authors' report, merchants seem to have set the threshold above the socially optimal one, resulting in the underuse of debit cards, and a higher than socially efficient cash share. The authors cite an earlier version of their paper to indicate that the social optimal threshold dropped

[130] Zinman (2009, p. 360) reports a fee of USD 0.25. The reason for this large difference could not be unveiled.

below EUR 5 (Bolt, Jonker, & van Renselaar, 2008, p. 9) – instead of EUR 11.63 as provided in chapter 3.2.2 (e.g. Table 3–5, p. 117). Other factors, such as merchant type and size measured by sales revenues were controlled for. These variables are positively associated to the share of debit card payments at the POS. This result appears plausible, as merchant type and transaction value, as well as merchant size and acceptance, are closely related (see chapter 4.4).

A novel route is taken by Carbó-Valverde et al. (2010) who analyse the impact of a number of regulatory interventions, which are gradually forcing interchange fees down. According to the two-sided market literature outlined in chapter 2.2.3, lower interchange fees should result in a lower merchant service charge, and thus higher acceptance rates. In turn, cardholders' fixed fees should rise (assumption that the price structure changes given a constant price level), and payment card adoption could come to a halt or even decrease. But, countervailing this tendency, higher acceptance means greater network value for cardholders, and thus, possibly a growing willingness to pay for cardholding. Besides, consumers may be inelastic to price changes, as suggested by Arango et al. (2011) with regards to rewards. Contrary to this, other studies already reviewed, such as Humphrey et al. (2001) and Borzekowski et al. (2008), endorse the view that consumers react rather sensitively to payment prices.

Carbó-Valverde et al. (2010) derived the following: First, as a consequence of forced-down interchange fees, and subsequently lower merchant service charges, acceptance for debit and credit cards broadens. Second, this situation is associated with more widespread payment card adoption – notwithstanding higher annual credit card fees (debit card fixed fees could not be included in the model). The effect is weaker for debit cards, as they appear to have reached a saturation point; they were introduced for ATM services more than a decade earlier. Together, higher acceptance and adoption result in more payment card transactions. Moreover, consumers adjust their payment behaviour if costs for obtaining cash ascend, and use debit cards more often. Fourth, most of the regulatory dummies incorporated in the model are significant and positively related to acceptance, as well as payment card adoption and use, pointing to a sound regulatory strategy. Finally, Carbó-Valverde et al. (2010) control for the crime

rate, which is significant and positively related to credit card adoption and use, suggesting a shift from cash to credit cards for higher purchase values (see chapter 4.3 for more details on the security attribute).

Liquidity costs

Besides Borzekowski et al. (2008), two other reports offer insights into substitution patterns between debit and credit cards. Zinman (2009) covers a decade of US consumers' payment behaviour while Simon et al. (2010) build on transaction data from Australian consumers' payment diaries. The two important motives for payment choice at the POS singled out by Arango et al. (2011), i.e. to the "avoid fees" and "delay payment", are closely related to the cost of liquidity. While fees are avoided if consumers draw from liquid accounts by spending cash or from debit cards, payments can be delayed by convenience use of credit cards.

As a starting point, Zinman (2009) argues that debit and credit cards are close substitutes, as long as only non-price characteristics such as acceptance, security and time costs (see sections on checkout time and cash availability in chapter 4.3) are considered. Consequently, debit and credit cards only differ in price. Further, the author assumes that consumers first decide whether to use cash or payment cards based on the non-price attributes mentioned, and then minimise costs. It is established that in general, holding a credit card is associated with a reduction in the probability of debit card use. However, cash-constrained consumers tend to more heavily spend out of liquidity, i.e. use debit cards more frequently than other credit card holders. For example, the model predicts that "revolvers" borrow 48% less from credit cards, and switch to debit cards. A few also use cash and cheques instead. The positive correlation between revolving credit card balances and debit card use has been growing over time. This seems a consequence of better fraud protection and debit card acceptance, making them a closer substitute for credit cards. In addition, if consumers' credit card balances approach credit limits, they pay more often with their debit card.

Additionally, Borzekowski et al. (2008) provide a deeper understanding of debit / credit card substitution patterns. According to the paper, consumers spend more from liquidity, i.e. choose their debit instead of their credit card for purchases if

they expect their economic situation to worsen, for example, due to impending unemployment. However, if consumers report that their financial status is worse now than a year ago, they rather turn to credit cards as a source of liquidity. This tendency supports the belief that consumers use credit cards to smooth consumption, if they experience liquidity constraints. In fact, Simon et al. (2010) detect significantly higher credit card use among the lowest income groups, compared to the average income segments.

The findings published by Simon et al. (2010) further substantiate the observations of Zinman (2009) and Borzekowski et al. (2008). Simon et al. (2010) indicate that cardholders who revolve their balances utilise their debit card significantly more often than the credit card, compared to convenience users. More specifically, credit card use drops by 16%-points (debit card use rises by 19%-points) if the payer does not benefit from a grace period. In sum, access to an interest-free period triggers substitution of debit to credit cards. Nevertheless, the impact of an interest-free period on payment choice is smaller than that of rewards on card transactions, as the next section shows. One of the reasons could be that some revolvers – although being burdened with interest – still draw on their credit card, owing to liquidity constraints.

In sum, Zinman (2009) determines that the average consumer strongly responds to the implicit price of credit card balances by adjusting his/her debit card use accordingly. Nevertheless, for 28% of the survey participants, no obvious pecuniary reasons for paying with debit cards could be found, as they possess a credit card, but pay off their balances at the end of the grace period. Diminishing time costs could be an explanation as, for example, debit cards allow obtaining cash at the POS (cash back).

Payment card rewards

In this section, Arango et al. (2011) and Simon et al. (2010) are investigated to assess the influence of rewards on payment decisions. Besides this aspect, Carbó-Valverde and Liñares-Zegarra (2009) explore, based on a survey among Spanish consumers, a wide range of payment choice indicators, and thus will be studied

in this section as well as in chapter 4.3. Ching and Hayashi (2010) examine, in particular, the influence of removing incentive programs.

Arango et al. (2011) solely consider credit card rewards. According to them, these are responsible for driving consumers away from cash for purchases below CAD 25. Above this value, consumers replace debit by credit cards. Due to the proportionality of rewards plans, the likelihood of paying with the latter increases in line with transaction values. Yet, payers appear relatively inelastic to credit cards incentives.

Arango et al. (2011)'s results are objected to by Simon et al. (2010) based on two notions. First, credit card rewards induce the substitution primarily from cash to credit cards, while debit card usage is almost unaffected. Second, consumer preferences vis-à-vis cash or credit card use are significantly affected by relatively minor price changes, as instituted by rewards – the existence of an incentive program enhances the probability of using the respective credit card by 23%-points, and reduces the likelihood of cash use by 14%-points.

Carbó-Valverde and Liñares-Zegarra (2009) contribute to the previously limited research on reward programs' effectiveness in terms of fostering card payments and cash substitution. It is estimated that the probability of employing payment cards instead of cash is heightened if incentives such as discounts, loyalty points or cash rewards are in place. Such incentives tend to stimulate debit card significantly stronger than credit card use. Obviously, they are most beneficial in stores where payment cards are the preferred instrument. Therefore, department stores and gas stations, for example, experience a strong increase in card payments, while no significant change occurs at grocery stores. The latter is not surprising, given a cash transaction share of 92%. Further, the authors quantify the impact of incentive programs, and show that they not only contribute to substitute payment cards for cash, but also that consumers spend more.

A different approach is adopted by Ching and Hayashi (2010). Three scenarios are modelled: A separate removal of credit and debit card rewards respectively, as well as abolishment of both at the same time. One of the key assumptions – consumers' perceptions towards the affected payment cards would remain

unchanged – is a rigid one. The policy experiences conducted by Ching and Hayashi (2010) derive the following outcomes:

– First, if credit or debit card rewards are eliminated, the probability of consumers paying with the affected payment card across all merchant types would be reduced. The effect is stronger with credit than debit cards (reflecting less generous rewards for the latter), although overall moderate. Still, cutting credit card incentives lowers the probability of paying with the card for convenience users, and revolvers thus could help to reduce credit card debt.

– Second, if consumers still receive rewards on the alternative payment card, they rather switch to the alternative than to cash or cheques.

– Third, if all payment card incentives are removed, consumers previously benefitting from both types of rewards would be less inclined to use their credit card. Whether they would turn to debit card payments depends on the merchant type. For example, the probability is higher in department stores and lower in grocery shops. The influence of merchant type on payment choice, in combination with average purchase amounts and acceptance restrictions, is reflected upon in the next chapter.

Overall, Ching and Hayashi (2010) state that abolishing payment card rewards would decrease the share of credit card transactions by 1 to 3%-points depending on merchant type. Consumers would switch to debit card as well as to cash and cheques. Debit card volumes would rise slightly, mostly at department stores and groceries, by about 1%-point. The remaining part would be left to the other payment means, leading to an increase by 1 to 2%-points at the most. Hence, the aggregate share of payment card transactions would not change considerably.

Comparing this somewhat surprising result to the ones drawn by Arango et al. (2011), Simon et al. (2010) and Carbó-Valverde and Liñares-Zegarra (2009) evokes the following conclusions: Payment card rewards are useful to drive payers away from cash and cheques in still developing markets. A key prerequisite for successful substitution is widespread acceptance by merchants. Once consumers are sufficiently comfortable with card payments, and a saturation

point has been reached, rewards could be gradually removed. This would allow lowering interchange fees and merchant service charges accordingly. Given that merchants pass through cost saving to consumers, these should profit from a smaller mark-up on prices for goods and services. Moreover, consumers would face clearer price signals and could adjust their payment choices accordingly.

4.3 Non-price characteristics of payment instruments

A growing body of literature is concerned with the question on how consumers' perceptions about certain features of payment instruments shape their payment choices. These non-price characteristics embrace time spent at the checkout, merchant acceptance, ease of use and security.

Checkout time is determined by the time consumers spend queuing in front of the salesperson while payment instruments are validated, and transactions initiated and settled by the merchant. The latter is closely related to authentication, verification and authorisation processes, subject to intra- and interbank arrangements. As explained in chapter 3.2.1, queuing / merchant processing time contribute to social payment costs.

Acceptance is closely linked to the transaction attributes of a payment, dealt with in chapter 4.4. There, it is demonstrated that consumers tend to choose payment instruments in accordance with purchase value. Typically, the average purchase amount differs across merchant types, such as department stores or groceries. In light of fixed costs for installing POS terminals, and two-part tariffs[131] (fixed per-transaction plus ad-valorem fees), merchants determine a break-even, above which they accept payment cards. Consumers, in turn, choose between card payments, given acceptance, or cash. Here, cash availability, the third transaction attribute in question, comes into play. Clearly, the acceptance level reflects the two-sided nature of the payment card market, as outlined in chapter 2.2.3.

Ease of use (or convenience) is another important factor of payment choice. If payment means are easy to handle, i.e. consumers regard, for example, payment

[131] Two part-pricing consists of a "fixed price to recover the average fixed cost of producing payment services (reflecting processing economies of scale) and a variable price or transaction-based fee to recover average variable costs" (Bolt & Humphrey, 2005, pp. 17-18).

initiation as simple, checkout times may be shorter, thereby lowering costs. Further, the perception of security mirrors the consumers' feeling that the mechanisms installed by providers to avoid counterfeiting and fraudulent use of payment means are sufficient. Another aspect is the security in a country (risk of being robbed). Counterfeiting, fraud and theft also increase social payment costs.

In the first section of this chapter, the impact of checkout time and acceptance on payment behaviour is analysed. The second section is concerned with ease of use and security. Table 4–2 below gives an overview on the literature surveyed in this chapter.[132] It has the same structure as Table 4–1 (p. 126). Also, the limitations in terms of comparability between the different papers exist as well.

Study	Country	Year	Source/scope	Highlight
Klee (2008)(3)	USA	2001	POS scanner: all instruments	Checkout times: cheques take longest, followed by credit > debit card > cash
Borzekowski and Kiser (2008)(2)	USA	2004	Survey: all instruments	Faster checkout times foster use of (new) payment card; consumers switch back to cash or cheque if either debit or credit card acceptance is abolished
Arango and Taylor (2009)[133](1)	Canada	2004	Survey: cash, debit and credit card	Ease of use and security decisive for shift from cash to payment cards, which is limited by acceptance
Schuh and Stavins (2011) (1)(2)(3)	USA	2008	Survey: all instruments, prepaid card	Ease of use is vital for payment card adoption, security for their usage
Arango (2011)(2)	Canada	2009	Survey, diary: cash, debit and credit card	One key determinant for payment choice is ease of use, security facilitates the shift from cash to debit card

All instruments = four major payment instruments used at the POS (cash, cheque, debit and credit card)
(1) Adoption and use modelled separately. (3) Merchants excluded who accept only cash.
(2) Consumers without a payment account and/or payment card excluded.

TABLE 4-2: Non-Price characteristics and payment choice at the POS[134]

[132] Studies that merely report results from consumer surveys without constructing a formal model explaining payment choice are left out of the discussion. Nevertheless, the data provided might serve as a useful basis for further analyses, as has been proven with Hoffmann et al. (2009), the first comprehensive study on payment behaviour at German POS terminals. Results are reported in von Kalckreuth et al. (2009), see review in chapter 4.4.

[133] Compared to census, adults aged 30-45 years and those with university education are overrepresented in the data set, while those with an education less than high school are underrepresented (Arango & Taylor, 2009, p. 4).

[134] Own compilation.

Checkout time and acceptance

Four reports are inspected to substantiate the influence of checkout time and acceptance on payment choice: Klee (2008), Borzekowski and Kiser (2008), Schuh and Stavins (2011) and Arango et al. (2011). Klee (2008) exploits POS scanner data from US groceries. She directly estimates checkout times based on the payment instrument used, the number of items bought, the change tendered and received, and whether cash back is requested, but does not link these to payment choice. Borzekowski and Kiser (2008) rank payment means according to socio-demographic and three payment instruments characteristics, i.e. "electronic" (payment card or cash/check), "liquid" (allow to tap credit or not) and "checkout time". Thereafter, they derive volume shares of payment instruments and model consumers' reactions to the introduction of a new contactless debit card. Further, Borzekowski and Kiser (2008) test what happens if merchants stop accepting an established payment mean. Schuh and Stavins (2011) and Arango et al. (2011) were already introduced. Both studies depict how consumers' payment decisions follow their assessment of payment instruments' characteristics.

Klee (2008) calculates that cheques take longest to be processed at the POS, followed by credit and debit cards. Cash requires the least effort, if the consumer tenders exact change. If not, cash transactions take as long as debit card payments. Consumers' perception as described by Schuh and Stavins (2011) coincides roughly with the estimated values. The authors reveal that checkout time is positively related to debit card adoption and usage, as well as the use of prepaid cards and cheques. Against this background, the authors propose that the declining importance of cheques is associated with payers' assessment of slower transactions at the POS, compared to other payment means. Arango et al. (2011) specifically point out that cash is still intensively used because consumers view it as being fast to handle.

Borzekowski and Kiser (2008) add a further dimension, and imagine the introduction of an alternative payment instrument. If this contactless debit card would be as fast to process as cash, it could take over substantial volumes (7 %-points) at the expense of cheques, credit cards and cash, experiencing roughly equal

losses of about 2%-points. Nevertheless, the authors indicate that replacing cash and cheques with newer, faster payment means would only take place gradually.

The authors also model consumers' reactions to limitations in the set of payment choices. If merchants would stop accepting cash or cheques, consumers would switch about half of these volumes to payment cards. Dropping debit cards from the choice set would push payers towards paper-based instruments; not even 30% would switch to credit cards. The result is even worse for credit cards. Only 17% of consumers seem to regard debit cards as a suitable substitute. In contrast to the other scenarios which would affect merchants' profits only a little, to stop credit card acceptance could be very profitable for merchants who, for instance, save merchant service charges. Why do they continue to take credit cards? Borzekowski and Kiser (2008) relate this to the fear of losing business, the hope of higher sales due to lifting liquidity constraints and other (unmeasured) merchant benefits. This is in line with theoretical findings presented in chapter 2.2.3.

The consumers surveyed by Arango et al. (2011) and Schuh and Stavins (2011) consider cash as most widely accepted, followed by credit and debit cards. Cheque and prepaid card acceptance is lower according to Schuh and Stavins (2011). Their paper is the only one exploring the connection between acceptance and the decision to adopt a payment instrument. The authors obtain a significant positive relationship only for prepaid cards, not for the other payment instruments. Unfortunately, no further explanations are provided. Reasonably, it could be assumed that the merchant infrastructure, e.g. for payment cards is well-developed, such that US consumers take acceptance for granted, and thus do not condition their adoption choice to this attribute. With respect to payment instrument use, Arango et al. (2011) note that if consumers have a choice, their payment card use signifycantly increases. The effect is stronger for credit than for debit cards.

Ease of use and security

"Ease of use" (also framed "convenience"), is besides "avoiding fees" and "delaying payments" one of the three key motives for payment choice at the POS, according to Arango et al. (2011). Just as Schuh and Stavins (2011), the authors are likewise interested in the correlation between security and the pay-

ment decisions of consumers. In addition, a third paper is reviewed: Arango and Taylor (2009) specifically look at convenience and the security attributes of payment instruments, based on a survey among Canadian consumers.

Arango and Taylor (2009) declare that consumers perceive debit cards as the most convenient and safest payment instrument, followed by cash and credit cards, which are seen as risky and not very easy to handle. Interestingly, Arango et al. (2011) and Schuh and Stavins (2011) establish a deviating ranking, according to which credit cards are the easiest and safest payment instrument to use, while debit cards and cash follow suit. Schuh and Stavins (2011) further claim that cheques and prepaid cards are considered less risky and less convenient than cash, but not as secure as debit cards.

So, how does convenience and security influence the adoption of payment instruments? According to Schuh and Stavins (2011), the convenience attribute is positively linked only to credit card and somehow to debit card adoption, but not to prepaid and cash. Arango and Taylor (2009) are able to distinguish a substitution relationship: Consumers appreciating debit or credit card convenience adopt cash and the alternative payment card significantly less often. In terms of security, its perception does not play a role for adoption (Schuh & Stavins, 2011). In Arango and Taylor (2009), however, the importance of risk is a little more pronounced: They observe that with higher debit card risk, credit cards are adopted more frequently and vice versa. The risk associated with cash does not have an influence.

Subsequently, the impact of ease of use on payment instrument use is explored. According to Arango and Taylor (2009), consumers substitute cash for payment cards if they believe that cash is easy to handle. Further, they pay more frequently with the higher regarded payment card, but do not replace cash. Hence, a floor may exist for cash substitution, since payment cards are not fully accepted yet. In contrast, Arango et al. (2011) obtain that credit cards replace cash and debit cards, on the grounds of convenience ratings. For debit cards, however, no such relationship is found. One of the reasons could be that consumers believe credit cards to be more widely accepted than debit cards (see ranking in the previous section). Schuh and Stavins (2011) note a significant positive relationship

between payment instrument use and convenience perception, except for prepaid cards. In sum, it can be inferred that consumers are willing to adopt and more often use payment cards at the POS, conditional upon widespread acceptance and convenience ratings.

Finally, the security aspect is examined. Schuh and Stavins (2011) reveal that payment instrument usage is strongly positively affected by the perceived security – except for credit cards. Along this line, Arango and Taylor (2009) verify that with the higher apparent risk of a particular payment instrument, consumers tend to employ it less frequently. Additionally, fraud risk favours debit card use at the expense of cash, as outlined by Arango et al. (2011). Both papers, Arango and Taylor (2009) and Arango et al. (2011) confirm a substantial shift away from cash towards debit cards, because of perceived risk. This process might come to a halt due to a lack of debit card acceptance.

4.4 Transaction attributes

Three determinants of payment choice are subsumed under the transaction attributes category: purchase value, merchant type (e.g. grocery, department store, gas station, restaurant etc.) and cash availability. As explained at the beginning of chapter 4.3, the first two factors are closely intertwined. Hence, merchant type and purchase value are jointly evaluated in the first section. In the second section cash availability is examined. It depends on the number of ATMs within reach of a consumer, as well as on the option to obtain cash at the POS (cash back). With lower distance to any ATM, shoe leather costs for obtaining cash decrease, possibly resulting in two countervailing tendencies. Cash demand might decline, as consumers would minimise cash holdings to avoid foregone interests. Alternatively, cash demand could rise, as cash is more easily available. There is no clear view in the empirical literature on which effect dominates (Stix, 2003, p. 8).

Conversely, if consumers are familiar with employing payment cards to withdraw cash, they could be more likely to use them as well at the POS – given widespread acceptance – and thus, employ cash less often. This experience factor is looked at in the next chapter, 4.5. In addition, cash back not only helps to avoid trips to the ATM, but could also facilitate payment card use further. Table

4–3 below briefly summarises the literature examined in the following. It is structured as Table 4–1 and 4–2 (pp. 126 and 137), and subject to similar limitations in terms of comparability between the different studies.

Study	Country	Year	Source/scope	Highlight
Merchant type and purchase value				
Hayashi and Klee (2003)[135(2)]	USA	2001	Survey: all instruments	Merchant type (linked to purchase value) matters for payment choice
Klee (2008)(3)	USA	2001	POS scanner: all instruments	Usage of payment means is associated with sales value, but other factors can outweigh its impact
Bounie and Francois (2006)(2)	France	2005	Survey, diary: cash, cheque, payment card	Transaction size matters for consumer choice, small merchants tend to restrict acceptance and favour cash instead
Simon et al. (2010)(1)(2)	Australia	2007	Diary: all instruments	Depending on purchase value (merchant type), consumers may regard payment instrument characteristics as more or less important and adjust payment choice accordingly
Arango et al. (2011)(2)	Canada	2009	Survey, diary: cash, debit and credit card	
Cash availability				
Stix (2003)(2)	Austria	2002	Survey: cash, debit card	Consumers frequently paying with debit card and withdrawing money hold less cash than other payers
Snellman (2006)[136]	Cross-country	1988-2003	Aggregate data: cash	Possibly, cash demand declines with rising numbers of ATMs
von Kalckreuth et al. (2009)[137(1)(2)(3)]	Germany	2008	Survey, diary: cash, credit card	Purchase value (merchant type) and ATM withdrawal frequency impact cash use, while number of ATMs and POS terminals does not

All instruments = four major payment instruments used at the POS (cash, cheque, debit and credit card)
(1) Adoption and use modelled separately.
(2) Consumers without a payment account and/or payment card excluded.
(3) Merchants excluded who accept only cash.

TABLE 4-3: Transaction attributes and payment choice at the POS[138]

Purchase value and merchant type

In this section, six studies are explored. Klee (2008) purely assesses the impact of purchase value, while Hayashi and Klee (2003) analyse the influence of the

[135] The sample might be biased as 70% of respondents use the internet to purchase goods versus only 19% of the national average (Hayashi & Klee, 2003, p. 178). Data of the 1998 Survey of Consumer Finances by the Federal Reserve are used for comparison. These surveys are conducted triennially. Data from 1983 up to 2010 are available at http://www.federalreserve.gov/econresdata/scf/scfindex.htm (retrieved 2012, August 8).

[136] Countries covered are: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the UK and the USA.

[137] Methodology and data set are available at Hoffmann et al. (2009).

[138] Own illustration.

merchant type. Bounie and Francois (2006), Arango et al. (2011), von Kalckreuth et al. (2009) and Simon et al. (2010) consider both variables. In contrast to the other researchers, Klee (2008) and Bounie and Francois (2006) specifically focus on the question of how the amount spent at which type of store affects payment decisions. Hayashi and Klee (2003) also emphasise how openness towards new technologies in general could facilitate the use of electronic payment means, i.e. payment cards. This topic is dealt with in the next chapter 4.5. Von Kalckreuth et al. (2009), additionally, specialise on credit card adoption and cash use indicators, tackled in the next section.

Consistently, all studies verify that the higher the value of the purchase the lower is the probability of paying cash. However, whether debit card, credit card or cheque is employed instead, seems to depend on the institutional conditions of the payment markets in question, as well as the perception of payment instrument characteristics and acceptance, as previously discussed.

Bounie and Francois (2006) establish that cash makes up 60% of POS transactions in France. Beyond a threshold of EUR 23, consumers use the domestic Carte Bancaire, rather than cash. Although being essentially a debit card, it carries some credit card functionalities. For example, it allows for Internet and international purchases, as well as for payment by instalments, agreed upon at the moment of purchase.[139] Above EUR 150 cheques are written more often. Consumers refer to cheques significantly more often at all types of stores except small shops. For Carte Bancaire this holds only true for department stores and supermarkets, while expenditures at public services are negatively related to card payments. The findings point to acceptance restrictions at small stores and public services (see section on acceptance in chapter 4.3). On the other hand, larger stores may even encourage card payments in order to reduce processing costs, although this issue is not further clarified. A similar observation is made by von Kalckreuth et al. (2009) who confirm that consumers pay less frequently with cash for example at department stores, gas stations or hotels.

[139] See http://www.cartes-bancaires.com/spip.php?article212 (retrieved 2012, August 8).

In addition, Bounie and Francoise (2006) support intuition in that Internet transactions are predominantly handled through payment cards, but are also significantly positive related to cheques. Von Kalckreuth et al. (2009) somewhat confirm this view. German consumers are more likely to adopt a credit card and shop less with cash if they opt for purchases on the Internet and abroad. It should be borne in mind that, here, such transactions are possible with credit cards only (looking solely at POS payment means). Moreover, cheques are almost extinct in Germany, and if used at all, mostly reserved for large-value transactions.[140]

Similar results are obtained by Simon et al. (2010). The authors explicitly model cash as well as credit and debit card use for sales values between AUD 0 and above AUD 200, in steps of AUD 10. Within the same equations, they control for merchant type. Purchases below AUS 40 are significantly positively related to cash on the expense of payment cards. The same holds true for stores associated with low acceptance rates, such as education/childcare, or with low average sales, such as grocery shops or fast-food restaurants. Here, the reasoning of the authors is that short checkout times and small reward benefits are important conditions for this payment choice. No clear picture is drawn for higher transaction sizes. Simon et al. (2010) explain that the type of merchant significantly influences payment card use, reflecting checkout time, Internet compatibility (only in place for credit cards), acceptance restrictions or cash-back (only available for debit cards). Hence, consumers may have a strong preference about which purchases and at which locations they use debit or credit cards. Cheques only play a role for payments above AUS 500, but their volume share is still far lower than that of credit cards. However, acceptance restrictions may play a role as especially professional services seem to honour cheques, but not payment cards.

Hayashi and Klee (2003) suggest the following order of most preferred payment instruments. For stores in which the average transaction value is low (e.g. fast food restaurants), cash is preferred. At midrange value merchants (e.g. grocery shops and drugstores), the probability of cheques and debit card payments is higher than that of the other payment instruments, while in shops with high

[140] In 2010, the average cheque value in Germany was EUR 5,496 versus EUR 585 in France, according to SDW (http://sdw.ecb.europa.eu, data retrieved 2011, August 10).

average purchase values (e.g. department stores), credit cards are most frequently used. This ranking exactly mirrors the one derived by Klee (2008). In addition, she draws the attention to the role of credit relative to debit cards for US consumers. For relatively small and large purchases (the exact value is not indicated), credit cards are used more often than debit cards. Here, low-income, liquidity constrained households appear to draw on credit lines, while higher-income households, i.e. convenience users, benefit from interest free periods (see section on interest rates in chapter 4.2).

Finally, Arango et al. (2011) indicate that cash dominates for transaction values below CAD 25 and cite two major reasons – the limited acceptance of payment cards and the perception that cash is more convenient and faster to process at the POS. Nevertheless, individuals tend to prefer debit cards over cash, given the higher security, and if they assess debit cards as being not very costly. All of these perception influences have already been addressed in the previous chapter. Above sales values of CAD 25, the authors found a strong substitution effect from debit to credit cards. This is inter alia a consequence of rewards granted on credit card payments. If the merchant type is considered, purchases of gasoline and durable goods are associated with higher credit card and less cash use, in line with results cited above.

Cash availability

In this section, Snellman (2006), as well as the studies by von Kalckreuth et al. (2009) and Stix (2003) are reviewed. Snellman (2006) is concerned with the connection between cash demand and number of ATMs across a number of countries. The two other papers are based on surveys among German and Austrian consumers, and attempt to explain the high share of cash transactions of about 80% at the POS. Von Kalckreuth et al. (2009) models credit card adoption and cash use, depending inter alia on the relative costs of obtaining and holding cash (e.g. frequency of ATM withdrawals, distance to the next ATM and POS density). Stix (2003) however, includes the frequency of ATM withdrawals and debit card payments at the POS. Possibly, the number of ATMs and POS terminals may restrict this frequency, but this is not included in the model because of

collinearity concerns. At least in the Austrian data, an almost linear correlation to the volume of debit card payments and cash withdrawals is observed.

Stix (2003) finds that individuals, who more than once a week withdraw cash at an ATM and/or pay by debit card at the POS, hold about 20% less cash than those with less frequent withdrawals and/or POS payments. Von Kalckreuth et al. (2009) verify that consumers withdrawing cash at least once a week are less likely to use it at the POS. Interestingly, higher POS density and lower distance to the next ATM seem to have no impact on cash use, but fewer consumers are inclined to adopt credit cards. This could be explained by the idea that (German) consumers first decide on their share of cash payments and then on debit versus credit card use. As both cards are regarded as close substitutes, the demand to hold a credit card diminishes if numbers of acceptance points for debit cards increase. The close substitute character of debit and credit cards is caused by institutional arrangements common to Germany and some other European countries: Overdraft facilities on payment accounts are widespread and easily accessible via debit cards; credit cards are in fact deferred debit cards, as balances are typically paid off at the end of the month (no revolving debt). Thus, both types of payment card meet the need for smooth liquidity and consumption over time.

Snellman (2006) complements the other two studies.[141] However, she could not establish a clear connection between the number of ATMs and cash in circulation across a range of different model specifications. This is in line with the somewhat ambiguous results of the literature, according to the review of this subject undertaken by Stix (2003, p. 8) as cited above, and herself (Snellman, 2006, pp. 20-21). Nevertheless, the author states that if the number of ATMs affects cash demand, probably a negative relationship exists. This assumption supports the argument, that in light of higher ATM density, consumers limit cash holdings and raise debit card payments owing to experience. That consumers economise on cash holdings appears plausible, given the significant negative correlation between cash demand and interest rate, attested to by Snellman (2006).

[141] The report includes a detailed account of the theoretical knowledge on ATM networks, market structure and pricing, as well as on money demand. Further, modelling considerations are presented in a comprehensive way. For a concise version, focusing on the impact of monopolisation tendencies in ATM network market, refer to Snellman and Virén (2006).

4.5 Constraints on payment choice

Constraints on payment choice may be a result credit restrictions imposed by the issuing bank, as well as of consumers' experience with payment instruments and technology adoption, all of which is handled hereafter.

Credit by issuing bank

The assumption underlying this section is that issuing banks may restrict access to credit card debt to manage risk. Respective credit worthiness ratings are constructed based on a number of indicators, such as income or education. In the following, emphasis is laid on credit card adoption, since the impact of credit lines on credit card use has been only included in one paper so far (Zinman, 2009). The author demonstrates that the closer the revolving balance approaches the total credit limit, the more revolvers utilise debit cards.

Credit card adoption is addressed by von Kalckreuth et al. (2009), Simon et al. (2010) as well as Schuh and Stavins (2011). Across all studies, a significant influence of income and education is found. According to von Kalckreuth et al. (2009) consumers with higher income and education are more likely to adopt a credit card. In particular, Simon et al. (2010) and Schuh and Stavins (2011) point out that, below an income of AUD 40.000 and USD 25.000, as well as an education below professional school or high school respectively, the probability of holding a credit card drops, compared to the base case of medium income and university education. Schuh and Stavins (2011) add that individuals who had filed for bankruptcy in the past are significantly less likely to receive a credit card. Overall, the results confirm the view that issuing banks limit credit card offers for certain segments of the population, and hence, impose supply constraints.

Technology adoption and experience

With respect to technology adoption, i.e. the affinity towards new technologies, and experience, it is assumed that the propensity for consumers to rather turn to payment cards instead of cash rises, because of familiarity with these instruments or other related technologies.

Only one study, Hayashi and Klee (2003), is interested in the impact of technology adoption on payment behaviour. The authors hypothesise that consumers who embrace new technologies openly may favour card payments over cash and cheque. As expected, they uncover evidence that individuals are more likely to pay with their debit card if they already use electronic credit transfers[142], or buy goods online. Acquaintance with mobile phones and computers had no significant effect. Unfortunately, factors fostering credit card use are not modelled. Hayashi and Klee (2003) propose that affinity for new technologies even better predicts debit card use than socio-demographic aspects. According to them, socio-demographic characteristics may be decisive for consumers' access to a payment account or credit card, hence limiting the choices, rather than determining the demand. In the previous section, evidence was provided to support this belief.

Until now, no direct measures of experience have been incorporated in models on payment choice. Stix (2003) and von Kalckreuth et al. (2009) approximate experience by measuring how often consumers use a given payment instrument. Both authors empirically found that consumers who frequently withdraw money at ATMs are less likely to pay cash (see chapter 4.4). One explanation offered is that the higher familiarity with debit card handling, such as the necessity for PIN-entry leads to an inclination towards debit card use at POS terminals.

4.6 Developing an institutional view of payment choice

Having discussed the literature on payment choice, the reluctance to focus empirical studies on institutional conditions for the emergence of a country specific payment mix becomes more apparent. In his review of recent contributions to the field of retail payments research, Humphrey (2010) summarises this situation as follows: "While the current payments literature is focused on consumer payment choice in response to price and non-price characteristics [...], it is often helpful to look beyond these standard influences and investigate how the institutional environment has shaped payment use as well."

[142] The study deals with direct deposits which are essentially, electronic credit transfers initiated via ACH according to http://www.electronicpayments.org/individual (retrieved 2012, August 16), the educational website of NACHA – the biggest ACH network in the USA.

Consequently, it is demonstrated how this process unfolds, by examining the papers published on this topic by Humphrey and varying co-authors. In fact, he seems the only author who consistently insists on the importance of the institutional view, while acknowledging the difficulties of capturing these influences statistically. In the second part of this chapter, an institutional perspective is developed, in order to detect particular conditions impacting consumers' payment choice, and thus shaping the payment mix of a country. It combines the conclusions on payment system development from chapter 2, as well as the cost perspective of chapter 3, and the aspects of payment choice researched so far in chapter 4. It is central to the development of the empirical model in chapter 5.

Underlying the whole discussion is the following assumption: In contrast to other factors, such as preferences, institutional determinants affecting payment behaviour can be modified. Given the ambition to realise an efficient payment system, these determinants – once identified – can be addressed, for example, by providers or public authorities aiming at encouraging a shift in the payment mix.

Qualitative assessments of institutional determinants

One of the first comprehensive accounts of the importance of institutional conditions for the formation of a country's payment mix was delivered by Humphrey, Sato, Tsurumi, and Vesala (1996, pp. 20-34). Therein, the authors describe the evolution of the payment systems in Europe, Japan and the USA. Later studies, such as Humphrey et al. (2001), and Humphrey (2010), substantiate these explanations. For the purpose of this thesis, the development in Europe is emphasised.

The studies consistently argue that a concentrated banking industry, with nationwide branch networks of banks and postal savings institutions, allowed early establishment of a giro (clearing) system, based on credit transfers between payment accounts. Centralisation of account maintenance across different locations allowed the verification of the payer's ability to pay, which minimised the risk of the payee, and thus supported trust among users of the payment system. Concentration of the banking industry facilitated cooperation, for example, in instituting centralised clearing facilities, and later shifting from paper to electronic transactions. Moreover, it fostered the set up of ATM and POS terminal networks.

Providers could lower investment and maintenance costs, and exploit economies of scale, while consumers benefitted from larger acceptance networks, or greater compatibility between competing networks. For instance, the dominance of debit cards in Norway is explained by the joint effort of banks to introduce the option to pay by card at the POS, in order to replace cheques (Humphrey et al., 2001).

Humphrey, Pulley et al. (1996)[143] add other important factors by carrying out one of the first cross-country analyses to detect sources of differences in the payment mix. The novelty of their approach lies in the attempt to capture the influence of institutional parameters, such as crime rate, level of economic development and asset concentration ratio of the largest five banks in a country. Incorporating the two-sided markets idea, the authors mention that the payment choice reflects the accessibility of payment options, e.g. merchant acceptance, cash availability or the types of payment means available. Further, the payment instrument use in the previous year and a country-specific dummy variable are included in the equation. Although results are not robust to specification variations, the authors claim that these factors indeed can help to explain usage patterns. In contrast to previous results seen in chapter 4.2, price has apparently little influence. The authors hold the general low transparency of pricing responsible for making consumers unaware of their payment costs. Another reason for this deviation might be that, due to data limitations, payment prices were calculated from implied cost formulas, rather than observed in the market (Humphrey, Pulley et al., 2001, p. 230).

Framework linking institutional characteristics to payment choice

This section aims at linking institutional characteristics of the payment system to the emergence of a distinctive payment mix at the POS, as depicted in Figure 4–2 (p. 152). It is acknowledged that other, unobserved factors may play a role as well. Nevertheless, the research reviewed so far, in conjunction with the factors that are to be investigated empirically, will provide a new view on the aspects affecting payment choice. The illustration starts with the institutional conditions of a payment system, its

[143] The following instruments are analysed: cheque, paper and electronic credit transfer, direct debit, credit and debit cards.

– functioning with a focus on issuing and acquiring banks as well as IFTSs as explained in chapter 2.1: Cooperation between providers is required for supplying and continuous upgrading of payment services, as well as allowing processing of transactions based on common standards. Small and/or concentrated markets with a few key providers are probably more effective in agreeing on a cooperative solution than a dispersed banking industry. Also, the establishment and maintenance of (central) clearing and settlement facilities is expensive, and therefore must be shouldered either by large bank consortia, or national central banks, while neutral access and system reliability is to be ensured;

– network character and two-sidedness, as illustrated in chapter 2.2: Networks shall reach a sufficient size to reap adequate benefits for providers and users in terms of network effects and economies of scale. The size of the acceptance network impacts consumers' willingness to pay by card, and influence its costs of obtaining cash (for example shoe-leather costs). It is associated with the degree of cooperation within the banking industry, as well as the competitive situation of merchants (acceptance may create strategic advantage and higher sales). On the other hand, monopolistic tendencies hinder competition and deter potential efficiency gains including technological advancements;

– other external factors, such as the perceived level of security, the regulatory framework, and economic development / situation of consumers or technological progress, as pointed out by Humphrey in a number of studies (see previous section), as well as in chapter 2.1 and 4.5: User demand for payments is fixed to his/her level of economic activity. The choice of instruments might be limited due to supply constraints imposed by banks, for example in times of economic downturn and growing unemployment. Also, a technology affine environment may shape payment preferences. Once providers cooperate to offer advanced payment technologies, and thereby give users the opportunity to test them (gain experience), this could facilitate switching to new, more efficient alternatives.

As indicated in Figure 4–2 (next page), these institutional conditions shape the supply of payment instruments and infrastructure, i.e. the

– types of payment instruments available (see chapter 2.1.2) and the acceptance network consisting of ATMs and POS terminals (see chapter 2.2.2);

– costs for processing (see chapter 3.1): Electronic transactions such as card payments can profit from economies of scale by processing larger payment volumes, as well as from technological advancements, potentially lowering unit costs. Such a situation more likely occurs once the IFTS serves a sizeable part of the market and/or operates in a large, economically thriving area. With respect to ACHs, central banks should avoid taking up conflicting responsibilities of overseer and competitor, if not based on serious grounds, such as ensuring smooth functioning of the payment system;

– costs for providing payment instruments (see chapter 3.2): For small transaction values, (debit) card payments are preferable, as they entail low social costs. But, non-transparent pricing and cross-subsidisation give rise to diverging private costs, leading to overuse of cash and underutilisation of (debit) cards. Installing a broader acceptance network could foster card payments and lower costs for obtaining cash. But, as investment and maintenance expenditures are substantial, it may be beneficial to share these among providers.

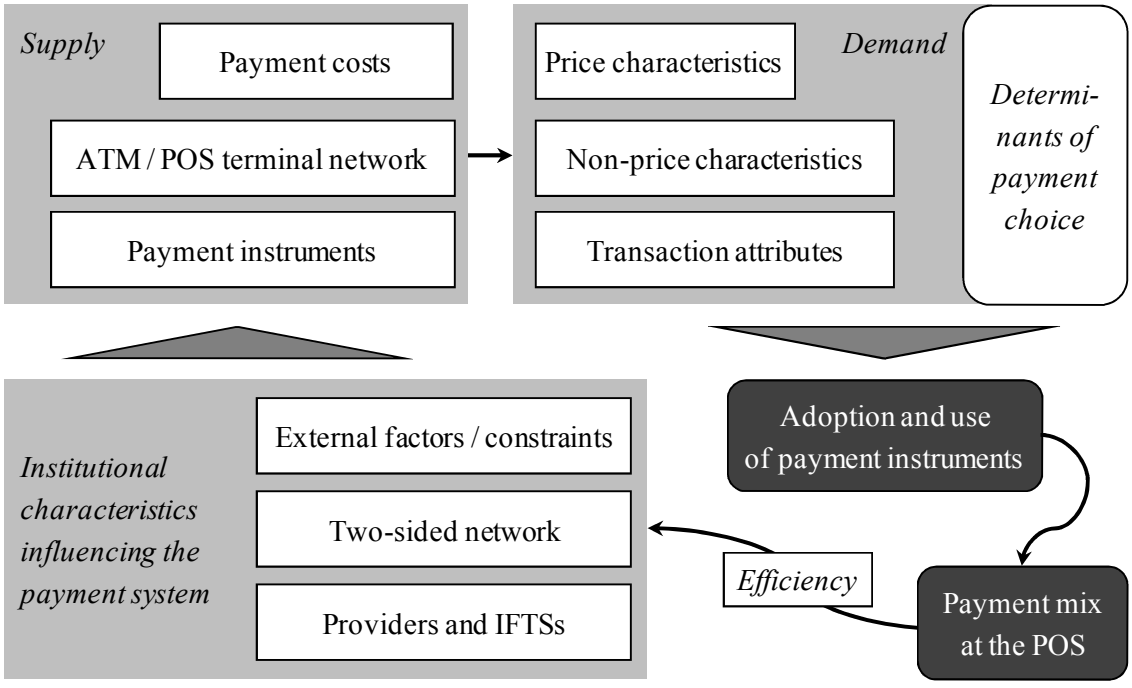

FIGURE 4-2: Institutional view on payment mix emergence[144]

[144] Own illustration.

Within the demand frame, the price- and non-price characteristics of the payment means supplied, as well as the circumstances of transactions made, are assembled. These determinants of payment choice have been analysed in chapter 4.2, 4.3 and 4.4 respectively, and are now linked backwards to the institutional conditions responsible for forming the supply frame.

First, the price characteristics of payment instruments are investigated. Level and structure of pricing, especially for card payments, is a function of the underlying payment costs for infrastructure and payment instruments. Further, the degree of competition among (i) providers in terms of channelling efficiency gains on to users and (ii) merchants in the case of surcharging plays a role. Both banks and merchants have been reluctant to directly charge for payment services, as not to lose deposit market shares or sales, even if this would be socially beneficial, resulting in a prisoner's dilemma. Other factors are:

– industry conventions e.g. with respect to cross-subsidising and the extent to which cost-differentials of payment instruments are reflected in prices, and
– legal requirements, such as the permission to surcharge, and non-discriminatory access to IFTSs and other interventions by public authorities, such as forcing down interchange fees or requiring transparent pricing (see example of Norway). While these measures could result in higher acceptance rates, cardholder prices may increase and rewards diminish.

Second, the non-price characteristics of payment instruments – checkout time, acceptance, ease of use and security – are connected to the institutional environment. How much time is spent at the checkout is associated with the inter- and intrabank processes in place for authorising and verifying a card payment, and the validation mechanisms for cash and cheques. Quality and speed of these processes depend on the regulatory framework as much as on the cooperation of providers to set up common routines.

Convenience, as well as security, is a matter of organising the payment process in a way that consumers perceive payment instruments as easy to handle, and non-risky. Payment initiation at the POS, cash withdrawals at ATMs and security features of payment cards shall abide by common standards, allowing a consistent

user experience. Network theory suggests that introducing new (easier to handle, safer) payment means and fostering their dissemination necessitates cooperation between providers. Here, banking associations or cooperation arrangements, such as a national payment council, can assist to overcome obstacles to developing common solutions.[145] Consumers' views of the security of payment means is also a result of the general level of security in a country (instances of fraud, theft etc.), as mentioned in the studies by Humphrey above.

Third, the institutional variables connected to the transaction attributes are similar to those already mentioned. For example, the preference for cash payments up to a certain purchase value depends on relative price and non-price characteristics. Moreover, purchase value, merchant type and acceptance are closely linked. In turn, cash availability is influenced by the number of ATMs, discussed above. Joint provision of ATMs could assist network growth.

In reaction to price- and non-price characteristics of payment instruments, as well as to transaction attributes, all determined by the underlying institutional variables and resulting supply, consumers decide to adopt and use suitable payment instruments, as was demonstrated in chapter 4. Finally, the emerging payment mix can be assessed against the efficiency ranks, established in chapter 3.2. If inefficiencies are recognised, respective changes of related institutional parameters could result in social savings.

5 Empirical analysis: Institutional determinants shaping the POS payment mix

This chapter is dedicated to the empirical analysis of the institutional determinants of payment card use in Europe. Underlying is the idea that to the extent that payment cards are preferred over cash and cheques for purchases, societies' per transaction payment costs decrease as was explored in chapter 3.2. If factors

[145] Liebena and Khiaonarong (2009, p. 30) mention that industry structures, such as national payments councils, serve as a forum for providers and central banks, and thus can facilitate capacity building efforts.

grounded in the institutional environment shaping these payment habits can be identified, these could be altered in a way that shifts the payment mix towards more efficiency. This chapter consist of two distinctive parts concerned with the

- introduction to the modelling approach and the data collection process and
- estimation of the model and presenting the results.

First, the idea of how to explain payment instrument use at the checkout in a two-step model is drafted. Subsequently, an overview on the panel construction process, followed by a description of the four central dependent variables introduced in chapter 5.1 is provided in chapter 5.2. A detailed account of the development of the different card payment systems in the eight countries investigated is given in chapter 5.3. In contrast to other empirical studies, such a thorough description allows to observe a number of institutional factors, for which no publicly available statistics exist. Further, the understanding for the characteristics of retail payment systems is deepened. Hence, this chapter complements chapter 2.

The second part of this chapter is concerned with the estimation of the model, and presentation of the results. Following the two-step modelling approach, first, the payment decision at the POS is estimated in chapter 5.4. Based on this, the underlying sourcing decisions are explored in detail, in chapter 5.5. It is revealed that institutional determinants do indeed influence the adoption of payment instruments and their acceptance network, and consequently impact payment card usage at the POS. In chapter 5.6 conclusions are drawn and the results are linked to chapter 4.6. Besides, a route to further research is suggested. It prepares the ground for chapter 6, which applies the findings to the recent challenges for the European retail payment markets on the way to achieve higher efficiency. The focus here is on the SEPA initiative.

5.1 Two-step modelling approach

This chapter clarifies the methodology used for modelling payment choice at the POS, contingent on institutional determinants, as well as other influential variables. A two-step modelling approach is selected, based on the literature on payment choice as reviewed in chapter 4. Notable examples are Borzekowski et al. (2008), Arango and Taylor (2009), von Kalckreuth et al. (2009), Carbó-Valverde

et al. (2010), Simon et al. (2010) and Schuh and Stavins (2011), who empirically examine adoption and use of payment instruments separately. This is reflected in the fact that the payment decision and the underlying sourcing decisions are modelled independent of each other. In contrast to the studies above, instead of survey results or diary entries, aggregate panel data are employed for modelling.

In the first step, the payment decision at the POS is analysed. Basically, the question asked is: What drives the payment choice of a society? Deviating from other empirical studies, which concentrate on explaining the number of card transactions (Bolt, Humphrey et al., 2008; de Grauwe et al.,2006 and Humphrey, Pulley et al., 1996), or the cash payment value (Snellman, 2006), the focus in this paper is on the value of card payments in relation to household consumption. The reason for choosing CARDVALCONS as the dependent variable is twofold. First, in contrast to the volume or value of card transactions per inhabitant, CARDVALCONS entails information as to what extent card payments substitute for more "traditional" payment means, such as cash or cheques. Second, no time series data on the share of the different payment instruments on POS turnover or transaction are available. Statistics on the volume of POS transactions in general are also not collected. Hence, CARDVALCONS is the closest approximation, if one is interested in how card payments gradually take over market shares from other payment means (see also chapter 5.2.2 and Figure 5–2, p. 166 for details).

Several potentially influential factors have been identified in chapter 4.6, including the (i) diffusion of payment cards and (ii) density of POS terminals, which captures the two-sided nature of payment markets. Further, the (iii) availability of alternative payment methods, namely cash and possibly cheques could play a role. Additional determinants reflecting the economic situation of consumers, the institutional set up of infrastructure arrangements or the innovation climate seem to be of interest as well.

The second step focuses on the sourcing of (i), (ii) and (iii). Here, the question is: What is needed to have the choice of card or cash? Three different regressions are run to explain the size of the payment card (CARDNB18) and POS terminal network (POS18), as well as the demand for cash at ATMs (ATMVAL18). The

emphasis is on the institutional aspects becoming part of the set of explanatory variables. Figure 5–1 below illustrates the approach in principle. Because, the ultimate model is designed to identify institutional determinants of payment choice at an aggregated level, individual socio-demographic factors and preferences are excluded. All dependent variables of equations (Eq.) I to IV are introduced in chapter 5.2.2 and 5.2.3. Table 5–1 (pp. 162-163) and page ix lists all variables employed for the empirical analysis.

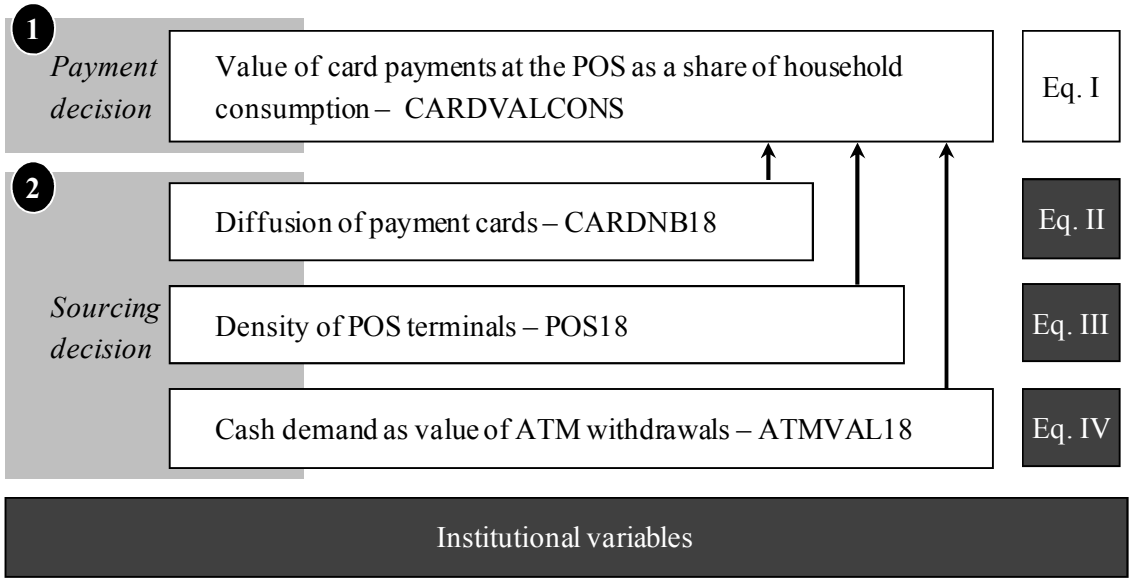

FIGURE 5-1: Model structure: Two-step approach[146]

5.2 Panel construction and exploration of key data series

This chapter unfolds as follows. First, the principle data collection process is outlined, and a list of all variables collected and used for modelling purposes is provided in chapter 5.2.1. Some estimations and alterations to the raw data became necessary; the most important ones are made transparent. A complete account, with respect to all variables, as well as a detailed description of all series is available upon request. The next two chapters (5.2.2 and 5.2.3) are dedicated to the four central dependent variables of the payment and sourcing decision equations, as indicated in Figure 5–1. Emphasis is laid on the underlying reasons for choosing these particular variables.

[146] Own illustration.

5.2.1 Panel data collection and overview of variables

For the purpose of this thesis, a new unbalanced data panel is constructed, comprising of aggregated payment, institutional and macroeconomic data spanning over 22 years from 1990-2011. The panel covers the eight most important European payment markets (UK, DE, FR, NL, ES, IT, BE, and FI) as defined in chapter 1.1. In contrast to earlier studies, not only far more observations (176) could be collected, but also the effort undertaken to validate and, if necessary, to carefully revise the data, is unique. This process is described below, and involved intense manual work. It became necessary due to the statistical limitations of the data published by the ECB, the main source used for this dissertation (see references in the next paragraph). Banco de Portugal (2007, p. 34) provides some insights into the problem.

As pointed out by other researchers cited in the literature review in chapter 3, consistent long-ranging payment data have only recently become available and are still difficult to obtain. In January 1991, national central banks entrusted a group of experts with a fact-finding mission regarding the payment systems of the 12 European Economic Community countries. For the first time, information on retail payment systems and instruments were assembled in a single report, alongside selected 1989 and 1990 data (Working Group, 1992). In later years, this exercise was repeated. These Blue Books were published in 1996, 2001 and 2007 (EMI, 1996; ECB, 2001a, 2007a and 2007b). In the meantime, data supplements (Blue Book addendum) were produced in 2000, and then yearly between 2003 and 2006 (ECB, 2000a, 2003, 2004, 2005a, 2006a).

Earlier information on the payment systems of 11 developed countries[147] was compiled by central bank experts, under the aegis of the Bank for International Settlements (BIS) in reports by the Group of Computer Experts (1980) and the Group of Experts on Payment Systems (1985 and 1989). However, only snapshots were provided, in contrast to coherent time-series data. Indeed, this is in part due to the fact that retail payment systems and instruments in particular were still evolving, as was statistical measurement, leading to a rather fragmented data

[147] Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

landscape. In 1993, 2003 and 2012, the BIS issued three more of these so-called "Red Books" (CPSS, 1993, 2003b and 2012b). These have been complemented by a yearly statistic supplement, which was first published in December 1989. The latest available record of January 2013 includes preliminary 2011 figures.[148] Unfortunately, two of the countries discussed in this thesis, namely Finland and Spain are not part of the BIS data.

Consequently, for the years 1990-199, the Blue Books as well as their Addenda, mentioned above, form the basis of the panel data collection. For the years 2000-2011, the ECB's SDW was consulted.[149] If necessary, these were supplemented by the BIS statistics and national payment statistics from Finland,[150] France,[151] and the UK.[152] In addition, other sources, deviating from those already mentioned, were also used, which will be indicated throughout the data description.

Besides, particular information on EU banking structures, e.g. concentration ratio (CR5) and number of domestic banks ($BANK_{dom}$) were primarily obtained from a series of specialised ECB reports (ECB, 2000b, 2002, 2005b, 2008b and 2010b), and national publications, in the case of Spain,[153] Finland[154] and the Netherlands.[155] Macroeconomic data (CONS, GDP, UNEMPL, RDEXP, and PATENT) were extracted from the Eurostat database.[156] The number of inhabitants being over 18 years old (INH18) was calculated based on applicable age cohorts, as provided by Eurostat: Total population minus the proportion of the population aged 0-19 years, plus the proportion of the population being 19 years old. Some data points were taken from the Blue or Red Books (see above), or estimated as is explained below. Plausibility checks were also performed.

[148] All reports mentioned are available at http://www.bis.org/list/cpss/tid_57/page_1.htm (retrieved 2012, November 8).
[149] http://sdw.ecb.europa.eu/ (data retrieved mainly in October and November of 2012).
[150] Federation of Finnish Financial Services (2011 and 2012a) for payment data.
[151] Groupement des Cartes Bancaires (2005 and 2006), publication http://www.cartes-bancaires.com/IMG/pdf/Expertise_04_GB_VF_pageapage.pdf (retrieved 2013, February 1).
[152] APACS (2007) and quarterly releases published at http://www.theukcardsassociation.org.uk/quarterly_statistical_release/index.asp (retrieved 2013, February 1).
[153] Number of banks derived from http://www.bde.es/webbde/es/estadis/infoest/series/be0445.csv (retrieved 2013, February 1).
[154] Number of banks as of yearly reports "Finnish banking in ..." 2006 until 2011 available at http://www.fkl.fi/en/material/publications/Pages/Banks.aspx (retrieved 2013, February 1).
[155] http://www.statistics.dnb.nl/usr/statistics/excel/t5.13ek.xls (retrieved 2013, February 3).
[156] http://epp.eurostat.ec.europa.eu/ (retrieved 2012, November 8).

For each of the series related to (i) payment data – the number of payment cards (CARDNB, DEBITNB), the number of ATM and POS terminals (ATM, POS), volume and value of ATM withdrawals and card payments (ATMVOL, ATMVAL, CARDVOL, CARDVAL), as well as the volume of cheque transactions (CHVOL) – and to (ii) banking sector competition ($BANK_{dom}$, CR5), the construction of the data set followed a distinctive pattern, consisting of five steps.

– ECB data served as the basis for the data collection, and were enhanced with BIS data. In the case of conflicting observations, in general the most recent accounts were used. On very few occasions, older data remained in the sample, to prevent a statistical break, if this was reversed later on. Nevertheless, in some cases it was not sensibly feasible to correct statistical breaks. One example for the latter is France. $CARDNB_{FR}$ escalated from 46 m in 2004 to 79 m in 2005, due to the inclusion of three-party credit cards, such as American Express (Visa and MasterCard are four-party schemes and were already part of the statistics). $BANK_{domFR}$ increased from 484 in 2003 to 827 in 2004, due to the inclusion of investment firms.

– If available, data from national sources were used to verify the ECB and BIS sources. In this way, statistical breaks and implausible observations could be corrected. For example, in Finland and France, the total number of cards is 30-50% lower than the sum of cards with a debit function, deferred debit and/or credit function. As will be explained in chapter 5.3.2, in these countries, debit cards may double as deferred debit and/or credit cards. Therefore, classification of payment cards in either category is not unambiguous, and changed over time in the ECB and BIS reports, sometimes without proper declaration, as in the case of Finnish card data. By double-checking with more detailed national statistics, a sensible revision was carried out for these countries.

– Wherever possible, retailer cards were not considered, as no consistent longitudinal data are available (see also chapter 5.2.3). However, sometimes they were not separable from the data on other payment cards, for example for Belgium. While $CARDVOL_{BE1990\text{-}1994}$ and $CARDVAL_{BE1990\text{-}1994}$ had transactions with retailer cards included, these were disregarded in $CARDNB_{BE1990\text{-}}$

$_{1994}$. This could have inflated initial values, especially compared to the Netherlands, as noticeable in Figure 5–2 on page 166.

– All series were checked for plausibility. If year-on-year growth rates were larger than $\left|25\%\right|$, while in the previous and subsequent years the variation in the observation values was much smaller, reasons for these discrepancies, such as institutional changes, were investigated. Volume and value development were compared. If they largely deviated by more than $\left|15\ \%\text{-points}\right|$, the underlying sources of this difference were researched. Outliers were treated with special care. For example, in Italy, ATMVAL rose from EUR 73 bn in 2001, to 94 bn in 2002, and dropped back to 72 bn in 2003, while $ATMVOL_{IT2001\text{-}2003}$ showed a steadier development. Since average cash value withdrawn at each transaction only declined slowly (from EUR 188 in 1990 to EUR 170 in 2011), $ATMVAL_{IT2002}$ was derived by applying the $ATMVOL_{IT2001\text{-}2002}$ growth rate.

– A number of data points had to be estimated. This was done by averaging observations before and after the missing value in question. Alternatively, a sensible growth rate was applied, either from a closely related data series, such as CONS and GDP, CARDVOL and CARDVAL, or from averaging a growth period before or after the value in question. One example is Belgian consumption for 1990-1994, which was assumed to increase at the same rate as the GDP. Nevertheless, such estimations were applied very rarely.

In contrast to the series discussed above, institutional data had to be estimated and/or manually assembled, to a large extent. This applies to the level of vertical integration of a countries' major card scheme (INTEGR), the number of ATM and POS terminal networks (ATMNW and POSNW), as well as information on the countries' main ACH, and involvement of the national central bank therein (ACH and NCB). Founded on an analysis of the institutional situation in the eight countries under consideration, based on Blue Book and Red Book information, respective observation values were assigned. These were confirmed and complemented by research papers, annual reports, websites and project documentations. In chapter 5.3, a full account of this analytical work and its outcomes is

laid out. Except for ATMNW, all the longitudinal institutional data are analysed for the first time.

Overall, a distinct database has been created, which could also serve as the foundation for future research. The majority of data was gathered throughout the months of October and November 2012.

Table 5–1 below (for a quick reference see the list of variables, p. ix) lists all variables collected or subsequently calculated from the former, as indicated by a star. A short description is included as well. All variables used for modelling are marked in bold. As the institutional variables, most of the other variables employed were not included in earlier studies either, namely the share of card payment values to household consumption (CARDVALCONS), the frequency of cash withdrawals at ATMs and card transactions at the POS (CARDATMFRQ and CARDPOSFRQ), research and development expenditure and number of patents (RDEXPGDP and PATENT18) the number of domestic banks (BANK$_{dom}$18) or consumption and unemployment rates (CONS18 and UNEMPL).

Variable	Description
ACH	Dummy, 1 if a domestic central ACH that processes card payments exists, 0 otherwise
ATM	Number of automated teller machines with a cash function in a country (excluding ATMs with a credit transfer function only, all ATMs without distinction between open and limited access)
ATM18*	= ATM / INH18, number per m inhabitants > 18
ATMNW	Number of ATM networks in a country
ATMVOL / ATMVAL	Volume / value of ATM withdrawals in m / m EUR (at ATMs located and with cards issued in the country); 1990-1994 local currency converted into ECU/EUR based on Eurostat yearly average foreign exchange rates
ATMVAL18*	= ATMVAL / INH18, EUR per inhabitant > 18
BANK$_{dom}$	Number of domestic banks in a country
BANK$_{dom}$18*	= BANK$_{dom}$ / INH18, number per m inhabitants > 18
CARDNB	Number of payment cards (sum of debit and deferred debit/credit) issued in a country in m
CARDNB18*	= CARDNB / INH18, number per inhabitant > 18
CARDATMFRQ*	= ATMVOL / CARDNB, withdrawals per card
CARDPOSFRQ*	= CARDVOL / CARDNB , payments per card

CARDVOL / CARDVAL	Volume / value of card payments in m / m EUR (at POS terminals located and with cards issued in the country); 1990-1994 local currency converted into ECU/EUR based on Eurostat yearly average foreign exchange rates
CARDVALCONS*	= CARDVAL / CONS x 100, share in %
CHVOL	Volume of cheque payments in a country in m
CHVOL18*	= CHVOL / INH18, number per m inhabitants > 18
CONS	Final consumption expenditure of domestic households at current market prices in m EUR
CONS18*	= CONS / INH18, EUR per inhabitant > 18
CR5	Market share of five largest banks in a country in terms of asset value in %
DEBITNB	Number of debit cards issued in a country in m
DEBITNB18*	= DEBITNB / INH18, number per inhabitant > 18
EUR	Dummy, 1 if EUR is legal tender, 0 otherwise
GDP	Nominal gross domestic product at current market prices in m EUR
GDP18*	= GDP / INH18, EUR per inhabitant > 18
INH18	Number of individuals in a country older than 18 in m (based on Eurostat total population – proportion aged 0-19 years + number aged 19)
INTEGR	Degree of vertical integration between 1-6 of the predominant domestic payment card scheme as described in chapter 2.1
NCB	Dummy, 1 if the national central bank operates and/or owns the domestic ACH, 0 otherwise
PATENT	Patent applications to the European Patent Office by domestic applicants
PATENT18*	= PATENT / INH18, number per m inhabitants > 18
POS	Number of POS terminals at domestic merchants
POS18*	= POS / INH18, number per m inhabitants > 18
POSNW	Number of POS terminal networks in a country
RDEXP	Expenditures for research and development in a country in m EUR
RDEXPGDP*	= RDEXP / GDP x 100, share in %
UNEMPL	Unemployment rate in a country in %
X_{it}	Observation of variable X in country i and year t
ΔX_{it}	First difference of variable X ($\Delta X_{it} = X_{it} - X_{it-1}$)
* own calculation, **bold** variables are employed for modelling purposes	

TABLE 5-1: List of variables

If applicable, data series were made comparable across countries by deriving ratios per inhabitant above 18 years of age, as this implies full legal capacity, and consequently complete choice of payment means (INH18), in relation to GDP or household consumption (CONS). If variables are written in the context of an equation, the subscript "it" as in X_{it} denotes the country i and year t of each observation of variable X with i = BE, DE, ES, FI, FR, IT, NL, UK and t = 1990,

... , 2011. Throughout the text and Table 5–1 above, the subscript is dropped for the sake of readability, if reference is made to all observations of a variable.

In the next two chapters, the four dependent variables for the payment and sourcing decision models are described. Table 5–2 and 5–3 (pp. 167 and 172) contain summary statistics, including the mean, median, standard deviation (Std. Div.), minimum (Min), maximum (Max) and compound annual growth rate in % (CAGR). For the other independent variables, such summary statistics are delivered in the Appendix A–3. A detailed description is provided upon request.

5.2.2 Card usage and cash holding

In this chapter, card usage and cash holding (ATM withdrawals) for consumption purposes (CARDVALCONS and ATMVAL18) are introduced. The underlying considerations leading to the selection of these variables for modelling are outlined, alongside a short description of noticeable peculiarities.

The value of card payments in relation to household consumption is the central dependent variable. By choosing CARDVALCONS, this dissertation leaves the pathways taken by other empirical studies based on aggregated data, as explored in chapter 4. These have concentrated on explaining the volume of card transactions (Bolt, Humphrey et al., 2008; de Grauwe et al., 2006 and Humphrey, Pulley et al., 1996) or the cash payment value (Snellman, 2006). The motivation to deviate from these tracks is grounded in two observations:

– First, in comparison to the volume or value of card transactions per inhabitant (CARDVOL18 / CARDVAL18), CARDVALCONS better mirrors the extent to which card payments replace other payment means. Even if CARDVOL18 or CARDVAL18 increases, the share of card payments on POS purchases might remain stable or shrink, if other payment means are more attractive for users. On the other hand, a higher share of card payment value on consumption implies a proportionally lower share of other payment instruments. As it can reasonably be assumed that the share of credit transfers and direct debits is not reduced, cash and cheque values should deteriorate. However, a direct substitutional relationship cannot be measured, as the use of credit transfers,

direct debits and cheques for private or business purposes, is not statistically separable. Moreover, the cash value used for private consumption purposes or directly at the POS is not available (see section on ATMVAL18 for details).

– Second, as this paper is interested in the use of payment means at the check-out, at first glance, POS turnover would have been the more appealing denominator. Unfortunately, no consistent, longitudinal statistics are available. Therefore, household consumption was chosen as a close alternative, although it contains POS purchases[157] and bill payments[158] alike. The latter are typically paid for by credit transfer or direct debit, while cheques have been used for both. Yet, in the UK for example, payment cards are employed to set up bill payments, such as rent or related expenditures. This explains the comparably high value for $CARDVALCONS_{UK2011}$ (see Figure 5–2, next page). Here, card payments replaced cheques, which were traditionally utilised for this purpose.

Overall, CARDVALCONS seems the best choice, if one is interested in how card payments gradually take over from other payment means at merchants' checkouts. Figure 5–2 (p. 166) shows its development in the eight countries concentrated on in this thesis in the years 1991, 2001 and 2011. Three groups of countries are distinguished. In the first group of "traditionalists", consisting of Italy, Germany and Spain, payment card usage has been and still is rather limited. Payment behaviour shifted in the second group of "card adopters", i.e. in the Netherlands and Belgium. While in the early 1990s, payment cards were used rather infrequently for purchases, the situation changed noticeably, already in the first half of the observation period. It will be interesting to detect the underlying forces of this shift in more detail. The last group of "card enthusiasts" contains France, Finland and the UK. In these countries, consumers pay for a large share of their consumption needs by card.

[157] These include (i) food and non-alcoholic beverages, (ii) alcoholic beverages and tobacco, (iii) clothing and footwear, (vi) furnishings and household equipment, (v) recreation and culture as well as (vi) restaurants and hotels (categorisation according to "classification of individual consumption by purpose" (COICOP) applied by Eurostat).

[158] These are (i) housing, water, electricity, gas and other fuels; (ii) health, (iii) transport (including purchase of vehicles), (iv) communications (including telephone services), (v) education and (vi) miscellaneous goods and services such as insurances, financial services and social protection (categorisation according to "classification of individual consumption by purpose" (COICOP) applied by Eurostat).

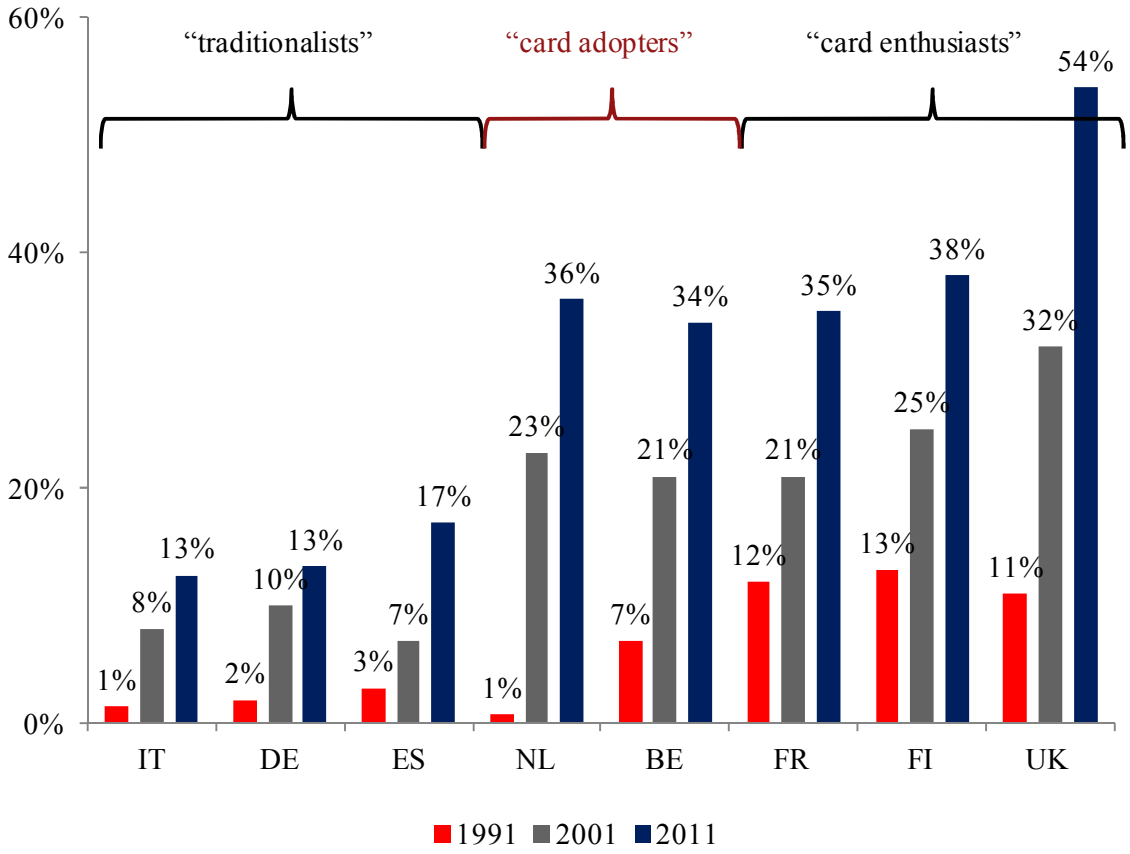

FIGURE 5-2: Value of card payments as a share of household consumption[159]

Judging from the summary statistics on CARDVALCONS provided in Table 5–2 (next page), the first impression that it differs widely across countries is supported. Nevertheless, figures consistently increased over time in all countries except for Finland and Italy. In Finland, a saturation point of around 40% seems to have been reached in 2008 after which CARDVALCONS moves rather sideways. This coincides with an only modest increase of $ATMVAL18_{FI,}$ pointing to a mature payment market, in which card transactions have already replaced cash. In Italy, CARDVALCONS reached a maximum of 14% in 2007, slightly decreased thereafter and remained stable at 12-13% since then. This is due to a drop by EUR 14 bn in debit card payment values, from 2007 to 2008. In Germany, a new reporting system led to a statistical break: Debit card payment values ($DEBITCARDVAL_{DE)}$ fell by EUR 20 bn, from 2006 to 2007, resulting in an almost 2%-points lower CARDVALCONS. On average, in 1990 more than 5% of consumption was paid by card, while in 2011 it was close to 30%, implying a growth of nearly 9% p.a.

[159] Own illustration based on data compilation as described in chapter 5.2.1.

In contrast, the development of ATMVAL18 was rather subdued, at a 6% yearly growth across all countries (see Table 5–2 below for country values). In Belgium, France, Italy and Germany – disregarding the statistical break in 2007 analogous to that in the $DEBITCARDVAL_{DE}$ series – cash withdrawals continuously increased over time. Conversely, Finnish $ATMVAL18_{FI}$ shrank from its maximum in 2001 onwards, in line with lower numbers of available ATMs. Spanish, Dutch and UK consumers' demand for cash reached its maximum in 2008, 2005 and 2007 respectively and declined since.

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR*
CARDVALCONS								
BE	1990-2011	22	19.95	20.52	9.17	5.93	33.73	8.63
DE	1990-2011	22	8.54	10.05	4.13	1.41	13.31	11.28
ES	1990-2011	22	9.10	6.61	5.29	2.64	16.75	9.19
FI	1990-2011	22	25.77	23.37	9.92	10.49	43.59	6.30
FR	1990-2011	22	21.07	19.93	7.96	10.49	35.18	5.93
IT	1990-2011	22	7.51	7.42	4.90	1.10	14.00	12.30
NL	1990-2011	22	19.52	21.64	12.05	0.50	36.00	22.60
UK	1990-2011	22	30.17	30.13	14.61	9.57	54.03	8.59
ATMVAL18								
BE	1990-2011	22	2,892	2,723	1,456	768	5,743	10.05
DE	1994-2011	18	4,062	4,230	1,086	1,915	5,724	5.72
ES	1990-2011	22	2,096	1,886	669	1,148	2,984	4.44
FI	1990-2011	22	3,736	3,961	562	2,521	4,375	1.71
FR	1990-2011	22	1,602	1,491	565	839	2,563	5.46
IT	1990-2011	22	1,478	1,589	563	433	2,503	8.72
NL	1990-2011	22	3,301	3,487	1,078	764	4,406	8.21
UK	1990-2011	22	3,692	4,329	1,513	1,394	5,802	5.78

* Compound annual growth rate in %.

TABLE 5-2: Value share of card payments and ATM withdrawal value[160]

Nevertheless, in most countries, cash is still the preferred payment instrument. Despite its importance for personal consumption, no time series on cash transactions are available across countries. Gresvik and Haare (2009) compare different methodologies to estimate cash usage with respect to the Norwegian market. Two promising methods are discussed.

[160] Own compilation based on data collection as described in chapter 5.2.1 and own calculation.

First, surveys among individuals and merchants regarding their payment instrument mix can be extrapolated to the whole population. This approach holds – in contrast to the second one – the advantage of generating cash value and volume data. Moreover, if both types of studies are contrasted, reasonably reliable figures can be derived. However, as indicated in the review of consumer surveys in chapter 4, this type of study is only conducted at one point in time, and only in a few countries. Hence, the resulting data can only be consulted to detect some general tendencies on cash use in certain countries and to perform sanity checks. But, to obtain consistent panel data, other approaches are needed.

Consequently, the second method proposed by Gresvik and Haare (2009) derives the value of cash payments from domestic household consumption, according to the following scheme:

Domestic household consumption from national accounts
– Bill payments typically paid by credit transfer or direct debit (footnote 158)
= Value of consumption at point of sale
– Value of card payments at point of sale
– Value of cheque payments at point of sale
= Residual value of cash payments at point of sale

While Gresvik and Haare (2009) demonstrate that this calculation yields consistent results for Norway, it is not applicable for the eight countries examined here. In all countries except for Germany in 2010 / 2011 and the Netherlands, the residual value becomes negative. One of the reasons is the dual nature of cheques, which have been employed at the POS and for paying bills, as well as for private and business purposes. The values for the latter are exceptionally high; for example in Finland the average value per cheque transaction is EUR 33,258 in 2011, while in France, where private use is prevalent, the corresponding value is EUR 602. Yet, these different functions are not statistically separated. However, excluding them from the equation would overstate cash use, especially in countries in which cheques were heavily (and are still) relied upon by consumers, such as in France or the UK. Moreover, in Belgium and Germany, the sum of cash withdrawn and card payment value is higher than the "Value of consumption at point of sale" from 2003 onwards, and in 2006 and 2007 respectively.

Another concept to approximate cash use is to rely upon cash in circulation. Amromin and Chakravorti (2009) demonstrated that with the rise of debit card payments at the POS in 13 advanced economies[161] between 1988 and 1999 (2003 for non-euro countries), the demand for small denomination currency – typically smaller than those commonly dispensed at ATMs – significantly decreased. At the same time, the demand for denominations larger than those commonly dispensed at ATMs was unaffected, demonstrating their store of wealth function. Regrettably, this idea is not replicable, since after 2001, currency in circulation was no longer recorded for any of the euro countries.

Therefore, it is assumed that cash payments at the POS are equal to the amount of cash withdrawn from ATMs. Especially for earlier years, this notion might severely understate cash usage, as obtaining cash at the counter was far more common, at least in those countries with low ATM density, such as Belgium, Germany, Italy and the Netherlands (see Table A–4 in Appendix A–3). Unfortunately, no sufficient time series data are available on cash withdrawals at the counter, or at the POS in the form of cash back.

5.2.3 Payment card diffusion and POS terminal density

In this section, the two-sided network structure of the card payment market is dealt with, in the form of the diffusion of payment cards and the density of the acceptance structure. Both are indispensable for carrying out card transactions, as modelled by de Grauwe et al. (2006). The authors present a discrete choice model to determine market shares, in terms of debit card to cash transaction volume[162], conditional on the number of debit cards and POS terminals – besides transaction fees and the density of ATMs. Their cross-country[163] model, based on

[161] These are Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States.

[162] The cash payment volume is determined as follows by de Grauwe et al. (2006, pp. 12-13): "We assumed the total number of transactions (cash + cashless) per day made by each inhabitant to be constant across countries and equal to two transactions per day per person. Given that official statistics on the number and amount of cashless transactions are available, we subtract this number form the total so as to obtain the estimated total number of cash transactions." Although the authors only observe a small period, deeper investigations appear necessary to substantiate this assumption.

[163] Countries covered are: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom, Czech Republic, Estonia, Hungary, Latvia, Slovenia, Poland, Romania, Switzerland, Norway

1998-2003 aggregate data, exhibits a positive correlation between the debit card volumes, and the size of the debit card and POS terminal network, underlining the two-sided nature of the card payments market.

Because this thesis concentrates on the payment function of cards as highlighted by von Kalckreuth et al. (2009), no distinction is drawn between debit and deferred debit or credit cards. Nevertheless, it is noticed that, in further research, such a distinction could be useful to detect differences in the institutional forces shaping the choice of one type of card over the other. However, throughout the panel construction, a number of severe obstacles emerged, preventing a straightforward determination of the number of debit and credit cards, including deferred debit cards. The most obvious ones are:

– dual functionality of payment cards in countries like Finland and France, serving in principle as debit and deferred debit or credit cards, as well as unclear and varying assignment of deferred debit cards into either category, as observed for example in Spain, leading to double counts which are not reconcilable, as reporting categories are not mutually exclusive to the total (physical) number of cards

– changing reporting categories impeding the gathering of time-series data. Since 2001, reporting for ECB Blue Books and Addenda was conducted in five categories: cards with a debit function, delayed debit function or credit function, as well as cards with a debit and/or delayed debit function, and cards with a credit and/or delayed debit function. Between 1997 and 2000 the first three categories were collected, while before 1997 there was only a distinction between debit and credit cards.

– unanimous collection of data on retailer cards, which were originally issued by merchants or petrol companies, in order to stimulate customer loyalty. Until 2003, respective numbers were indicated, but not in a consistent manner throughout time and across countries. In the subsequent report (ECB, 2006a, p. 706) covering 2001 to 2005 data, it is stated that only retailer cards issued by merchants in conjunction with banks or giving rise to substantial business

and Iceland.

will be specified. But, no data are reported, even if these are readily available, and match the above criteria. For example in Finland, retailer cards were co-branded with either Visa or MasterCard and made up 13% (9%) of card payment volume in 2001 (2005), according to Federation of Finnish Financial Services (2011).

Consequently, the total number of payment cards as displayed in the ECB, BIS or national statistics and carefully modified if necessary (see chapter 5.2.1 for a description), served as reference for CARDNB. Then, information on debit cards (DEBITNB) were gathered and verified (see Table A–4 in Appendix A–3). As far as was feasible, and based on a judgement about how combined cards are truly used by cardholders, deferred debit cards were excluded. Retailer cards were always excluded, if statistically separable from other card types. From the two series, in principle, it would have been possible to deduce the number of credit and deferred debit cards. Nevertheless, additional information is necessary, on whether adjustments and inferences made provide an accurate picture of the split between debit and deferred debit/credit cards, before employing the data in further empirical analysis.

In contrast to the procedure applied for CARDNB, assembling the number of POS terminals was rather straightforward. In order to allow comparisons between countries, POS18 was derived, although, for instance, the number of POS terminals per merchant outlet would have been a promising alternative. Unfortunately, no sufficient data on this denominator could be obtained.

Table 5–3 (next page) displays the statistical properties of the CARDNB18 and POS18 series. While in Belgium, Germany and Finland, CARDNB18 has been steadily increasing, the other countries show signs of saturation, since mid-2000. While in France, Italy and most notably the UK, credit card numbers appear to decline, in the Netherlands and Spain these remain rather stable as DEBITNB18 decrease. In Spain this even resulted in a marked reduction in CARDNB18 from the maximum of 2.1 cards per holder in 2008, to 1.8 in 2011. As already indicated in chapter 5.2.1, a major statistical break occurred in France, resulting in a jump in CARDNB by 33 m from 2004 to 2005.

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR*
CARDNB18								
BE	1990-2011	22	1.67	1.75	0.48	0.85	2.33	4.91
DE	1990-2011	22	1.38	1.60	0.48	0.46	1.93	7.11
ES	1990-2011	22	1.49	1.49	0.40	0.83	2.07	3.85
FI	1990-2011	22	1.13	1.04	0.37	0.66	1.85	4.53
FR	1990-2011	22	1.00	0.83	0.51	0.47	1.77	6.21
IT	1990-2011	22	0.87	0.87	0.43	0.26	1.42	8.27
NL	1990-2011	22	1.91	2.13	0.58	0.74	2.53	5.66
UK	1990-2011	22	2.24	2.36	0.81	1.12	3.15	4.65
POS18								
BE	1990-2011	22	12,052	12,969	4,234	3,706	18,101	7.34
DE	1990-2011	22	5,278	6,114	3,617	368	10,516	17.31
ES	1991-2011	21	25,353	25,825	10,013	7,594	38,561	8.15
FI	1990-2011	22	21,786	17,515	12,456	7,022	48,079	9.59
FR	1990-2011	22	18,319	18,967	7,685	4,301	28,951	9.50
IT	1990-2011	22	13,867	14,788	10,212	508	29,624	20.47
NL	1990-2011	22	11,691	13,137	6,800	196	21,592	25.08
UK	1990-2011	22	18,908	16,829	7,426	2,545	28,008	12.10

* Compound annual growth rate in %.

TABLE 5-3: Diffusion of payment cards and density of POS terminals[164]

Across all countries, only 70% of the population above 18 possessed a payment card in 1990. Yet, in 2011, each inhabitant had more than two in his/her wallet, which implies a growth rate of more than 5% annually. Expansion of POS18 has been even more impressive, with almost 12% p.a., leading to an increase from 2,664 to 26,914 terminals per million inhabitants in the 22-year period, on average across countries. Looking at each country separately reveals that in most of them, the POS terminal network still becomes denser. In Spain and Italy however, this development came to a hold probably as a consequence of the financial crises. On the other hand, in Belgium $CARDNB18_{BE}$ deteriorates by 30% from its maximum in 2001 until 2004. No clear reason could be singled out. In 2006, the national debit card scheme Banksys was taken over by an international active PSP, Atos Worldline, which could have been a reaction to deteriorating issuing activities. From 2005 onwards, the series followed its earlier growth path, but the 2001 value has not yet been reached.

[164] Own illustration.

5.3 European card schemes and markets

This chapter aims at uncovering the institutional development of the eight major European card markets. Throughout the process, the emergence of the major domestic (debit) card scheme(s) is outlined, while the extent to which the respective bank community has cooperated is highlighted. This allows inferences on the number of POS and ATM networks (POSNW and ATMNW), as well as the degree of vertical scheme integration (INTEGR), the existence of a domestic ACH processing card payments (ACH), and the involvement of the national central bank (NCB).

Thereby, a comprehensive picture of the particularities of the different card payment markets is evoked. Only through this process, could the collection of the institutional data series just mentioned be completed. If applicable and beneficial for understanding the market's peculiarities, an overview is offered on the different types of payment cards available in the country. This also facilitated the assessment of payment card related data, published by ECB, BIS and national authorities or associations, as outlined in chapter 5.2.1.

This chapter is divided into three parts. In the first chapter 5.3.1, the framework for the institutional data compilation is proposed. Chapter 5.3.2 focuses on the description of the different card schemes and markets. The last chapter 5.3.3, summarises the findings, and describes the resulting data series.

5.3.1 Institutional data collection

In this chapter, the determination of five institutional variables – POSNW and ATMNW, INTEGR, as well as ACH and NCB – central to the modelling of payment choice is explained.

ATMNW and POSNW have been part of the data set published by ECB and BIS up to 2003 (ECB, 2005a and CPPS, 2005), although the records are only fragmentary. The missing observations, including those for the subsequent period of 2004 to 2011, have been derived from other sources, indicated in due course. An ATM or POS network is defined as a group of network terminals "managed by one or more service providers for a bank or group of banks" (CPPS, 2005, p.

228). Not only does this description seem rather vague, but also the interpretation of what constitutes a network appears to have changed throughout the years, without appropriate disclosure. Snellman (2006, p. 47) enumerates the difficulties in clearly distinguishing the number of ATM networks, and mentions backward corrections, for example, for Germany and Italy. Hence, there is a need to clarify the "network" term, which is done based on following questions:

(i) How many physical networks run by different operators exists? If there is more than one, especially in case of low (potential) transaction volumes, networks effects and economies of scale are probably not fully exploited. Hence, transactions may be unnecessarily expensive, which might hinder the further development of payment card use. This scenario even holds true if these different networks can be accessed by a single payment card brand.

(ii) How many networks exists that charge for transactions which are made by holders of a "foreign" payment card, issued by banks that are part of a competing network? These are also counted as separate networks, with the same underlying rationale as (i) even if the payment cards used are all issued under a single brand name. Moreover, fees for using "foreign" ATMs for example, raise costs of cash for cardholders.

(iii) Are there additional (proprietary) networks offered by single banks, and available only to customers of these banks? As maintenance of these networks is expensive, while they offer only limited access, per transaction costs are high, increasing overall societal payment costs.

If not indicated otherwise, the subsequent information in the descriptive parts stems from the respective country chapters in these four Blue Books: Working Group (1992), EMI (1996), ECB (2001a, 2007a and 2007b).

The extent to which a card scheme assumes responsibility for certain parts of the cards business is described by INTEGR. According to chapter 2.1.1, card schemes' vertical integration can range from (1) solely owning the brand to (2) switching authorisation requests, (3) authorising and processing, as well as (4) clearing and/or settling the card transactions up to (5) acquiring merchants and

(6) distributing network terminals. A first assessment of this factor was undertaken by the European Commission (2006a, p. 89), reflecting the situation in 2005. All other data were estimated based on the information gathered about the different card schemes, substantiated below.

Two further data series were observed: ACH and NCB; both are dummy variables. ACH turns to one if there is a central ACH, operated by the domestic banking community, which processes card payments. Otherwise ACH is zero. Multilateral clearing not only offers economies of scale benefits (see chapter 3.1.1). It may also have competition-enhancing effects within the domestic card payment systems, as it facilitates market entry by foreign banks (European Commission, 2006a, p. 93), as long as access rules are non-discriminatory. In contrast, foreign banks may experience difficulties in entering the local market if they are dependent on bilateral clearing arrangements like the Finnish Pankkikortti and the UK SWITCH/SOLO debit card schemes (European Commission, 2006a, p. 93).

NCB takes on the value of one if the national central bank is involved in management or ownership of the domestic ACH. Khiaonarong (2003) found that a strong involvement of the central bank in ACH operations results in higher processing costs per transaction, as discussed in chapter 3.1.1. Although, an involvement of the national central bank could ensure non-discriminatory access to the ACH's services, Guibourg (1998, p. 21) warns not to misunderstand the argument, and encourage ever more entrants, if economies of scale and network externalities are already exploited (for deeper insight see chapter 2.1.3).

All card transactions are settled through LVPSs, using central bank money. Hence, this factor is not looked at throughout the subsequent discussion. Three-party card schemes, such as American Express and Diners continue to play a niche role, and are therefore not explicitly covered.

5.3.2 Description of European card markets

In the following, the institutional set-up of the eight European card markets covered in this dissertation is explored in detail (in alphabetical order). Hereby, the values for five institutional series, namely POSNW, ATMNW, INTEGR,

ACH, and NCB are collected, as these are only partly, if at all, available in the statistical sources used for this thesis. In general, the country sections follow the same structure: First, the national debit card scheme(s) alongside the prominent RPS is investigated. On this foundation, the institutional data are derived and payment card related data (CARDNB, CARDVOL, CARDVAL) verified.

Belgium

In 1989, the two Belgian debit card schemes – Bancontact and Mister Cash – merged to form Banksys, an interbank organisation. Besides taking over the two debit card brands, Banksys has continued to operate the ATM and POS networks of both schemes. In addition, the society initiates the clearing process taking place via the national ACH (CEC – Centre for Exchange and Clearing). CEC was founded as a non-profit organisation by the banking sector in 1974, and is operated by the national central bank NBB.

The Bank Card Company (BCC), which was held by the Belgian banks as well, administered the distribution of Visa and MasterCard branded payment cards. Banksys was entrusted with the authorisation and further processing of the emerging transactions. In 1999, Banksys took over most operations from BCC, while in 2006, both societies were acquired by Atos Worldline. Besides administering the issuing process, including card and PIN distribution, Atos Worldline is responsible for the whole card payment process, ranging from authentication to verification, authorisation, as well as transmission of transfer information into CEC for clearing and subsequent settlement. Moreover, the company delivers and operates POS terminals, and supports the operation of ATMs, which are, since 2005, owned by the banks themselves.[165] These ATMs had been available to all Bancontact/Mister Cash and Visa or MasterCard cardholders. However, a number of banks run their own ATM networks, but agreed in 2006 to grant access to customers holding cards issued by other banks.

Based on the information above, the following decisions were taken:

[165] Atos Worldline is still active in these segments of the cards business: http://www.atosworldline.de/en/14/Solutions-Services/Payments.html (retrieved 2012, November 14).

- In contrast to the ECB data, only one POS network is assumed throughout the whole time period. In EMI (1996, p. 39) five and six networks are mentioned for 1990 and 1991-1993, as five or six companies independently acquire merchants, i.e. POS clients. However, all transactions are passed through the Banksys network. In ECB (2000a and 2005a) two networks are indicated until 2000, one afterwards. One explanation for the mentioning of two networks could be the existence of BCC, who might have acquired own merchants for Visa or MasterCard payments. Nevertheless, these were also routed through Banksys. From an economies of scale perspective, this circumstance is in favour of assuming only one network.

- With respect to ATMs, from 1993 onwards, the proprietary bank ATM networks are included in the ECB/BIS data, increasing their number from 3 to 15. In contrast to EMI (1996, p. 39) and Snellman (2006), the 1990-1992 figures have been adjusted upwards to 15, to avoid a statistical break. For 2004 and 2005, no data are available, but 13 networks as in 2003 have been assumed. This number collapses to one in 2006, following the decision to open access to customers, and possibly handing over operations to Atos Worldline.

- Based on the description of the range of tasks handled by Atos Worldline and its predecessors, the vertical integration has been set to six throughout 1994-2011. This is also in line with the assessment of the European Commission (2006a, p. 89). For the period 1990-1993, INTEGR is assumed to be four, as a number of independent acquirers seem to exist.

- The ACH and NCB dummy variable is set to one throughout the whole time period, as debit card transactions are routed through CEC acting as central national ACH, which is operated by the national central bank.

Germany

In 1982, the three major German banking associations of the commercial, savings and co-operative banks formed a national payments body, the Gesellschaft für Zahlungssysteme mbH (GZS). The company administered the Eurocard licence, and acted as issuer, acquirer and processor for Eurocard delayed debit and credit

cards. Since 1968, the European card scheme Eurocard had been affiliated with MasterCard. Yet, it was not until 2003 that the Eurocard brand was abandoned and replaced by the MasterCard brand in Germany. In Finland and other Nordic countries, MasterCard delayed debit and credit cards are still co-branded.[166] In 1997, GZS was split into two societies, the EURO Kartensysteme GmbH and another one taking over the processing and acquiring business. EURO Kartensysteme is still owned by the German banking associations. It is now inter alia concerned with the management of the MasterCard licence, and issues MasterCards on behalf of member banks.

The German debit card scheme – since 2007 girocard, formerly known as electronic cash[167] – emerged from the eurocheque card scheme, which was originally introduced to guarantee eurocheque payments. In 2001, the guarantee function expired, contributing to the further decline of retail cheque payments. In 1990, the associations of the German banking industry concluded an agreement on a nationwide system for POS payments, on the basis of eurocheque / debit cards. Since then, the POS system is based on a number of "electronic cash agreements" between the German banking associations' umbrella organisation (Die Deutsche Kreditwirtschaft, formally known as ZKA – Zentraler Kreditausschuss) and the participating banks, merchants and network service providers. It includes inter alia technical requirements and provisions regarding the payment guarantee and merchant fee (so-called "Händlerentgelt").[168]

Within this framework, private contracts are concluded between the merchant and its bank, as well as between the merchant and a network service provider. In Germany, the latter assumes most of the tasks typically carried out by acquiring banks. Each network service provider operates its own POS network, which is connected to one of four gateways that switch authorisation requests to the

[166] See http://www.fgg.at/kreditkarten/mastercard/eurocard/ and http://www.presseportal.de/pm/38715/410330/der-doppelname-faellt-aus-eurocard-wird-mastercard (retrieved 2012, November 15).

[167] http://girocard.eu/en/about-girocard.html (retrieved 2012, November 15).

[168] For details on the contractual relations, role models, fees, participation requirements and technical characteristics see http://www.electronic-cash.de/en/contractual-basis.html (retrieved 2012, November 15).

issuing bank.[169] Once authorisation is granted, the transfer information is sent from the POS terminal to the merchant bank. Then, the merchant bank generates a direct debit, to be subsequently cleared using bilateral IFTS arrangements, as indicated in chapter 2.1.3.

It should be noted that, in Germany, no central ACH exists. Instead, commercial savings and cooperative banks operate bilateral clearing systems (giro networks) for non-cash payment, and collectively own and operate card-processing centres ("gateway")[170] (CPSS, 2003b, p. 154 and 160 in conjunction with CPSS, 2012b, p. 181). In contrast to an ACH, a giro network has no system owner, and there are no governance arrangements. To allow other banks not belonging to one of these groups to process retail payments, the central bank introduced the competitively neutral RPS (Deutsche Bundesbank, n.d.). It has a market share of below 15% on German credit transfers, direct debits and converted cheques.[171]

With respect to the ATM network, each bank provides and operates its own ATMs. They form four ATM groups who offer cash withdrawals to customers of the affiliated banks without charge.[172] Holders of payment cards not issued by a participating bank pay a per transaction fee. Technical requirements and other provisions necessary for the acceptance of girocards are agreed within the Deutsche Kreditwirtschaft, analogous to the POS system.[173] Cash withdrawals are authorised directly by the issuing bank, without being switched by a gateway. After being authorised, the ATM operator (acquiring bank) initiates a direct debit, which is cleared and settled throughout the IFTSs.

Taking the above information into account, the following data will be used:

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[169] See http://www.electronic-cash.de/en/contractual-basis/contractual-relationships.html and http://www.electronic-cash.de/en/contractual-basis/role-model/authorisation-system.html (retrieved 2012, November 15).

[170] These gateways are CardProcess GmbH, Finanzinformatik GmbH, VÖB-ZVD Bank GmbH und BV Zahlungssysteme according to http://www.bv-zahlungssysteme.de/index.php?id=866&no_cache=1&tx_ttnews%5Btt_news%5D=780&cHash=a0c2cb256b6670f97003f77026ac1385 (retrieved 2012, November 28).

[171] http://www.bundesbank.de/Navigation/EN/Core_business_areas/Payment_systems/Retail_Payment_System/retail_payment_system.html (retrieved 2012, November 15).

[172] These are Cash Group and CashPool as well as the ATMs of savings and co-operative banks.

[173] http://www.deutsches-geldautomatensystem.de/index_en.html (retrieved 2012, Nov. 15).

– The number of POS networks, i.e. network service providers, is taken from the ECB statistics; it ranges from 11 in 1990 to 30 in 2001. Data for 2004 and 2006-2011 are missing. For 2004, 25 networks are assumed, the same number as in 2003 and 2005. In press releases by the working group of electronic cash network service providers, the figures for 2007 and 2009-2011 are revealed.[174] For 2006 and 2008, the average of the previous and the following year was taken as the basis.

– Besides the bank-based POS payment framework, merchants introduced as early as 1992 a procedure that allowed POS payments by debit card, without involving the issuing bank for authentication, authorisation or verification – so called ELV (Elektronisches Lastschriftverfahren). With the help of the magnetic strip on the card, a direct debit collection authorisation is generated and signed by the cardholder. While merchants avoid paying the merchant fee, they lack a payment guarantee. Although cardholders regard the transaction as card payment, statistically, these are counted as direct debit. Information by the EHI Retail Institute indicates that these made up between 1.7% and 12.6% of the retail turnover in 1994 and 2011, compared to 0.8% and 20.7% of "regular" girocard payments. During the same time period, cash turnover declined from 93.8% to 57.2% (see Figure 5–10, p. 232 for details).[175]

– Until 2002, the ECB reports four ATM networks – latest in ECB (2004a). But in the following year, this number was retroactively revised downwards to one (ECB, 2005a). According to Snellman (2006, pp. 95-96), the actual "number of networks has not decreased, but the interpretation of network arrangements has changed." From the above, it is acknowledged that cardholders are not free to use all German ATMs under the same conditions, and therefore network benefits are restricted. This is still the case today, which leads to the conclusion of four networks instead of one – in contrast to ECB (2005a) and Snellman (2006, p. 96).

[174] http://www.ak-ec-netzbetreiber.de/ (retrieved 2012, November 15).
[175] Rüter (2010, p. 3) and http://www.ehi.org/presse/pressemitteilungen/detailanzeige/article/mehr-kartenzahlung-mit-mehr-mobilitaet.html (retrieved 2012, November 15).

– INTEGR of the girocard scheme is set to one throughout 1990-2011. This is also in line with the assessment provided by the European Commission (2006a, p. 89). The ACH, and consequently the NCB, dummy variable is set to zero, as no central clearing takes place.

Spain

In Spain, three different card schemes have existed since the mid 1970s – ServiRed, Sistema 4B and Euro 6000. Figure 5–3 below shows the schemes' market shares in percent for 2011, in terms of payment cards issued, ATMs installed and merchants affiliated.[176]

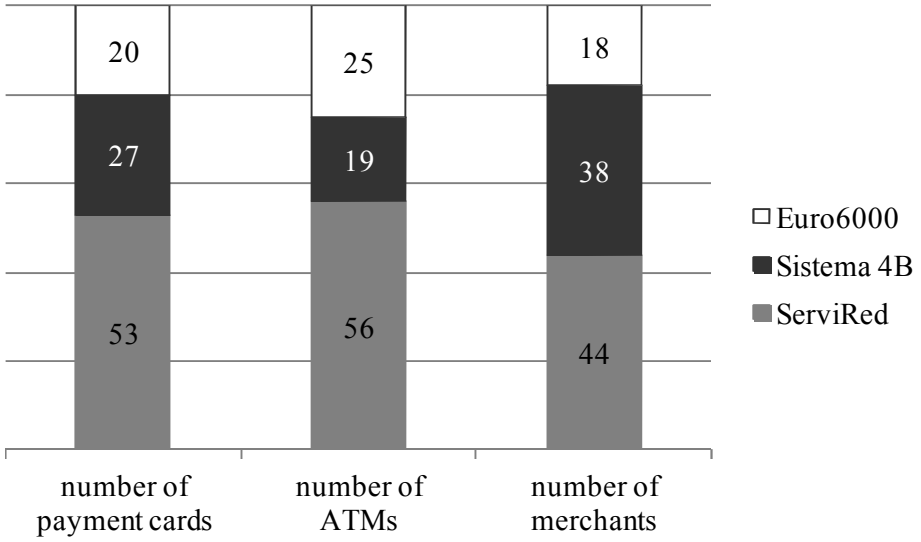

FIGURE 5-3: Market share of Spanish card networks[177]

All three offer debit, delayed debit and credit cards co-branded by Visa or MasterCard, which ensures nationwide and international acceptance (European Commission, 2006a, p. 121-122). As a consequence, the transactions in question – for instance, a EURO 6000 card is accepted by a merchant affiliated with Sistema 4B – are routed via MasterCard or Visa processing centres, thereby diminishing economies of scale benefits for the central ACH. Member banks affiliate merchants and install ATMs, but the operation of the networks, as well as processing and clearing, was part of the schemes' portfolio of tasks until 2008.

[176] Blue Book information complemented by statements at the companies' websites: http://www.servired.es/ingles/indexx.htm and http://www.4b.es/welcome (retrieved 2012, Nov. 16).

[177] Own illustration. Market shares in percent based on information given in the 2011 annual reports of ServiRed (2012, p. 4), Sistema (4B, p. 12) and EURO 6000 (2012, pp. 13 and 16).

In 2009, all schemes have been declared to be SEPA-compliant, in accordance with the respective ECB's Terms of Reference (ECB, 2009c).[178] That implies inter alia the separation of scheme management and processing.

Balances from card transaction clearing are settled at the Spanish ACH, SNCE (National Electronic Clearing System), in conjunction with the LVPS, run by Banco de España. SNCE was established in 1987; operations were carried out by the national central bank until the payment systems reform in 2005. Thereafter, the operational functions were transferred to Iberpay, a private company held by Spanish banks, which participate in the SNCE, while oversight remained at Banco de España.[179]

Against this background, the following decisions were taken:

- In accordance with ECB reports, three POS and ATM networks are laid down for the years 1990-2003, the last record year. After 2003, the three networks remain. There is no countervailing evidence.
- INTGR is set to four, in light of the tasks handled by the three schemes between 1990-2008. After that, the formal separation of scheme and processing has been declared by all schemes leading to a degree of integration of one.[180]
- Throughout the period under review, the ACH dummy variable is set to one, as card transactions are routed through SNCE. However, the NCB was only involved in operations until 2005, requiring a shift to zero from 2006 onwards.

Finland

In contrast to the other country sections, this one starts by explaining the primary classes of payment cards having been available in Finland as listed in Table 5–4 (next page). In the first column, the seven classes are labelled for the reader's

[178] All three statements are available at the respective company website: http://www.servired.es/espanol/pdf/ToR_SEPA_compliant_card_schemes_ServiRed_Responses_PublicVersion.pdf, http://www.4b.es/download.php?id=300 and http://www.euro6000.com/privilegios/canalWeb/pdfs/sepa.pdf (retrieved 2012, November 16).

[179] Banco de España (2005, p. 6) and http://www.bde.es/bde/en/areas/sispago/Sistemas_de_pago/El_SNCE/El_SNCE.html (retrieved 2012, November 16).

[180] http://www.servired.es/espanol/pdf/ToR_SEPA_compliant_card_schemes_ServiRed_Responses_PublicVersion.pdf, http://www.4b.es/download.php?id=300, http://www.euro6000.com/privilegios/canalWeb/pdfs/sepa.pdf (retrieved 2012, November 16).

reference. In the following columns, these classes are characterised in more detail by identifying their type, the scheme under which they are issued, their reach, as well as the authorisation and verification procedures (columns two to five).

Besides usual debit and credit cards, Finnish consumers are offered so-called combination cards. Here, the cardholder can choose when – immediately or after a pre-determined time period – and how – the whole amount or instalments – he/she repays balances arising from purchases. Thus, with one (bank) combi card (iv and v), consumers hold in fact three different payment cards, although the (revolving) credit option is less often used. In 2011, 2.6 m of these cards were issued compared to 4.2 m debit cards (i, ii, iii) and 1.1 m pure credit cards (vi).[181] Besides the Blue Books, this section also draws on Jyrkönen and Paunonen (2003) and Nordic competition authorities (2006) if not indicated otherwise.

Referred to	Type	Scheme	Reach	Authorisation / verification
(i) bank card	debit	Pankkikortti	domestic	Offline
(ii) Visa Electron	debit	Visa	international	Online
(iii) ICS debit card	debit	ICS*	international	Offline
(iv) bank combi card	combination	Pankkikortti + ICS*	international	online
(v) ICS combi card	combination	ICS*	international	online
(vi) credit card	credit	ICS*	international	offline
(vii) ATM card	--	Pankkikortti	domestic ATM	n/a
* International card scheme (ICS), in general Visa or Eurocard/MasterCard. ** Allows also domestic POS payments and ATM withdrawals.				

TABLE 5-4: Principle card types in Finland[182]

Payment cards have been issued either under the national debit card brand Pankkikortti, co-branded with one of the international card schemes (ICS), i.e. Visa and, since 1999, Eurocard/MasterCard, or solely ICS branded. Although other schemes, such as American Express and Diners, offer deferred debit or credit cards respectively, they only play a minor role in the market, and are thus not included in further discussion. The branding also indicates where the cards can be used, either solely at domestic ATM and POS terminals, or abroad as well, i.e. international reach. Finally, an "online" card implies that transactions

[181] Federation of Finnish Financial Services (2011 and 2012a).
[182] Own illustration.

are instantly authorised by the issuing bank, and the availability of sufficient funds in a cardholder's current account is verified, prior to sending the transfer order. In contrast, "offline" card transactions are initiated without consulting the issuing bank first. Yet, they are checked against a blacklist.

Throughout the preparation for SEPA, the Finnish banks decided to phase out Pankkikortti, and started to issue SEPA-compliant debit cards in 2008 (Federation of Finnish Financial Services, 2012b, p. 22). As a result, bank cards (i) are replaced by Visa Electron (ii) and ICS debit cards (iii), while bank combi cards (iv) are substituted by ICS combi cards (v). Visa Electron had been introduced in 2000, while ICS debit cards and ICS combination cards came into existence in 2006 and 2008 respectively. Since ATM cards (vii) – designed for cash withdrawals at domestic ATMs – are linked to the Pankkikortti scheme, they too will become extinct in the near future. Because ATM cards do not contain a payment option, they are excluded from further analysis. While in 2001 they made up almost 40% of cards in circulation, this figure shrank to 0.4% in 2011, equalling 29,000 ATM cards (Federation of Finnish Financial Services, 2011 and 2012a).

A particular mixture of coordination and cooperation arrangements has been characterising the Finnish payment card landscape. These are first explained with respect to Pankkikortti bank and bank combi cards followed by Visa Electron and ICS debit and combi card arrangements.

Issuing and merchant acquiring for the national debit card scheme Pankkikortti has been decentralised, i.e. handled by member banks. The scheme is managed by the Finnish Bankers' Association (now Federation of Finnish Financial Services). Verification and authorisation, as well as bilateral clearing are initiated via PMJ, the country's interbank retail payment system. The PMJ is jointly owned and run by the Finnish Bankers' Association and its member banks, according to Nordic competition authorities (2006, pp. 33, 39 and 56-57). It is not an ACH, where multilateral netting could be conducted. Settlement takes place via the LVPS run by the national central bank, Suomen Pankki.

ATM services were centralised in 1994, and since then have been performed by Automatia Pankkiautomaatit Oy. The company administers the nationwide Otto.

ATM network, and is jointly owned by the three most important Finnish banks / banking groups. ATMs which are still operated by single banks are nevertheless connected to the Otto. network. Processing is conducted via the PMJ, as long as bank (combi) cards or ATM cards are inserted. For all other cards, the payment platforms of an ICS are employed.

Following the decision to replace the Pankkikortti, the PMJ appear to handle only legacy transactions, since processing, as well as clearing, is gradually taken over by Visa or MasterCard respectively (Federation of Finnish Financial Services 2012b, p. 22). Since its peak in 2007, the number of bank card transactions decreased by 82%, down to 112 m in 2011, resulting in diseconomies of scale (Federation of Finnish Financial Services, 2012a).

Like bank (combi) cards, Visa Electron and Eurocard/MasterCard products are issued by individual banks, while this task is handled by Luottokunta Oy on behalf of Finnish banks for all Visa cards. The company was founded by Finnish banks and individual merchants, but sold to Nets in 2012.[183] Luottokunta is the sole acquirer of Visa since the 1980s, and of Eurocard / MasterCard since 2004, according to the Nordic competition authorities (2006, pp. 54-55) and the European Commission (2006a, p. 91). Authorisation requests, as well as transfer orders are routed via Luottokunta's network towards the ICSs payment platforms.

In the light of recent developments – phasing out Pankkikortti and selling Luottokunto – the current state and future development of the issuing and acquiring business with respect to the division of tasks is vague. Evaluating the information obtained so far, the following judgements are made:

– With respect to the number of debit POS networks, the ECB reports covering 1997-2003 mention one network. For 1990-1996, one network is assumed as well – that of Pankkikortti. However, from 2001 onwards, Visa Electron was on the rise and hence, a second network gained soon importance for processing, e.g. switching authorisation and clearing. In 2001, only 2 m payments

[183] http://www.luottokunta.fi/en/Services/News-archive/2012/Nets-has-acquired-Finlands-largest-payment-company/ (retrieved 2012, November 19). Nets is a leading Nordic payment service provider which emerged from the former national card schemes of Demark and Norway. Its major shareholders are Danish and Norwegian banks including central bank of Denmark. See company's website for details: http://www.nets.eu/ (retrieved 2012, Nov. 19).

were made using the latter, compared to 291 m by Pankkikortti. In 2011 however, Visa Electron gave rise to more than 367 m transactions (Federation of Finnish Financial Services, 2011 and 2012a).

– Prior to consolidation towards the single Otto. network, three (1990-1992) and two (1993) ATM networks were present in the country, according to ECB. From 2004 onwards one has been assumed as well.

– In contrast to the assessment by the European Commission (2006a, p. 89) of a degree of integration of one, INTEGR appears to be higher and more likely three. This assessment is based on the observation that, although Pankkikortti scheme management is separated from processing, the same banks participating in the Finnish Bankers' Association also own PMJ, through which authorisations are routed and cleared. Moreover, in Finland the degree of concentration based on assets (CR5, see below) is very high. Hence, a handful of major banks/banking groups dominate the market. Since the European Commission (2006a, p. 89) assumes for Visa Electron and other ICS debit cards also a degree of integration of three, this is assigned throughout the whole time period.

– Since there is no ACH in Finland, the ACH and NCB dummy is set to zero.

France

In 1984, a group of major French banks signed a draft agreement to develop a national debit card scheme – Carte Bancaires.[184] It has been administered by an economic interest group (Groupement d'Intérêt Economique – GIE), which is supported by more than 130 mainly French banks and PSPs. Via its holding company, GIE Carte Bancaires operates – inter alia – an authorisation platform to route authorisation requests to the issuing banks. This so-called e-rsb network and its predecessors have existed since 1991. Issuing and acquiring, as well as operating ATMs is done by individual banks. Since 1995, transactions have been cleared centrally via the CORE system and its predecessors. It is owned and

[184] For this section, the Blue Book records have been supplemented by information given on http://www.cartes-bancaires.com/spip.php?lang=en and http://www.stet.eu/en.html (retrieved 2012, November 27).

managed by the six major French banks via STET (Systèmes Technologiques d'Echange et de Traitement).

Cartes Bancaires has been associated and co-branded with Visa since its foundation. Later on, Carte Bancaire issued Europay/MasterCard co-branded cards as well. In general, these cards can be employed as debit or deferred debit cards, subject to the decision by the issuing banks and cardholder's discretion at the checkout. According to Capgemini Consulting (2008) in 2006, of the 53.6 m Cartes Bancaires, 25% doubled as debit and deferred debit card, while 6% were deferred debit cards only. As the total number of cards is roughly in line with ECB statistics, more of such private information could help to verify the split between debt and deferred debit/credit cards, thereby offering a promising field for further research.

Based on the information above, variables are set as follows:

- In line with the Blue Books, one POS network is included in the data throughout 1990-1998. The same holds true for ATMNW. The reason behind this is that, although banks decide individually about affiliating merchants or installing ATMs, authorisation and transfer orders are all routed through the same network. For the years 1999-2011 no data are available. But, circumstances as described above allow continuous assumption of one POS and ATM network.
- Against the backdrop of the range of activities GIE Cartes Bancaires is performing, the attribution of an INTEGR of three is appropriate up to 1994, changing to four afterwards due to establishing the domestic ACH. This also corresponds to the assessment by the European Commission (2006a, p. 89). In 2009, the society declared SEPA-compliance of the scheme, lowering INTEGR to one.[185]
- The ACH dummy variable is set to one, as Cartes Bancaires transactions have been routed through a central national ACH since 1995. Between 1990-1994,

[185] http://cartes-bancaires.betatilt.com/en/IMG/pdf/JMB09.11.245_Annexe_summary_reponse_CB_a_BCE_BDF_Questionnaire_SEPA_compliance_version_EN_0.3-2.pdf (retrieved 2012, November 27).

transfer orders were sent through a decentralised network of bilateral connections, requiring assigning zero to ACH. NCB is assigned zero until 2011.

Italy

The main debit card scheme in Italy is operated by Consorzio BANCOMAT (formerly Co.GE.BAN – Convenzione per la Gestione del marchio Bancomat) under the trademarks Bancomat for ATM withdrawals, and PagoBancomat for POS payments. Besides this, BancoPosta operates an own debit card scheme – Postamat.[186] In 1995 both parties signed an agreement to create interoperability between postal and Bancomat payment cards, especially for ATM withdrawals. Postamat cards allow POS payments by co-branding with Visa or MasterCard.

Consorzio Bancomat is an interbank cooperative, which was created in 1995 to promote debit card payments and ATM withdrawals. PagoBancomat is the major nationwide debit card network. It provides the common infrastructure, single trademark and set of rules established by the ABI and Convention for the Management of the Bancomat Trademark (CO.GE.BAN), which are responsible for organising and operating network facilities. Almost all ATMs and most POS terminals are connected to its network. Issuing and merchant acquiring is arranged by the banks.

With respect to processing, and even terminal management, three (four) network service operators were active in the POS (ATM) space until 2008. In that year, two of them – ICBPI, the central institution of the Italian co-operative banks (Istituto Centrale delle Banche Popolari Italiane), and Seceti – joined forces to operate a common clearing platform. A second ACH, bank-owned SIA-SSB was created by the merger of SIA (Società Interbancaria per l'Automazione) and SSB (Società per i Servizi Bancari) in 2007, according to Kokkola (2010, p. 196).[187] SIA (SIA-SSB) has been acting as the main national ACH and also operated the BI-COMP system on behalf of the Banca d'Italia. In 2000, Banca d'Italia completed disposal of its stake in SIA. Nevertheless, both clearing institutions

[186] Information about Postamat is drawn from http://www.poste.it/bancoposta/cartedipagamento/indexpostamat.html (retrieved 2012, November 28).

[187] See company brochure http://www.sia.eu/Engine/RAServeFile.php/f/SIA-SSB_Illuminating_paym_cards_business.pdf for details on the range of tasks handled (retrieved 2012, Nov. 29).

only perform bilateral netting operations while multilateral clearing then is undertaken by the BI-COMP system managed and owned by Banca d'Italia (SIA-SSB & Banca d'Italia, 2008). ATM transactions are processed through the retail subsystem and settled through BI-COMP.

Since 1985, CartaSi credit cards have been issued co-operatively by Servizi Interbancari. These cards have been co-branded with Visa or MasterCard for international acceptance. Servizi Interbancari is mainly owned by banks. Later on, individual banks also launched their own credit cards linked to an ICS. Ardizzi (2003, p. 13) gives an overview of the market share in credit card issuing and acquiring for 2000. CartaSi enjoys the strongest market presence with 57% and 46% share in value of card purchases and POS transactions respectively. It is followed by BankAmericard of Deutsche Bank and Amex. All other issuing and/or acquiring banks have single-digit market shares. While in the earlier years, credit card transactions were settled through correspondent accounts, in 2001 a new procedure was developed that involved processing by Servizi Interbancari, and subsequent settlement in the BI-COMP system.

Based on this information, it can be inferred that:

- Corresponding to ECB data ranging until 2003 and Snellman (2006, p. 96), three POS and four ATM networks are assumed until 2007. Due to the ICBPI-Seceti merger in 2007, these numbers were adjusted downwards to two and three respectively. No POS network data are available for 1990-1995, but there is no evidence that the number changed until the beginning of ECB reports in 1996.
- INTEGR is set to one during the whole time period. This is also in line with the assessment by the European Commission (2006a, p. 89).
- The ACH dummy variable is set to one, as debit card transactions are routed through SIA / BI-COMP acting as the main national ACH. Due to the disposal of its stake, NCB dummy changes from one to zero in 2000 until 2011.

Netherlands

In 1987, Dutch banks, including Postbank, started closer cooperation in the field of POS card payments by founding BEANET, an interbank society responsible for installing the acceptance network, and processing the transactions. These POS terminals were eligible to process cheque guarantee cards, from which the national debit card scheme PIN was developed. 1994 saw the creation of Interpay, which combined inter alia BEANET and Eurocard Nederland (Möller, 2008, p. 16), a credit card organisation in which banks and the Postbank participated. Interpay was responsible for managing the PIN debit card, and Eurocard/MasterCard credit card licence, as well as issuing these cards and acquiring merchants. Moreover, Interpay handled authorisation requests and clearing for ATM, as well as POS transactions. Each bank installed its own ATMs. Credit cards have also been issued by other banks.

Following interventions by the DNB and Dutch competition authority, Interpay split up its organisation in 2004. Interpay transferred its acquiring tasks for PIN and Chipknip, the Dutch e-purse, to the banks. Further, processing was separated from brand management. While the former remained within the company, the latter was taken over by Currence (formerly Brands & Licences Betalingsverkeer Nederland B.V.), which was set up by eight major Dutch banks. Currence inter alia centrally manages the PIN and Chipknip brand. Also, PaySquare B.V. (still a wholly owned subsidiary of Equens) was founded to take over the card issuing activities, as well as the MasterCard Europe licence, in 2004.

Also in 2004, Interpay established a joint venture with Banksys of Belgium, and SSB of Italy, to form SinSYS, with the aim to achieve economies of scale and safe processing costs. Following the merger with the German Transaktionsinstitut für Zahlungsverkehrsdienstleistungen AG, a subsidiary of DZ Bank, in 2006 Interpay was renamed Equens (Möller, 2008, p. 16). However, full integration was not reached until 2011.[188] Currently, Equens SE is held by major German, Dutch, and Italian banks.[189]

[188] http://www.equens.com/Images/Developments_Milestones_2009.pdf (retrieved 2012, Nov. 30).
[189] http://www.equens.com/aboutus/organisation/governance.jsp (retrieved 2012, November 30).

As a consequence of the above, the following data are derived:

– Corresponding to ECB data ranging until 2003, two POS networks are found in 1990-1992 and one thereafter. Also in line with ECB and Snellman (2006, p. 96), two ATM networks are present between 1990 and 1997, and one thereafter. Because there are no signs that POSNW or ATMNW might have increased, one is assigned also past 2003 until 2011.

– In line with the assessment by the European Commission (2006a, p. 89), INTEGR is set to four. In 2011, the PIN brand was discontinued and replaced by Maestro or VPay, subject to the issuing bank's decision[190] implying an INTEGR of one.

– The ACH dummy variable is set to one, as debit card transactions are routed through Equens and its predecessors, acting as the main national ACH. As the national central bank has no stake in it, NCB is zero.

United Kingdom

Debit and credit card schemes in the UK developed in close association with Visa and MasterCard. First, the different debit card schemes are described. The SWITCH scheme was launched in 1988 and rebranded Maestro (UK) in 2004. These cards were intended primarily for domestic use – in contrast to the international Maestro cards launched in 1993, and targeted at consumers who wished to make payments abroad. In 1997, SWITCH presented the SOLO scheme, which required full online verification and authorisation, and did not allow overdrafts. In 2011, MasterCard integrated the (still separate) SWITCH processing network into the Maestro platform, and decommissioned the SOLO scheme.[191] Hence, issuing banks replaced SOLO cards by other debit cards.

The competing VISA debit card has been in existence under different brand names – most notably Visa Delta – since 1987. In addition, from 1996, banks also issued Visa Electron cards. These have characteristics similar to the SOLO

[190] http://www.betaalvereniging.nl/en/fields-of-activity/debit-card-transactions-and-pos-terminals/ (retrieved 2012, November 30).
[191] http://www.streamline.com/assets/AssociatedDownloads/maestro-newsletter.pdf (retrieved 2012, December 5).

card, but are gradually being replaced by alternative Visa offers, also allowing instant online authorisation. However, in contrast to the Switch/Maestro card, until 2011, Visa debit cards had been processed and cleared through a single network. Issuing and merchant acquiring is conducted individually by the banks.

In 1990, three ATM networks existed in the UK – LINK, MINT and a network shared by four major banks. All three were supported by a number of banks.[192] In 1999, all networks were consolidated at LINK, which merged with Voca Ltd to form VocaLink (Snellman, 2006, p. 99). This holding operates the national processing infrastructure for retail payments, including credit transfer, direct debits, ATM withdrawals and other related services.[193] ATM transactions are switched to an ICS platform, depending on the branding of the payment card used for the withdrawal in question. VocaLink is owned by a consortium of 18 major – mainly UK domiciled – banks. ATMs are installed by banks[194] themselves, but managing them can also be outsourced to VocaLink.

A number of UK banks established the Joint Credit Card Company to market an independent credit card scheme, called Access, as early as 1972. However, it was crowded out by MasterCard in the 1980s. Since then, the credit card market in the UK is dominated by Visa and MasterCard, while other international payment schemes only play a niche role.

Based on the above, the variables of interest in this chapter are set as follows:

- Contrary to ECB records which states three POS networks from 1990-1996, and four thereafter until 2003, the number of POS networks is corrected to:
  - 1990-1992 two networks: SWITCH, Visa Debit
  - 1993-1996 three networks: SWITCH, Visa Debit, Maestro
  - 1997-2010 three networks: SWITCH/SOLO, Maestro, Visa Debit/Electron
  - 2011 two networks: SWITCH processing network integrated into Maestro, Visa Debit/Electron. Underlying this attribution is the assumption that the

[192] http://www.theukcardsassociation.org.uk/Advice_and_links/index.asp (retrieved 2012, Dec. 5).
[193] See for the remainder of this paragraph http://www.vocalink.com/about-vocalink.aspx and the sub-sites on Organisation and ATM services (retrieved 2012, December 5).
[194] Independent ATM deployers are active since 1998 in the UK but have only a small market share in terms of volume and value according to http://www.ukpayments.org.uk/payment_options/plastic_cards/cash_machines/independent_atm_deployers/ (retrieved 2012, Dec. 5).

SOLO and Visa Electron transactions are authorised through the (updated) structure of the existing SWITCH and Visa Debit processing network.

– The number of ATM networks published in the Blue Books – three between 1990 and 1998, one thereafter until 2003, is in line with the above, and also with Snellman (2006, p. 96). One network is also applied for 2004 until 2011, as no counter information has surfaced.

– With respect to INTEGR, the assessment by the European Commission (2006a, p. 89) of three is followed and applied until 2006. Starting in 2007, INTEGR is set to one, following a declaration of SEPA compliance by Visa and MasterCard[195], which was implemented earlier than foreseen by the ECB.

– The ACH und NCB dummy variable are set to zero, as debit card payments are cleared and settled using Visa and MasterCard platforms (CPSS, 2012b). This is arguable, as the clearing platforms act as ACHs. However, since more than one dominates the card market, the assessment of zero remains.

5.3.3 Overview of institutional data series

Figure 5–4 (next page) depicts the number of ATM and POS networks. In Spain and France, both variables are three and one respectively, throughout the time span analysed (red line). In Belgium and the Netherlands, observations of the two series take on the same value of one in 2006 and 1998, until 2011 respectively (red line). In Finland and the UK, the number of networks is the same between 1994 and 2000 (one), and between 1993 and 1998 (three), indicated by a red line.

The other three variables, INTEGR, ACH and NCB are depicted in Figure 5–5 (next page). In Belgium, Germany, Finland and the UK, ACH is the same as NCB throughout the whole time span, i.e. one for Belgium and zero for the other countries (green line). In Italy, INTEGR and ACH remain unchanged at one (green line until 1999, red line afterwards). In Spain, ACH and NCB were one between 1990 and 2005 (green line).

[195] http://www.visaeurope.com/idoc.ashx?docid=435ed5a4-6bf1-4136-b268-56859c1dc441&version=-1 and http://www.mastercard.com/us/wce/PDF/MasterCard_Europe_SEPA_self_assessment_June_2009.pdf (retrieved 2012, December 6).

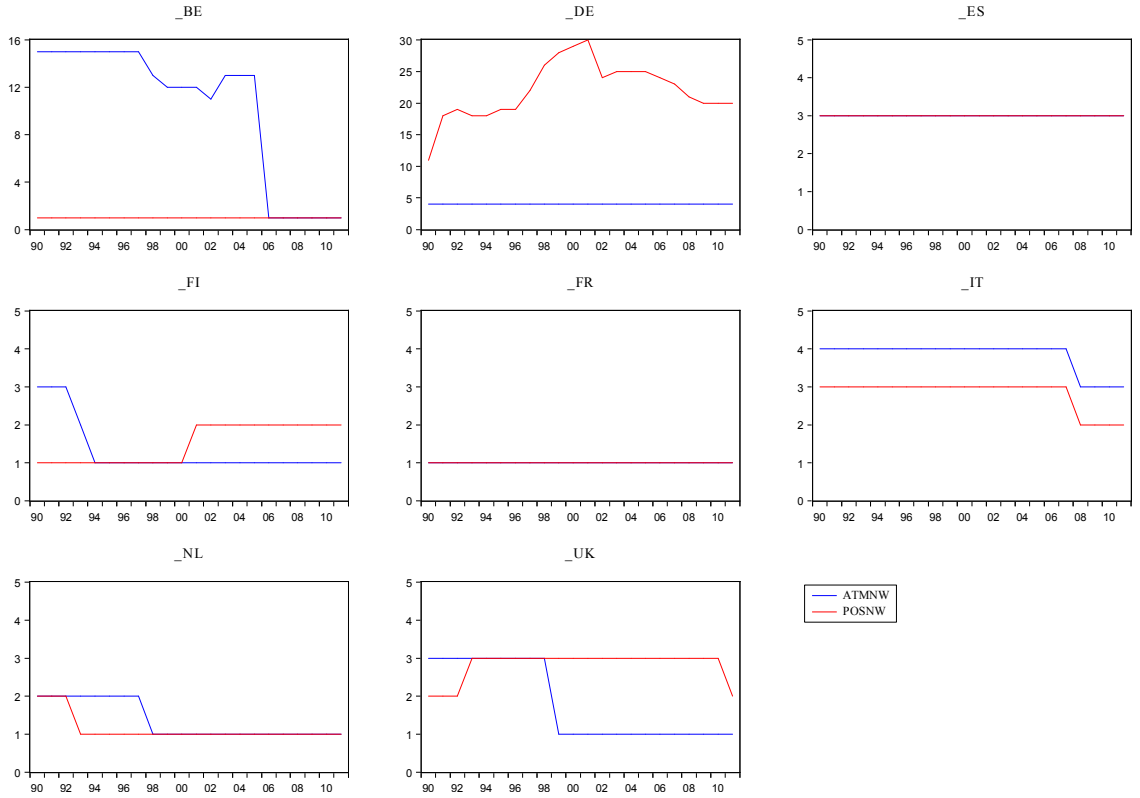

FIGURE 5-4: Institutional variables: ATM and POS networks[196]

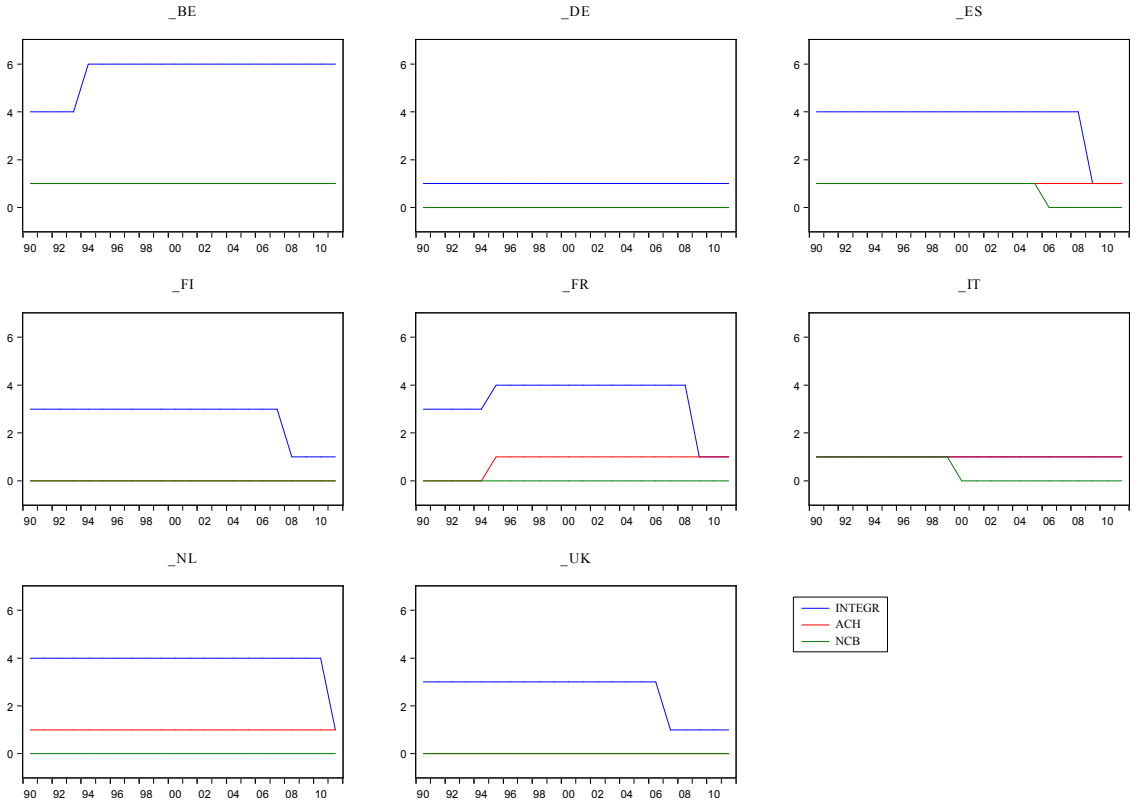

FIGURE 5-5: Institutional variables: Card scheme infrastructure[197]

[196] Own representation.
[197] Own collection and representation.

5.4 Payment decision

This chapter is concerned with empirically explaining the collective payment decision of consumers at the POS. After introducing a first parsimonious model (equation 1.1), some possible extensions and alterations are proposed throughout chapter 5.4.1 (equations 1.2 to 1.5). All equations are first developed based on economic reasoning and the insights gained throughout this thesis. More detailed functional specifications are introduced at the end of the chapter and stated in Table 5–5 (p. 202) entailing the overview of estimation results. The latter are discussed in chapter 5.4.2 to arrive at the final model (Eq. I). A number of diagnostic tests are carried out in chapter 5.4.3. The principle route taken in this chapter is also applied the three sourcing decision models, described in chapter 5.5.

It is worth mentioning that, owing to the small number of observations – 176 at the most – the confidence interval has been extended to 90%. Thus, significance levels of 10% will be reported alongside the common 5% and 1%. Small deviations above the 10% level (*p*-value of up to 0.14) will be mentioned as well in the results tables to indicate that a relationship between the independent and dependent variable may exists, but further research is necessary to verify or reject it.

5.4.1 Development of the model and possible extensions

In the following, a first parsimonious payment decision model is developed. It is based on a simple observation: Consumers wishing to buy products will base their choice of a means of payment on three questions. First, which instruments are available to them? Second, which instruments are honoured by merchants? Third, which other factors possibly influence availability or acceptance? These thoughts led to equation 1.1, which is gradually extended by additional determinants and a behavioural aspect, to create subsequent models. The process is outlined below.

1.1 $CARDVALCONS_{it} = f\,(CARDNB18_{it}, POS18_{it}, ATMVAL18_{it}, CHVOL18_{it})$

Hence, the share of card payments on consumption CARDVALCONS is a function of the number of (i) payment cards and (ii) POS terminals, as well as (iii) the

value of cash withdrawals at ATMs and (iv) the volume of cheque payments per inhabitant above 18 years of age.

In line with de Grauwe et al. (2006), it is assumed that the diffusion of payment cards throughout the population – CARDNB18 – as well as the density of POS terminals – POS18 – is positively related to CARDVALCONS. The authors establish that one decisive parameter for card usage, in terms of number of transactions, is how widespread they are. Further, they find a significant positive relationship between the number of POS terminals per merchant, and card payments. A comparable relationship is expected for POS18.

Since neither value, nor volume, of cash payments at the POS is gathered by statisticians, it is assumed that all cash withdrawn at ATMs is spent at the checkout. In order to capture the amount of cash being available to consumers for purchases, ATMVAL18 is relied upon. The influence on the regressand is less straightforward than for the first two variables. There are good arguments for both signs. If the substitution argument, as proposed by Stix (2003), for debit cards holds true, a reverse relationship between card payments and cash holdings may exist. Otherwise, experience in handling payment cards gained through ATM withdrawals could raise consumers' affinity for card transactions, leading to a positive relationship as Stix (2003) and von Kalckreuth et al. (2009) suggest.

Klee (2008) found evidence that cash is less likely used for purchases if credit cards are favoured, while debit card and cash payments are made based on the same underlying preference for liquid transaction assets. Moreover, while Bolt, Humphrey et al. (2008) and de Grauwe et al. (2006) establish that consumers substitute debit card payments for cash withdrawals in response to price changes, Humphrey et al. (2001) could not observe such a connection. It is acknowledged that all three studies refer to card transaction volumes not values, hence their results are not directly transferable, but provide a first indication.

An inverse relationship is foreseen for CHVOL18 and card payment values in line with observations made by Humphrey et al. (2001). The authors verified that debit cards substitute for cheques once prices change. While in recent years, cheque transactions dramatically plummeted in most countries, they are still

common in France, and to a certain degree in the UK. Hence, it was decided to include the variable in the model. Not the value but the volume of cheque transactions per inhabitant over 18 years is employed, as this mitigates the problem of distinguishing between personal and business cheques. The latter tend to be of high value, but are drawn rather infrequently. Still, the inseparability between POS and bill payment remains.

Additional drivers may influence payment choice. These are grouped into three clusters, and their influence on card payment value is assessed. The first cluster contains institutional variables; the second one is concerned with macroeconomic indicators, while in the third one, factors for the innovation friendliness of a country are collected.

Institutional variables analysed below are the number of ATM networks, as well as a dummy (EUR), which turns to one in 2002, when euro cash replaced the national currency in all countries analysed, except for the UK. It is proposed that cardholders take into account the current level of cash holdings and replacement costs when making payment choices. Cash replacement costs can be substantial as Garcia-Swartz et al. (2006), Bergman et al. (2007) and Takala and Virén (2008) show, and the charge for using a "foreign" ATM forms a large part of these.[198] Hence, a larger number of networks appear to inflate cardholders' cost of cash replacement. Moreover, if banks support a range of small networks instead of a single one, operational costs are probably higher, which may translate into higher consumer prices for ATM withdrawals. Subsequently their propensity for card payments should rise.

In principle, the diffusion of ATMs per inhabitant older than 18 years (ATM18) could have been regressed instead of ATMNW. However, there is a thread of introducing multi-collinearity in the model. In chapter 5.5.3, a significant positive relationship between ATMVAL18 and ATM18 is ascertained.

[198] While ATMs nowadays are mostly compatible with all payment cards independent of the issuing bank, clients of banks, which are part of a particular network, may be charged for withdrawing money at "foreign" ATMs, being part of a different network. Charging conventions differ. In some countries such as the UK and recently Germany, ATM acquiring banks levy directly a fee on the cardholder for each withdrawal. In other countries the acquiring bank charges the issuing bank which in turn invoices its clients for using "foreign" ATMs.

The introduction of the euro (EUR) might have fostered card use because banks and other payment services providers exerted major efforts to update their systems, and may have exploited the incident to also promote card transactions. Consumers, on the other hand, needed to become familiar with the new currency. They might have turned to payment cards to bridge the transition phase, and stuck to this new behaviour later on.

In the second cluster on macroeconomic indicators, three variables are examined: household consumption and GDP per inhabitant over 18 years (CONS18 and GDP18), as well as the rate of unemployment (UNEMPL). CONS18 is included based on the idea that consumers might be more inclined to employ their payment card if purchase values rise, as Bounie and Francoise (2006), Klee (2008), Simon et al. (2010) and Arango et al. (2011) suggest. In a similar vein, an improved economic situation, i.e. higher GDP18 could induce consumers to consume more, and consequently employ their payment card more often (see Humphrey, Pulley et al., 1996). On the contrary, unemployment could lead to a decreasing rate of card transactions alongside deteriorating financial well-being. Von Kalckreuth et al. (2009) concluded that if consumers are employed, they utilise cash less often in favour of payment cards.

A third cluster is looked at as well, namely research and development expenditures as a percentage of GDP (RDEXPGDP), and the number of patents per inhabitant aged over 18 (PATENT18). These shall indicate the society's affinity for innovation, which might create a climate in which card payments prosper. The line of argument is close to Hayashi and Klee (2003), who link the openness towards new technologies to an intensified use of payment cards. Thus, higher RDEXPGDP or PATENT18 could be associated with higher card transaction values.[199]

After having studied the impact of all the determinants as outlined above, equation 1.2 is proposed as an alternative model to explain CARDVALCONS.

[199] Alternative variables to measure this phenomenon could be the percentage of the population having access to the Internet, the number of cards with an e-purse function or the volume or value of e-purse transactions. However with only 76, 99, 83 or 76 observations respectively, reasonable results are difficult to achieve.

1.2 $CARDVALCONS_{it} = f\,(CARDNB18_{it}, POS18_{it}, ATMVAL18_{it}, ATMNW_{it}, ATMNW_{it}^2)$

A procedure similar to the one above was undertaken for a second type of model, based on the primary thoughts leading to equations 1.1 and 1.2. Here, a behavioural aspect is incorporated, namely how many transactions consumers carry out with each of their payment cards at the POS, i.e. CARDPOSFRQ = CARDVOL / CARDNB. The respective equation 1.3 is:

1.3 $CARDVALCONS_{it} = f\,(CARDNB18_{it}, POS18_{it}, CARDPOSFRQ_{it}, ATMVAL18_{it}, CHVOL18_{it})$

A certain risk of introducing collinearity between ΔlnCARDPOSFRQ and either ΔlnCARDNB18 or ΔlnPOS18 into the model is recognised. The correlation between the first and the two other variables is -0.351 and 0.398 respectively. Nonetheless, it is believed that interesting insight can be gained by introducing this independent variable, although the results are treated with care. It seems sensible to assume that CARDPOSFRQ is positively related to CARDVALCONS. The more often consumers employ their cards, the more confident they become in the technique, the higher the probability that they pay a larger share of their purchases with a payment card, instead of cash. The propositions made before about the relationships of the other regressors to the regressand remain valid.

As previously, further determinants of payment choice are inspected. Again, these are the three groups of regressors containing institutional variables, macroeconomic indicators and factors indicating innovation friendliness. Their study led to model 1.4 that helps us to understand the drivers for CARDVALCONS:

1.4 $CARDVALCONS_{it} = f\,(CARDNB18_{it}, POS18_{it}, CARDPOSFRQ_{it}, ATMVAL18_{it}, CONS18_{it})$

Following model specification was chosen. According to a number of unit root tests, most series are integrated of order one – I(1), notably CARDVALCONS, CARDNB18, POS18, ATMVAL18, CARDPOSFRQ, CONS18, GDP18, UNEMPL, RDEXPGDP, and PATENT18.[200] Results are reported in Appendix A–4.

[200] Although CHVOL18 is I(0), it was differenced for modelling purposes to allow for consistent interpretation of results.

Before proceeding, a Pedroni cointegration test is performed for all I(1) variables as they appear in equations 1.1 to 1.4; I(0) variables were not included.[201] Cointegration is present if the regression of I(1) variables results in residuals being integrated of order zero – I(0). Consequently, they could be estimated in levels. Otherwise, their first difference should be included in the model. The null hypotheses of no cointegration is not rejected, hence variables are first differenced, as indicated by Δ, before they are incorporated into the model.[202]

In line with the route taken by Snellman (2006) and Bolt, Humphrey et al. (2008), a double-log specification is applied. Due to this, results should to be interpreted thoroughly. The coefficients measure the extent to which the growth rate of CARDVALCONS changes when the growth rate of the investigated regressor increases by 1%. Discrete variables, however, such as ATMNW and EUR are I(0) and thus estimated in levels. In addition, observation values hardly change over time. Thus, differencing the series would make inferences about the nature of the relationship to CARDVALCONS difficult. Further, I(0) variables are not logged, since their value only change by one unit at a time. Hence, coefficients provide information on the impact on card usage in percent, if regressors change by one unit.

Throughout the subsequent chapters on regression results, namely 5.4.2, as well as chapter 5.5, it is important to bear in mind that the coefficient interpretation varies, depending on whether independent variables are I(1) or I(0).

All equations were estimated using ordinary least squares (OLS) techniques. White diagonal standard errors were implemented to correct for heteroscedasticity, in line with Snellman (2006).[203] Additionally, cross-section fixed effects (α_i) were incorporated in equation 1.1 to 1.4, allowing for country-specific variations of the intercept (Hill, Griffiths, & Lim, 2012, pp. 543-544 and Verbeek, 2012,

[201] Pedroni cointegration test was performed with and without individual cross-section intercepts. The results differ in a way that *p*-values for the former are lower than for the latter. Yet, a cointegration relationship could not be established.

[202] Bolt, Humphrey et al. (2008, p. 106) points out that due to the small sample size, unit-root and cointegration tests have reduced power. Thus interpretation of estimation results should be made with caution. Therefore, a number of different specifications were tested as well for the models on payment and sourcing decisions to ensure robustness of results.

[203] Regressions were run with EViews 7.2, which does not allow for Newey-West robust standard errors to protect against heteroskedasticity and autocorrelation.

pp. 384-385). It was tested, whether the fixed effects are jointly significant compared to the restricted equation without them. The null hypothesis of redundant fixed effects is evaluated, based on the *F*-test and *Chi-square* test. For equation 1.1 and 1.2, this could be rejected on a 1%-level, pointing to the relevance of the cross-section fixed effects. Yet, in equation 1.3 and 1.4 cross-section fixed effects are redundant. The latter model was assessed without these leading to equation 1.5, which is identical to 1.4, except for the fixed effects.

In a similar vein, all equations were re-estimated with fixed period effects, which could be shown to be redundant, as the null hypothesis could not be rejected. Overall, it is concluded that unobserved country-specific time-invariant factors impact payment choice. CARDPOSFRQ may absorb some of these effects, leading to their redundancy. But further research is necessary to learn more about these forces, and how they could possibly be influenced in favour of a more efficient payment instrument use.

5.4.2 Discussion of the regression results

Table 5–5 (next page) displays the modelling results, starting with equation 1.1, in column two. Columns three to six contain equations 1.2 to 1.5, as outlined above. As discussed, the first four OLS regressions include cross-section fixed effects and White diagonal robust standard errors. While the latter holds true for the last model as well, no fixed effects were implemented. The head row references the equation number, estimated sample period and number of observations. Beneath, the explained variable is shown. In addition, it is indicated whether cross-section fixed effects α_i were employed. The left column lists the explanatory variables, while the figures in columns two to six contain the coefficient values, their significance level and related standard errors in parentheses.

In the bottom part of the table, adjusted R^2 and the standard error (S.E.) of the regression are displayed alongside, with the Akaike Information Criterion (AIC) and Schwarz Criterion (SC). The higher adjusted R^2 and the lower regression S.E., AIC and SC, the better the model fits the actual data. Further, the Durbin-Watson statistic is disclosed to detect serial correlation in the residuals. Residual diagnostics is discussed in detail in chapter 5.4.3.

Equation **Period** **Nb. of obs.**	1.1 1991-2011 153	1.2 1991-2011 163	1.3 1991-2011 152	1.4 1991-2011 163	**1.5** **1991-2011** **163**
$\Delta lnCARDVALCONS_{it} = f(...) + \alpha_i + \varepsilon_{it}$					$= f(...) + \varepsilon_{it}$
$\Delta lnCARDNB18_{it}$	0.372 (0.216)*	0.400 (0.212)*	0.877 (0.223)***	0.954 (0.226)***	**0.949** **(0.224)***
$\Delta lnPOS18_{it}$	0.282 (0.090)***	0.365 (0.105)***	0.096 (0.060)*	0.119 (0.067)*	**0.128** **(0.072)***
$\Delta lnCARDPOSFRQ_{it}$			0.598 (0.151)***	0.630 (0.157)***	**0.655** **(0.157)***
$\Delta lnATMVAL18_{it}$	0.273 (0.126)**	0.296 (0.117)***	0.202 (0.075)***	0.251 (0.072)***	**0.239** **(0.072)***
$\Delta lnCHVOL18_{it}$	0.052 (0.055)		0.037 (0.039)		
$ATMNW_{it}$		**0.028** **(0.012)****			
$ATMNW_{it}^2$		**-0.002** **(0.001)****			
$\Delta lnCONS18_{it}$				**-0.274** **(0.148)***	**-0.236** **(0.157)**[#]
Adjusted R^2 (S.E. of regression)	0.496 (0.097)	0.480 (0.096)	0.671 (0.078)	0.675 (0.076)	**0.672** **(0.076)**
AIC (SC)	-1.759 (-1.522)	-1.780 (-1.533)	-2.179 (-1.921)	-2.248 -2.000	**-2.279** **(-2.165)**
Durbin-Watson	1.856	1.792	1.772	1.731	**1.634**

* / ** / *** Coefficient statistically significant at 10%, 5% or 1% level. Standard errors in parentheses.
[#] *p*-value 0.135.

TABLE 5-5: Model specification: Payment decision[204]

Five key observations hold through all equations. First, CARDNB18 and POS18 are always significant and have the expected sign. It is concluded that if consumers possess, and merchants accept, more payment cards, the former pay a larger share of their purchases by card. More precisely, if ΔCARDNB18 or ΔPOS18 increases by 1%, ΔCARDVALCONS is enhanced by about 0.4-0.9% and 0.1-0.3% respectively. In Italy and Germany, for example, CARDNB18 and POS18 have been lowest (almost) throughout the whole time period, while card payments are less common compared to the other six countries.

Second, ATMVAL18 is highly significant, and exhibits a positive relationship to CARDVALCONS. This could be interpreted in favour of the experience argument, put forward above. A 1% plus of ΔATMVAL18 leads to 0.2-0.3% increase

[204] Own illustration.

in ΔCARDVALCONS. Moreover, as consumption expands, following a widely stable upward trend, so too does ATMVAL18 and CARDVALCONS. Yet, the key observation is that cash payments grow much slower than card payments. Plotting the value of ATM withdrawals as a percentage of consumption (ATMVALCONS) alongside CARDVALCONS, as in Figure 5–6 below, reveals that, in most countries, ATMVALCONS only slightly increased throughout the years, or even decreased, as in Finland. Only in Belgium, Germany and Italy cash appears to still play a decisive role for consumers' payment choice.[205] Although substitution effects are probably substantial in some countries, the insufficient database – lacking observations on overall POS cash payments being likely higher than ATMVALCONS, especially in the first half of the observation period, as well as on consumer cheque transaction values – hinders their determination.

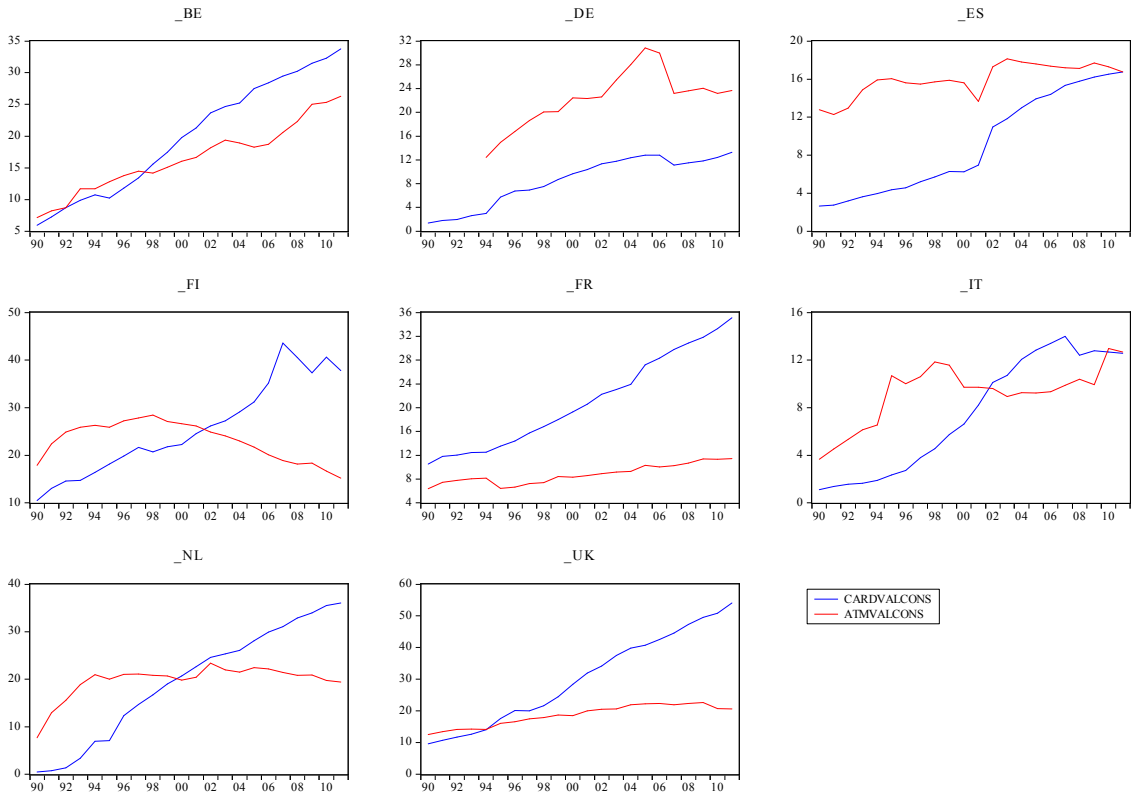

FIGURE 5-6: Share of cash and card payments on consumption[206]

Third, in contrast to expectation, the coefficient of CHVOL18 is positive, albeit not significant. In equation 1.1, restricting the sample to 1999-2011, the coefficient becomes negative, while the *p*-value deteriorates from 0.347 to 0.532. No

[205] The same picture emerges if ATMVAL18 and the value of card payments per inhabitant being at least 18 years old (CARDVAL18) is depicted.

[206] Own representation.

critical changes with respect to the other three variables are detected. Similar observations are made for the periods starting in 2000 and 2001 respectively, until 2011. With each of these steps, the fit of the equation drops, finally reaching an adjusted R^2 of 0.119. Similar observations are made by restricting the sample for equation 1.3. Further limiting the sample would result in even lower measures, while the number of observations shrinks in a way that makes regression analysis hardly feasible.

Overall, these results could point to a situation in which, in earlier years, cheque and card payments expanded alongside consumption. Approximately at the end of the 1990s, cheques were rapidly substituted by cards, and thereby quickly lost significance. This is confirmed by Humphrey et al. (2001), who discovered that debit cards are a powerful substitute for cheques, based on cross-price elasticities. Towards the end of the 22 years analysed, cheques were nearly extinct in most countries, which consequently left hardly any room for further substitution by cards. One technical note is warranted. As CHVOL18 was differenced and logged as well, ten observations were removed from the sample prior to estimation. These were namely the 2002-2011 data points for the Netherlands, since no transactions were executed after 2001 ($CHVOL18_{NL2002\text{-}2011} = 0$). Nevertheless, CHVOL18 is excluded from all other models, since it does not meaningfully contribute to explaining card use, and degrees of freedom become higher.

Fourth, except for ATMNW and CONS18, none of the additional independent variables out of the three clusters introduced to the original models 1.1 and 1.3 (EUR, GDP18, UNEMPL, RDEXPGDP, PATENT18) is significant, seriously alters the above mentioned results nor notably enhances the model fit.[207] Yet, ATMNW is significant, and exhibits the expected positive sign. If $ATMNW^2$ is incorporated to form equation 1.2, the coefficient value of ATMNW markedly increases, as does its significance and R^2. $ATMNW^2$ bears a negative sign, which indicates that the parabola resulting from the quadratic function $CARDVALCONS = -0.002\ ATMNW^2 + 0.028\ ATMNW + c$ opens downwards. Calculating the turning point, it is revealed that beyond the number of eight, additional ATM

[207] Detailed regression results available upon request.

networks do not contribute to a higher share of card payments on consumption.[208] The example of Belgium nicely supports this finding: Payment card values experienced a dramatic upward shift, while the number of ATM networks dropped from 13 to one, in 2005. Even though these results are appealing, deeper investigation is needed into whether ATM network numbers were rightly identified.

Employing CONS18 to form equation 1.4 indicates a significant influence on the share of card transactions on consumption. A 1% increase in ΔCONS18 would imply a 0.3% step up in ΔCARDVALCONS. However, as in equation 1.3, the cross-section fixed effects are redundant, and model 1.4 was re-assessed without them. Now, in equation 1.5, the per-head consumption becomes insignificant (*p*-value of 0.135), but redundant variable tests[209] suggest that it be kept in the equation, as the null hypothesis of redundancy is rejected. An attempt was made to include ATMNW and $ATMNW^2$ in equation 1.4 and 1.5. Yet both variables turn insignificant while other coefficients remain largely stable. CONS18 even becomes significant in the latter model. Against this background, the preferred equation 1.5 was created. According to this, whether consumers pay by card mainly depends on the diffusion of payment cards, the density of POS terminals and the value of cash obtained at ATMs (cash holdings), not to mention how often consumers use their card for transactions, and the per-head consumption. This model (renamed Eq. I) is preferred over the ones previously discussed, based on the goodness-of-fit measures adjusted R^2, AIC and SC. Nevertheless, the influence of ATMNW / $ATMNW^2$ needs further investigation to establish a more stable link to the dependent variable.

Eq. I $$\Delta lnCARDVALCONS_{it} = 0.949\ \Delta lnCARDNB18_{it} + 0.128\ \Delta lnPOS18_{it} + 0.655\ \Delta lnCARDPOSFRQ_{it} + 0.239\ \Delta lnATMVAL18_{it} - 0.236\ \Delta lnCONS18_{it} + \varepsilon_{it} \qquad [ATMNW_{it} / ATMNW_{it}^2]$$

Fifth, adjusted R^2 is close to 0.5 for the first two equations. The introduction of CARDPOSFRQ in the last three increased this number to almost 0.7. Hence, about 70% of the variation in CARDVALCONS can be explained by the varia-

[208] For the quadratic function $y = ax^2 + bx + c$, the turning point is derived by -b/2a. In this case: -0.028466 / 2*(-0.001700) = 8.372353.

[209] Based on *t*- and *F*-statistic as well as the likelihood ratio.

tion in the independent variables. Given the low number of observations and high divergence across countries, this value is quite high.

5.4.3 Diagnostic tests

All equations were tested following, in principle, the diagnostic tests performed by Snellman (2006, pp. 65-66). First, residuals were inspected. The Durbin-Watson statistic shows no sign of serial correlation. This is supported by inspecting the correlogram Q-statistics. They reveal that the null hypotheses of no serial correlation cannot be rejected. Further, panel unit root tests with and without cross-section intercept reject the null hypotheses, and indicate that residuals are stationary in levels. According to the Jarque-Bera statistic, residuals deviate from the normal distribution, as the null hypothesis is rejected. Yet, mean and median are roughly zero. The histogram is bell shaped, but the residuals' distribution is peaked, and has a long right tail, relative to the normal distribution (kurtosis of 14.135 and skewness of 0.452 in equation 1.5). Nevertheless, the OLS results including *t*- and *F*-statistics remain approximately valid (Verbeek, 2012, p. 35 and Wooldridge, 2010, p. 174). Heteroscedasticity is controlled for by applying White diagonal standard errors. Second, possible multi-collinearity and endogeneity are searched for. Since panel data are used, no suitable statistical test is available. Against this backdrop, cross-correlations among regressors on the one hand, and between equation residuals and independent variables on the other, were inspected. No sign of multi-collinearity and endogeneity could be detected.

5.5 Sourcing decision

In the previous chapter 5.4, the payment decision was modelled. A clear link between the card transaction value as a share of consumption and the diffusion of payment cards, the density of POS terminals and cash holdings (ATM withdrawals) was established. This chapter is designed to explain the sourcing decisions for these three variables. Consequently, chapter 5.5.1 is concerned with the determinants of payment card diffusion, while the subsequent chapters 5.5.2 and 5.5.3 identify the factors that govern the density of POS terminals, as well as the demand for and availability of cash at ATMs. In principle, the same structure as before is applied for each of the chapters. First, a preliminary model is proposed,

which is stepwise enhanced by additional variables to arrive at a preferred model. While the preliminary equation development is based on qualitative reasoning founded in the knowledge developed throughout this thesis, the functional specification is detailed afterwards. Second, the regression results are discussed, and diagnostic checks are carried out to ensure the robustness of the estimations.

5.5.1 Diffusion of payment cards

Before modelling CARDNB18, some related properties of the payment market should be recalled. First, payment cards are network goods, i.e. the larger the network, the easier it becomes to attract new users, owing to positive network externalities. Second, payment markets are two-sided. In this case, without a proper acceptance network, e.g. POS terminals and ATMs, card transactions cannot take place. Third, cooperation between market participants – in this case, banks and other payment service providers – facilitates the development of such network markets. For an overview on these topics with emphasis on payment markets refer to Shy (2011) and Verdier (2006). Resulting from these considerations, equation 2.1 is developed.

2.1 $CARDNB18_{it} = f\,(CARDNB18_{it-1}, POS18_{it-1}, ATM18_{it}, CR5_{it}, INTEGR_{it})$

Owing to the network properties of the market, present payment card diffusion is assumed to be related to its own past $CARDNB18_{it-1}$. The variable is not differenced, because the primary interest here is on understanding the influence of the previous network size on its expansion. Economides (2004, pp. 11-12) demonstrates that, due to network effects, the diffusion of network goods is much faster compared to other industries. At the same time, adoption externalities may impede a rapid diffusion of new payment instruments, in the absence of suitable incentives to reward new users adequately for the benefit they bring to the network. Moreover, users fear becoming locked-in to a proprietary network (Katz & Shapiro, 1994, pp. 101-102), thus also dampening expansion, if a number of competing networks exists.

As a consequence, it is proposed that the smaller the network was in the past, the higher the growth rate in the present period, under the assumption that almost no

alternatives exists, as is the case in most countries considered here, with respect to debit cards. If there are alternatives available, like in Spain, with its three debit card networks, adoption externalities could lead to slower network growth. If all of the above is accounted for, a negative sign is assumed for the lagged variable.

The second independent variable is the density of POS terminals. Consumers will first observe whether the acceptance network is sufficiently large, and then actively demand a payment card. For this reason, POS18 it lagged by one period, in accordance with the methodology of Bolt, Humphrey et al. (2008). The situation with respect to the ATM network – the third explanatory variable – is slightly different. In the past, banks actively promoted cash withdrawals, to save operational costs. As a result, consumers became quickly aware of having the option to withdraw money at ATMs, and, in the meantime, came to simply expect to find at least one at any bank premises. Lagging ATM18 is therefore not appropriate. For both, POS18 and ATM18, it is assumed that the larger the network, the stronger the demand for payment cards, in line with Schuh and Stavins (2011) and Carbó-Valverde et al. (2010) who found a significant link between acceptance and payment instrument adoption.

Now, the institutional parameters are looked at. Supposedly, if a handful of banks dominate the market (CR5 is large), these will have the financial power to drive rejuvenation of the payment system, for example by encouraging payment card demand. Further, they benefit from economies of scale throughout the whole value chain, from producing the cards, to processing and settling the transactions. Hence, a positive correlation is assumed. No studies exist on the effect of banking concentration on the adoption of payment means, which could support this assessment. But Humphrey, Pulley et al. (1996) reveal that a higher concentration in the banking system is associated with more debit card payments.

A similar argument is offered for INTEGR. The more a single scheme is vertically integrated, the better it is able to attract new users, exploit economies of scale and manage relationships between the different market participants – cardholders, merchants, issuing and acquiring banks. Moreover, investments can be shared between scheme members, thus enabling the continuous upgrading of

the system, and keeping it attractive to users. Milne (2006) confirms the facilitating effects of shared investments on innovation in the payment system. Taken together, this could support payment card use. However, such a highly integrated scheme may exert market power and impose anti-competitive rules, thereby resulting inter alia in higher prices for users, merchants and cardholders alike, and socially inefficient payment instrument choice (OECD, 2007, pp. 7-10 and European Commission, 2006a, pp. vi–vii). This issue is addressed by introducing the second-degree polynomial term $INTEGR^2$ to derive equation 2.2.

2.2 $CARDNB18_{it} = f\,(CARDNB18_{it-1}, POS18_{it-1}, ATM18_{it}, CR5_{it}, INTEGR_{it,} INTEGR_{it}^2)$

After that, three groups of further determinants for card diffusion are analysed. These are, as before in chapter 5.4, additional institutional variables, macroeconomic indicators and factors for the innovation friendliness.

With regards to the first group, ATMNW and EUR are looked at. A higher number of ATM networks could induce consumers to obtain payment cards from a number of issuing banks belonging to different networks, in order to save withdrawal fees, and have a wider range of ATMs at their disposal. As suggested above, the introduction of the euro could have fostered the update of existing card systems for example with additional e-money functions and therefore boosted demand for payment card.

In the second group of independent variables, CONS18, GDP18 and UNEMPL are integrated. The rationale behind this is as follows. First, alongside rising purchase values, the propensity for payment card adoption could increase. The same holds true for rising living standards. Third, in the event of unemployment, issuing banks could impose supply restrictions for payment cards. Schuh and Stavins (2011) established a significantly lower adoption of payment cards for unemployed persons. For instance, debit cards are often issued, once a new payment account has been opened. Yet, unemployed people might experience difficulties in opening such an account. Moreover, the circulation of credit cards is most likely linked to prior checks of the applicant's credit worthiness. Unem-

ployed consumers will most likely score lower, and thus may not be given such a card, as demonstrated by von Kalckreuth et al. (2009).

Finally, a third group is assessed regarding its impact on card diffusion: RDEXP-GDP and PATENT18. High expenditures for research and development, or a high number of patents could be an indicator for an innovation friendly environment, which may in turn positively influence the demand for payment cards.

By studying the influence of these additional variables, specifications 2.3 and 2.4 are developed. The reasoning is detailed below. Regression 2.5 is part of model robustness checks at the end of this chapter. In Table 5–6 (next page), all OLS regression results for equations 2.1 to 2.5 are provided in the same manner as in Table 5–5 (p. 202).

With respect to modelling, the considerations detailed in chapter 5.4.1 remain valid for this chapter. CARDNB18, POS18, ATM18, CR5, CONS18, GDP18, UNEMPL, RDEXPGDP and PATENT18 are I(1) and consequently first differenced before including them in the model. Alongside $CARDNB18_{it-1}$, they are also logged, leading to a double-log specification. INTEGR, ATMNW and EUR are I(0) and hence taken in levels. Neither fixed cross-section nor fixed period effects are included, since the null hypothesis of redundant effects could not be rejected. White diagonal robust standard errors are incorporated to adjust for possible heteroscedasticity in residuals.

Throughout all equations, the five main influencing determinants for the diffusion of payment cards, as identified above for equation 2.1, turn out significant and with the expected sign. One minor exception is noted for INTEGR, in case of including CONS18 or GDP18 in regression 2.2; the coefficient's *p*-value deteriorates to 0.120 and 0.149 respectively. The consequences are discussed below.

A negative, highly significant relationship to ΔCARDNB18 for its lagged values could be established. This suitably ties in with the observation that those countries with the lowest card diffusion in 1990, and no alternative debit card networks – Germany, France and Italy – show the highest yearly growth rates.

Estimation **Period** **Nb. of obs.**	**2.1** **1996-2011** **127**	2.2 1996-2011 127	2.3 1996-2011 127	2.4 1996-2011 127	2.5 1996-2011 127
$\Delta lnCARDNB18_{it} = f(...) + \varepsilon_{it}$				$\Delta lnDEBITNB18_{it}$ $= f(...) + \varepsilon_{it}$	$\Delta lnCARDNB18_{it}$
$lnCARDNB18_{it-1}$	**-0.055** **(0.015)*****	-0.053 (0.015)***	-0.053 (0.016)***		
$lnDEBITNB18_{it-1}$				-0.030 (0.009)***	
$\Delta lnPOS18_{it-1}$	**0.119** **(0.060)****	0.120 (0.058)**	0.115 (0.058)**	0.132 (0.050)***	0.186 (0.050)***
$\Delta lnATM18_{it}$	**0.218** **(0.098)****	0.226 (0.094)**	0.197 (0.058)*	0.166 (0.072)**	0.258 (0.110)**
$\Delta lnCR5_{it}$	**0.091** **(0.051)***	0.093 (0.050)*	0.084 (0.051)*	0.072 (0.047)$^{\#\#}$	0.073 (0.048)$^{\#}$
$INTEGR_{it}$	**0.005** **(0.002)****	0.024 (0.011)**	0.005 (0.002)**	0.004 (0.002)$^{\#\#\#}$	0.005 (0.002)**
$INTEGR_{it}^2$		**-0.003** **(0.002)***			
$\Delta lnUNEMPL_{it}$			**-0.065** **(0.034)***	-0.046 (0.033)	
Adjusted R^2 (S.E. of regression)	**0.234** **(0.060)**	0.242 (0.060)	0.240 (0.060)	0.259 (0.043)	0.142 (0.064)
AIC (SIC)	**-2.730** **(-2.595)**	-2.732 (-2.575)	-2.729 (-2.572)	-3.414 (-3.257)	-2.624 (-2.512)
Durbin-Watson	**2.153**	2.199	2.200	1.628	2.058
* / ** / *** $^{\#}$ / $^{\#\#}$ / $^{\#\#\#}$	Coefficient statistically significant at 10%, 5% or 1% level. Standard errors in parentheses. *p*-value 0.130 / 0.132 / 0.119				

TABLE 5-6: Model specification: Sourcing decision – Payment cards[210]

With respect to the terminal network, if ΔPOS18 accelerates by 1% in the previous year, ΔCARDNB18 will climb up by approximately by 0.1%, while the impact of ΔATM18 is almost twice as strong. Again, Germany and Italy belong to the group of countries with the fastest expansion of POS terminals and ATMs. In Belgium and the Netherlands, the highest increase in ATMs and POS terminals respectively occurred, which may have contributed to the apparent shift in payment behaviour.

Furthermore, it could be established that a larger concentration in the banking market and a higher vertical integration of the card scheme is supportive for the diffusion of payment cards. Germany saw the most rapid concentration process

[210] Own illustration.

in its banking market, leading to the highest increase in CR5 among the countries considered here, while CARDNB18 spread comparably fast as well. In those countries with the highest share of card payments on consumption value, INTEGR has been three or four, almost throughout the whole observation period.

Bearing this in mind, an interesting insight is generated by integrating $INTEGR^2$, as shown in equation 2.2. While most coefficients hardly change, the one for INTEGR increases by a large amount. $INTEGR^2$ is negatively related. The parabola resulting from the quadratic function CARDNB18 = -0.003 $INTEGR^2$ + 0.024 INTEGR + c opens downwards, and has a turning point of four.[211] Hence, a vertical integration beyond clearing and/or settling the card transactions seems not to contribute to intensifying payment card diffusion. However, in Belgium, where a fast shift towards a "card payment culture" took place, the dominating scheme had, until recently, a vertical integration of six. Hence, in the following, it is assessed whether the influence of $INTEGR^2$ is relatively stable, once additional variables are added.

Out of the three groups of additional variables identified above (ATMNW and EUR; CONS18, GDP18 and UNEMPL; RDEXPGDP and PATENT18) only UNEMPL seems to influence the diffusion of payment cards, if included in equation 2.2, though albeit not significantly (*p*-value of 0.124). No others are significant at any reasonable level, and decrease the fit of the newly estimated equation. Nevertheless, they call the impact of $INTEGR^2$ into question, because in 2/3 of the cases the coefficient becomes insignificant (*p*-values of 0.129-0.176).

For this reason, the former regressions were run again, based on equation 2.1. None of the explanatory variables exert a significant stimulus on the diffusion of payment cards, except for UNEMPL (see equation 2.3 below and column four in Table 5–6, p. 211 for estimation results). While for CONS18 and GDP18 further investigations about their impact on CARDNB18 are warranted, due to relatively low *p*-values of 0.132 and 0.143, ATMNW, EUR, RDEXPGDP and PATENT18 are far from being suitable to explain the regressand. Only the latter notably sup-

[211] The turning point is derived by: 0.023502 / 2*(-0.002892) = 4.063278 as in footnote 208.

presses the significance of INTEGR. As this is a singular case, the positive influence of higher vertical scheme integration on CARDNB18 is not questioned.

2.3 $CARDNB18_{it} = f\,(CARDNB18_{it-1}, POS18_{it-1}, ATM18_{it}, CR5_{it}, INTEGR_{it}, UNEMPL_{it})$

The unemployment rate is found to be significant and has the expected sign. This seems to support the supply restriction hypothesis put forward above. Should ΔUNEMPL drop by 1%, this could facilitate ΔCARDNB18 by almost 0.1%. In line with the analyses of the relationship of UNEMPL and credit card adoption in von Kalckreuth et al. (2009), one could expect an even stronger significance, if the diffusion of credit cards were taken as regressand, instead of CARDNB18, which might be an attractive route for further research. If the diffusion of debit cards, DEBITNB18, is included, instead of CARDNB18, the link to the rate of unemployment should consequently become looser.[212] In fact, as regression results of equation 2.4 show, UNEMPL turns out to become insignificant, supporting the closer link to credit card diffusion.

2.4 $DEBITNB18_{it} = f\,(DEBITNB18_{it-1}, POS18_{it-1}, ATM18_{it}, CR5_{it}, INTEGR_{it}, UNEMPL_{it})$

Overall, equation 2.1 (renamed Eq. II) remains the preferred model for descrybing CARDNB18, while the impact of $INTEGR^2$ and UNEMPL should not be underestimated, but needs deeper investigation.

Eq. II $\Delta lnCARDNB18_{it} = -0.055\ lnCARDNB18_{it-1} + 0.119\ \Delta lnPOS18_{it-1} + 0.218\ \Delta lnATM18_{it} + 0.091\ \Delta lnCR5_{it} + 0.005\ \Delta lnINTEGR_{it}) + \varepsilon_{it}$ $[INTEGR_{it}^2 / UNEMPL_{it}]$

Similar to the outline in chapter 5.4.3, diagnostic tests were made for each of the equations 2.1 to 2.4. Residuals are stationary in levels, but not normally distributed, except for equation 2.4. Mean and median are close to zero, while kurtosis is 28.106, and skewness is 2.971 for equation 2.1. Multi-collinearity and endogeneity seem not to be present. Nonetheless, the latter could potentially be pro-

[212] A comparable regression using the diffusion of credit cards, CREDITNB18, instead could not be run as ΔCREDITNB18 takes on negative values, which cannot be logged. Nevertheless, if alternative specifications are developed in further research, it appears worthwhile to also implement CREDITNB18.

blematic, since the lagged value of the explanatory variable was included in the model. Hence, an alternative specification 2.5 without this term was tested to enhance the robustness of the model.

2.5 $CARDNB18_{it} = f\,(POS18_{it-1}, ATM18_{it}, CR5_{it}, INTEGR_{it})$

Interestingly, the principle assessment about the relevance of the other independent variables is not changed (see regression results, Table 5–6, p. 211). Equation 2.5 offers an alternative approach to estimate CARDVALCONS, albeit one with a rather low explanatory power. Therefore, Eq. II remains the preferred model.

5.5.2 Density of POS terminals

The composition of the model explaining the density of POS terminals follows, in parts, the preferred specification for payment card density. Network effects, adoption externalities and two-sidedness are present as well. Additionally, based on the knowledge of the card market, a number of institutional peculiarities are suspected of shaping POS18, leading to the preliminary equation 3.1 below.

3.1 $POS18_{it} = f\,(POS18_{it-1}, CARDNB18_{it-1}, POSNW_{it}, INTEGR_{it}, ACH_{it}, NCB_{it})$

Owing to the network and two-sided market character, presumably the density of POS terminals depends on its own lag, as well as on the previous diffusion of payment cards. $POS18_{it-1}$ (not differenced) is expected to be negatively related to the regressand, in line with the arguments put forward when determining the CARDNB18-model, while $CARDNB18_{it-1}$ probably will exhibit a positive link. The latter variable is lagged, based on the argument that, before merchants will install a new POS terminal, they tend to observe whether consumers possess payment cards and demand to pay by card.

In line with the reasoning by Snellman (2006), with respect to ATM networks, it is foreseen that competing POS networks intend to invest heavily in extending their networks. In this way they attempt to benefit from positive externalities and scale economies. Hence, a growing number of networks may be related to a higher density of POS terminals. On the other hand, if too many competitors are active, all might end up with small and inefficient networks, not able to support

further expansion. Also, merchants might hold back investments in terminal infrastructure, since they are afraid of becoming stuck with an inferior and costly solution (Katz & Shapiro, 1994 and Economides, 1996). This notion is in favour of the incorporation of a second-degree polynomial term.

A deeper vertical integration of a card scheme could foster merchant acceptance, especially if acquiring merchants and distributing POS terminals belongs to its range of activities (degree of integration of five or six). Also, if a scheme undertakes authorisation, processing or clearing and settlement related tasks, its members should profit from economies of scale. This could result in greater efficiency and lower transaction costs, which may make accepting card payments more attractive to merchants. However, such arrangements possibly inhibit competition, and ban new payment service providers from entering the market (European Commission, 2006a, pp. 94-95), leading to smaller POS networks than optimal. Therefore, the second-degree polynomial term is introduced.

Centralised processing of card transactions in an ACH entails large economies of scale, as Khiaonarong (2003) and Beijnen and Bolt (2009) argue. If this situation results in lower prices for card acceptance, merchants could be induced to install (additional) POS terminals at their premises. Finally, and in line with the exposition in chapter 5.3.1, a negative relationship between NCB and POS18 appears more likely than a positive one.

The aforementioned thoughts, in conjunction with the results from the preliminary regression 3.1, led to the formulation of a new equation 3.2, which is explained in more detail below.

3.2 $POS18_{it} = f\,(POS18_{it-1}, CARDNB18_{it-1}, POSNW_{it}, POSNW_{it}^2, INTEGR_{it}, INTEGR_{it}^2, NCB_{it})$

Based on this enhanced model, a range of additional variables are tested, again clustered into three groups – institutional, macroeconomic and innovation factors. In particular, the number of competing banks per inhabitant older than 18 ($BANK_{dom}18$) is assessed, as well as EUR. $BANK_{dom}18$ was chosen, since it is imagined that if a rising number of (acquiring) banks compete for merchants, the density of POS terminals may climb as well.

The euro could have helped POS network growth, as it required adjustments in merchants' point of sale and accounting systems anyway. On this occasion, merchants might have decided to enhance their POS terminal network as well. With respect to the macroeconomic factors, the already well understood CONS18, GDP18 and UNEMPL variables are evaluated. Higher consumption, better living conditions and lower unemployment may induce merchants to invest in their POS terminal network, as they foresee larger purchases. In addition, a more innovation friendly environment, indicated by higher RDEXPGDP or PATENT18, might also foster card acceptance by merchants.

Out of this procedure, equation 3.3 emerges; estimation details are discussed in due course below.

3.3 $POS18_{it} = f\,(POS18_{it-1}, CARDNB18_{it-1}, POSNW_{it}, POSNW_{it}^2, INTEGR_{it}, INTEGR_{it}^2, NCB_{it}, RDEXPGDP_{it})$

Finally, an alternative model is developed, which entails the behavioural aspect of how often consumers use their payment cards, CARDPOSFRQ. Underlying is the idea that, the more often consumers tend to employ their cards, the more likely merchants are to enlarge their POS networks to meet respective cardholders' demand. Based on these thoughts, equation 3.4 is introduced and analysed.

3.4 $POS18_{it} = f\,(POS18_{it-1}, CARDPOSFRQ_{it}, POSNW_{it}, POSNW_{it}^2, INTEGR_{it}, INTEGR_{it}^2, NCB_{it})$

Table 5–7 (next page) indicates the regression results for equations 3.1 to 3.5. The latter is part of the diagnostic tests run at the end of this chapter. Model specifications are comparable to those employed previously. POS18 – except for its lagged values – CARDNB18, CARDPOSFRQ, $BANK_{dom}18$, CONS18, GDP18, UNEMPL, RDEXPGDP and PATENT18 are differenced and logged,[213] while POSNW, INTEGR, ACH, NCB and EUR are I(0) and thus integrated in levels. Further, cross-section fixed effects are part of all equations, as the null hypothesis of their redundancy could be rejected.

[213] All variables mentioned are I(1) except for $BANK_{dom}18$ which was differenced nevertheless to allow for unambiguous interpretation of results.

Estimation **Period** **Nb. of obs.**	3.1 1992-2011 160	3.2 1992-2011 160	**3.3** **1992-2011** **160**	3.4 1991-2011 167	3.5 1992-2011 160
$\Delta lnPOS18_{it} = f(...) + \alpha_i + \varepsilon_{it}$					
$lnPOS18_{it-1}$	-0.163 (0.022)***	-0.171 (0.017)***	**-0.173** **(0.017)*****	-0.151 (0.019)***	
$\Delta lnCARDNB18_{it-1}$	0.164 (0.122)	0.103 (0.115)	**0.105** **(0.112)**		0.478 (0.238)**
$\Delta lnCARDPOSFRQ_{it}$				0.217 (0.078)***	
$POSNW_{it}$	0.025 (0.032)***	0.119 (0.031)***	**0.126** **(0.032)*****	0.082 (0.037)**	0.101 (0.072)
$POSNW^2_{it}$		-0.002 (0.001)***	**-0.002** **(0.001)*****	-0.001 (0.001)*	-0.002 (0.002)
$INTEGR_{it}$	-0.013 (0.009)	-0.271 (0.077)***	**-0.277** **(0.078)*****	-0.233 (0.074)***	0.018 (0.080)
$INTEGR^2_{it}$		0.057 (0.016)***	**0.058** **(0.016)*****	0.049 (0.016)***	-0.001 (0.017)
ACH_{it}	-0.030 (0.087)				
NCB_{it}	-0.084 (0.037)**	-0.125 (0.034)***	**-0.129** **(0.034)*****	-0.094 (0.037)**	0.095 (0.031)***
$\Delta lnRDEXPGDP_{it}$			**0.300** **(0.175)***		0.094 (0.249)
Adjusted R^2 (S.E. of regression)	0.641 (0.090)	0.687 (0.084)	**0.691** **(0.083)**	0.704 (0.088)	0.167 (0.136)
AIC (SIC)	-1.904 (-1.635)	-2.036 (-1.748)	**-2.043** **(-1.736)**	-1.929 (-1.649)	-1.057 (-0.768)
Durbin-Watson	1.137	1.314	**1.328**	1.713	0.707
* / ** / *** Coefficient statistically significant at 10%, 5% or 1% level. Standard errors in parentheses.					

TABLE 5-7: Model specification: Sourcing decision – POS terminals[214]

Inspecting the observation results across the first three specifications, the most surprising one is the insignificance of the payment card diffusion variable. Although the sign is as expected, a *p*-value of 0.182 is observed in equation 3.1. This even drops dramatically to 0.689 if CARDNB18 is not lagged while the other coefficients are not strongly affected by this change to the first model. The respective *p*-values are even lower for equations 3.2 and 3.3.

This suggests that the link between the number of payment cards and POS terminals is not as straightforward as two-sided-market theory proposes. One might expect that this relationship was strong at the beginning and loosens as

[214] Own illustration.

card and POS terminal networks mature. It is noticed from Figure 5–7 below that in most countries, the gap between the two is widening, which is in favour of this argument. However, difficult macroeconomic conditions since 2007 (financial and sovereign debt crisis) could be also one of the reasons for a slowing development of the card network. Overall, it is concluded that, for a successful introduction of a new card system in a mature market, first widespread acceptance should be ensured, as suggested by Eq. II. Then, the new payment cards should be distributed to cardholders.

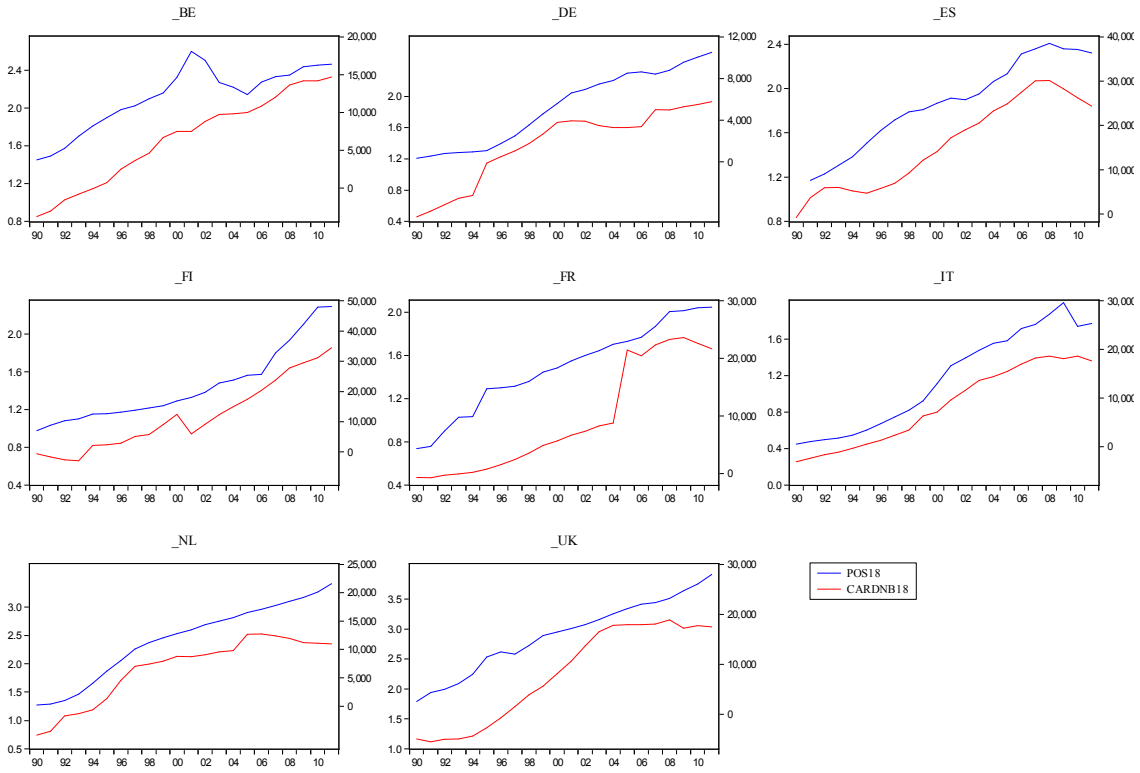

FIGURE 5-7: Diffusion of payment cards and density of POS terminals[215]

Secondly, lagged POS18 is highly significant, and has the expected negative sign, thus supporting the idea that networks with initially low POS density will develop faster than others. This is the case for Germany, Italy and the Netherlands; the three countries started with the lowest POS density, which extended the fastest.

Out of the four institutional variables, only two – POSNW and NCB – are significant and show the expected sign. The negative NCB coefficient supports the idea that the central bank should abstain from owning or operating the domestic

[215] Own illustration.

ACH. In this way, it also avoids possible conflicts of interests by being supervisor and competitor at the same time. According to the estimates above, if the national central bank is involved in the domestic ACH, ΔPOS18 was 0.1% lower than in countries where this is not the case. INTEGR and POSNW are explored in the next sections.

As already discussed, the design of equation 3.2 imagines a second-degree polynomial relationship between the dependent variable and INTEGR, as well as POSNW. Therefore, the terms $POSNW^2$ and $INTEGR^2$ are added. ACH has been left out in order to save degrees of freedom, since it remains insignificant, and does neither enhance the fit of the model nor notably change the other variables' coefficients. According to Table 5–7 (p. 217), the two polynomial terms are highly significant, while INTEGR becomes so. Impact and significance level of $CARDNB18_{it-1}$ and $POS18_{it-1}$ do not change. Overall, the equation's fit is markedly strengthened. Therefore, equation 3.2 will serve as the starting point for including the three clusters of additional explanatory variables, mentioned above.

Before doing so, the turning points for the two parabolas resulting from the quadratic functions $POS18 = 0.119\ POSNW - 0.002\ POSNW^2 + c$ and $POS18 = -0.271\ INTEGR + 0.057\ INTEGR^2 + c$ are derived. As the first one opens downwards, extending the number of networks beyond 28 will not necessarily lead to a higher density of POS terminals.[216] Only in Germany did such a high number of networks exist, and was even exceeded between 1999 and 2001. This is in line with the fact that ΔPOS18 density is the third highest among the countries under investigation. The second parabola opens upwards, meaning that the turning point of two corresponds to the lowest change in ΔPOS18.[217] Hence, all card schemes of higher or lower degree of vertical integration are more successful in attracting new merchants. In fact, most schemes are vertically integrated of degree three or four.

Among the additional regressors extending equations 3.2, only RDEXPGDP is significant and shows the expected sign. In particular, a 1% rise in the ΔRDEXPGDP implies a 0.3% higher growth in ΔPOS18. The resulting model

[216] The turning point is derived by: 0.118529 / 2*(-0.002064) = 28.713421 (see footnote 208).
[217] The turning point is derived by: -0.271400 / 2*(0.056501) = 2.401727 (see footnote 208).

3.3 shows a slightly better fit in terms of adjusted R^2 and AIC than the previous two models.

Finally, the insignificant CARDNB18 is exchanged by CARDPOSFRQ in equation 3.2, as already justified above, to form equation 3.4. The new regressor is highly significant, pointing to a strengthening of ΔPOS18 by 0.2%, following an increase of ΔCARDPOSFRQ by 1%. None of the other explanatory variables ($BANK_{dom}18$, EUR; CONS18, GDP18, UNEMPL or RDEXPGDP, PATENT18) were significant, enhanced the model's fit or altered the other coefficients. RDEXPGDP coefficient's *p*-value would even deteriorate to 0.280 if it were included in equation 3.4.

Judging from the fit of all models analysed, equation 3.3 (renamed Eq. III) is preferred over the others. It explains about 70% of the variance in the POS network density. Residuals are approximately normally distributed, with a kurtosis of 3.880 and skewness of 0.227.

Eq. III $$\Delta lnPOS18_{it} = -0.173\ lnPOS18_{it-1} + 0.105\ \Delta lnCARDNB18_{it-1} + 0.126\ \Delta lnPOSNW_{it} - 0.002\ \Delta lnPOSNW_{it}^2 - 0.277\ \Delta lnINTEGR_{it} + 0.058\ \Delta lnINTEGR_{it}^2, - 0.129\ \Delta lnNCB_{it} + 0.300\ \Delta lnRDEXPGDP_{it}) + \alpha_i + \varepsilon_{it} \quad [CARDPOSFRQ_{it}]$$

In line with the outline in chapter 5.4.3, diagnostic tests were conducted for each of the equations 3.1 to 3.4. Residuals are stationary in levels, but correlogram Q-statistics point to some serial correlation – except for model 3.4. They are normally distributed, as the Jarque-Bera null hypothesis of normal distribution is not rejected for residuals resulting from equation 3.1 to 3.3, while for the 3.4 it is. Mean and median are close to zero for all models. Multi-collinearity and endogeneity appear rather unlikely. However, there is a danger of endogeneity owing to the lagged variable $POS18_{it-1}$. Therefore, the final specification Eq. III is analysed without this term, in equation 3.5.

3.5 $$POS18_{it} = f\ (CARDNB18_{it-1},\ POSNW_{it},\ POSNW_{it}^2,\ INTEGR_{it},\ INTEGR_{it}^2,\ NCB_{it},\ RDEXPGDP_{it})$$

While, in contrast to the other estimations, card diffusion of the previous period is significant, and has the expected sign, the sign of the significant NCB coeffici-

ent turns from negative to positive. Against the background of the earlier discussion, this result would require further investigation. All other coefficients become insignificant, along with a marked drop in the model's fit. A Durbin-Watson value of 0.7, and corresponding correlogram Q-statistics indicate severe serial correlation in the residuals, pointing to a misspecification of the model. Detailed regression results are laid down in Table 5–7 (p. 217). Overall, it is inferred that this model seems unsuitable to explain CARDVALCONS and Eq. III is kept.

5.5.3 Cash holding and availability at ATMs

Two different approaches can be used to model the value of cash withdrawals from ATMs. First, the "network approach" is applied, i.e. ATMVAL18 is related to the size of the payment card, POS terminal and ATM networks, as well as to per-head consumption. Equation 4.1 below depicts the original model.

4.1 $ATMVAL18_{it} = f(CARDNB18_{it}, ATM18_{it}, ATMNW_{it}, POS18_{it}, CONS18_{it})$

The idea behind it is straightforward. Consumers wishing to withdraw cash must possess a payment card – the larger the card network, the more cardholders are able to obtain cash at ATMs. However, the ATM network needs to be sufficiently dense to lower the replacement costs of cash as Garcia-Swartz et al. (2006), Bergman et al. (2007) and Takala and Virén (2008) outline. If more than one ATM network exists, cardholders also need to be aware of potentially "foreign" ATM withdrawal fees. Therefore, while ATM18 is assumed to be positively correlated to the regressand, the opposite is expected for ATMNW.

Further, it is believed that if card acceptance is wide spread, i.e. POS18 is high, cardholders are more likely to use their payment cards at the checkout, which should help suppressing ATMVAL18. De Grauwe et al. (2006) and Bolt, Humphrey et al. (2008) highlight the affect of more expensive cash on the demand for it, and on payment card use, given sufficient merchant acceptance.

Lastly, based on the notion that the cash withdrawn will be primarily used for purchases, increased household consumption should imply higher cash withdrawals. As before, the role of GDP18 and UNEMP, instead of CONS18, is also assessed. If consumers feel in a comfortable economic situation, they may tend to

withdraw and subsequently spend more money. This implies a positive link between GDP18 and ATMVAL18. Nevertheless, it is also reasonable to suppose that an enhanced economic situation entails more experience with electronic payment means in general, and thus higher confidence in card payments, which could have an adverse effect on cash demand. In addition, the question of whether the rate of unemployment negatively impacts cash demand is inspected.

Three further control variables were chosen, the already well-known EUR, as well as RDEXPGDP and PATENT18. Inverting earlier lines of argument, all three are suspected to move opposite to the explained variable. The introduction of the euro could have supported card payments, as already outlined above, possibly reducing cash demand. Distinct expenditures for research and development, as well as many patents outstanding, may be in favour of a more innovative climate in the society, resulting in growing card use, to the detriment of ATM withdrawals. $BANK_{dom}18$ and CR5 were not included in the set of control variables, so as to avoid collinearity with ATM18. This is based on the argument that, guided by competition, banks may wish to increase service levels by installing more ATMs, which at the same time assists in saving costs, by steering customers away from using branch services – ATMVAL18 would rise. Out of these calculations, equation 4.3 emerges:

4.3 $ATMVAL18_{it} = f(CARDNB18_{it}, ATM18_{it}, POS18_{it}, CONS18_{it})$

The second model 4.4, sketched below, is inspired by behavioural aspects. In contrast to equation 4.1, ATMVAL18 is made dependent on how often cardholders use ATMs, i.e. the volume of cash withdrawals per card – CARDATMFRQ = ATMVOL / CARDNB. Since collinearity between ΔlnCARDATMFRQ and ΔlnCARDNB18 is suspected, owing to a correlation of 0.423, the latter is excluded. Collinearity seems less an issue vis-à-vis ΔlnATM18, as correlation is 0.236. CARDATMFRQ is integrated of order one, and therefore differenced prior to estimation. Further, it is checked whether including GDP18 or UNEMPL instead of CONS18 leads to a better fit of the model. The three control variables EUR, RDEXPGDP and PATENT18 are tested stepwise, as well as whether they suitably extend equation 4.4.

4.4 $ATMVAL18_{it} = f\,(CARDATMFRQ_{it}, ATM18_{it}, ATMNW_{it}, POS18_{it}, CONS18_{it})$

In Table 5–8 below, the major regression results for models 4.1 to 4.5 are indicated. Equation 4.2 is a derivative of 4.1, while model 4.5 is derived from 4.4.

Estimation Period Nb. of obs.	4.1 1991-2011 163	4.2 1991-2011 163	4.3 1991-2011 163	4.4 1991-2011 163	**4.5 1991-2011 163**
$\Delta lnATMVAL18_{it} = f\,(...) + \varepsilon_{it}$					
$\Delta lnCARDNB18_{it}$	0.080 (0.078)		0.079 (0.077)		
$\Delta lnDEBITNB18_{it}$		0.156 (0.093)*			
$\Delta lnCARDATMFRQ_{it}$				0.505 (0.120)***	**0.506 (0.120)*** **
$\Delta lnATM18_{it}$	0.328 (0.065)***	0.322 (0.064)***	0.348 (0.059)***	0.233 (0.080)***	**0.240 (0.076)*** **
$ATMNW_{it}$	0.001 (0.001)	0.001 (0.001)		0.001 (0.001)	
$\Delta lnPOS18_{it}$	0.134 (0.062)**	0.131 (0.064)**	0.130 (0.063)**	0.097 (0.039)**	**0.096 (0.039)** **
$\Delta lnCONS18_{it}$	0.570 (0.144)***		0.574 (0.144)***	0.883 (0.115)***	**0.885 (0.115)*** **
$\Delta lnGDP18_{it}$		0.432 (0.142)***			
Adjusted R^2 (S.E. of regression)	0.308 (0.082)	0.295 (0.083)	0.310 (0.082)	0.579 (0.064)	**0.581 (0.064)**
AIC (SIC)	-2.133 (-2.019)	-2.115 (-2.001)	-2.142 (-2.047)	-2.630 (-2.516)	**-2.641 (-2.547)**
Durbin-Watson	1.867	1.854	1.862	1.945	**1.945**
* / ** / *** Coefficient statistically significant at 10%, 5% or 1% level. Standard errors in parentheses.					

TABLE 5-8: Model specification: Sourcing decision – Cash withdrawals[218]

As previously, variables being I(1) are differenced and logged, while those being I(0), notably ATMNW and EUR are taken in levels. Before proceeding, cointegration relationships between explained and explanatory I(1) variables in the proposed equations 4.1 on the one hand, and 4.4 on the other, were searched for. However, the respective null hypothesis of no cointegration in the Pedroni test (conducted without and with individual intercept) could not be rejected. Hence, no cointegration relationship is found, further strengthening the case for estima-

[218] Own illustration.

tion in first differences. Both models were estimated without fixed effects, since these proved redundant.

Surprisingly, with respect to the first approach, the diffusion of payment cards seems not to determine the value of cash withdrawals. One reason might be that, in CARDNB18, debit and credit, as well as deferred debit cards are summed up. But only the first category is the preferred instrument to obtain cash at an ATM. Hence, regression 4.1 was run again with the diffusion of debit cards, instead of CARDNB18. The estimation results support the above assumption. Although, DEBITNB18 is not significant, it is close to the 10% level *p*-value 0.120. Once CONS18 is replaced by GDP18 as in equation 4.2, the variable is significant and has the expected sign. The coefficient points to a 0.2% growth in the change of ΔATMVAL18, once the growth of ΔDEBITNB18 inflates by 1%.

4.2 $ATMVAL18_{it} = f(DEBITNB18_{it}, ATM18_{it}, ATMNW_{it}, POS18_{it}, GDP18_{it})$

Because ATMNW is insignificant, the number of networks may not be as important to determine consumers' cost of cash, as believed. This led to the formulation of equation 4.3, serving as foundation for the introduction of additional variables, to test whether they affect cash withdrawals.

4.3 $ATMVAL18_{it} = f(CARDNB18_{it}, ATM18_{it}, POS18_{it}, CONS18_{it})$

Regarding the other regressors, diffusion of ATMs and per-head consumption are significant and carry the expected sign, while POS terminal diffusion is also an important driver of the dependent variable, but in the opposite direction as expected. It appears that a 1% increase in ΔATM18, or ΔPOS18 respectively, entails a 0.3% and 0.1% expansion of ΔATMVAL18. Against first intuition, but in line with results in chapter 5.4.2, POS18 is positively related to the dependent variable. However, its impact is much lower than that of ATM18.

As potential alternatives to CONS18, GDP18 and UNEMPL were identified. Based on equation 4.3 these were regressed on ATMVAL18. As expected, GDP18 is positively and highly significant, while the other coefficients are not affected, compared to the original regression. The model fit is slightly lower than for equation 4.3 (adjusted R^2 0.291, AIC -2.114, SC -2.019). Introducing instead

the rate of unemployment markedly changes the results for CARDNB18. It becomes significant (coefficient 0.155, standard error 0.072) while UNEMPL itself seems irrelevant, although it shows the expected sign. Overall, adjusted R^2 of 0.242, AIC -2.049, SC -1.954 indicate that this model is inferior to those outlined before.

Finally, the control variables mentioned above were added to equation 4.3, leading to the following conclusions. None of the three were significant or changed notably the results for the other explanatory variables. The model fit decreased slightly.

Exchanging CARDATMFRQ for CARDNB18, as in equation 4.4 and 4.5, the model fit essentially profits. Adjusted R^2 is highest, AIC and SC are lowest, if the insignificant variable ATMNW is eliminated in the latter regression. CARDATMFRQ is highly significant; a 1% change in its growth rate results in an increase of ΔATMVAL18 by 0.5%.

Based on equation 4.5, CONS18 was exchanged by GDP18 and UNEMPL, in line with the procedure conducted for 4.3. As foreseen, the first regressor is highly significant and has a positive sign. While the coefficient of POS18 becomes highly significant, the ones for ATM18 and CARDATMFRQ remain stable. Compared to equation 4.5, adjusted R^2 (0.567), as well as AIC (-2.609) and SC (-2.514) decrease slightly. Thus, there is no consistent argument in favour of either CONS18 or GDP18. As the impact of the former is somewhat higher than that of the latter – the coefficient of GDP18 is 0.791 (standard error 0.118) – a closer relationship of consumption to cash demand is suspected. Further, a highly significant negative relationship of the unemployment rate to the regressand is found with a coefficient of -0.143 (standard error 0.048). However, the model fit deteriorates, judged from adjusted R^2 (0.458), as well as AIC (-2.383) and SC (-2.288). Therefore, the original model 4.5 is kept for further inspection.

In the next step, the influence of EUR, RDEXPGDP and PATENT18 is analysed. None of these factors are significant or enhance the goodness-of-fit measures compared to regression 4.5. While significance of POS18 is increased if EUR or

PATENT18 are inserted, the other independent variables are not altered. The inclusion of RDEXPGDP does not modify any of the coefficients.

As in chapter 5.4.3, diagnostic tests were performed for each of the equations 4.1 to 4.5. Residuals are stationary in levels, but not normally distributed. Mean and median are close to zero, while kurtosis is 8.120 and skewness is 1.266 for equation 4.5. Multi-collinearity and endogeneity appear rather unlikely. Considering all regression results, model 4.5 (Eq. IV) is to be preferred over the others.

Eq. IV $\Delta lnATMVAL18_{it} = 0.506\ \Delta lnCARDATMFRQ_{it} + 0.240\ \Delta lnATM18_{it} + 0.096\ \Delta lnPOS18_{it} + 0.885\ \Delta lnCONS18_{it} + \varepsilon_{it}$

5.6 Conclusions: Institutional determinants of payment choice

After having analysed the payment decision at the POS and the preceding sourcing decision in detail, it appears beneficial to combine the results with the findings on consumers' payment choice. This is the aim of chapter 5.6.1. In chapter 5.6.2, suggestions are made for further empirical research.

5.6.1 Linking empirical and theoretical analysis

In this chapter, the main empirical findings are linked to the results of chapter 4.6. The preferred equations Eq. I to Eq. IV are reviewed, and an overall picture of the determining factors of payment choice at the POS, with an emphasis on the institutional factors, is drawn. Some suggestions for further research are made.

The preferred models for explaining the determinants of the payment decision at the POS (Eq. I), as well as for the underlying sourcing decisions made by consumers (Eq. II and Eq. IV) and merchants (Eq. III) are summarised in Figure 5–8 (next page). The variables in brackets were also identified as being influential on the respective dependent variable. Yet, due to a number of reasons specified above, these were not included in the final model. Further research is needed to better understand their impact on payment choice.

Eq. I $\Delta lnCARDVALCONS_{it} = 0.949\ \Delta lnCARDNB18_{it} + 0.128\ \Delta lnPOS18_{it} + 0.655\ \Delta lnCARD\text{-}POSFRQ_{it} + 0.239\ \Delta lnATMVAL18_{it} - 0.236\ \Delta lnCONS18_{it} + \varepsilon_{it}$ $[ATMNW_{it} / ATMNW_{it}^2]$

Eq. II $\Delta lnCARDNB18_{it} = -0.055\ lnCARDNB18_{it-1} + 0.119\ \Delta lnPOS18_{it-1} + 0.218\ \Delta lnATM18_{it} + 0.091\ \Delta lnCR5_{it} + 0.005\ \Delta lnINTEGR_{it}) + \varepsilon_{it}$ $[INTEGR_{it}^2 / UNEMPL_{it}]$

Eq. III $\Delta lnPOS18_{it} = -0.173\ lnPOS18_{it-1} + 0.105\ \Delta lnCARDNB18_{it-1} + 0.126\ \Delta lnPOSNW_{it} - 0.002\ \Delta lnPOSNW_{it}^2 - 0.277\ \Delta lnINTEGR_{it} + 0.058\ \Delta lnINTEGR_{it}^2 - 0.129\ \Delta lnNCB_{it}, + 0.300\ \Delta lnRDEXPGDP_{it}) + \alpha_i + \varepsilon_{it}$ $[CARDPOSFRQ_{it}]$

Eq. IV $\Delta lnATMVAL18_{it} = 0.506\ \Delta lnCARDATMFRQ_{it} + 0.240\ \Delta lnATM18_{it} + 0.096\ \Delta lnPOS18_{it} + 0.885\ \Delta lnCONS18_{it} + \varepsilon_{it}$

FIGURE 5-8: Summary of preferred models[219]

Overall, a number of important inferences can be drawn from the above. First, for the first time, the importance of institutional factors for determining payment choice is empirically confirmed. Most notably, the degree of vertical integration of a card scheme, the number of POS terminal and ATM networks, as well as the involvement of the national central bank are singled out. For the first three, a second degree polynomial functional form could be identified, thereby enabling the determination of a turning point, after which a further increase or decrease of the respective variable would not contribute to a larger share of card payments on POS purchases. The results for INTEGR highlight that, as expected, collaboration between banks in establishing a card scheme, which arranges common tasks, plays a crucial role in fostering card use, but only up to a point where competition in the acquiring business is still fostered.

Second, from the data, the impact of larger economies of scale in processing networks and the clearing system on card use is not confirmed, as the turning point for POSNW and ATMNW is rather high, and ACH is not significant. Possibly, savings achieved through larger networks and more efficient clearing are not adequately passed through to users, thus holding back the development of a card payment culture. On the other hand, a high concentration ratio is found to foster it. Hence, regulation in this field needs to strike the right balance between collaboration and competition. Policy measures should also take into account the

[219] Own illustration.

stage of market development. In an already mature market with a high share of card payments on consumption, such as the UK, fostering competition is probably to be preferred. On the other hand, in still underdeveloped markets, such as Germany, a different route may be more promising.

Third, the importance of behavioural aspects, i.e. the frequency of card use at POS terminals and ATMs, is underlined. It is believed that payment service providers and policy makers are able to campaign in favour of card payments. Whether the SEPA initiative, aiming at an integrated European market for electronic payments, will offer the right incentives in this respect requires further investigation (see chapter 6 for details on SEPA and its impact).

Forth, the rapid shift in Dutch payment behaviour, in favour of card payments, can be associated with an extensive diffusion of payment cards, the fast expansion of the POS network and the spreading of ATM withdrawals. Moreover, banking sector concentration is relatively high, while a vertical integration degree of four also fosters card payments. Moreover, consumption increased and unemployment decreased the most, compared to other countries. Also, Dutch consumers changed their payment habits very quickly, as CARDPOSFRQ rose the fastest. With respect to Belgian consumers, the following is observed. Belgium is the country with the highest number of cards per head, after the UK and the Netherlands, and saw the fastest ATM network extension, in addition to ATM withdrawal growth, among the countries analysed. Concentration in the banking sector is also very dense. Moreover, consumption and CARDATMFRQ grew tremendously as well.

Figure 5–9 (next page) links the institutional determinants found to be important to the framework developed in chapter 4.6. Here, the underlying forces driving card payment use are depicted, including the direction in which they impact CARDVALCONS. The NCB dummy is part of the institutional, as well as the supply dimension, because if the national central bank operates the domestic ACH, costs per transaction tend to be higher, compared to those clearing houses in which it is not involved. CARDATMFRQ and CARDPOSFRQ are part of the demand function, as they mirror the behaviour of consumers. The fixed effects

collect unobserved differences between the countries lying in the institutional design, in user preferences and other characteristics of the payment system.

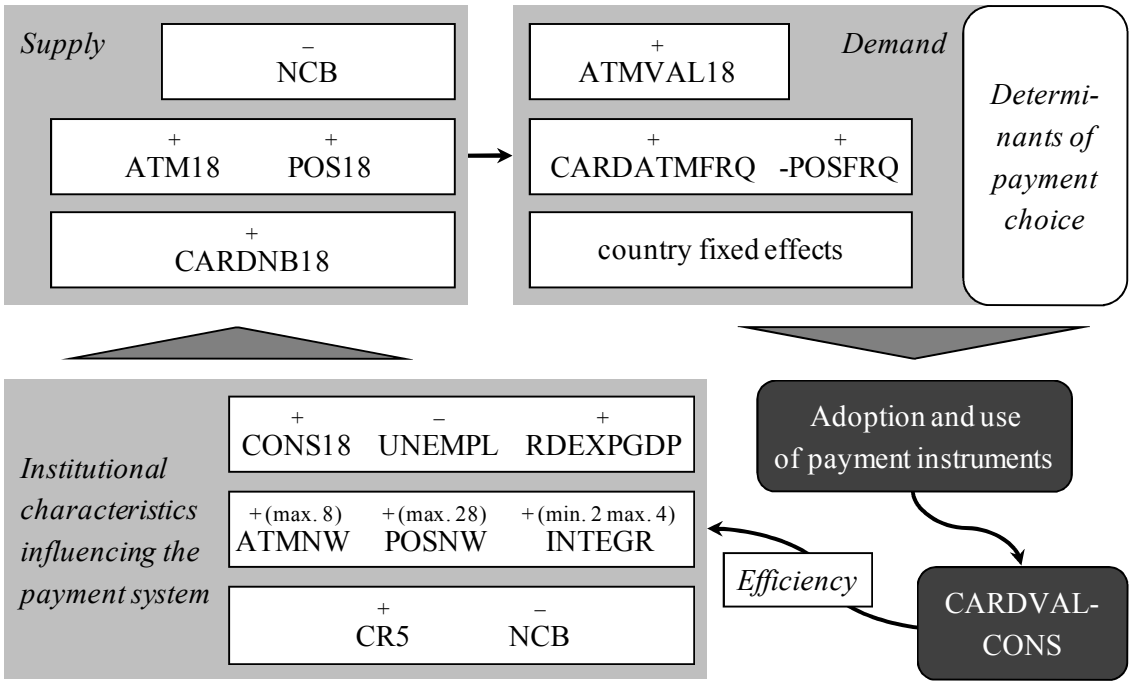

FIGURE 5-9: Institutional determinants of the POS payment mix[220]

5.6.2 Route for further research

Further research is needed to confirm the relationships established, as well as to uncover further institutional aspects responsible for the differences in payment behaviour. This crucially depends on the availability of respective time series data. One option to overcome this deficiency is to manually collect the necessary data, as was demonstrated in this thesis. Although this approach is associated with uncertainty about the "true" value of the observed variable, if estimates are well grounded, this seems no more problematic than the uncertainty engrained in the published statistics, especially those of earlier years. Interviews with national payment experts, as well as case studies could markedly enrich data quality.

Inter-group comparisons between the three country groups identified in chapter 1.1, along the lines of Bolt, Humphrey et al. (2008), comparing the payment behaviour in two countries, could be a fruitful extension to this study. In addition, a separate assessment of debit, deferred debit and credit cards could valuably contribute to the understanding of payment behaviour. The influencing determi-

[220] Own illustration.

nants for their use might differ, as indicated in chapter 4.2 to 4.5. Moreover, existing research on credit cards is mainly grounded in the US market, and therefore not directly transferable to European markets, where credit cards only play a niche role, since deferred debit cards dominate – at least in Belgium, Germany, Finland, the Netherlands and Spain (in Italy and the UK credit cards are more important than deferred debit cards, while in France both types are widely spread). An improved methodology is needed on how to better differentiate the payment and the credit function of payment cards to pave the ground for a separate analysis of debit and credit cards as well as deferred debit cards. Also, such an undertaking could enhance the understanding of the role, combination cards play in fostering the use of payment cards at the POS. Further empirical research could take into account the following variables:

- a measure for economies of scale, such as the volume of card payments transacted through the respective ACH, in comparison to all similar transactions (either dedicated card payments or other electronic fund transfers used for cards and payment instruments) in the operational area of this ACH;
- the regulatory framework, such as (i) whether a bank licence is required to offer payment services or not, (ii) interventions in the payment card market (permitting surcharging or forcing down interchange fees) which would allow the study of the effect of policy changes;
- differences in the set-up of the dominating (debit) card scheme, i.e. a non-profit member organisation establishing a proprietary national debit card network, which targets specifically the needs of the domestic market, versus a shareholder organisation that operates on large scales an internationally active card scheme;
- a parameter reflecting the safety, soundness and liability of the payment infrastructure used for processing POS transactions. These aspects seem crucial in maintaining trust in the payment instruments used;
- availability of obtaining cash at the POS – either as dummy as in Humphrey et al. (2001), or as the value received at this occasion. If the latter figures were

made available and combined with cash withdrawn at bank offices and ATMs, assumptions about cash payments at the POS were enhanced;

– interest rate to account for balancing interest-free periods for deferred debit or credit cards, and income received from deposits maintained at bank accounts on the one hand, and the costs borne for drawing on credit lines, on the other, as has been outlined in chapter 4.2; and

– degree of merchant competition would have been interesting to enhance the sourcing decision equation on the number of POS terminals (strategic advantage of accepting card payments).

Another aspect is worthwhile to be inspected: ELV in Germany (see chapter 5.3.2 for an explanation). As ELV is statistically counted as a direct debit, although being initiated with a debit card and signature, the overall volume and value of card payments might be systematically underestimated. Figure 5–10 (next page) suggests that 13% of turnover at the POS was paid for by ELV in 2011, which compares to 21% by debit card and PIN. If ELV were taken into account, Germany would be possibly placed closer to the group of "card adopters" as defined in chapter 5.2.2. Unfortunately, absolute ELV payment volume and value data were not available holding up deeper analysis of this phenomenon.

Looking forward, much more clarity on the functioning and development of transactions with alternative payment methods would be helpful to answer questions like: Under which conditions could new payment methods become more efficient than established non-cash payment instrument? Which institutional requirements are to be met to reach these conditions? Then, when will users turn to these payment methods? What consequences would that have for the functioning and stability of the payment system and the competition among providers of payment services? Similar questions have been asked by European authorities prior to proposing measures on harmonizing the European payment markets. Subsequently, these measures are being investigated and put into context with the prior discussions on determinants of payment choice.

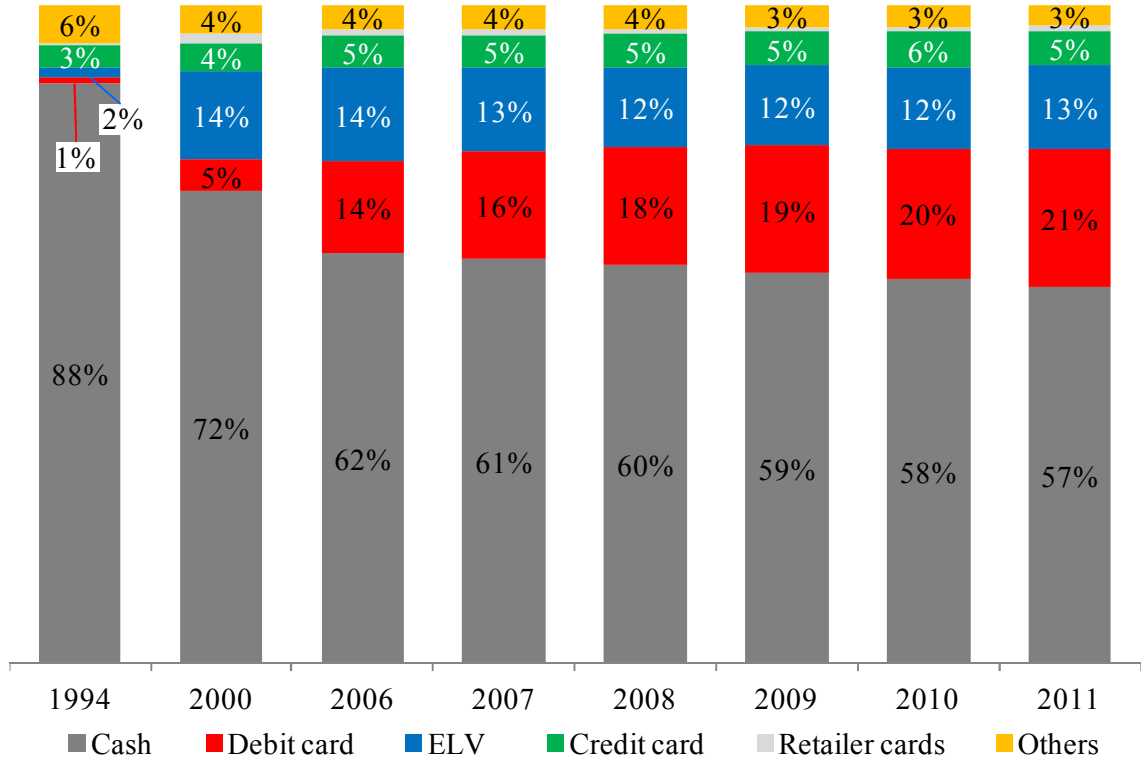

FIGURE 5-10: Share of payment instruments on POS turnover in Germany[221]

6 Prospects for an efficient European payment mix

This chapter aims at assessing whether establishing SEPA will enhance the efficiency of the European card payments market by fostering the use of payment cards. This is analysed against the framework on institutional determinants for payment choice, and the results of the empirical analysis, as of chapter 4.6 and 5.6 respectively. As of today, SEPA encompasses electronic euro payments in 33 countries, i.e. the 31 countries of the European Economic Area (EEA)[222], consisting of the 28 EU member states plus Iceland, Norway and Lichtenstein. Switzerland and Monaco also participate in SEPA, but without implementing the supporting European law (see Table 6–1, p. 239 for a differentiation).[223]

[221] Own illustration. Based on figures by the EHI Retail Institute, which conducts yearly surveys among merchants on payment behaviour of their customers. See footnote 175 and http://www.ehi.org/presse/pressemitteilungen/detailanzeige/article/mehr-karte-weniger-schlange-stehen.html (retrieved 2012, November 15).

[222] See http://www.efta.int/eea.aspx (retrieved 2013, February 25).

[223] http://www.ecb.int/paym/sepa/about/countries/html/index.en.html provides an overview on national SEPA migration plans (retrieved 2013, February 22).

The remainder of this chapter is structured as follows. First, the SEPA objectives are reviewed in chapter 6.1. In the subsequent chapter 6.2, the regulatory framework, including the self-regulatory approach by the payment services industry, is examined. Afterwards, chapter 6.3 evaluates to what degree the use of non-cash means of payments is fostered by these measures. Obstacles for the emergence of a more efficient payment mix are identified. This is complemented by a brief outlook on the future development of POS payments, including mobile options.

6.1 Objectives for establishing a European payment markets

Until the first ideas to harmonise electronic retail payments in Europe, a wide range of payments-related legislation had been already implemented designed to

(i) protect and sustain payment systems,
(ii) regulate providers of payment services,
(iii) support competition,
(iv) protect consumers and other users and
(v) avoid misuse of payment systems for money laundering and terrorism financing (Wandhöfer, 2010, pp. 35-40).

The introduction of the euro for electronic transactions in 1999, and the replacement of national currencies in 2002 in the euro area[224] triggered immense efforts in the banking and payment services industry to modify processing as well as clearing and settlement infrastructures as Wandhöfer (2010, pp. 45-51) has explored.[225] The European System of Central Banks (ESCB)[226] is entrusted with the promotion of the smooth operation of payment systems (see Article 3 and 22 of Protocol (No 4)) and consequently introduced TARGET in 1999, the first European RTGS and predecessor of TARGET2. At the time of introduction, it linked 15 (later 17) national RTGSs, with the aim of providing "sound and efficient mechanisms for settling same-day cross-border payments" (ECB, 2001b, p. 5). TARGET has contributed to euro money market integration and smooth processing of large-value payments within the euro area. In addition, EBA Clearing –

[224] The evolution of the Euro area is shown at http://www.ecb.int/euro/intro/html/map.en.html (retrieved 2013, February 20).
[225] The remainder of this paragraph also draws from Wandhöfer (2010, pp. 45-51).
[226] The ESCB comprises the European Central Bank (ECB) and the national central banks of the EU members (Article 1 Protocol (No 4)).

jointly owned by large, mainly European banks – launched EURO1 in 1998. This DNS system settles large-value domestic and cross-border euro transactions via TARGET2 and provides immediate finality for all processed payments.[227] Later, it was complemented by ACHs for retail payments (see Table 2–2, p. 38).[228]

Although these efforts significantly eased the processing of large-value payments across Europe, the retail payment market remained fragmented along national borders. Consequently, the Commission stated in its communication on retail payments (Commission of the European Communities [Commission], 2000, p.2): "The European Union has an internal market and the euro. It does not yet have a 'single payments area'. Large value (wholesale) payments can now be made across borders nearly as quickly and cheaply as they can domestically, yet small value (retail) cross-border payments are less reliable, usually take longer and cost significantly more than domestic payments". Further, the Commission urged that a "significant improvement in the efficiency of small value cross-border payments, and substantial reductions in cross-border charges to customers" be made.

While the Commission paper imposed strict requirements on the banking industry to achieve this goal, it claimed, at the same time, to build "largely on a market-led approach requiring voluntary co-operation by the banking sector and investments" (Commission, 2000, p. 2). This dichotomy has been characteristic for the whole SEPA project, and gave rise to a complex web of reciprocal calls for action; the burdensome process is retraced in detail by Wandhöfer (2010).[229]

In their joint statement,[230] the European Commission and ECB envisioned the SEPA "as an integrated market for payment services which is subject to effective

[227] For additional information see https://www.ebaclearing.eu/EURO1-N=EURO1-L=EN.aspx (retrieved 2013, February 20).

[228] See chapter 2.1.3 and Appendix A–2 on different settlement methods (RTGS and DNS) for large-value and retail payments.

[229] Major documents are available at DG Internal Market and Services' website including regulations and impact studies as well as SEPA progress reports, competition enquiries, conference documentations and press releases, in particular at:
- http://ec.europa.eu/internal_market/payments/sepa/ec_en.htm,
- http://ec.europa.eu/internal_market/payments/framework/archive_en.htm#preparation,
- http://ec.europa.eu/internal_market/payments/cim/index_en.htm

Related actions by DG Competition can be viewed at http://ec.europa.eu/competition/sectors/financial_services/banking.html (retrieved 2013, February 21).

[230] http://www.ecb.int/press/pr/date/2006/html/pr060504_1.en.html (retrieved 2013, February 21).

competition and where there is no distinction between cross-border and national payments within the euro area". Therefore, they require the "removal of all technical, legal and commercial barriers between the current national payment markets" in order to enable users to "make cashless payments throughout the euro area from a single payment account [...] using a single set of payment instruments as easily, efficiently and safely as they can make payments today in the domestic context." In the context of card payments, technical barriers to cross-border acceptance at POS terminals and ATMs should be removed and interoperability, based on common standards, ensured.

Moreover, the European Commission and the ECB demand that national IFTSs become SEPA-compliant, i.e. adhere to the PE-ACH/CSM framework, as introduced in chapter 6.2.3, with the intention to attain interoperability and effective competition. In the same vein, they expressed support for the work of the European Payments Council (EPC). This association of the European banking industry is entrusted with the coordination of efforts and decisions on the introduction of SEPA payment instruments (as opposed to domestic ones), and SEPA-compliant clearing and settlement arrangements (see chapter 6.2.3 as well).[231]

More specifically on payment cards, national central banks have defined their view in ECB (2006b) and set the following key conditions (p. 8):

– "consumers can choose among a diversity of competing payment card schemes" at the POS and "merchants are indifferent to what brand of card they accept", provided these are SEPA-compliant[232] – the so-called "any card at any terminal"[233] requirement – while fair and open access is guaranteed to any potential issuing or acquiring bank located in the euro area;
– "there is a competitive, reliable and cost-efficient card market including service and infrastructure providers"; and
– "technical and contractual provisions, business practices and standards" leading to "national segmentation [...] have to be eliminated".

[231] As stated at http://www.europeanpaymentscouncil.eu/ (retrieved 2013, February 21).
[232] Hence, adhere to the EPC's SEPA Cards Framework (SCF) as is explained in chapter 6.2.3.
[233] The "any card at any terminal" requirement was postulated first in 2004 by Gertrude Tumpel-Gugerell, Member of the ECB Executive Board, at the 2004 EFMA Cards and Payments Conference in Paris, see http://www.ecb.int/press/key/date/2004/html/sp040921.en.html (retrieved 2013, February 25).

The ECB clearly prefers the emergence of a European card scheme, whose cards are issued and acquired throughout (broadly) the whole euro area. For international reach, co-branding with ICSs is deemed acceptable. However, co-branding for transactions within the euro area should be avoided, as this would solely perpetuate the current situation (see chapter 2.2.4), and run counter the SEPA objective of greater efficiency. In addition, the ECB warns to simply replace the domestic schemes with an international one as this would likely result in higher costs for users and weakened competition (ECB, 2006b, p. 2). Although, the ECB's position is not legally binding, it clarifies the expectations for the EPC's work, and is in line with the Commissions' stance and actions on this topic, as stressed inter alia in the SEPA-Roadmap (European Commission, 2009a, p. 3).

6.2 SEPA for cards regulatory framework

In this chapter, the main provisions targeting the SEPA objectives are screened. Thereby, those provisions which could potentially alter the determinants of payment choice as identified in chapter 4.6 and 5.6 are focused upon. Chapter 6.2.1 explains the regulatory ecosystem relevant for the card payments market and its participants. Against this background, the differences between the SEPA project implemented by the European banking and payment services industry, and its main underlying law – namely the PSD and surrounding payment regulations – are distinguished. Based on these explanations, provisions are singled out which may potentially alter the payment instrument mix. While chapter 6.2.2 is concerned with the European law, chapter 6.2.3 focuses on the self-regulatory part.

6.2.1 Regulatory ecosystem

The regulatory ecosystem governing the card payments market covered in this chapter is depicted in Figure 6–1 (next page). Three levels of considerations can be determined. At the first level, European authorities, namely the European Parliament and the Council, as well as the Commission and the ECB issue laws, rulings or guidelines to be observed by the market participants. In particular, the PSD (Directive 2007/64/EC), the Regulation (EC) 924/2009 on cross-border payments, as well as the rulings against Visa and MasterCard regarding interchange

fees[234] are reviewed. In addition, the ECB's Terms of Reference for the SEPA-compliance of card schemes (ECB, 2009c) and infrastructures[235] are looked at.

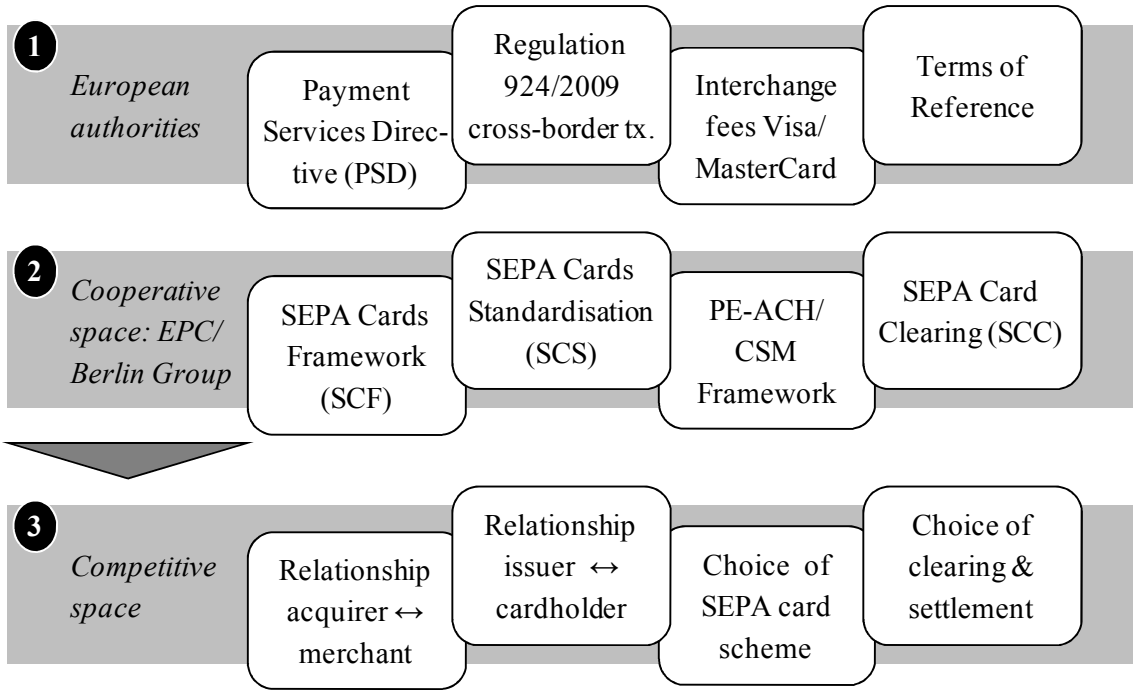

FIGURE 6-1: European payment harmonisation: Regulatory ecosystem[236]

At the second level reside cooperative self-regulatory decisions made by bodies of the banking and wider payment services industry with respect to standardisation and business conduct. Here, the SEPA Cards Framework (SCF) and the SEPA Cards Standardisation "Volume" (SCS), both published by the European Payments Council (EPC, 2009 and 2011) are examined. The other SEPA payment instruments launched by the EPC, namely SEPA Credit Transfer (SCT), SEPA Core Direct Debit (SDD Core) and SEPA Business-to-Business Direct Debit (SDD B2B),[237] meant to replace the respective national payment means, are considered out of scope. Moreover, the SEPA Card Clearing Framework

[234] As listed at http://ec.europa.eu/competition/sectors/financial_services/enforcement_en.html (retrieved 2013, February 25).
[235] Recorded at https://www.ecb.int/paym/sepa/elements/compliance/html/tor.en.html#ftn.fnid1 (retrieved 2013, February 25).
[236] Own illustration.
[237] The three schemes define technical standards and business rules for the initiation and processing of such transactions, see the respective rulebooks (EPC, 2012a, 2012b, 2012c) for details. Updated rulebooks for SCT and SDD Core as well as SDD B2B become effective in February 2014 in line with SEPA migration end-date Regulation (EU) 260/2012. These and other documents supporting implementation are stored at http://www.europeanpaymentscouncil.eu/content.cfm?page=sct_2014_rulebook and http://www.europeanpaymentscouncil.eu/content.cfm?page=sdd_2014_rulebooks (retrieved 2013, February 22).

(SCC) which was drafted by the Berlin Group (2012a)[238] is studied. It is based on the EPC's PE-ACH/ CSM Framework for SCT and SDD clearing and settlement (EPC, 2008). The Berlin Group is an association of 27 European ACHs and domestic card schemes domiciled in Europe as well as Visa Europe, EAPS[239] and Payfair[240].

The competitive space of the third level is determined by the legal and self-regulatory framework of level one and two as indicated by the arrow in Figure 6–1 and, hence, is about to widen dramatically. It first comprises the arena in which acquirer and issuer compete to affiliate merchants and attract cardholders. Note that, in contrast to the former chapters of this thesis, the term acquiring (issuing) bank is amended to "acquirer" and "issuer". This is due to the fact that the PSD allows the entry of new competitors, i.e. payment institutions, into the market which will be explained in the next chapter. Furthermore, the affiliation of acquirers and issuers to a payment card scheme will also be left to competitive forces. The same holds true for the decision of which clearing and settlement arrangement best suits the needs of these market participants.

Although level one and especially the PSD was designed to support the creation of SEPA under level two, the scope of the two levels differs in terms of geographical reach and types of payments covered. Table 6–1 (next page) depicts the main differences: While SEPA encompasses 32 countries, the PSD is applicable in 30, since Switzerland and Monaco – although banks and other PSPs participate in SEPA – are not obliged to adopt the PSD. Moreover, while establishing SEPA is closely related to SCT, SDD and SCF-compliant payments in euro, the PSD covers all electronic retail payments in euro and other EEA currencies. The PSD provides generic rules for these but without reference to the respective SEPA instruments. However, Regulation (EU) 260/2012 on mandatory migration from

[238] These operational rules are accompanied by implementation guidelines (Berlin Group, 2012b) concerned with specification of the clearing messages based on ISO 20022 exchanged between the acquiring and the issuing bank (or respective other PSPs). For more details on ISO 20022 see http://www.iso20022.org/ (retrieved 2013, February 28).

[239] See footnote 67.

[240] The Payfair card scheme is the only serious attempt known so far to create a new European card scheme from scratch, in line with the ECB's vision. It also aims to establish international reach independently of ICSs, and recently signed an agreement with EAPS to potentially become a member. http://www.payfair.eu/overview and http://www.payfair.eu/newsletter5-agreement-with-EAPS#scroll (retrieved 2013, February 26).

domestic to European-wide electronic retail payments ("migration end-date regulation") acknowledges the work done by the EPC. It requires moving proprietary national credit transfer and direct debit transactions in euro to harmonized European formats – that closely resemble the requirements laid down in the SCT and SDD rulebooks – by 1 February 2014 for the euro area, and 31 October 2016 for non-euro countries.[241] Legacy niche products are to be phased out by 1 February 2016. A regulatory endorsement of the SCT and SDD schemes as such was avoided as this potentially could have created a private monopoly situation (European Commission, 2010a, p. 35).

	PSD	SEPA
Regulatory nature	**Legally binding instrument** proposed by the European Commission and adopted by the European Parliament and Council to be transposed into national law[242] and observed by banks and other PSPs	**Private law contracts**: EPC mediates multilateral contracts (SCT/SDD rulebooks and adherence agreements) and legally nonbinding agreements (PE-ACH/CSM framework, SCF/SCC) to which banks and other PSPs operating in SEPA declare adherence
Regional coverage	**31 countries**: EEA countries (in Iceland, Liechtenstein and Norway obligatory transposition into national law under EEA Agreement)[243]	**33 countries**: EEA countries (28 EU member states + Iceland, Lichtenstein and Norway) + Switzerland and Monaco
Scope	Electronic retail **payments in EUR** and other **currencies of EEA** countries processed within EEA by banks / other PSPs operating therein	SCT, SDD (core and B2B), card **payments in EUR** processed within SEPA by banks and other PSPs operating therein that have declared adherence to the related rules
Legal relationships	Between banks, other PSPs and users of payment services	Among banks and other PSPs
Throughout the chapter, PSP refers to payment institutions including card schemes.		

TABLE 6-1: Comparison of SEPA and PSD characteristics[244]

6.2.2 Regulatory framework set by European authorities

While this and the following chapter 6.2.3 are dedicated to describing selected provisions of the different regulations considered, their impact is discussed in chapter 6.3. Throughout the two chapters, reference is made to the regulatory framework as explained in the previous chapter 6.2.1 if not indicated otherwise.

[241] See http://www.ecb.int/paym/sepa/pdf/sepa_migration.pdf (retrieved 2013, February 26).
[242] See http://ec.europa.eu/internal_market/payments/docs/framework/transposition/plans_en.pdf for transposition plans. A report on the state of transposition and areas of concern was published by Tipik Communication Agency (2011) on behalf of the European Commission.
[243] See http://www.efta.int/eea/eea-agreement.aspx (retrieved 2013, February 25).
[244] Own compilation based on applicable documents as examined in chapter 6.22 and 6.2.3.

Payment Services Directive

The PSD accompanies and enables the establishing of SEPA, and needed to be transposed into national law by 1 November 2009. It aims at overcoming legal fragmentation and instituting a coherent legal framework for the supply of payment services in the EU. Key intentions are improved efficiency and reduced costs of payment systems. For this reason, competition shall be fostered and the exploitation of economies of scale facilitated (European Commission, 2007b, section 1). Title II, III and IV of the PSD contain its central rules and are touched upon in the following paragraphs.

In Title II chapter 1, a new category of PSPs, the so-called payment institutions, are inaugurated to enter the market in competition to banks and electronic money institutions (see Box 1–1, p. 33 for a definition). Article 16 and the PSD Annex list the range of activities in which payment institutions may engage. They are entitled to provide inter alia the following payment services:

(i) enabling cash deposits for the purpose of executing a payment transaction as of (ii) and cash withdrawals only, while taking deposits or other repayable funds in the sense of Article 5 Credit Institutions Directive 2006/48/EC or electronic money as of Article 2 E-money Directive 2009/110/EC is not allowed;
(ii) carrying out payment transactions via credit transfer, direct debit, payment cards or similar payment means;
(iii) granting temporarily credit but only if linked to a payment transaction;
(iv) issuing and acquiring of payment instruments including cards and
(v) execution of e- and m-payments as defined in Box 1–1 (p. 33).

Payment institutions may hold payment accounts, but solely for the purpose of supplying the above services. In accordance with the limited range of activities allowed to payment institutions, they are subject to a lighter prudential regime than banks, as outlined in the Articles 6 to 9 PSD.[245] Apart from the activities (i) to (v), payment institutions are allowed to operate payment systems such as

[245] In a memo accompanying the PSD ("Frequently Asked Questions"), the Commission roughly compares the capital requirements for different ranks of payment institutions and banks (European Commission, 2007b, section 18 and 19).

ACHs or other clearing and settlement arrangements, as explored in chapter 2.1.3. Moreover, they are not restricted to payment services, but can also perform other unrelated business activities. Hence, any company may be eligible to apply for a licence as payment institution in order to carry out payment services.

Article 28 in Chapter 2 of Title II PSD determines the non-discriminatory access of PSPs, including payment institutions, to clearing and settlement arrangements except for

- IFTSs in the meaning of the Settlement Finality Directive 2009/44/EC which covers essentially RTGS systems, i.e. TARGET2[246] and most ACHs such as PMJ, CORE, BI-COMP, Equens or SNCE (see chapter 5.3.2 for details)[247] and
- IFTSs managed by one PSP, which licenses others to participate and act as a PSP to both, payer and payee; potentially these are three-party card payment schemes, such as American Express or girocard.

Title III PSD constitutes numerous rules regarding the transparency of fees and the information to be delivered to payee and payer in single transactions, as well as for framework contracts for payment services provision. Exceptions are made for certain low-value transactions in Article 34.[248] The purpose is to foster the use of seemingly cost-efficient payment means, such as e-money and new payment methods (e- and m-payments), typically employed for small purchase amounts.

Title IV PSD clarifies the rights and obligations of the participants in a payment transaction. Most important are

- the payee's right to surcharge or discount the use of a payment mean;

  E.g. a merchant is allowed to add a fee Y to or deduct a certain amount Y from the price depending on the instrument the customer likes to pay with while being aware of Y. The idea is that merchants choose Y based on costs and thus steer their customers towards more efficient, less costly payment instruments (cost-

[246] Including its components operated by participating national central banks.

[247] A complete list is available at European Securities and Markets Authority (ESMA) designated to receive information on IFTSs included in the scope of the directive under http://www.esma.europa.eu/page/Designated-Payment-and-Securities-Settlement-Systems (retrieved 2013, February 27).

[248] These are transactions not exceeding EUR 30 and payment instruments that have a spending limit of EUR 150 or store funds not exceeding EUR 150 at any time. EEA countries can assign designate deviating low value amounts.

differentiated pricing, see chapter 2.2.5). National transposition, however, can deviate from this provision and limit or forbid surcharges (Article 52);

– the obligatory authorisation of each payment transaction (Article 54);

  In case a payer denies to have given consent to a payment, the burden of counter-proof resides with her/his PSP, who is also obliged to refund debited amounts (Article 59 and 60). This is to protect consumers from illegitimate claims by payees. If the payment instrument used for the transaction was lost or stolen, the payer bears EUR 150 of potentially unlawful debited amounts until the issuer is notified (Article 61).

– that payments need to be carried out within one business day ("D+1" execution time).

  National transposition can nevertheless prescribe even faster execution (Article 69 and 72). The payee's account is to be credited immediately after the funds arrived at his/her PSP's account (Article 73).

Other European regulations

In this section, Regulation 924/2009 on cross-border payments, the Commission's interchange fee rulings and the ECB's Terms of Reference for the SEPA-compliance of card schemes and infrastructures are glanced upon.

With respect to card payments, only Article 3 of Regulation 924/2009 is relevant. It stipulates that for cross-border transactions, i.e. those in which issuer and acquirer are located in different countries of the EEA, the same fees apply as for comparable national transactions. The same holds true for cash withdrawals at ATMs. In the long run, a convergence of prices between member states would be a desired outcome, and in line with the development of the single market.[249]

The Commission has exerted a lot of effort to determine the level of interchange fees applied throughout the EU, and hence increased transparency in this field, starting with a retail banking sector inquiry (European Commission, 2006a).[250] It was concluded that the setting of interchange fees by Visa and MasterCard may

[249] See "Frequently Asked Questions" provided by the Commission at http://ec.europa.eu/internal_market/payments/docs/reg-924_2009/faq-924-2009_en.pdf (retrieved 2013, February 27).

[250] See also for the MasterCard and Visa case discussed below: http://ec.europa.eu/competition/sectors/financial_services/enforcement_en.html (retrieved 2013, February 27).

create market entry barriers to competition between local and foreign member banks (European Commission, 2007a, pp. 116-117). Moreover, the "large divergences in interchange fees between countries and between merchant segments" (p. 117) indicates the exercise of market power by acquirers. Also, it remains questionable whether competition between the two card schemes is sufficient to penalise high interchange fees, at least for cross-border payments. Consequently, the Commission proposed antitrust-enforcement in relation to interchange fees and resulting merchant service charges (European Commission, 2007c, p. 9).

Subsequently, investigations were opened against MasterCard. These focused on a certain interchange fee applicable to (i) cross-border transactions with Maestro debit and MasterCard credit cards in the EEA, (ii) domestic credit card transactions in Belgium, Ireland, Italy, the Czech Republic, Latvia, Luxembourg, Malta, and Greece as well as (iii) domestic debit card payments within Greece and the Czech Republic (see European Commission, 2007d and 2007e for this paragraph). It was set by the scheme based on a multilateral agreement between the participating member banks in line with the mechanism explained in chapter 2.2.3. This specific interchange fee was prohibited in 2007 on the grounds that it restricts price competition by setting a floor on the merchant service charge imposed by acquiring banks, finally leading to higher prices for consumers. However, the Commission acknowledged that once certain conditions are met, an interchange fee may be acceptable.

After intense consultations with the Commission, MasterCard announced a new methodology[251] for determining cross-border interchange fees in 2009 resulting in a charge of 0.3% and 0.2% of the transaction value for credit and debit cards respectively (see European Commission, 2009b and 2009c for this paragraph). This meant a substantial decrease from on average of previously 0.8-1.9% of the purchase value for credit card transactions, and 0.4-0.75% for debit cards. Nevertheless, the fee level might be forced downwards even further in the future, once

[251] The so-called "tourist test" or "merchant indifference test" assumes that a merchant accepts a card payment from a non-repeat customer (tourist) as long as the cost of card acceptance is not higher than the cost of cash handling (Rochet & Tirole, 2007). Based on cost studies by the central banks of Belgium, the Netherlands and Sweden (see chapter 3.2.2) the appropriate debit card fee was derived. Since granting temporarily credit is an additional service, a higher fee for credit cards seems justified.

new information on payment costs becomes available. Moreover, the Commission continues to call the justification of an interchange fee for the efficient functioning of card schemes into question, as

(i) other mechanisms such as rebates granted by merchants could promote payment card use sufficiently well while not being a collusive action,

(ii) once the market has reached maturity, further incentivising payment card use to exploit network effects is not indispensable and

(iii) other means such as directly rewarding cardholders for employing their cards may be more effective to increase card transaction volumes.

Following the MasterCard decision, the Commission opened comparable anti-trust investigations against Visa, and concluded inter alia that the multilateral interchange fees set by Visa Europe harm competition. Subsequently, Visa Europe committed to reduce the debit card fee levels by 60% for cross-border payments and 30% for domestic transactions to Maestro levels in accordance with the same methodology. This decision became legally binding in 2010 (European Commission, 2010b).

In 2009, the ECB issued its Terms of Reference for the SEPA-compliance of card schemes. It is based on the SCF and the ECB's vision of a "SEPA for cards" (ECB, 2006b, p. 8) which was introduced in chapter 6.1. Once all 34 mandatory questions have been answered with "yes" in a self-assessment by the respective card scheme, it is allowed to consider itself SEPA-compliant. While the answers had to be published at the schemes' website until end of June 2009, the ECB lists all SEPA-compliant card schemes at its own site[252], and invites further schemes to conduct the self-assessment as well.

A SEPA-compliant scheme should fulfil (inter alia) some essential requirements:

– Scheme rules and practices ensure: (i) consistent services for users across the euro area, (ii) ATM owners/merchants may accept competing SCF-compliant card schemes at the same ATM/POS terminal, (iii) separation of brand mana-

[252] Besides eight of the schemes looked at in chapter 5.3.2 (girocard, Servired/Sistema 4B/Euro 6000, Cartes Bancaires, PagoBancomat, MasterCard, Visa), the following payment card schemes have declared SEPA-compliance: Activa (Slovenia), American Express (USA), JCB (Japan) and Multibanco (Portugal) according to https://www.ecb.int/paym/sepa/elements/compliance/html/index.en.html (retrieved 2013, February 28).

gement from processing (authorisation, clearing and settlement), (iv) acquiring open to competition; (iii) and (iv) promote a degree of vertical integration of one (as detailed in chapter 2.1.1).

- Scheme participation: (i) transparent, equal and non-discriminatory access criteria for all banks and payment institutions within SEPA as acquirer and/or issuer, (ii) only a single licence required to provide payment services across SEPA, (iii) free choice of processing services provider;

- Transaction features: (i) authorisation by the issuer for all transactions (online at the payment account or via PIN), (ii) free choice of card scheme and payment mode (immediate/delayed debit or credit) at the POS if contained at the payment card used and supported by the POS terminal;

- Fees and pricing: (i) transparent pricing (no "bundling" of services) and single interchange fee (if any) for the euro area in the long run, (ii) disclosure of fee level and calculation methodology, (iii) concordance with PSD surcharging rules (as transposed by EEA countries) and cross-border price regulation;

- Standards: Interoperability across SEPA in the following four domains: cardholder to terminal interface, card to terminal, terminal to acquirer interface and acquirer to issuer interface. All domains are handled by different standardisation initiatives. Except for the acquirer to issuer interface covered in the SCC framework (see chapter 6.2.3), none of these is examined hereafter due to being out of scope for this thesis.

Further, in 2008, the ECB announced Terms of Reference for the SEPA-compliance of infrastructures applying essentially to IFTSs, as defined in chapter 2.1.3. The Terms of Reference contain four key criteria and were first published in the 5th Progress Report on SEPA (ECB, 2007c, p. 18). They require complying with the EPC's SCT/SDD rulebooks, the PE-ACH/CSM Framework and accompanying implementation guidelines, as well as ISO 20022 XML message standards by January 2008. The other three principles demand (i) interoperability between IFTSs for the sending of SCT/SDD transfer orders, (ii) reachability for these

messages to and from banks[253] across SEPA and (iii) free choice of banks for an infrastructure provider. By separating scheme (SCT/SDD) from infrastructure, the SEPA objective of fostering competition and efficiency through interoperability and exploitation of economies of scale is enforced. IFTSs shall declare their adherence to the four principles on a regular basis on their websites, based on a self-assessment.[254]

6.2.3 Standardization industry initiatives

In this chapter, the standards set by the EPC are examined. Since the ECB Terms of References for card schemes and infrastructures largely include the SCF- and PE-ACH/CSM requirements, only complementary explanations are provided. The SCS on cards standardisation and SCC on cards clearing are also briefly dealt with. As in the previous chapter, only main provisions are presented.

In contrast to SCT/SDD schemes, the SCF rather contains high-level principles to be implemented by banks, payment institutions and card schemes. It aims at supporting the achievement of the SEPA objectives, outlined in chapter 6.1. Emphasis is laid on interoperability ("any card at any terminal") and enhanced competition between card schemes and infrastructure providers, such as ACHs or card scheme processing platforms.

The SCF envisions that banks and payment institutions issue SCF-compliant cards from January 2011 onwards, as outlined in its chapter 2. At the same time, chapter 2 SCF requires that ATMs and POS terminals are able to handle transactions generated by these cards. The necessary standardisation decisions are compiled in the SCS, dealt with below. Banks and payment institutions are expected to ensure that card schemes they participate in seek SCF-compliance, as described in chapter 3 SCF. Here, a "consistent payment and cash withdrawal service

[253] The reference to banks instead of PSPs including payment institutions has not been updated.

[254] As with the terms of reference for SEPA-compliant card schemes, a list is available at the ECB's website comprising of Bankart (Slovenia), BORICA-BANKSERVICE (Bulgaria), CEC (Belgium), DIAS (Greece), EBA Clearing, EKS (Latvia), Equens, Eurogiro (giro network originally created by European posts according to http://www.eurogiro.com/index.php/en/about-eurogiro/the-company), Iberpay (Spain), ICBPI/BI-COMP (Italy), KIR (Poland), RPS (Germany), SIA-SSB/BI-COMP (Italy), SIBS (Portugal), STEP.AT (Austria), STET (France) according to https://www.ecb.int/paym/sepa/elements/compliance/html/index.en.html (retrieved 2013, February 28).

experience throughout SEPA" for European consumers is requested. It is suggested that card schemes investigate non-competitive elements of their rules and work towards common core services to be provided at SEPA level contributing to such a consistent experience.

The SCS specifies technical, functional and security requirements (standards), as well as the certification process. It aims at ensuring interoperability and a gradual convergence of these standards across the card value chain. Hence, (i) manufacturers of payment cards, POS terminals and ATMs, (ii) card schemes, issuers and acquirers, (iii) providers of processing services including authorisation and IFTSs, as well as (iv) certification entities decide whether to comply with these standards (section 2.2.3.1 SCS). In this case, they can avail themselves of being SCF-compliant – as a result of a self-assessment process. The final version to be implemented by market participants is planned for early 2014.[255]

Finally, the SCC Framework issued by the Berlin Group is based on the EPC's PE-ACH/CSM Framework is briefly touched upon. A comprehensive overview is provided in a briefing issued by the Bundesverband Öffentlicher Banken Deutschlands (2011).[256] According to this, the framework complements the existing EPC standards, and enables full straight through processing for clearing between issuing and acquiring banks (payment institutions are not mentioned) and ACHs, or other multilateral clearing and settlement arrangements. Adherence to it, however, is not mandatory, but subject to the participating banks' decision.

In its 2009 White Paper, the Berlin Group envisions the drafting of the SCC Framework and outlines its basic idea (Berlin Group, 2009, p. 8): Until today, the domestic card schemes of various European countries, such as Belgium, Finland, France, Italy and the Netherlands, use proprietary message formats to process card transactions. Yet, in other countries, such as Germany and Spain, card transactions are essentially handled as direct debits. In addition, cross-border card payments are performed by the networks of the ICSs – in case of co-branding – or by the interlinked network of EAPS. The latter already relies upon Berlin

[255] According to http://www.europeanpaymentscouncil.eu/article.cfm?articles_uuid=DE5636A7-5056-B741-DB7241A17C37CBE0 (retrieved 2013, May 10).

[256] The publisher, Bundesverband Öffentlicher Banken Deutschlands (Association of German Public Sector Banks), was closely involved in the mediation of this framework.

Group standards for bilateral processing. In the future, card payments in euro should be treated as direct debits throughout SEPA. The advantages would be twofold: A single message format based on open standards allows unbundling of card schemes. If SDDs and card payments are processed jointly, higher economies of scale may be realised. Consequently, infrastructure competition could be facilitated and processing costs driven down. Moreover, this approach eases the creation of a new SCF-compliant card scheme which would be in line with SEPA objectives. Unfortunately, is seems as if not much progress has been made so far towards a unified card payment message standards.[257] Consequently, there is still a lot to do to arrive at the vision of a more efficient payment cards market.

6.3 Remaining obstacles for an efficient payment mix and outlook

Throughout the previous discussion, the three key mechanisms justifying and driving the establishment of SEPA for cards based on changes in the regulatory framework emerged: higher efficiency, more competition, lower prices for users. This will be addressed in the first section of this chapter. In the final section, the SEPA for cards measures are assessed against the institutional drivers of higher card use at the POS.

Three SEPA key mechanisms: Efficiency, competition, prices

Efficiency is to be increased by enabling interoperability between network components, i.e. the four domains in the card payments process (see chapter 6.2.2), and in relation to clearing and settlement arrangements based on common standards. This can result in higher economies of scale if network capacities, for example at ACH level, are consolidated and more fully exploited. Industry experts are of the opinion that an ACH at least needs to process 10 bn payments per year to achieve sufficient economies of scale. This would enable it to operate at the same (low) unit cost levels as large players, such as STET and Equens (Mai, 2009, pp. 17-18 and A.T. Kearney, 2008, p. 6). Given 63 bn transactions in 2011 in the euro area, according to the SDW,[258] only a handful of providers are likely to survive in the long run. Smaller markets especially will tend to reallocate

[257] See http://www.berlin-group.org/implementation.html (retrieved 2014, January 1).
[258] http://sdw.ecb.europa.eu/ (data retrieved 2013, March 3).

payment volumes, in order to lower costs. The Finnish banking community, for example, decided to discontinue PMJ and use EBA's STEP2 instead (Federation of Finnish Financial Services, 2012, p. 10).

Building on these efficiency measures, competition can intensify at two levels, among providers of payment services and providers of processing services. At the first level, this situation is spurred by (i) introducing payment institutions to the (retail) market which has been dominated by banks so far and (ii) enabling the emergence of SEPA-domestic payment card schemes, in competition to the monopoly or duopoly of national and international schemes respectively. While most of PSPs now applying for a licence as a payment institute have been already in the market – often as an outsourcing partner of banks –, a number of new players are about to emerge.[259]

Most notably are initiatives from a number of telecommunication firms, merchants and transport companies, attempting to leverage their own customer base. For example, three of the four mobile network operators in the UK announced the formation of a joint venture working on a mobile wallet and NFC-enabled payment solution (see Box 1–1, p. 33 for definitions). The proposed solution is envisioned to replace consumers' physical wallets.[260] Yet, due to Article 28 PSD access to clearing and settlement arrangements is not completely on equal footing to banks. As a result, payment institutions in principle need to rely on banks or payment card schemes to process payments.

Two consequences possibly arise from this situation. On the one hand, banks could become commodity-type providers of processing services while the interface towards users would be occupied by new payment institutions providing innovative access solutions to traditional payment instruments. In this scenario,

[259] More information is available at http://www.paymentinstitutions.eu/about-epif/the-payment-institutions-sector/about (retrieved 2013, March 2), the website of the newly founded sector representation body, European Payment Institutions Federation (EPIF). See also http://ec.europa.eu/internal_market/payments/docs/framework/transposition/public_registers_en.pdf (retrieved 2013, March 2) for a list of national public authorities entrusted with keeping a register for payment institutions.

[260] See press release http://pressoffice.telefonica.com/documentos/nprensa/042_-_2011_Mobile_Marketing_and_Payment_JV_Announcement.pdf (retrieved 2013, March 2) as well as in-depth investigation of potential competition concerns and clearance (European Commission, 2012b and 2012c).

banks' revenues from payments would most likely shrink probably leading to lower prices for payment services overall. On the other hand, the dependence of payment institutions from competitors (e.g. banks or ACHs extending their value chain beyond processing) to process, clear and settle transactions may create an entry barrier which needs to be carefully assessed by competition authorities. Alternative ways to directly transfer funds from one individual user to another without involving established IFTSs are in principle conceivable. Yet, instalment of such a system appears rather difficult given concerns around security, misuse for unduly purposes and reachability of users, just to name a few.

With respect to (ii), it should be noticed that until today, no new influential European card scheme has materialised so far, despite strong encouragement by European authorities. The Payfair initiative (footnote 240) is attempting to create such a scheme, but is far from universal reach throughout SEPA. Another project by major German and French banks, Monnet, was not carried beyond the feasibility study.[261] Hence, the Commission states in its 2012 Green Paper that integration of this market is "far from complete"; prices for consumers and merchants have not adjusted downwards despite large volume increases and suspected scale effects (European Commission, 2012a). Following the subsequent consultation, it is expected that the Commission will propose further measures to enhance the situation. These could be directed at interchange fees, cross-border acquiring, separation of scheme management and processing, non-discriminatory access to clearing and settlement arrangements, co-branding between (former) domestic and international card schemes and substantiating the SCF.

Competition among PSPs such as ACHs and processing providers is encouraged by forcing to unbundle the scheme management from processing, and by offering processing services SEPA-wide. On the one hand, this will facilitate consolidation among PSPs, resulting in large scale effects and lower transaction unit costs. This option also includes that large banks may decide to attract transactions from others who wish to outsource their payments infrastructure. Such a development requires close observation by regulators as insourcing banks may become syste-

[261] http://www.cfo-insight.com/financing-liquidity/cash-management/payment-card-market-monnet-project-failed/ (retrieved 2013, March 2). Results of the feasibility study are documented in Capgemini Consulting (2008).

mically important ACHs and henceforth subject to the respective regulations (see Appendix A–2).

On the other hand, ACHs are seeking additional revenue sources given foreseen pressure on transaction prices. As they are entitled to apply for a payment institutions licence, they could opt for extending their value chain by targeting consumers directly. One example is MyBank,[262] an e-payments solution enabling consumers to pay at online shops using their familiar online banking environment (similar to the German "sofortüberweisung", as mentioned in Box 1–1, p. 31). In contrast to other solutions, this one was initiated by EBA Clearing, and thus benefits initially from a preferred relationship to a majority of European banks.

As a result of

(i) higher economies of scale and more competition, and

(ii) in response to Commission's rulings on ICS interchange fees, as well as

(iii) the required unbundling of services leading to more transparent prices,

impact studies expect payment services costs to decrease. This should ultimately result in lower prices for users, in particular for consumers (Capgemini Consulting, 2007 and Schmiedel, 2007). Nevertheless, from the two-sided markets literature, it is known that forcing down interchange fees and merchant service charges may lead to increases in prices for cardholders (see chapter 2.2.3). Hence, the overall effect of the prior described measures on consumers is not clear, and depends on the extent to which providers and merchants pass on cost savings down the value chain.

The Commission has announced that it will continue monitoring price developments.[263] Consequently, it asked the European banking industry[264] to provide key indicators that enable a proper understanding and comparability of prices and conditions applicable to consumers. If respective initiatives are deemed inade-

[262] Details are provided at https://www.mybankpayments.eu/Home-N=Home-L=EN.aspx and https://www.mybankpayments.eu/How-does-it-work-N=5417cf21-70d0-487b-ac5f-921605569fc0-L=EN.aspx (retrieved 2013, March 2).

[263] The comprehensive study by Van Dijk & CEPS (2009) on behalf of the Commission is seen as reference point for further monitoring prices for retail financial services.

[264] More specifically, the representative body European Banking Industry Committee (EBIC) was approached.

quate, the European Commission (2011, p. 13) reserves the right to undertake further actions, including a legislative proposal.

Linking SEPA for cards and determinants of payment choice

In this chapter, an answer for one of the original questions of this dissertation is thought for: Are the SEPA mechanisms appropriate to (i) alter the institutional environment in a way that payment card use is encouraged and (ii) consequently to contribute to a more efficient payment mix?[265] Consequently, Figure 6–2 (next page) was developed. It combines the different perspectives of the previous section as well as of chapter 4.6 and 5.6. Its structure mirrors that of Figure 4–2 and 5–9 (pp. 152 and 229). Subsequently, Figure 6–2 is explored step-by-step.

In a number of ways, the SEPA project improves the institutional environment such that payment card use is facilitated. Here, a triad of factors, namely cooperation, consolidation and competition is looked at.

First, cooperation among providers of payment services is encouraged, noticeable through the establishment of the EPC. Moreover, in a number of countries, national payment (SEPA) councils were formed to combine activities necessary to establish a harmonized euro payment area. Some banking communities, e.g. those in Belgium, the Netherlands and France, started early in 2003 and 2006[266] to set up dedicated governance structures with the aim to support SEPA implementation. This included intense communication directed towards various stakeholders, and in particular users. However, others such as Germany, have been waiting longer, in this case until 2011. It should be noted that in 2006, German

[265] For a more generic SEPA assessment and impact analysis see inter alia:
- Capgemini Consuling (2007) foresees up to EUR 123 bn societal benefits spread over six years mostly for consumers if SEPA is openly endorsed and implemented rapidly;
- Schmiedel (2007) confirms initial investment costs and reduced bank revenues while efficiency gains could diminish running costs after full SEPA implementation;
- Schäfer (2008) finds that highflying expectations on SEPA benefits might be exaggerated from a social welfare perspective and suggests the promotion of electronic payments;
- Kemppainen (2008) highlights that SEPA introduction may not lead to a fully competitive and integrated retail payment market; yet despite higher consumer prices, consumer surplus is expected to increase alongside a larger network size.

[266] See FEBELFIN & National Bank of Belgium (2008, pp. 4-6), http://www.nbb.be/DOC/ts/Enterprise/Press/2006/E/cp20060512En.pdf (retrieved 2013, July 5) and National SEPA Committee (2006, p. 37 and 2008, p. 5). Moreover, http://www.ecb.europa.eu/paym/sepa/pdf/SEPA_community_fora.pdf?98ecc022ec06f7f071e9b97dca541f49 (retrieved 2013, July 5) gives an overview on all national SEPA fora.

banking associations had set up a committee to facilitate SEPA implementation, which concentrated on the providers of payment services (mainly banks), but had seemingly underestimated the need to involve other stakeholders, i.e. users.[267]

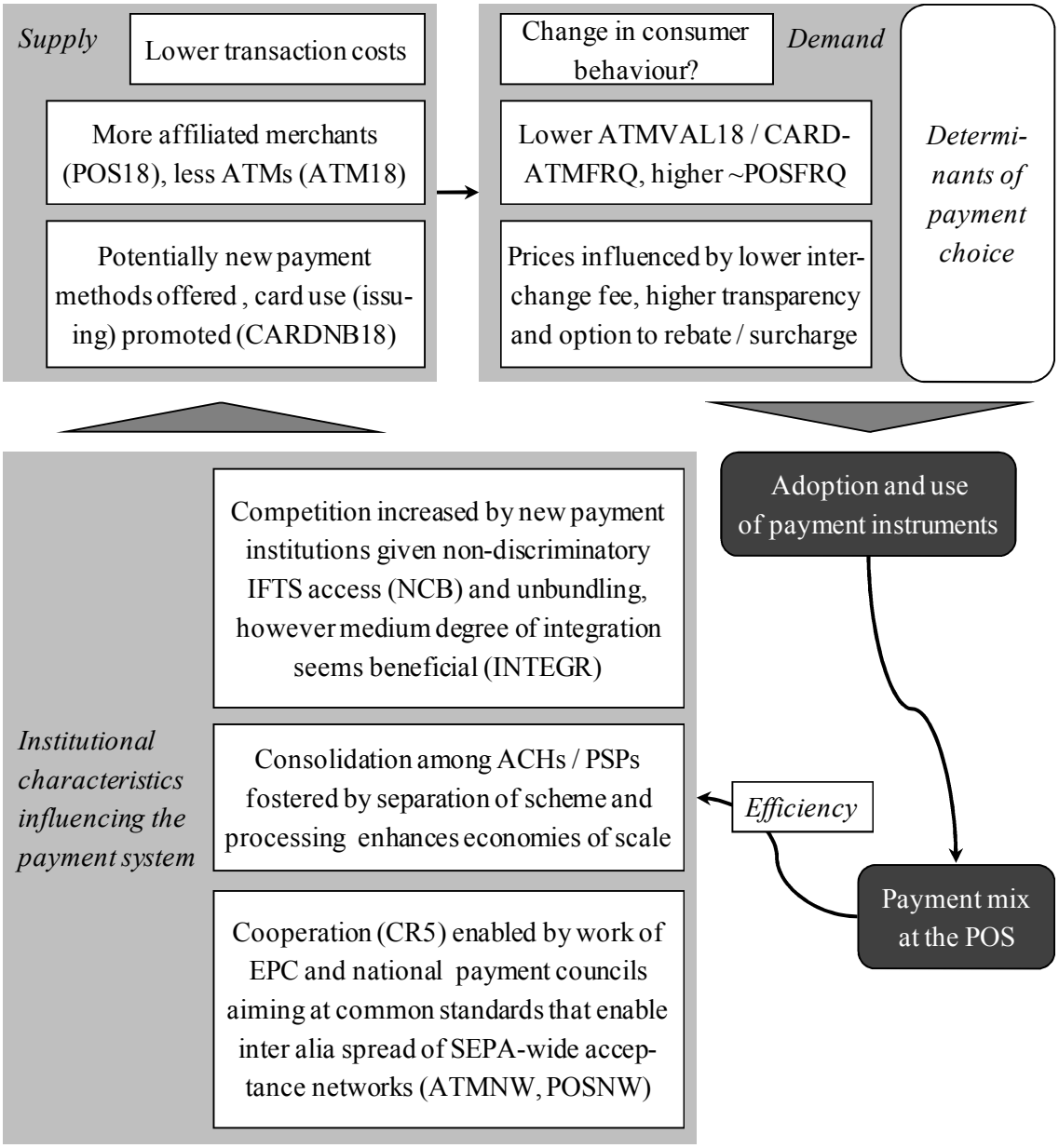

FIGURE 6-2: Impact of European payment harmonization on determinants of payment choice[268]

In the empirical part of chapter 5, a positive effect of CR5 on payment card usage was found. It was assumed that higher bank concentration facilitates the establishment of common standards as it may have helped coordination specifically within the national market. Now, with the SEPA project, the governance struc-

[267] http://www.bundesbank.de/Redaktion/DE/Downloads/Presse/Pressenotizen/2011/2011_05_31_sepa.pdf. For the SEPA-Komitee, see also Zentraler Kreditausschuss (2007, pp. 6-7).
[268] Own illustration.

ture set up by the EPC and national fora to guide these fairly informal processes, as described in the above paragraph, was geared towards the European market. In addition, the financial power and access to users united in these committees has paved the way to overcome start-up and coordination problems associated with the development and implementation of the new SEPA standards.

At the same time, the foundations for extending the acceptance networks for payment cards (ATMNW, POSNW) beyond national borders were laid. Enabled by European-wide standardisation, ATM and POS networks are now able to compete and grow beyond their national borders. Hence, scale economies might be better exploited due to the extension of the potential market on the one hand, while the new framework allows more competition on the other. In the empirical part of this thesis, it was found that there is indeed room for more than one network without harming card use especially with respect to POSNW, less so with ATMNW. Given interoperability of payment cards with the different networks, consumers could profit from this development and use their cards more often while merchants may also benefit from competition of acquiring networks.

Second, as indicated in the first part of this chapter, consolidation among PSPs and ACHs could be one outcome of the SEPA initiative. Already Humphrey and Vale (2004) suggested that measures to enhance the payment system's efficiency should be geared towards consolidating providers of payment services (chapter 3.1.2). At the level of clearing and settlement facilities, the advantages of increased economies of scale and subsequent lower transaction prices could be demonstrated in chapter 3.1.1 and in the previous section. The requirement to separate the management of a payment scheme from the processing of respective transactions enables these developments.

Nevertheless, there is a flipside to it. Empirically, it was shown, that a medium degree of vertical integration (INTEGR) has been beneficial for the success of card payments. Given full separation, it is acknowledged that issuers, for example, can now source distinctive parts of the card payments value chain independently, tailored to their needs and that of associated card holders. Such a setting has the potential to improve transparency and intensify competition, thus con-

tributing to lower prices compared to a bundle of scheme services. Nonetheless, the handling of interfaces becomes more complex; the higher effort may even outweigh potential cost savings. Taken together, this notion could explain why card schemes are tending to only legally separate scheme management from processing, and offer some of the components to the market, while keeping all entities together under the same holding (see chapter 5.3.2 for examples). Besides, it seems as if no standardisation rules have been fixed for authorization messages so far. For a complete unbundling of scheme services, this would be necessary.

Another aspect to be considered in this section is the introduction of new providers, i.e. payment institutions into the market, which will foster competition for users of payment services. The possible impact on banks, such as the potential commoditisation of processing and related transaction services, and with respect to the dependency on potential competitor's clearing and settlement facilities was already explored in the previous section. So far, the outcome of the two counteracting trends is difficult to assess.

It could be argued that participation of national central banks or the ECB in ACHs could solve potential access discrimination issues. Yet, from the empirical part of this thesis (NCB variable) it is known, that national central banks are better advised not to intervene, as transaction prices are likely higher. Until now, national central banks and the ECB have been acting as catalysts to spur payment systems' development and set the right framework for providers and IFTSs. It is believed, that this understanding of the central banks' role has been beneficial.

Three other determinants belonging to the institutional environment have been found to influence payment choice: CONS18, UNEMPL and RDEXPGDP. If the societal savings foreseen by some impact studies (see footnote 265) were realised, this could have a positive effect on GDP, and subsequently on consumption and unemployment. Empirically, RDEXPGDP was found to foster card use, but is not addressed in any way by the SEPA project. The emergence and European-wide dissemination of new payment methods could be spurred if concrete measures were taken following the publishing of a Green and a White Paper on e- and/or m-payments by the Commission and the EPC respectively (European

Commission, 2012a and EPC, 2012). Overall, the impact of the new payments framework on these three determinants appears rather limited and, if at all existent, hard to prove.

As explored before (chapter 4.6 and 5.6), the institutional environment shapes the supply of, and thus the demand for, payment services. With respect to SEPA for cards, a number of inferences can be made. First, competition is fostered between and among established and new payment services providers, e.g. banks, payment institutions as well as card schemes. One result could be that card schemes and issuers promote card use, for example by issuing more payment cards with user friendly features (such as NFC technology). Payment institutions may try to become established in the market, either by issuing their own payment cards or by inventing new payment methods which initiate, for instance, a card transaction, an SCT or SDD. Thus, overall, CARDNB18 is likely to increase. Further, stronger competition in the acquiring field may lead – in combination with potentially lower processing costs – inter alia to lower prices for merchants. As a consequence, they may be more inclined to accept payment cards, POS18 will probably increase.

Second, given higher acceptance and card numbers, users tend to use their payment cards more often at the POS (CARDPOSFRQ) to the detriment of cash leading to more efficiency in retail payments. If this development is seen in conjunction with the invention of new payment methods that could replace cash, the need for obtaining cash diminishes. Thus, less ATMs are needed, the value withdrawn at ATMs and the frequency of trips to the ATMs would possibly be reduced. In the empirical analysis, a positive relationship between theses three variables and payment card use was found. Hence, this observation (lower ATM18, ATMVAL18 and CARDATMFRQ) would at a first glance imply a decline in CARDVALCONS. Though, this outcome appears rather implausible.

Instead, a new scenario can be imagined in which consumers start to demand more of the new payment methods such as m-payments or transactions with NFC-enabled cards. Here, the importance of the three ATM-related factors of payment choice diminishes. Such a process could result in a complete new set-up

of the demand-side of the market. As of today, it is hardly possible to determine the likelihood of such a development.

Third, as a result of increased economies of scale in processing, clearing and settlement, payment costs could decay. Another reason could be seen in the expansion of card payments or new payment methods at the POS envisioned above. These are more efficient to process than other payment means. To what extend these options are leading to lower prices for consumers depend on a number of factors such as the degree of competition among merchants and among providers of payment services. Given a wide dispersion of prices across Europe as discussed in chapter 4.2 (see footnote 115 for references), some downward harmonisation to the level of lower price countries is expected.

The measures taken by the European Commission in this regard take three directions: forcing down interchange fee to lower merchant service charges passed on to consumers, increasing transparency of prices through unbundling of services and allowing rebates or surcharges to reflect the underlying costs for a payment. The idea is to enable users to make informed decisions and choose the most efficient payment instrument. It remains unclear whether consumers will indeed value higher transparency or surcharges. A number of payment services have been perceived as free by users as long as they were part of a service bundle with a specific price to it. So, if banks are urged to explicitly attach a price tag to, for example, a card transaction, card holders might be reluctant to use this service anymore.

A similar argument could be put forward for the issue of surcharging. Experience shows that merchants rather refrain from adding an extra charge to transactions, even if this reflects their own cost structure, out of fear to lose sales. Moreover, implementation of PSD surcharging rules has been patchy (see European Commission, 2010c, no 18) throughout the participating countries leading to consumers' uncertainty about what to expect at the checkout. Moreover, taking the two-sided nature of the cards market into account, forcing down interchange fee could mean higher prices for card holders. Overall, the European Commission's actions and the PSD requirements may not have the desired effect on payment behaviour.

Finally, will SEPA foster the use of payment cards and thus contribute to a more efficient payment mix at the POS? Certainly, the new European framework contains a number of elements suitable to enhance some of the determinants of card payment use and thus could spur a more efficient use of payment instruments. These are notably (i) coordination to implement common standards – a preconditioning element for the emergence of sufficiently large networks, (ii) higher efficiency in processing due to the realisation of economies of scale across SEPA, (iii) the enlargement of the POS terminal and payment card network as well as (iv) enhanced competition across the whole cards value chain. The impact of other elements, however, is more ambiguous. This applies not only to the separation of scheme management from processing as a medium degree of vertical integration was found to be beneficial, but also to the regulations around pricing.

The biggest uncertainty lies in the diffusion of new payment methods among users. Some might have the potential to "change the game", finally leading to a more efficient payment instrument use at the POS and thus lower costs of payments to society. It is acknowledged that experiences gained for the expansion of card payments and proved in the empirical analysis of chapter 5 are not completely transferrable to new payment methods (or instruments). Nevertheless, the principle mechanisms outlined above seem to hold valid: coordination to set common standards, a broad acceptance infrastructure and dissemination among consumers, competition among interoperable networks as well as a medium degree of integration of the payment scheme.

With respect to SEPA for cards, despite the different mechanisms in place and the effort undertaken by market participants and regulators, the card payments market is still fragmented. This leaves a lot of room for future investigations as regards the success of ECB's call to establish a genuine European card scheme (ECB, 2006b) or the effect of the Commission's Green Paper designed to encourage the integration of the European cards market and the dissemination of new payment methods (European Commission, 2012a).

Appendix

6.3.1 A–1: Credit- and debit-based payment mechanism

The credit-based payment mechanism is exhibited in Figure A–1 below, and typically initiated through a credit transfer or by using e-money. Following, information from Rambure and Nacamuli (2008, p. 28), Mai (2005, pp. 19-20) and Kokkola (2010, p. 29) are assembled and applied to the six payment process steps. It evolves as follows: After receipt of an (1) invoice for goods or services delivered, the payer places a (2) transfer instruction that requires his/her bank to transfer funds to the payee's account. Now, the payer's bank checks (5) the payer's identity, whether the instruction is valid (correctly formatted, containing a valid payee account number) and enough funds are available and (6) transmits the transaction information. Through a clearing and settlement arrangement, the settlement accounts of payer's and payee's banks are (7a) debited and (7b) credited respectively. To complete the payment, the payee's bank (8) ensures that the payee's account number is correct, and the account is still active. Finally, the banks (9a) debit or (9b) credit the payment accounts of payer and payee.

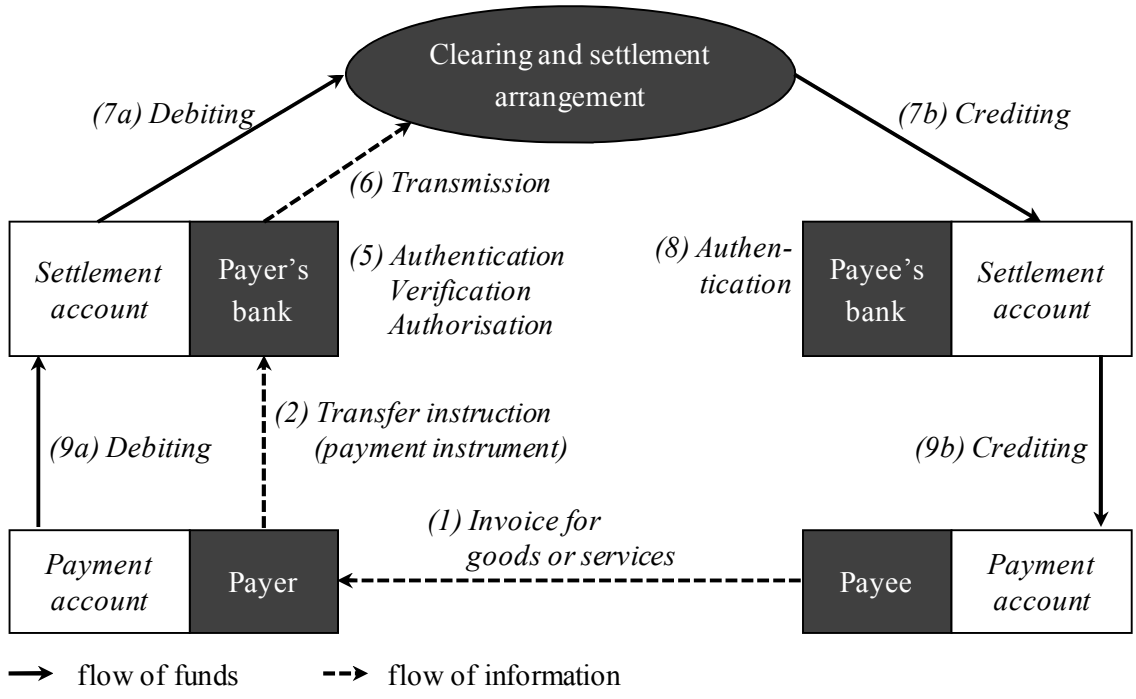

FIGURE A-1: Credit-based "push"-transaction[269]

[269] Own illustration, adapted from Kokkola (2010, p. 25, 29), Rambure and Nacamuli (2008, p. 28, 30) and Guibourg and Segendorf (2004, p. 5) to mirror the generic payment process.

Analogous to the credit-based mechanism, the debit-based payment mechanism is displayed in Figure A–2 below. It is used to handle direct debits, payment cards and cheques. Hereafter, the processing of all three payment instruments is depicted in a generalised form, based on Rambure and Nacamuli (2008, pp 26, 30-31 and 33), Mai (2005, pp. 21-24) and Kokkola (2010, p. 29) taking the generic payment process into account. After receipt of an (1) invoice for goods or services delivered, the payer uses one of the aforementioned payment instruments to initiate a (2) transfer instruction (or issue a mandate in case of a direct debit) that entitles the payee to request his/her bank to collect the agreed amount. Then, the payee's bank (3) checks the payee's account number and checks for formatting errors. For direct debits, the existence of a valid mandate is confirmed. Subsequently, the payee's bank (4) sends an authorisation request to the payer's bank, which then carries out step (5) and (6). Lastly, settlement and payment accounts are (7a) / (9a) debited and (7b) / (9b) credited accordingly.

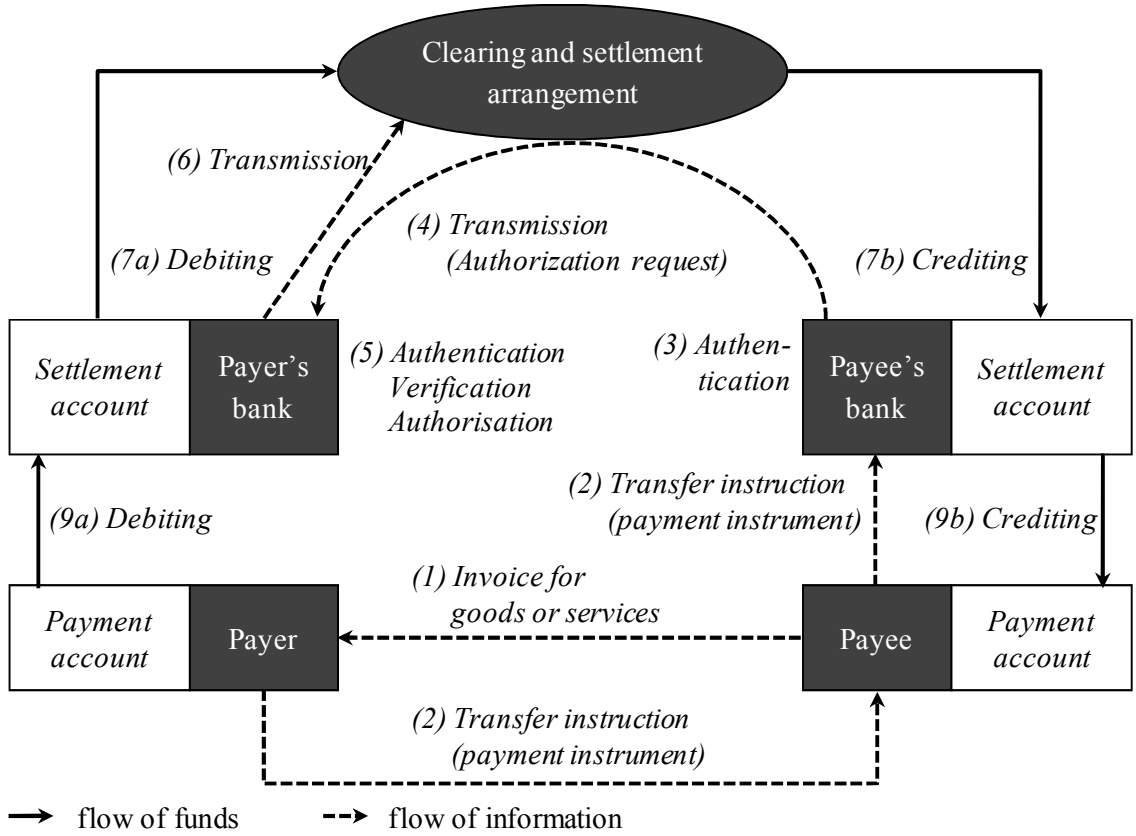

FIGURE A-2: Debit-based "pull"-transaction[270]

[270] Own illustration, adapted from Kokkola (2010, p. 25, 29), Rambure and Nacamuli (2008, p. 28, 30) and Guibourg and Segendorf (2004, p. 5) to mirror the generic payment process.

With respect to card payments,[271] it is worth mentioning that, depending on the type of card, the issuing bank either (9a) debits the payer's account directly, or at a certain monthly date. Otherwise, the payer repays the outstanding balance by initiating a credit transfer. Further, the issuing bank receives an interchange fee per transaction from the acquiring bank. The acquiring bank in turn (9b) credits the merchant's account with the purchase amount, less a merchant service charge. The European Commission (2006a, p. 34) states that this charge, paid by merchants for each transaction to their acquiring bank, covers the interchange fee, as well as other acquiring (processing) costs and a profit margin. Details on the function of interchange fees in card payments are provided in chapter 2.2.3.

Cash withdrawals are in principle conducted in the same way as card payments, through a debit-based payment mechanism. Acquiring banks or other providers operate automated teller machines (ATMs) as acceptance points (European Commission, 2006a, Glossary). ATMs allow cardholders, by utilising their machine-readable payment cards, to withdraw cash from their accounts and access other banking services (ECB, 2009a). Authorisation is granted based on PIN entry.

[271] Here, a high-level approach is taken concentrating on the principle payment mechanism shared between all debit-based payment instruments. To view the card payment process including PSPs refer to European Commission (2006a, p. 3) and Mai (2005, p. 24).

6.3.2 A–2: Multilateral settlement: Access, settlement assets and methods

Access criteria for IFTSs and participation levels

Membership and participation in an IFTS is governed by access criteria designed to control financial, operational and legal risk, as laid down by Kokkola (2010, p. 40). The system may set standards concerning, for example, the capital base, credit rating, transaction volumes, technical or operational capabilities, legal status and location of potential participants (members). Full access as a direct participant is usually restricted to banks, which thus gain a competitive advantage over nonbank PSPs in providing payment services (Kahn & Roberds, 2009, p. 4). Direct participants can place orders and settle directly with the IFTS through settlement accounts, which are held at the IFTSs' settlement agent. Indirect participants need to connect with a direct member acting as settlement agent, to transact and settle payments (ECB, 2009a).

Manning et al. (2009, pp. 171-173) discuss the advantages and disadvantages of such participation decisions. For banks processing large payment volumes and values, it is beneficial to directly connect to an IFTS and act as settlement agent for others. Not only are the high costs of infrastructure, personnel and IFTS' access spread over a large number of transactions. Liquidity can also be managed more effectively. On the contrary, direct participants need to closely monitor their customer banks (indirect participants), to limit credit risk arising from extending intraday overdraft facilities, to enable timely settlement (Manning et al., 2009, p. 179). Customer banks, on the other hand, depend on the direct participant's financial and operational resilience, to provide continued and uninterrupted transaction services. Further, as the indirect participant essentially assigns its liquidity management to the bank acting as settlement agent, it might experience constraints, in case of unexpected liquidity needs (Manning et al., 2009, pp. 180-182).

Settlement assets for large-value and retail payments

Settlement in IFTSs may take place in central or commercial bank money, as settlement asset. Whether central or commercial money is used depends on the regulatory framework and central bank policies, as well as on the design of the

various clearing and settlement arrangements in a currency area, and the preferences of its participants (CPSS, 2003d, p. 13). For the latter, the determining factors are primarily safety considerations, the credit and liquidity risks involved, neutrality requirements, as well as regulatory costs and benefits for participants, as suggested by CPSS (2003d, pp. 13-15): Relying on central bank money has some distinctive advantages, since it is safe, with apparently no credit risk involved. Furthermore, central banks can create liquidity to support settlement, by lending money to banks (in general against collateral). Central banks are neutral in providing their services, and do not compete with commercial banks. Finally, although banks bear regulatory and opportunity costs (for the provision of liquidity against collateral), once they maintain a settlement account with the central bank; these burdens are probably offset by the benefits of being moved into the central bank's safety net.[272]

For this reason, systemically important IFTSs, i.e. those capable of triggering disruptions or transmitting shocks across the financial system, always settle in central bank money. Thereby they conform to paragraph 3.0.2 and 6.6 of the BIS core principles for systemically important payment systems (CPSS, 2001). CPSS (2008, pp. 26-27 and 74-75) shows how risks are transmitted: An initial disruption, such as a credit, liquidity or operational failure might cause one or more IFTS participants not to be able to settle transactions, as expected. As a result, other banks might suffer a liquidity shortfall, or other losses that prevent them from meeting their obligations, leading to a (partial) gridlock situation. If banks participate in a number of different IFTSs, shortfalls could be passed on to participants in these other systems, and consequently disturb the financial system.[273] According to the core principles (CPSS 2001), IFTSs are likely to be systemically important, when they (i) are the only or principle system in a country, (ii) handle mainly payments of high value or (ii) settle financial market transactions or those of other IFTSs. As a rule, this holds true for all LVPSs. Besides, RPSs may also qualify as systemically important.

[272] A comparison of different policy approaches, with respect to the role of the central bank in providing interbank funds transfer services, is undertaken in chapter 0.

[273] Interdependencies between IFTSs and systems that support securities transactions and countervailing measures are summarised in CPSS (2008).

PSDG (2008, p. 41) reveals that there is an increasing tendency to clear and settle retail payments via LVPSs. This notion is supported by Skinner (2008, p. 12), who states that it is technologically feasible to process any payment in real-time at the same costs, given correct authorisation. As of today, the realisation of such views seems difficult, as costs per LVPS transaction are several times higher than at RPSs (see chapter 3.1.1). However, if fixed infrastructure expenses are spread over more transactions, by including retail payments, economies of scale are exploited, which could result in a sharp decline of unit costs.

Settlement methods for large-value and retail payments

Besides the settlement asset, the settlement method is decisive for the way an IFTS operates. Real-time and designated time settlement can be distinguished from gross and net settlement, resulting in four different settlement methods, as shown in Table A–1 below. The most common methods are designated-time net settlement (DNS) for retail transactions, and real-time gross settlement (RTGS) for large-value payments (Kokkola, 2010, p. 48). Both are explained hereafter.

Settlement method	Gross	Net
Designated-time (deferred)	Designated-time gross settlement	**Designated-time net settlement (DNS)**
Real-Time (continuous)	**Real-time gross settlement (RTGS)**	Hybrid systems

TABLE A-1: Settlement methods[274]

In DNS systems, the obligations of the system's participants are accumulated throughout a predetermined period (settlement cycle), netted on a bi- or multilateral basis, and settled at the end of that period. This gives rise to credit risks, as members may not be able to fulfil their net obligations at the end of the cycle, e.g. due to failure in the meantime (Manning et al., 2009, pp. 47-101).

RPSs often perform several settlement cycles during the day (Kokkola, 2010, p. 48), which helps to reduce intraday credit risk. Further, the BIS core principles require installing a number of risk mitigants, including the setting of bi- and multilateral net exposure limits, establishing appropriate access criteria, as well as agreements on loss sharing and collateralisation. Moreover, netting should be

[274] See Kokkola (2010, p. 48).

legally robust: once settlement is final, the payment should not be reversed, even in the event of insolvency of a system's participant (CPSS, 2001, paragraph 7.3.3, 7.3.5-7.3.7).

For large-value payments, there has been a marked shift away from DNS to RTGS systems, given the credit risks involved with deferring payments (ECB, 2008c, p. 8). RTGS systems settle each transaction individually, without netting in real-time, resulting in immediate finality of payments. Prerequisite is that participating banks have sufficient funds or overdraft facilities available. Therefore, participants' liquidity needs are several times higher than in DNS systems (Kokkola, 2010, pp. 51-52). If participants are not able to meet their obligations, a gridlock situation could arise: a substantial number of transfer orders are not executed, because of insufficient funds on some participants' settlement accounts that, if settled, would allow other participants' transfer instructions to be settled (Rambure & Nacamuli, 2008, pp. 16-17).

In order to decrease such liquidity risks in RTGS systems, central banks provide intraday credits to participants against pledged collaterals; hence, participants bear opportunity costs, as Kokkola (2010, pp. 52-53) indicates. The author lists a number of liquidity saving measures installed by RTGS systems and participating banks. These include, for example, the prioritisation, timing and queuing of payments, in addition to setting bi- and multilateral limits to control funds outflow. If – as another liquidity saving feature – payments are netted, a so-called hybrid system is created; CHIPS and TARGET2 for example resemble some characteristics of a hybrid system. In compliance with paragraph 7.3.4 BIS core principles (CPSS, 2001), LVPSs are typically organised as RTGSs, with the central bank acting as settlement agent and operator of the system (PSDG, 2011, pp. 14-15).

6.3.3 A–3: Statistical properties of variables[275]

Table A–2 to Table A–7 contain summary statistics for each variable used in the empirical analysis including mean, median, standard deviation (Std. Div.), minimum (Min), maximum (Max) and compound annual growth rate in % (CAGR).

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR
INH18								
BE	1990-2011	22	8.02	7.96	0.27	7.62	8.59	0.57
DE	1990-2011	22	65.73	65.73	1.33	62.95	67.60	0.34
ES	1990-2011	22	32.77	32.26	3.08	28.30	37.43	1.34
FI	1990-2011	22	3.98	3.97	0.14	3.77	4.22	0.54
FR	1990-2011	22	46.16	45.95	2.29	41.85	49.87	0.84
IT	1990-2011	22	46.72	46.42	1.71	43.69	49.49	0.59
NL	1990-2011	22	12.19	12.23	0.46	11.32	12.95	0.64
UK	1990-2011	22	45.24	44.77	1.63	43.22	48.58	0.56

TABLE A-2: Inhabitants older than 18 years

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR
CHVOL18								
BE	1990-2011	22	9.39	8.21	8.62	0.76	27.05	-15.66
DE	1990-2011	22	6.50	5.42	5.45	0.60	14.50	-13.45
ES	1990-2011	22	5.92	6.21	1.92	2.53	9.54	-6.13
FI	1990-2011	22	0.77	0.25	0.97	0.09	3.68	-16.20
FR	1990-2011	22	93.54	96.12	17.99	59.59	116.54	-3.14
IT	1990-2011	22	11.64	12.27	3.15	5.89	16.70	-4.84
NL*	1990-2011	22	5.49	0.80	7.78	0.00	22.98	-32.74
UK	1990-2011	22	53.39	58.84	18.11	19.97	74.78	-6.07
CARDATMFRQ								
BE	1990-2011	22	15.32	15.42	2.69	10.93	20.28	2.99
DE	1994-2011	18	17.19	15.90	2.83	14.78	22.89	-1.21
ES	1990-2011	22	14.69	14.40	1.67	12.42	17.79	-0.53
FI	1990-2011	22	50.64	55.74	17.74	21.09	80.32	-3.34
FR	1990-2011	22	26.53	28.96	5.80	18.16	35.88	-1.65
IT	1990-2011	22	10.90	10.26	3.25	7.24	17.56	0.70
NL	1990-2011	22	18.02	17.87	3.37	13.86	26.24	0.17
UK	1990-2011	22	20.82	19.92	2.17	17.69	24.84	-0.04

continued on the next page

[275] All tables in this section: own compilation.

CARDPOSFRQ								
BE	1990-2011	22	34.46	33.95	13.93	14.73	57.70	6.72
DE	1990-2011	22	13.57	13.98	6.74	4.24	22.57	8.29
ES	1990-2011	22	15.87	11.48	9.49	3.35	34.28	12.28
FI	1990-2011	22	97.12	82.68	36.06	44.31	152.01	5.73
FR	1990-2011	22	80.32	78.27	11.64	59.89	101.12	2.24
IT	1990-2011	22	14.10	16.55	6.74	4.25	23.36	8.44
NL	1990-2011	22	35.54	35.51	23.34	3.23	80.26	16.54
UK	1990-2011	22	39.88	39.59	12.28	17.56	67.25	6.60
* From 2002 onwards, no cheque payments occurred. CAGR was derived for the 1990-2001 period.								

TABLE A-3: Variables on payment instrument usage

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR
DEBITNB18								
BE	1990-2011	22	1.31	1.38	0.38	0.69	1.83	4.76
DE	1990-2011	22	1.14	1.33	0.40	0.38	1.54	6.92
ES	1991-2011	21	0.84	0.83	0.10	0.69	1.01	0.23
FI	1990-2011	22	0.64	0.65	0.19	0.34	0.99	4.85
FR	1990-2011	22	0.82	0.83	0.28	0.46	1.21	4.65
IT	1990-2011	22	0.48	0.47	0.20	0.15	0.76	7.94
NL	1990-2011	22	1.60	1.72	0.39	0.74	2.03	4.56
UK	1990-2011	22	1.11	1.16	0.45	0.44	1.78	6.88
ATM18								
BE	1990-2011	22	689	843	294	123	1,001	10.49
DE	1990-2011	22	650	753	211	180	834	7.59
ES	1990-2011	22	1,259	1,423	400	495	1,675	5.52
FI	1990-2011	22	512	532	97	398	737	-0.50
FR	1990-2011	22	766	784	276	345	1,166	5.98
IT	1990-2011	22	699	736	280	224	1,104	7.63
NL	1990-2011	22	537	575	126	239	683	4.51
UK	1990-2011	22	849	778	385	393	1,354	5.95

TABLE A-4: Diffusion of debit cards and ATM network density

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR
				CR5				
BE	1990, 1995-2011	18	72.44	76.37	12.89	48.00	85.29	1.87
DE	1990, 1995-2011	18	21.41	21.04	5.05	13.91	33.55	4.28
ES	1990, 1995-2011	18	41.86	42.75	4.45	31.40	48.10	1.54
FI	1990, 1995-2011	18	79.41	82.43	10.62	41.00	87.86	3.29
FR	1990, 1995-2011	18	46.24	46.92	4.18	39.50	52.33	0.61
IT	1990, 1996-2011	17	29.89	29.19	4.67	22.68	39.84	1.45
NL	1990, 1995-2011	18	82.13	83.13	3.78	73.39	86.75	0.62
UK	1995-2011	17	35.89	35.75	6.67	22.99	44.13	2.82
				$BANK_{dom}18$				
BE	1990-2011	22	9.19	8.85	2.77	5.59	13.88	-3.13
DE	1990-2011	22	43.24	38.77	15.18	26.51	72.98	-4.71
ES	1990-2011	22	7.89	7.04	2.43	5.03	11.56	-3.87
FI	1994-2011	18	82.05	83.24	7.01	68.21	91.80	-1.73
FR	1990-2011	22	13.58	13.57	2.25	10.31	18.62	-1.97
IT	1990-2011	22	18.10	16.64	3.42	13.60	24.38	-2.74
NL	1990-2011	22	9.69	9.65	1.81	6.33	13.52	-3.55
UK	1990-2011	22	8.62	10.23	3.21	4.22	12.45	-5.02

TABLE A-5: Banking sector competition

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR
				RDEXPGDP				
BE	1991-2011	21	1.86	1.86	0.13	1.62	2.07	1.16
DE	1990-2011	22	2.49	2.50	0.23	2.10	2.88	-0.06
ES	1990-2011	22	0.98	0.91	0.25	0.64	1.39	3.58
FI	1990-2011	22	3.00	3.33	0.72	1.51	3.94	4.46
FR	1990-2011	22	2.24	2.22	0.11	2.08	2.47	-0.40
IT	1990-2011	22	1.08	1.07	0.10	0.94	1.26	1.17
NL	1990-2011	22	1.92	1.92	0.09	1.77	2.17	-0.29
UK	1990-2011	22	1.83	1.80	0.11	1.69	2.09	-0.77

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PATENT18								
BE	1991-2011	21	1.86	1.86	0.13	1.62	2.07	1.16
DE	1990-2011	22	2.49	2.50	0.23	2.10	2.88	-0.06
ES	1990-2011	22	0.98	0.91	0.25	0.64	1.39	3.58
FI	1990-2011	22	3.00	3.33	0.72	1.51	3.94	4.46
FR	1990-2011	22	2.24	2.22	0.11	2.08	2.47	-0.40
IT	1990-2011	22	1.08	1.07	0.10	0.94	1.26	1.17
NL	1990-2011	22	1.92	1.92	0.09	1.77	2.17	-0.29
UK	1990-2011	22	1.83	1.80	0.11	1.69	2.09	-0.77

TABLE A-6: Innovation friendliness

Country	Years	Obs.	Mean	Median	Std. Div.	Min	Max	CAGR
CONS18								
BE	1990-2011	22	16,477	16,671	3,373	10,688	21,844	3.46
DE	1990-2011	22	17,137	17,483	2,304	12,413	20,856	2.50
ES	1990-2011	22	12,918	12,743	3,102	8,989	17,451	3.10
FI	1990-2011	22	16,715	16,316	3,963	10,351	23,803	2.52
FR	1990-2011	22	17,711	17,632	3,134	13,181	22,436	2.56
IT	1990-2011	22	15,598	16,010	2,928	11,298	19,704	2.47
NL	1990-2011	22	16,344	17,334	3,793	9,957	20,924	3.53
UK	1990-2011	22	18,987	20,871	5,235	11,106	26,468	3.32
GDP18								
BE	1990-2011	22	32,183	32,164	7,123	20,375	43,055	3.63
DE	1990-2011	22	31,023	31,562	4,788	18,782	38,352	3.46
ES	1990-2011	22	21,127	20,301	5,666	14,194	29,523	3.36
FI	1990-2011	22	33,390	34,210	7,875	19,466	44,850	2.10
FR	1990-2011	22	31,777	31,937	5,692	22,916	40,037	2.59
IT	1990-2011	22	26,094	26,432	4,661	18,975	32,213	2.13
NL	1990-2011	22	34,469	35,374	9,004	20,523	46,940	3.97
UK	1990-2011	22	31,041	34,269	8,522	18,608	44,009	3.19
UNEMPL								
BE	1990-2011	22	8.05	8.25	1.05	6.40	9.80	0.42
DE	1991-2011	21	8.42	8.50	1.47	5.50	11.30	0.35
ES	1990-2011	22	14.80	14.45	4.41	8.30	21.70	1.97
FI	1990-2011	22	9.92	9.05	3.44	3.20	16.60	4.33
FR	1990-2011	22	9.47	9.30	1.05	7.80	11.10	0.87
IT	1990-2011	22	9.00	8.65	1.57	6.10	11.30	-0.27
NL	1990-2011	22	4.56	4.45	1.18	2.50	7.10	-0.70
UK	1990-2011	22	6.80	6.45	1.74	4.70	10.20	0.71

TABLE A-7: Macroeconomic indicators

6.3.4 A-4: Unit root tests

Three types of unit root tests were performed: Levin, Lin and Chu (denoted LLC), as well as Fisher-type tests using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) method. These were chosen based on their suitability for panel data with a limited number of observations. The results for each series listed in the left column are shown in the table below. While the second to fourth column indicate results from testing the respective series in levels; the fifth to last column shows results for the series' first difference ($\Delta X = X_{it} - X_{it-1}$). No intercept or trend was applied, due to the small number of observations.

Unit root tests / variables	LLC	ADF	PP	LLC	ADF	PP
	Levels			First differences		
ATM18	0.242	8.548	1.666	-4.834***	56.572***	57.676***
ATMVAL18	6.231	1.481	0.941	-6.963***	77.206***	86.756***
$BANK_{dom}18$	-7.086***	85.103***	109.814***	--	--	--
CARDNB18	4.319	3.815	0.388	-5.185***	62.146***	66.875***
CARDATMFRQ	-0.400	24.007*	10.114	-10.952***	122.687***	135.739***
CARDPOSFRQ	10.878	0.529	0.492	-5.452***	68.888***	67.740***
CARDVALCONS	10.202	2.396	0.238	-2.922***	30.138**	51.340***
CHVOL18	-8.391***	125.992***	112.876***	--	--	--
CONS18	11.250	0.290	0.248	-5.481***	55.039***	55.001***
CR5	2.216	2.627	3.041	-8.426***	89.680***	87.346***
DEBITNB18	5.325	2.179	1.008	-4.349***	52.684***	65.378***
GDP18	10.071	0.425	0.343	-6.664***	68.495***	67.595***
PATENT18	2.244	3.197	2.051	-6.018***	62.245***	64.521***
POS18	5.373	1.296	0.332	-3.383***	38.901***	47.164***
RDEXPGDP	0.854	10.002	9.717	-8.584***	92.978***	95.715***
UNEMPL	-0.591	10.268	8.146	-7.757***	80.884***	63.742***

Automatic lag length selection based on Schwarz information criterion.
Newey-West automatic bandwidth selection and Bartlett kernel for LLC and PP test.
* / ** / *** Coefficient is statistically significant at 10% / 5% / 1% level.

TABLE A-8: Unit root tests[276]

[276] Own illustration.

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