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The Cost of Consumer Payments in Sweden[†]

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Abstract

We estimate the social and private costs of consumer-to-business payments in Sweden in 2009. The combined social cost for these payments was 0.68 per cent of GDP. At the point of sale, cash is socially less costly than debit cards for payments below EUR 1.88 (SEK 20) and credit cards below EUR 42.37 (SEK 450). The corresponding thresholds for the individual consumer are higher for debit cards and much lower for credit cards. Using unique survey data we show that consumers' payment behaviour is not consistent with what is socially optimal.

Keywords: Cash payments, Card payments, Credit transfers, Direct debits, Social costs, Private costs

JEL classifications: D12; D23; D24

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1 Introduction

Both in economics and real life we usually take efficient payment methods for granted, but the cost of making retail payments can be significant.[1] Both cash and electronic payments require an infrastructure but of a different kind and with different functions. The basic difference between cash payments and electronic or paper-based retail payments is that the former are immediately settled by the exchange of banknotes and coins while the settling of the latter requires intermediaries such as banks, clearing houses and settlement system operators. However, although cash payments are settled without intermediaries, the distribution of cash to users and the devolution of excess cash to banks etc. require a logistical system with transportation, cash depots and so on. Both cash- and non-cash payments thus depend on an infrastructure; an information-processing infrastructure in the case of non-cash payments and a mainly logistical infrastructure in the case of cash. Both these types of infrastructure are associated with substantial fixed costs and low marginal costs which give rise to economies of scale. The unit cost of production consequently falls as the number of payments processed increases. Costs also occur at the end users, i.e. the payer and payee, in terms of the time needed to execute the payment, back-office costs, equipment etc. In short, the characteristics of different payment methods differ, as do their cost profiles to all involved parties who may not internalize the effect of their choice on other parties, and the payment system may therefore not be utilized in the most efficient way. This paper analyses the social and private costs of different payment methods for payments from consumers and firms in Sweden in 2009. For cash and cards we also explore which payment method is most efficient as a function of the payment value.

We find that the social cost for payments by cash and debit- and credit cards is 0.54 per cent of GDP, of which 0.26 percentage points relate to cash, 0.19 percentage points to debit cards, and 0.09 percentage points to credit cards.[2] The social unit cost, or social average cost, for a cash payment was EUR 0.78 (SEK 8.30). The corresponding costs for debit cards and credit cards were EUR 0.42 (SEK 4.50) and EUR 1.10 (SEK 11.70), respectively. The total social cost for credit transfers was 0.1 per cent of GDP and the social unit cost was EUR 1.03 (SEK 10.90). The corresponding numbers for direct debits were 0.02 per cent and EUR 0.31 (SEK 3.30).[3]

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[1] Humphrey et al. (2000) estimated this cost to be as high as 3 per cent of GDP in the US.

[2] In 2009, Swedish GDP was SEK 3 106 billion (EUR 292.5 billion) (source: Statistics Sweden, National Accounts) and the average exchange rate SEK/USD was 7.6134 and SEK/EUR was 10.6191 (Source: ECB Statistical Data Warehouse).

[3] Contrary to the costs for cash and cards, the costs for credit transfers and direct debits do not include consumers' cost of time since we had no reliable data on this for these two payment instruments. For cash and cards this time cost was low, suggesting that an inclusion of consumers' time cost for credit transfers and direct debit would only have a small impact on the social cost for these payment instruments.

The unit costs above are calculated at the average transaction amount for each payment instrument. However, the social unit cost functions of the different payment instruments differ from each other because the payments are produced by different technologies. In the case of cash it is an increasing function of the transaction value, since a higher transaction value on average implies more handling of notes and coins among all the actors involved. Debit and credit cards have approximately constant social unit cost functions since an increase in the transaction value does not on average imply any extra administration or processing. Since cash and cards are close substitutes at the point of sale we investigated for what transaction values one payment instrument is socially preferable to another. We found that for low-value payments cash is more cost efficient than debit cards; the break-even point is estimated to be EUR 1.88 (SEK 20) and for credit cards EUR 42.37 (SEK 450). This contrasts sharply with the incentives of the consumer. According to the private costs of the consumer, cash should be preferred to debit cards for transaction values below EUR 16.29 (SEK 173) and EUR 0.38 (SEK 4) for credit cards. Using unique survey data, we estimate the probability that a consumer will pay with a debit card rather than with cash. This probability reaches 50 per cent at the transaction value EUR 7.91 (SEK 84). We show that consumers do not use cash and debit cards in line with what is socially optimal. In other words, consumers use too much cash by paying too often and too high values in cash. We also show that women do not use cash and debit cards in accordance with the economic incentives they are exposed to, while men seem to do so.

Our study contributes to the existing literature (see below) in two ways. First, and most importantly, by combining two unique data sets it goes beyond the standard calculations of social costs and thresholds by also testing two different hypotheses of what governs the consumers' choice of payment method. Secondly, it is a part of a group of country studies made by a number of EU central banks. These studies, each with a unique data set, cover the same type of payments over the same time period using the same methodology, which has been developed jointly and coordinated by the ECB.[4] This, for the first time, will allow for proper cross-country comparisons between Sweden and other countries. The unique combination of results on costs and behaviour enable a more comprehensive policy discussion.

1.1 Related literature

There is a small but growing body of literature on the cost of payments. However, the methodologies differ which makes it difficult to compare countries, or even the situation in the same country over time, and hence difficult to draw robust conclusions on the relation between costs and underlying factors. The literature on the cost of payments can be divided into subgroups. The first group, to which our study belongs, uses a cost and revenue model in which both costs and revenues for major stakeholders (central banks, banks, retailers, infrastructure providers, and sometimes consumers) are collected. The focus of these studies is mainly on payments at the POS (point of sale); i.e. payments made by cash, debit- and credit card, cheques and e-money. Examples of studies in this group are Banque Nationale de Belgique (2005), Bergman et al. (2007), Brits and Winder (2005), Danmarks Nationalbank (2012), Guibourg and Segendorf (2007) and Turján et al. (2011).

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[4] See Danmarks Bank (2012) for a detailed description of the methodology.

The second group of cost studies use an ABC (Activity Based Costing) methodology which allocates the cost of the activities to the different payment products and services within a bank in accordance with the volume of the different payment instruments considered. In addition to point of sale payment instruments, these studies often also consider direct debits and credit transfers. Examples of studies in this group are Banco de Portugal (2007), Gresvik and Owre (2003) and Gresvik and Haare (2009).

The differences in methodology and scope, i.e. which instruments, stakeholders and type of costs that are included, combined with the fact that they have often been conducted in different years, contribute to a large variation in the results, both between studies within the same literature subgroup and between subgroups. As an example, Humphrey et al. (2000) estimated the social cost of retail payments to be 3 per cent in the US while Turjan et al. (2011) found it to be 1.49 per cent in Hungary and Danmarks Nationalbank estimated it to be 1 per cent in Denmark. The social costs for payments at the point-of-sale were estimated to be 0.65 per cent of GDP in the Netherlands in 2002 (Brits and Winder (2005)), 0.74 per cent in Belgium in 2003 (Bank Nationale de Belgique (2005)), and approximately 0.4 per cent in Sweden in 2002 (Bergman et al. (2007)). In Norway, the banks' costs were estimated to be 0.49 per cent of GDP (Gresvik and Owre (2003)). In general our results are close to those of Danmarks Bank (2012).[5] Compared with Bergman et al. (2007) our methodology includes a broader range of costs, which largely explains why our social costs are somewhat higher. Our results on social costs are also broadly in line with the findings of other studies, given the differences in methodology and time period.

The social unit cost for different types of payments varies too; partly because of different methodologies and scope but also because of differences in the use of payment instruments in combination with substantial economies of scale in the production of payment services. De Nederlandsche Bank (2004) estimated the social unit cost per cash transaction to be EUR 0.30 and Brits and Winder (2005) found that the unit cost per debit card transaction was EUR 0.49. The corresponding costs in Sweden in 2002 were EUR 0.52 and EUR 0.34 (Bergman et al. (2007)), i.e. almost the opposite situation. In Belgium in 2003, the social unit costs of cash and debit cards were approximately of equal size, EUR 0.53 and EUR 0.55, respectively (Banque Nationale de Belgique (2005)). The differences between our results and the results of Bergman et al. (2007) partly reflect differences in methodology where we include a broader range of costs, but also the changed use of cash and cards which, through economies of scale, affects the cost functions of the different payment methods.

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[5] The joint methodology worked out by the ECB and a number of national central banks of the ESCB (European System of Central Banks) did not cover consumers' costs. Some countries, among them Denmark and Sweden, decided to include consumer costs but in different ways. One major difference in this regard is the valuation of consumers' time. Danmarks Nationalbank (2012) uses post-tax income while we use a lower time cost calculated by using an inventory model (Tobin (1956)). The time valuation is further discussed in the study and we sometimes also provide post-tax income based results in order to discuss the robustness of the results.

Ten Raa and Shestalova (2004) estimate the fixed and marginal (in the transaction value) social cost of making cash and debit card payments. They find that low fixed transaction costs favour cash for small transactions, while low variable transaction costs favour debit card payments for large transactions. The break-even point was EUR 30, or EUR 13 if the subsidies to cash by the central bank and other banks are included. Kaas Jacobsen and Mølgaard Pedersen (2012) found that the threshold value between cash and Dankort was EUR 3.90 in Denmark in 2009. Brits and Winder (2005) estimate this threshold to be EUR 11.63, not including consumers' costs. Bergman et al. (2007) estimated it to be EUR 7.8 for debit cards and EUR 17.6 for credit cards. Our result indicates that the social threshold between cash and debit cards decreased considerably between 2002 and 2009. This may partly be a consequence of differences in methodology but more likely the driving force is the increased economies of scale in card payments while cash usage has been decreasing.[6]

The outline of this paper is as follows. In Section 2 we give an introduction to the economics of payments, describe the method used to calculate private and social costs, and describe the data. The costs for payments at the POS are presented in Section 3 and the costs of remote payments in Section 4. The threshold transaction values are derived and tested empirically in Section 5. Section 6 discusses and concludes.

2 The economics of payments

The concept of economies of scope is related to the concept of economies of scale but where economies of scale refer to the production of a single product, economies of scope refer to a situation where the producer achieves the lower unit cost by jointly producing two or more different products. Economies of scope are common in payment intermediation because the infrastructure used to process one type of payment can often be used to process another type. A concrete example is the ACH (automated clearing house) which often process several types of payments on the same platform, e.g. cheques, credit transfers and direct debits, with the aim of reducing total costs by increasing volumes.

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[6] The number of card payment per capita increased from 66 to 182 between 2002 and 2009 (source: ECB Statistical Warehouse). There are no official statistics on the number of cash payments.

When analysing the costs of an industry, one must make a distinction between private and social costs. Private costs are the costs that individual participants incur, while the latter are the total costs to society reflecting the real use of resources in the whole production process, i.e. the value of the most valuable production where these resources could have been used if they had not been used in the production of payment services. However, payment services are produced in a supply chain and one cannot simply add all participants' private costs since this may overestimate the true amount of real resources that has been used in the process. For example, the cost of real resources used for transporting cash is borne by the CIT (cash-in-transit company) that produces the transport services. This includes wages, cars, fuel, etc. If these services are bought by a bank, the bank will report the fees paid to the CIT as a (private) cost even though it has not used any real resources of its own for the transport. Furthermore, if a merchant buys the services via a bank, the merchant will also report fees paid to the bank as a cost. Simply adding up private costs may consequently give rise to double counting of the cost of consumed real resources (at market prices). In order to focus on the cost to society one has to eliminate fees paid between the actors involved. Also, due to the presence of economies of scale (and possibly of scope) the market is not likely to be perfectly competitive and one cannot use the fees paid by the merchant to accurately measure the value of the real resources used in producing the underlying services.

The main actors in both cash and non-cash payment markets are to a large extent the same; the general public, firms, banks, sub-contractors and the central bank (see Figure 1). In order to have a generic model for all payment services we let the difference between the different markets be captured by the so called sub-contractor, which here acts as a residual for all the other parties involved. In the case of cash, the main subcontractors are depot owners and CITs that logistically handle cash. In the market for non-cash retail payments, the main sub-contractors are ACHs and switches that process, convert, and direct information.

In Figure 1, the capital letters A to E represents the total private costs of each sector, respectively, i.e. costs for own resources and services bought. The arrows (capital letters F to K) represent payments for payment-related services. In the cash-related example above, D is the cost of the CIT, C is the total costs reported by the Swedish banking sector in relation to cash and J is the fees paid to the CIT. H is the banks' revenue for cash services delivered to firms and B are the total private costs of firms (including fees paid). Clearly, adding up the total costs for CITs, banks and firms gives B+C+D but this includes a double counting of transportation costs. The value of consumed real resources is (B-H-I)+(C-J)+D. Eliminating the fees paid between all the actors involved gives that the social cost for cash is total private costs minus total fees paid; (A+B+C+D+E)-(F+G+H+I+J+K). Table 1 provides an overview of how to calculate the private cost, net private cost, and real resource consumption for each party in the payment chain and how to aggregate this to achieve the total social cost to society. Note that in the case of cash one has eventually to correct for seignorage (denoted S, see below) if seignorage costs have been included in the private costs for all other participants than the central bank.[7]

Figure 1. The retail payment market.

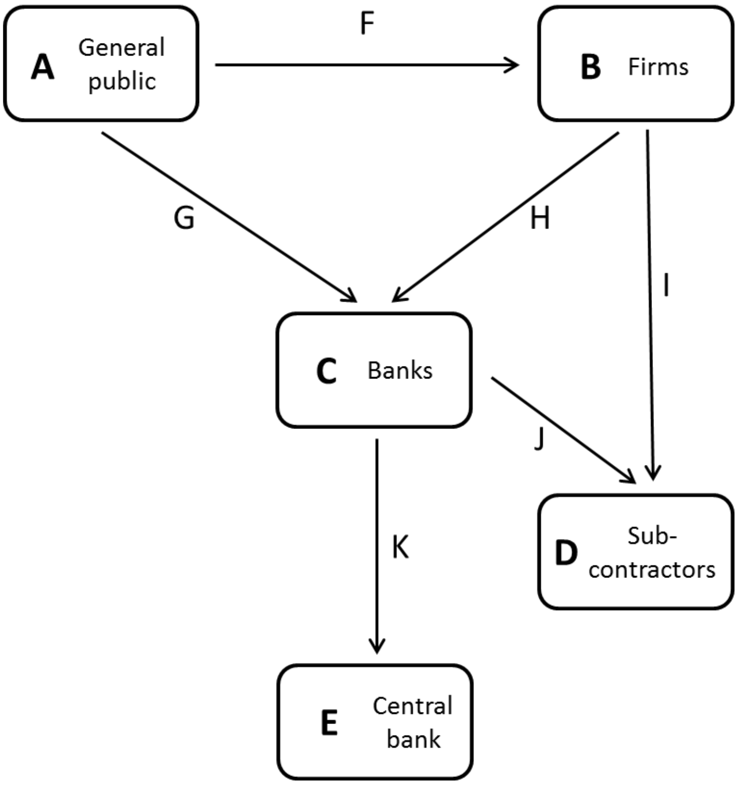

Table 1. Schematic calculation of private costs, private net costs and own production costs for individual sectors and for the economy as a whole.

	Private cost	Private net cost	Own production cost
General Public	A	A	A-F-G
Firms	B	B-F	B-H-I
Banks	C	C-G-H	C-K-J
Sub-contractors	D	D-J-I	D
Central bank	E	E-K	E
Sum		(A+B+C+D+E)-(F+G+H+I+J+K)	(A+B+C+D+E)-(F+G+H+I+J+K)
Correction for seignorage (cash only)		-S	-S
Social cost		**(A+B+C+D+E)-(F+G+H+I+J+K)-S**	**(A+B+C+D+E)-(F+G+H+I+J+K)-S**

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[7] Central bank seignorage is the difference between the interest earned on securities acquired in exchange for banknotes and coins and the central bank's costs for producing and distributing the notes and coins in question. Seignorage was deliberately left out of Figure 1 in order to simplify the figure.

Notice that both counterfeit cash and other types of fraud are to be considered as private and not social costs since they are in essence a monetary transfer between the swindler and the swindled. Counterfeit and fraud only give rise to social costs if they affect the behaviour, and thus the use of real resources, of the market participants. Similarly, seignorage (i.e. the private cost in terms of foregone interest of holding cash) should be treated as a transfer from all other sectors in the cash payment chain to the central bank. Hence, if seignorage is included in the private costs A to D one has to correct the calculated social cost by deducting the seignorage (denoted S in Table 1) from the sum of private net cost and own production cost.

2.1 The Swedish retail payment market

As mentioned earlier, this study is restricted to the study of P2B (person-to-business) payments. This type of payment can be divided into two categories; (i) payments at the POS comprising foremost cash- and card payments and (ii) remote payments comprising foremost credit transfers and direct debits but also card-not-present payments for purchases made over the Internet. Cheques could be used both for POS- and remote payments but they are rarely used in Sweden and are therefore not included in this study.[8] For POS payments, debit cards were the most used payment instrument in 2009, followed by cash and credit cards where credit cards comprises both credit cards and delayed debit cards, see Table 2.[9] Our data does not allow us to distinguish card-not-present transactions from card POS transactions and all card payments are in the following treated as POS payments. The most prominent payment method for remote P2B payments was credit transfers followed by direct debits.

Table 2. The value, volume and average transaction value for different P2B payment methods in Sweden in 2009.

		Cards				
	Cash	Debit	Credit	Total	Credit transfers	Direct debits
Value (SEK, billions)	261	550	123	673	491	232
volume (million)	1034	1337	240	1577	274	190
Average transaction value (SEK)	252	411	513	427	1792	1221

Source: Sveriges Riksbank (2011) and own estimations.

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[8] Only 1 million transactions were made using cheques in 2009, see Sveriges Riksbank (2011), Table X.

[9] In a debit card payment, funds are directly drawn from the payer's account and within a day or two credited to the payee's account. Debit cards do not provide any kind of credit. A credit card payment is similar to a debit card payment except that the funds are not immediately drawn from the payer's transaction account. Instead the purchases are gathered together and the consumer is billed at the end of the month. In this sense the consumer is given interest-free credit for an average of 45 days. Credit cards and delayed debit cards both work in this way but the difference is whether the consumer has the ability to roll the credit over (credit card) or has to pay in full after having being billed (delayed debit).

Payment data is usually accounted for on a national level and not broken down in categories such as P2B payments. The figures in Table 2 will therefore differ from what typically can be found in other sources such as the Red Book or the ECB's Statistical Warehouse. Nor is payment data generally reported in this format to the Riksbank. For a more detailed description of the data in Table 2, see Annex 1.

2.2 The data sets

We use two different and unique data sets. The first data set, on costs, value and volume for the various payment instruments was collected from the Riksbank, CITs, banks and firms during the period August 2010 to November 2011. The methodology for the data collection was constructed jointly in an umbrella project by a number of EU national central banks and the ECB, see Turjan et al. (2011) and Danmarks Nationalbank (2012). Cost data for the Riksbank and the CITs covers 100% of the market in their respective sectors. In the case of banks, and depending on which payment method is considered, the sample comprised approximately 81-94% of the market.[10] Non-sampled banks were relatively small and often local, regional or specialized in business areas. Costs have been scaled up to sector level by assuming that the non-sampled banks have the same cost structure as the sampled banks, i.e. that they use a similar production technology.

In the case of firms, data from 2010 was collected through interviews with 11 firms.[11] [12] The firms were selected to generate a spread over different sectors in the economy (based on SNI-codes used for statistical purpose).[13] Their turnover ranged between SEK 90 million and SEK 20 billion, some of them having a nation-wide presence while others only being active in one of the major cities. This means that larger firms are over-represented in the sample. This allows us to capture a large share of the transaction while we believe that this will only have a small impact on social costs. First, most sectors in the Swedish economy are highly concentrated. As a rule of thumb, we found that approximately 20 to 25 per cent of the firms tended to account for approximately 75 to 80 per cent of the turnover. Secondly, the set of technologies for receiving payments is rather limited. As described above, the banking sector offering such services is concentrated and the diversity of services is therefore limited. Another factor limiting the set of technologies is that only cash registers approved by the Swedish Tax Authority can be used.[14] Given the limited set of technologies, an over sampling of larger firms should have at most a very limited effect on the calculated social costs. However, larger firms should in expectation pay lower transaction fees to the banks since the bargaining power of the firm vis-à-vis the bank is likely to be positively correlated to the size of the firm. We may consequently underestimate fees paid by the corporate sector. However, as described earlier in Section 2, one has to subtract fees between different actors from their private costs when calculating the social cost. The size of the fee should therefore not affect the results on social welfare.

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[10] The sampled banks' had the lowest market share (81%) in the market for credit card payments and the highest (94%) in the market for debit card payments. Market shares were calculated as an average of their market shares in total value and volume in each type of transaction.

[11] The interviewed firms claimed that their costs for payments were the same in 2010 as in 2009. Interviews were conducted in 2011 and the data from 2010 was more easily accessible and fresher in the minds of the interviewees than data from 2009. The decision to use corporate data from 2010 instead of 2009 was based on these reasons.

[12] As an alternative, we considered to send questionnaires by mail only. Experiences with very low response rates in some other countries using the same methodology made us opt for interviews. In essence, we had to choose contacting a larger number of firms by mail only with a low expected response rate and to contact a smaller number of firms in person and have a higher expected response rate. Interviews also allowed for a discussion regarding some cost elements and therefore a better understanding on our part. Approximately 50% of the contacted firms agreed to participate.

[13] More information on SNI Swedish Standard Industrial Classification 2002 can be found in Statistics Sweden (2004) or on the web page of Statistics Sweden, www.scb.se

In order to aggregate firm-level data to sector-level data and then to country-level figures, we constructed weights from both turnover and household consumption. First, the corporate sector was divided into subsectors by the expected payment pattern for different types of consumption, i.e. consumption with the same expected payment pattern, such as foremost cash and/or card, foremost credit transfers and/or direct debits, large or small payments etc. This can be done because cheques are not used in Sweden, nor are cards used to pay household bills. The size of each such payment-pattern determined subsector was determined by the size of the relevant household consumption.[15] In this way the size of the sector should match its share of the value of person-to-business payments. However, on the firm level we could not consistently distinguish person-to-business payments from business-to-business payments, we had to use the turnover of each firm to relate its size to the size of the sector. The aggregate cost for each payment instrument was then calculated by assigning weights to the relevant firms as a function of their turnover and the size of the relevant subsector. As a test we compared the predictive power of the set-up described above on known payment volumes and values (given in Table 2) with set-ups based on SNI-code constructed subsectors using (i) data on both consumption and turnover or (ii) data on turnover only. It turned out that our payment-pattern based set-up had a somewhat better predictive power in terms of average deviation in per cent from the benchmark compared to the SNI-code based set-ups. In general, the aggregated cost for the corporate sector tends to be somewhat lower with our method, see Annex 5.

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[14] This requirement is laid down by law (see Lag (2007:592) om kassaregister m.m.) and further specified in regulations issued by the Swedish Tax Authority. In essence, for POS payments, with few exceptions firms are required to have tax registers that are difficult to manipulate and that store encrypted transaction information that only the tax authority has access to. See Skatteverket (2009a) on the requirement to have certified cash registers and on the technical requirements for such cash registers, see Skatteverket (2009b).

[15] Statistics Sweden; Expenditures per household (0-79 years)(HBS) - disposable income and type of expenditure. (Survey) Year 2006-2009.

The second data set contains household payment data and was obtained through a telephone interview survey conducted in 2010.[16] 1,220 respondents were asked about the characteristics of their latest payment (purchase amount and instrument of payment) and about their individual characteristics, such as age, income, and household size. This payment data allowed us to calculate the volume of cash transactions and to test our two hypotheses on consumers' choice of payment method.

Consumers' opportunity cost of time has been calculated by using an inventory theoretic model (see Annex 3). The household survey data, however, allowed us to construct an alternative measure of opportunity cost based on post-tax income data that is used to discuss the robustness of our results. These latter results are accounted for in Annex 5.

3 The costs of payments at the point of sale

Payments at the POS were almost exclusively made by cash, debit card or credit card. This section accounts for the costs of these payment methods.

3.1 The cost of cash

The Riksbank, CITs (including cash depots), banks, retailers, and the general public are the main actors on the cash market. In short, the Riksbank issues, and redeems, notes and coins. CITs transport cash to and from the Riksbank to regional and local cash depots which they also operate. They supply banks and retailers with cash, collect excess cash and daily takings. Banks supply the retail sector and general public with cash services such as ATM withdrawals and deposits. ATM is the main channel for the supply of cash to the general public. Retailers mostly receive cash from the general public but also, to a lesser extent, supply cash to the general public. The latter is done foremost via change in coins and small denomination notes. Some retailers also permit cash withdrawals through cards (so called cash-back). In figures, the value of notes and coins in circulation was on average SEK 106.5 billion of which SEK 10 billion were held by the banking sector. The public withdrew SEK 229 billion from ATMs and approximately SEK 31 billion in cash-back from merchants.[17] Estimated withdrawals and deposits OTC (over the counter) at banks of SEK 25-30 billion more or less cancel each other out. The cash turnover in the retail sector was thus SEK 260 billion and the net flow from retailers to banks and CITs was SEK 230 billion.

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[16] Markör Marknad och Kommunikation AB conducted interview surveys in the fourth quarters of 2009 and 2010 on behalf of the Riksbank. Data has not been published. We use the 2010 and not the 2009 survey since there is no data about the respondents' latest payment in 2009. In both 2009 and 2010, however, the respondents were asked which method of payment they primarily use for purchases of different sizes. In 2009 (2010), 35% (41%) answered that they primarily use credit or debit cards for payments below SEK 100, 78% (77%) answered that they primarily use debit or credit cards for payments between SEK 100 and 500, and 86% (87%) answered that they primarily use credit or debit cards for payments above SEK 500. In other words, for payments above SEK 100 the differences in the use of credit and debit cards between the 2009 and 2010 surveys are very small. For purchases below SEK 100, however, the respondents prefer to use debit and credit cards to a larger extent in 2010 than in 2009.

[17] For ATM withdrawals, see Sveriges Riksbank (2011) Table Y. The value of cash-back is estimated from consumer data obtained by the telephone interviews in 2009 and 2010.

The total private costs of the Riksbank in 2009 were SEK 240 million.[18] The costs (see Table 3) were for the procurement of notes and coins, vault and safe-keeping, destruction etc. of notes and coins and issuing and sorting. The Riksbank paid nearly SEK 30 million in interest rate compensation to the banks and SEK 6 million in fees to CITs. It received SEK 5.8 billion in seignorage and SEK 6 million in fees from CITs.

CITs had a total private cost of SEK 1.63 billion. The main cost element was the collection and transport of cash, including the maintenance and management of ATMs and cash deposit machines. Other main cost drivers were cash handling at the cash centres, security, clearing and settlement etc. The CITs received SEK 1.67 billion in fees, of which SEK 350 million came from the banking sector, SEK 5.5 million from the Riksbank and SEK 1.3 billion from other parts of the private and public sectors, foremost retailers. The CITs do not hold cash on their own books and consequently do not contribute to the seignorage.

The banking sector had a total private cost of SEK 3.4 billion including seignorage. The lion's share came from withdrawals in ATMs and OTC. Interbank fees for ATM withdrawals are not included in this amount since they represent a transfer within the banking sector. Deposits were also a major cost driver. These two items include fees to CITs of approximately SEK 350 million for collection, transport and ATM-related services. Regarding seignorage, the banks held 9.34 per cent (SEK 10 billion) of the cash that was in circulation. Consequently the banking sector carried a corresponding share of the seignorage, i.e. SEK 540 million.

The retail sector carried a large part of the costs for cash. Fees paid to banks and CITs for cash collection, supply of change, storage and safe keeping etc., amounted to nearly SEK 1.8 billion. Another main cost element was the on average 26 seconds it took for the cashier to receive a cash payment. Using the reported labour costs, including social security contributions, this translates into SEK 1.70 per cash payment. Hence, the total time costs for the estimated 1.034 billion cash payments were nearly SEK 1.76 billion. Back-office costs, which include emptying and balancing cash registers etc., were also time consuming and accounted for a large share of the total private costs of retailers. The cost of maintaining cash registers, changing paper rolls and so on was also significant. This item includes SEK 50 million that was reported as deficits in the cash registers. The deficit, however, is not a social cost but a transfer to consumers. Calculating the corporate sector's contribution to the seignorage is difficult. The daily taking in cash was only SEK 700 million and, combined with the need to hold change, this is not likely to add up to more than SEK 2 billion. Not all firms turned in their takings daily and in some cases firms may have held extra buffers. In total, we estimate that the corporate sector and the authorities held SEK 11 billion at most and thus contributed SEK 620 million at most to the seignorage. Recall that the lack of accuracy in the seignorage calculation does not affect the social cost since the seignorage does not represent a consumption of real resources.

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[18] Throughout the study, and to indicate the uncertainty of the figures, we have rounded off the cost figures as follows. For aggregated cost we have rounded off to the nearest SEK 10 million for large amounts, to the nearest SEK million for intermediate amounts and to the nearest SEK 0.1 million for small amounts. The figures for the central bank are sometimes expressed with a higher degree of precision reflecting the data accuracy of specific cost elements. Social unit costs are rounded off to the nearest SEK 0.1 and thresholds to nearest SEK 1. Any mismatches between tables and the text are due to the rounding off and to the fact that some minor costs are not mentioned in the text.

Consumers had three main costs; (i) periodical fees and transaction fees, (ii) time cost for paying and making withdrawals, and (iii) foregone interest on cash held. However, consumers rarely faced any transaction fees or withdrawal fees. Such fees were mainly charged for cashing payment notices or cheques. Periodical fees related to cash were calculated as total periodical card fees (estimated to SEK 4.1 billion) multiplied by ATM withdrawals as a share of total card usage (19 per cent). Regarding the time cost, consumers' cash payments and withdrawals occur during non-working time. Total working time is typically a predetermined discrete variable and in reality the consumer faces no choice between increasing her working time or making a payment. For this reason, post-tax income is not a good measure of the opportunity cost of time. Instead the time cost for withdrawals and POS transactions has been calculated using an inventory theoretic model (see Annex 3). This allows us to derive the time costs as a function of the observed payment behaviour and interest rates. In 2009, consumers' estimated time cost was low. This may partly depend on the unusually low deposit interest rate (0.27 per cent) which in the model lowers the time cost.[19] Consumers' contribution to the seignorage is calculated as total seignorage minus seignorage contributions from the banking- and retail sectors, i.e. SEK 4.6 billion. Consumers received a transfer from retailers of SEK 50 million in the form of too much change given back.

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[19] An interest rate of 2.5 per cent would have resulted in an almost 10 times higher cost of time, i.e. SEK 170 million.

Table 3. The main cost drivers (SEK million) for cash payments

Riksbank		**Firms**	
procurement	125	Fees to CITs and banks	1770
vault, safe keeping	50	time cost at cashier line	1740
interest rate compensation	30	back-office cost	2130
destruction, issuing, sorting	40	maintenance etc.	460
		seignorage	620
CITs			
collection, transport	1100	**Consumers**	
cash handling at cash centres	350	time cost at ATM & cashier line	20
security	60	periodical fees	770
clearing, settlement, etc	130	seignorage	4640
Banks			
withdrawals	2030		
deposits	410		
safe keeping/handling	70		
customer services	150		
management & monitoring	50		
seignorage	540		
other	110		

Summing up the costs of the different sectors gives a total private cost of SEK 17.4 billion. Subtracting seignorage and fees for cash services shows that the social cost of cash was close to SEK 8.6 billion which was equivalent to 0.28 per cent of GDP. Dividing the social cost with the volume of cash payments gives the social unit cost of a cash payment, SEK 8.30.[20] Table 4 gives an overview of the distribution of costs.

Table 4. The private and social costs of cash in Sweden 2009 (SEK million). The social cost can be read either as "net cost" or "consumed resources".

	Net cost	Fees received	Seignorage received	Private costs	Seignorage paid	Fees paid	Consumed resources
Riksbank	- 5 566	6	5 800	240	-	30	210
CITs	- 20	1 650		1 630	-	6	1 624
Banking sector	2 090	1 270		3 360	540	350	2 470
Retailer sector	6 720	-		6 720	620	1 820	4 280
Consumers	5 380	50		5 430	4 640	770	20
	8 604	**2 976**	**5 800**	**17 380**	**5 800**	**2 976**	**8 604**

Table 4 offers two ways of looking at the distribution of the social cost among the parties depending on whether paid fees or received fees are deducted from the private costs of each sector. In the column "Consumed resources" we have deducted the fees paid by each sector. This shows how much real resources each sector contributed to keep cash circulating in the economy. Consumers contributed least real resources simply because their valuation of time was exceptionally low in 2009. Also the Riksbank provided relatively little resources as its main activities were procurement and the wholesale distribution of notes and coins. For CITs, banks and retailers the consumption of real resources ranged between SEK 1.6 billion and SEK 4.3 billion. The resources provided by the CITs were mainly used for collecting and transporting cash. Banks' main costs were the management of withdrawals and deposits. In the retail sector, the main resource consumption was the time used for receiving payments and for back-office activities.

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[20] If pre-tax income had been used to valuate consumers' time, the social cost would have been nearly SEK 10 billion and the social unit cost would have been SEK 9.60. An interest rate of 2.5% in the inventory model would have given a social cost of almost SEK 8.8 billion and a social unit cost of SEK 8.50. More information on results in alternative scenarios is given in Annex 5.

The other way of looking at the distribution of social costs is given by the column "net cost" where the fees each sector receives are subtracted from its private cost. This shows the economic result of each sector from cash-related activities expressed as a net cost. A negative sign thus indicates a profit and the sum of all net costs adds up to the social cost of cash. It is worth noticing that only the Riksbank made a substantial profit from cash. The CITs broke even and the other sectors made a loss of between SEK 2 billion and SEK 7 billion. However, for banks it is difficult to define the exact scope of cash-related activities and therefore also to give an accurate estimate of the economic result. For example, to make a withdrawal you have to have an account at the bank. Much of the costs of administrating accounts are not accounted for, nor is the revenue from the interest rate margin on deposits. Here, the banking sector's loss from cash should be viewed as being the result of a narrow definition of cash-related activities. The picture might change if this definition is widened.

3.2 The cost of debit card payments

Several parties are involved in a card payment: the cardholder (payer), the merchant (payee), the cardholder's bank (card issuer) and the merchant's bank (acquirer) where the latter two may or may not be the same bank. In a debit card payment funds are directly drawn from the payer's account and within a day or two credited to the payee's account. Debit cards do not provide any kind of credit. Besides users and intermediaries, card payments require the involvement of processors of payment information; switches, clearinghouses etc. As described in Section 2.2, the data comprises the card holders (consumers), the corporate sector, and the banking sector. Regarding the costs of the infrastructure such as switches, clearing houses and settlement systems we have assumed that the fees paid to these entities reflect their true costs (including a reasonable profit reflecting the opportunity cost of capital). This assumption is well motivated for the ACH, switches, and the settlement system, which all operate on a cost-recovery basis and are often owned jointly by the banks. Debit cards had approximately 85% of the card market in 2009.

The total private cost of the banking sector for debit card payments was nearly SEK 3.5 billion. The main cost drivers are accounted for in Table 5. The first step in a debit card payment is authorization and debit control. This refers to the fact that the identity of the payer and her authority to initiate the payment must be verified. The bank must also check that the requested amount is available. The next step is clearing and settlement, here denoted payment processing, i.e. the debiting and crediting of accounts, settlement and so on. Interchange fees between banks have not been included in the processing cost. The reason is that interchange is a transfer between banks and it should not turn up as a cost on an aggregated level since the fee paid by one bank is a fee received by another. Besides the direct cost of the payment itself, acquirers incurred a substantial cost for managing the purchases, including costs for IT and telecommunication. Adding these costs gives that the banking sector's private cost directly related to the payment process was approximately SEK 2.3 billion. On top of this cost, banks incurred non-transaction costs such as marketing, card issuing, fraud prevention and handling, customer service and benefits of which SEK 40 million in essence was a transfer back to consumers, licenses to the card schemes, management of POS terminals, and management and monitoring of activities.

The private cost of the retail sector for debit cards was nearly SEK 3.9 billion. Major cost elements included fixed fees and transaction fees, where the latter amounted to approximately SEK 1 billion. The average transaction fee was nearly SEK 0.80 in our sample, but this may understate the true average transaction fee. The reason is that small and medium-sized retailers are underrepresented in our sample and that they were likely to have a weaker bargaining position vis-à-vis the banks and consequently more likely to have to pay a somewhat higher fee. Time in the cashier line for receiving debit card payments turned out to be an even bigger cost driver than fees. A card payment took on average 25 seconds which translates into a time cost of SEK 1.70 per payment.[21] Using the number of debit card payments (Table 2), the total time cost became nearly SEK 2.3 billion. Firms also had back-office costs for balancing cash registers etc. Fraud can be viewed as a fee (unwillingly) paid by retailers to consumers and it is here regarded as a transfer not to be included in the social cost. Retailers also reported lost sales due to down-time in the card infrastructure. This cost is disregarded since it only decreases the turnover at the point of sale if it increases the savings of households, i.e. if lost sales are not substituted by sales at another merchant or at a point somewhat later in time.

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[21] The rounded off time cost for debit cards is the same as for cash even though the time needed for a card payment is a little less than the time needed for an average cash payment. The reason is that the time and time cost are calculated as weighted averages and the wages in cash-intensive firms were marginally lower than in card-intensive firms.

As in the case of cash, consumers' cost is made up by card fees paid to the bank and time spent in the cashier line for making the payment. The estimated periodical fees for debit cards was calculated as total periodical fees for debit cards minus the amount that was attributed to ATM-withdrawals in Section 3.1. The time needed to make a debit card payment was approximately the same as for cash and the number of debit card payments was close to the number of cash payments plus ATM-withdrawals. Consumers' cost for debit card payments is therefore close to the time cost for cash.[22]

Table 5. The main cost drivers (SEK million) for debit card payments.

Banks		**Firms**	
authorization, debit control	280	fixed and varialbe fees	1350
payment processing	110	time cost at cashier line	2300
IT, telecommunication etc.	1900	back office	100
marketing etc.	130	fraud	30
card issuing	180	other	110
fraud prevention & handling	130		
customer services etc.	300	**Consumers**	
licences	140	time cost at cashier line	20
management & monitoring	240	periodical fees	1890
management of POS-terminals	30		
other	30		

The total cost of debit card payments in Sweden in 2009 is summarized in Table 6. The total private cost was SEK 9.3 billion and the total social cost was close to SEK 6 billion. This corresponded to 0.19 per cent of GDP. The social unit cost was SEK 4.50.[23]

Table 6. The private and social cost of debit cards in Sweden 2009 (SEK million). The social cost can be read either as "net cost" or "consumed resources".

	Net cost	**Fees received**	**Private costs**	**Fees paid**	**Consumed resources**
Riksbank	-				-
CITs	-				-
Banking sector	230	3 240	3 470	40	3 430
Retailer sector	3 890		3 890	1 380	2 510
Consumers	1 840	70	1 910	1 890	20
	5 960	**3 310**	**9 270**	**3 310**	**5 960**

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[22] Using pre-tax income as consumers' opportunity cost of time would give a time cost of nearly SEK 1.1 billion.

[23] Had pre-tax income been used as opportunity cost, the social unit cost would have been SEK 5.20. If, instead, the interest rate would have been 2.5 per cent the social unit cost would have been approximately SEK 4.60.

Notice that banks appear to have made a loss from debit cards of SEK 230 million. This is somewhat surprising since the commonly held belief is that banks make a substantial profit from their card activities. This may nevertheless not be true for debit cards but it deserves some consideration.[24] As mentioned above, the calculated average transaction fee may be too low. For example, if one assumes that 15 per cent of all card payments were made at small retailers that paid a transaction fee of SEK 2, the banks would gain SEK 250 million and break even.[25] This, however, does not explain the low profitability. Another possibility is that the bias towards large firms may also contribute to the underestimation of periodical fees. Large firms tend to have a high volume of debit card payments and therefore also a low periodical fee per payment. A third possibility is that fixed fees paid by consumers are underestimated. For consumers the official prices are explicitly stated by the banks, but in practice the actual periodical fee may depend on a number of things. For example, if two cards have been linked to the same account; the second card tends to be cheaper. Cards are sometimes included in a package of services offered to the consumers, e.g. internet bank combined with a debit card, in which case it is difficult to determine the periodical fee for the card. Finally, as for cash the profitability of debit cards for the banks depends on how wide or narrow one defines the debit card service. Debit cards move funds from the payer's transaction account to the payee's transaction account but on both accounts the banking sector accrued revenue from the interest rate margin between the deposit interest rate and the short-term lending rate.[26] The banks may also have earned so-called float, i.e. an interest rate income on a transacted amount during the time between the payer's account being debited and the payee's account being credited.[27] These interest-rate incomes have not been included in the calculations.

3.3 The cost of credit card payments

A credit card payment is similar to a debit card payment except that the funds are not immediately drawn from the payer's transaction account. Instead the purchases are gathered together and the consumer is billed at the end of the month. In this sense the consumer is given an interest-free credit for 45 days on average. Credit cards and delayed debit cards both works in this way, but the difference is whether the consumer has the ability to roll the credit over (credit card) or has to pay in full after having being billed (delayed debit). In this study, delayed debit cards have been counted as credit cards. In Sweden, credit cards had approximately 15 per cent of the card market in 2009. Table 7 accounts for the major private costs.

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[24] Guibourg and Segendorf (2007) show that credit cards account for most of the card related profit of an average Swedish bank in 2002. Their study included only costs related to the payment process and given that our study includes a wider range of costs it is reasonable that the profitability of debit cards is low.

[25] This corresponds to an average transaction fee of nearly SEK 1 which is substantially higher than the nearly SEK 0.8 that we have estimated.

[26] Households held SEK 623 billion in short-term deposits at banks and Riksgäldskontoret (Government Debt Office), see Statistics Sweden, Financial Market Statistics, Table 2.3 Money supply, Notes and coins held by Swedish non-bank public, M1, M2 and M3. Suppose only a quarter of this is held in transaction accounts. Then, with an interest rate margin of 2.08 percentage points (see Sveriges Riksbank (2011), Table O) between short-term deposits and short-term credits, this would yield a revenue of SEK 3.2 billion to the Swedish banking system.

[27] Most card payments are settled on t+1, i.e. the payee's account is credited the day after the transaction date on which the payer's account was debited. The average daily turnover was SEK 1.5 billion and the short-term lending rate was 2.35%. On an early basis, this would yield a float revenue of SEK 35 million from debit card transactions.

The banks’ total private cost for credit card payments was SEK 2.8 billion. As for debit cards, banks incurred a cost for the payment process; authorization, verification, debiting and crediting accounts, settlement etc. (interchange is not included). The management of purchases (acquirers) was also a major cost driver. Specific for credit cards are the costs of performing credit-risk analyses of new customers and of issuing statements. Banks also had costs for marketing, issuing cards, fraud prevention and fraud handling, customer service and benefits of which SEK 140 million was transfers back to the consumers, e.g. loyalty schemes etc., licences to the card schemes, management of POS terminals and management and monitoring of activities. The banks also had a substantial cost for financing the 45-day loans provided to consumers (see below).

The private cost of the retail sector for debit cards was nearly SEK 2.5 billion. The single largest cost was periodical fees and transaction fees, of which the latter accounted for nearly SEK 1.8 billion. The average transaction fee was somewhat above SEK 0.80 plus almost 1.30 per cent of the transacted value, making the average transaction fee approximately SEK 7.30. As in the case of debit cards, it is likely that this understates the true average transaction fee. The second largest cost driver was the time needed at the cashier line to make a credit card transaction. The time and cost per transaction are the same as for debit cards. As for debit cards, we disregard reported lost sales of SEK 30 million due to down-time in the card system infrastructure.

Consumers paid almost SEK 1.5 billion in periodical fees and a small estimated cost of time. At the same time, consumers received benefits from loyalty programmes etc. and the value of the 45-day free credit. The latter was calculated as follows. Consumers spent SEK 337 million per day with credit cards. Assuming that the same amount is spent each day consumers’ average credit card debt was approximately SEK 15 billion. The average short-term lending rate was 2.35 per cent (Sveriges Riksbank (2011), Table O). This makes the economic value of not having to pay any interest SEK 350 million.

Table 7. The main cost drivers (SEK million) for credit card payments.

Banks		**Firms**	
authorization & verification	220	fixed and varialbe fees	2010
payment processing	80	time cost at cashier line	410
IT, telecommunication etc.	500	back office	40
credit risk analysis	200	other	10
issuing of statements	130		
marketing etc.	140		
card issuing	120		
fraud prevention & handling	100	**Consumers**	
customer services & benefits	320	time cost at cashier line	3
licences	40	periodical fees	1480
management & monitoring	660		
management of POS-terminals	10		
financing of loans	350		

The cost of credit card payments in Sweden in 2009 is summarized in Table 8. The total private cost amounted to SEK 6.8 billion and the total social cost to SEK 2.8 billion, corresponding to 0.09 per cent of GDP. The social unit cost was SEK 11.70.[28]

Table 8. The private and social cost of credit cards in Sweden 2009 (SEK million). The social cost can be read either as "net cost" or "consumed resources".

	Net cost	**Fees received**	**Private costs**	**Fees paid**	**Consumed resources**
Riksbank	-				-
CITs	-				-
Banking sector	- 650	3 490	2 840	490	2 350
Retailer sector	2 470		2 470	2 010	460
Consumers	990	490	1 480	1 480	-
	2 810	**3 980**	**6 790**	**3 980**	**2 810**

The retail sector carries most of the net costs of credit cards while banks make a profit of approximately SEK 650 billion. As discussed in Section 3.2, this profit may be too low, understating the costs of the retail sector by the same amount. It should also be noted that the financing cost or interest-rate revenue from rolled over credit-card debt are not included in our calculations. Also, recall that the focus of the study is P2B-payments and that we therefore have excluded B2B payments. Approximately one third of the credit card payments are initiated with credit cards held by other firms. If these business-to-business payments were included, the banking sector's profits from credit card transactions are likely to be at least SEK 1 bn.

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[28] Had pre-tax income been used as the opportunity cost, the time cost would have risen to SEK 190 million and the social unit cost would have been SEK 12.40. An interest rate of 2.5 per cent would have increased the time cost to approximately SEK 30 million and the social unit cost to SEK 11.80.

4. Remote payments

Payments that are not executed at the point of sale, i.e. payments where the payer and the payee are separated by distance, we here call remote payments. In Sweden, the most commonly used means of remote payments are direct debits and credit transfers. Of the latter there are two different types; "dataclearing" and Giro credit transfers. The main difference is that dataclearing, originally designed for cheque truncation, is built to carry less information than the Giro payments. Giro payments are commonly used for household bills and households use dataclearing to transfer money between accounts and therefore prominently for person-to-person payments and not for person-to-business payments. Volume and value under "Credit transfers" in Table 2 are therefore almost exclusively Giro payments. Giro payments, in turn, can be either electronically initiated or be paper based. Approximately 30 per cent of the 274 million credit transfers in Table 2 were paper based.

Two things have to be emphasized. First, although cards can also be used for remote payments, usually called card-not-present payments, they are not accounted for here. The cost for remote card payments is included in the costs for debit- and credit cards in Section 3. The reason is that data did not allow for an accurate separation between card payments at the POS and remote card payments.[29] Secondly, almost all person-to-business credit transfers are initiated at home, either by filling in a paper form or logging on to the Internet bank. We had no estimates of the time households spent on initiating the payments. Nor have we found a good way of modelling this cost. The cost estimates accounted for below do not take consumers' costs into account. The time required to initiate a credit transfer may be substantially higher than for payment at the point of sale. Direct debits should take less time. As seen for cash and cards, the time cost of consumers was very low in 2009. The effect on the results, in terms of understating the true social cost, from not including the time costs should therefore be limited, especially for direct debits.

4.1 Credit transfers

The total cost of the banking sector for credit transfers amounted to SEK 1.1 billion of which processing accounted for approximately half of these costs (see Table 9). Processing costs here includes costs of checking the validity of transfer orders, executing the transfer order, clearing, settlement, processing transfers received, crediting the payee’s account, etc. Paper-based credit transfers accounted for one third of the processing costs. The banks also had an additional cost for collecting the transfer orders. The second largest cost was for providing customer services which includes the costs of responding to customer complaints or providing further clarifications related to credit transfers. Banks also had costs for advertising, handling service contracts, money laundering control, fraud prevention, and cancellation.

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[29] Approximately 90 per cent of all card payments are made at the point of sale but their value accounts for only approximately 70 per cent of the total value. This indicates that the transaction value of remote card payments on average is considerably higher than for card transactions at the point of sale. Source: Sveriges Riksbank (2011), Tables X and Y where remote card payments are calculated as the difference between the values and volumes in the two tables.

The two main cost elements for firms receiving credit transfers were the time spent on handling incoming payments and fees paid to the banks. The time spent on a single credit transfer varied between a few seconds up to nearly 12 minutes depending on the nature of the business, its turnover and the degree of integration of account keeping. Other costs were rather small. For reasons explained above, we only included periodical fees in the costs of the households.

Table 9. The main cost drivers (SEK million) for credit transfers.

Banks		**Firms**	
payment processing	590	time cost	1880
collecting payment orders	50	fixed and transaction fees	850
customer services	250		2730
Advertising, service contracts etc.	50	**Consumers**	
other costs	170	periodical fees	750

Table 10 illustrates the costs among the involved parties. The total social cost is almost SEK 3 billion which corresponds to nearly 0.1 per cent of GDP. The social unit cost for a paper-based credit transfer was SEK 11.50 and for the electronic credit transfer it was SEK 10.70. This is a smaller difference than we expected. One reason may be that household credit transfers are concentrated to the end of the month and that several credit transfers are then sent in the same envelope. Another is that the number of paper-based credit transfers is still substantial and that economies of scale are utilized. The average social unit cost was SEK 10.90.

Table 10. The private and social cost of credit transfers in Sweden 2009 (SEK million). The social cost can be read either as “net cost” or “consumed resources”.

	Net cost	Fees received	Private costs	Fees paid	Consumed resources
Riksbank	-				-
CITs	-				-
Banking sector	- 490	1 600	1 110	-	1 110
Retailer sector	2 730		2 730	850	1 880
Consumers	750		750	750	-
	2 990	**1 600**	**4 590**	**1 600**	**2 990**

The social unit cost of a credit transfer may be perceived as high and is close to that of a credit card payment, which is higher than we expected. There may be several explanations for this. First, payments tend to be chi-square distributed in terms of value; most payments are small but there is a “tail” of relatively large payments that causes a separation of the median value and the average value of a payment by increasing the value of the latter. Calculating the volume of payments using the average transaction value instead of the median value gives a too low estimated volume and therefore a too high social unit cost. Unfortunately, we were unable to calculate the median transaction value due to the lack of information on the distribution of person-to-business credit transfers. Secondly, the time cost may be exaggerated if the number of person-to-business credit transfers to small firms, restaurants and hotels is overestimated. This is possible since we only look at a subset of all credit transfers and the sample of firms is small. However, we notice that the social unit cost is relatively low compared with the corresponding cost in Denmark (Danmarks Nationalbank (2012)).[30]

4.2. Direct debits

The total cost of the banking sector for direct debits was SEK 150 million of which half of the costs were related to processing, see Table 11. Other major cost drivers were customer services and authorization, e.g. managing the data base on which authorization agreements are stored. The remaining costs were advertising, management of service contracts, and other activities.

The firms’ cost structure for receiving direct debits is similar to that of credit transfers, i.e. the two main cost elements were time costs and bank fees. The time spent on a single credit transfer was approximately 20 seconds. Other costs were small. We estimate that households paid SEK 200 million in fees related to direct debits.

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[30] In Denmark in 2009, the social unit cost of remote payments excluding households time cost were as follows: Internet bank payments DKK 28.07, other transfers DKK 31.77 and direct debits DKK 13.51-14.69. Source: Danmarks Nationalbank (2012), Table 6.6.

Table 11. The main cost drivers (SEK million) for direct debits.

Banks		**Firms**	
payment processing	70	time cost	470
customer services	40	fixed and transaction fees	180
authorization	20		
other costs	20	**Consumers**	
		periodical fees	200

Table 12 accounts for the private and social costs of direct debits. The total social cost is approximately SEK 620 million, consumers' time cost not included (see discussion above). This corresponds to 0.02 per cent of GDP and the social unit cost was SEK 3.30. Potentially there are substantial gains to be made by moving from credit transfers in general, and paper-based in particular, to direct debits.

Table 12. The private and social cost of direct debits in Sweden 2009 (SEK million). The social cost can be read either as "net cost" or "consumed resources".

	Net cost	Fees received	Private costs	Fees paid	Consumed resources
Riksbank	-				-
CITs	-				-
Banking sector	- 230	380	150	-	150
Retailer sector	650		650	180	470
Consumers	200		200	200	-
	620	**380**	**1 000**	**380**	**620**

5 Social efficiency at the point-of-sale

This section investigates the social efficiency of cash and cards. In principle, the same analysis could be made between credit transfers and direct debits but here we lack reliable time data. The first subsection aims at discussing the use of cash and cards from a social-efficiency perspective. The next subsection extends the discussion by contrasting what is socially desirable with the incentives of the consumer. The final subsection tests whether consumers act in accordance with what is socially optimal or are governed by private economic incentives.

5.1 The incentives of the consumer at the point-of-sale

In the sections above, it is shown that the estimated social unit cost for cash is higher than for debit cards but lower than that for credit cards. This does not mean that, from a social point of view, debit card payments are always to be preferred since the unit costs are calculated at the actual average transaction sizes, assumed to be SEK 252 for cash transactions, SEK 411 for debit card transactions, and SEK 513 for credit card transactions. As described in Sections 3.1-3.3, the cost structures of cash and cards differ from each other and they have different cost functions. The optimal choice will depend on the size of the transaction. Ideally, one would like to compare the marginal cost of one type of transaction with the marginal cost of another type of transaction. Then, "fixed cost" would refer to a fixed per-transaction cost, i.e. a cost that is fixed in the size of the transaction, although it is variable in the number of transactions. The switching cost of a card payment is an example of such a cost. Other costs, that are traditionally referred to as fixed, such as costs for setting up a system for cash or card transactions, e.g. central switching systems or the fixed costs of operating a central bank, should be referred to as sunk and should not be considered. A variable cost would then be a cost that increases with the value of the transaction. In the case of cash it would be the costs associated with counting, transporting, and filling ATM terminals. For credit cards it would be the bank's cost of granting credit in the context of a credit card transaction etc. The corresponding cost does not exist for debit cards whose variable costs are negligible.

The data, even though reported in accordance with different activities related to the relevant payment instrument, does not always allow for a division into fixed and variable costs in the sense above. Turjan et al. (2011) develop a method for dividing costs into different categories depending on whether they are fixed or variable in value or volume. The method, however appealing, is sensitive to assumptions on to what degree a variable cost varies with value or volume. Especially for cash, this distinction is crucial since the volume dependency translates into the fixed cost and the value dependency into the variable cost in the sense above. Both an increased value and volume increases the cash handling at retailers, banks, CITs, and the central bank but it may do so in different ways depending on the composition of notes and coins. Likewise, it is also unknown how the composition of notes and coins affects the time costs at the cashier line or back-office costs. A statistical test based on such a division will ultimately be a test of a large number of assumptions that one has to make. Early calculations of the threshold transaction value at which cash and debit cards have the same marginal cost and therefore are equally preferable from a social perspective indicated this weakness. Depending on the assumptions made it varied by more than SEK 150. Because of this sensitivity we instead follow Bergman et al. (2007) who use a less fine division of variable and fixed costs. To identify the variable costs we still rely heavily on Turjan et al. (2011), see below. According to this method, total social costs are divided into fixed and variable costs. A linear cost function is then constructed by dividing the fixed costs by the volume of cash transactions in the economy to find the intercept, and the slope of the cost function is obtained by dividing the variable cost with the value of cash transactions in the economy:

$$f(v) = \frac{fixed\ costs}{total\ volume} + v * \frac{variable\ costs}{total\ value} \tag{1}$$

where $v \geq 0$ is the value of the transaction in SEK. Table 13 shows the division between fixed and variable costs for all actors involved in cash circulation. Variable costs are those that Turjan et al. (2011) identify as variable in value, volume or both. All costs that are not variable are counted as fixed (see Annex 4). The total volume and total value of cash transactions are found in Table 2. Using the figures in Table 2 and Table 13 to calculate the intercept and the slope gives: $f(0)$=4.118 and $f'=0.0167$.

Table 13. The fixed and variable social costs of cash (SEK million).

	Social costs		
	Fixed	**Variable**	**Total**
Riksbank	140	70	210
CITs	930	690	1620
Banks	1780	690	2470
Retailers	1400	2880	4280
Consumers	0	20	20
	4250	**4350**	**8600**
Share:	0,49	0,51	

Because the social cost of a debit- or credit card payment does not depend on the value of the transaction their marginal costs are set equal to their social unit costs, i.e. SEK 4.50 and SEK 11.70, respectively. The threshold values under which cash is preferable to debit- and credit cards are found by setting the cost function *f* equal to each of the two unit costs and solving for *v*. It turns out that from a social point of view cash should be preferred to debit cards for transactions below SEK 20 and to credit cards for transactions below SEK 450, see Figure 2.[31] The former threshold is substantially lower than that found by Bergman et al (2007) for 2002 while the latter threshold is substantially higher. There are two main reasons for this. The first is that, especially for cards, we include a much broader range of costs. As a consequence, the unit costs of debit- and credit card payments increase and thereby the threshold values. This is especially true for credit cards where these costs are relatively large. Secondly, the number of card payments increased dramatically from 66 to 182 per capita between 2002 and 2009. At the same time, the number of cash payments has decreased. This affects the distribution of fixed and variable costs. For the threshold between debit cards the second effect dominates the first and this pushes the threshold downwards. For the threshold between credit cards and cash we have the opposite situation.

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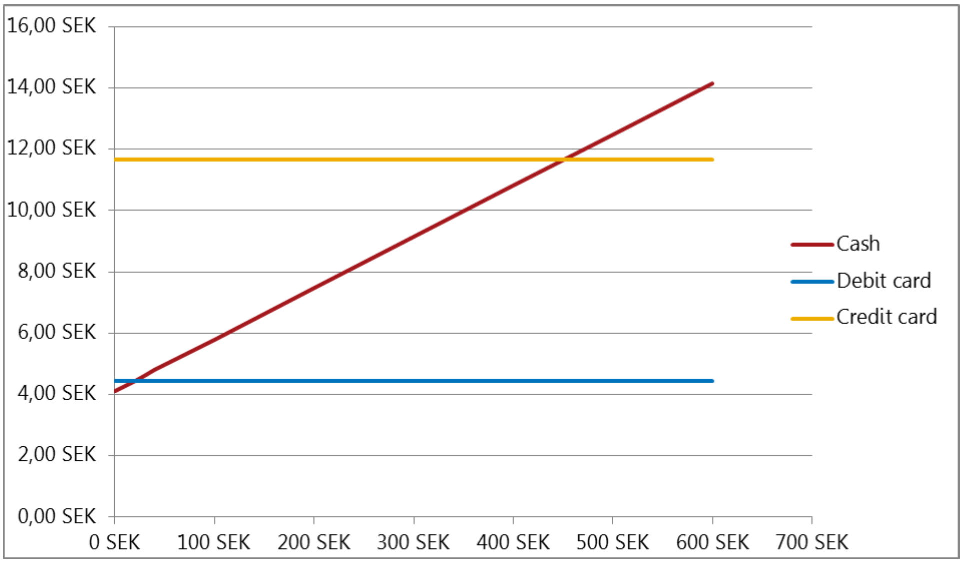
[31] The calculations have been made using the non-rounded off figures where the social unit costs of debit- and credit card payments are SEK 0.04-0.05 lower than their rounded-off equivalents.

Figure 2. The social threshold transaction values (SEK) under which cash is socially preferable to debit cards and credit cards.



The calculated thresholds depend on the division between fixed and variable social costs. A higher share of fixed social costs increases the intercept of the cash cost function *f* but lowers its slope, i.e. the rate at which the cost increases with the size of the transaction. However, since the denominator in the first expression in Equation (1) is smaller than the denominator in the second expression, an increased share of fixed costs will decrease the threshold values since the shift upwards in the intercept is not fully compensated by the decrease in the slope. Threshold values for different shares of fixed and variable costs can be found in Annex 4. Correspondingly, a higher consumer opportunity cost of time moderately increases the cash/debit card social threshold and lowers the cash/credit card social threshold. Annex 5 provides these threshold values together with the social thresholds at other cost aggregation weights.

5.2 The incentives of the consumer at the point-of-sale

In practice, the actual choice between cash and card payments is, in most situations, made by the consumer. This choice is not determined by the social costs of each payment, but rather by the users' private costs and preferences over the two alternatives. When paying with a card, the consumer's main cost will be the time cost at the cash register. This cost is the same irrespective of the value of the payment. The cash payment will also have a time cost that depends on the value of the payment but it will also be associated with a withdrawal time cost, i.e. time spent withdrawing cash from an ATM. The logic behind Equation (1) can also be applied to the private costs of the consumer in order to find threshold values above which the consumer prefers to use one payment instrument rather than another.

For cash, debit- and credit cards the only cost that matters is the opportunity cost of time. Any periodical card fees are regarded as sunk and the consumer almost never meets any transaction fees at the ATM or the cashier line. When the consumer pays in cash, the payment consumes some time but the liquidity buffer also decreases, implying that they are more likely to have to go to the ATM soon. Here, for the sake of simplicity, we let the cost of time be a function of the transaction value only. This can be interpreted as a reduced-form cost function including the liquidity buffer. The consumer is assumed to be able to make the smallest cash payment possible (SEK 0.50) very quickly by just handing over the coin. It is assumed that a larger payment will take longer because of the increased likelihood of involving notes or coins of different denominations and possibly getting change back. In theory, the time cost of a cash transaction is likely to increase with the transaction amount with local minima at the denomination values of the notes and coins in circulation. Here, we approximate this true cost function with a linear cost function expressing the consumers' private cost of the transaction as a linear function of the transaction value:

$$c(v) = v * \frac{consumers' \, time \, cost}{total \, value} \tag{2}$$

where $v \geq 0$ is the transaction value, the consumers' time cost is found in Table 4 and the total value of cash payments in Table 2. Regarding debit card transactions, the consumer only spends time at the cashier line and the amount of time spent is independent of the transaction value. Hence, the consumers' cost for a debit card transaction is:

$$d(v) = \frac{consumers' \, time \, cost}{total \, volume} \tag{3}$$

where the time cost is found in Table 6 and the total debit card volume in Table 2. Making a credit card payment takes the same time as paying with a debit card. The consumer's credit card cost function should therefore have the same intercept at *v=0* as the debit card cost function. The difference between a debit card transaction and a credit card transaction is that the latter provides an on average 45-day credit on the transaction amount. Let *b(v)* denote the credit card cost function, then:

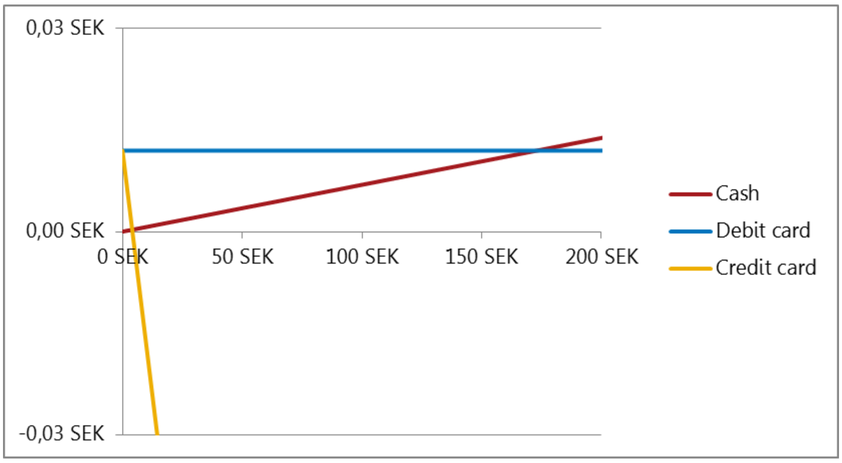
$$b(v) = d(v) - v * r * \frac{45}{365} \qquad (4)$$

where *r* is the average short-term interest rate offered by the banks. In 2009, this interest rate was 2.35 per cent.[32] The private economic threshold values between the different payment instruments are found by setting two equations equal to each other and solving for *v*. Table 14 and Figure 3 illustrate the solutions.

Table 14. The intercepts, slopes, and private economic threshold values of the consumer.

	Cost function		Threshold value		
	Intercept	slope	Cash	Debit card	Credit card
Cash	-	0,000069	-	173	4
Debit card	0,011967	-		-	-
Credit card	0,011967	- 0,002897			-

Figure 3. The private economic cost functions and thresholds of the consumer.



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[32] Source: Sveriges Riksbank (2011).

An assumption made in the calculations above is that the minimum cash payment can be made instantly. This is a simplification and as a check of the robustness of the thresholds we instead assume that the minimum time of a cash payment is 5 or 10 seconds. This shifts the intercept of the cash cost function upwards from the origo but it also decreases the slope of the function. The impact of the threshold value is thus ambiguous. Table 15 shows that such a change lowers the private economic threshold between cash and debit- and credit cards. The threshold value for cash and credit cards seems robust in the sense that assuming a moderate time cost for the minimum cash transaction does not significantly change the size of the threshold. The change in the private threshold for cash and debit cards changes more in nominal terms. However, even for the relatively high minimum payment time of 10 seconds the private economic thresholds are not close to the social thresholds.

Table 15. Private economic threshold values (SEK) between cash and debit- and credit cards for different levels of time required for the minimum cash transaction.

Cash cost function			Threshold (SEK) between cash and	
Seconds	Intercept	Slope	debit card	credit card
0	-	0,000069	173	4
5	0,004092	0,000068	115	3
10	0,008183	0,000052	73	1

As mentioned in Section 3.1, 2009 was a year with unusually low interest rates, both on deposits and credit. Annex 5 contains the private threshold values under alternative assumptions on consumers' opportunity cost of time. In all the studied scenarios, the private thresholds for cash and debit cards were substantially higher than the social thresholds, while the private thresholds for cash and credit cards were substantially lower than the corresponding social thresholds.

5.3 How do consumers act in reality?

Using the unique data set on household payments and background variables described in Section 2.2 we can test the following two hypotheses:

i) Do consumers use cash and debit cards in accordance with what is socially optimal?

ii) Do consumers use cash and debit cards in accordance with the economic incentives they are exposed to?

We expect a clear positive relationship in the data between the purchase amount and the share of purchases that is made with a card.[33] To test this, and also to be able to control for other covariates, we run a probit regression model to estimate the probability of paying with a debit or a credit card instead of paying with cash at the point of sale.[34] [35] As explanatory variables we include age, household size, college education, income level, gender, and the purchase amount. Due to the limited number of credit card payments in the data (only 9 per cent of the total number of card payments is made with a credit card) we do not distinguish between debit and credit card payments in the empirical analysis.

The estimated coefficients from the probit regression are reported in Table 16. We find that all variables except college education are statistically significant, possibly because of the high correlation between education and income. Younger individuals are more likely to pay with a card. A larger purchase amount and a higher income also increase the probability of paying with a card, *ceteris paribus*. We also find that women are more likely than men to pay with a card instead of with cash. The reason for this is unknown; possible explanations are different consumption patterns or preferences over payment methods.

Table 16. Empirical results from a probit regression model on paying with a debit or credit card instead of paying with cash at the point of sale

Parameter	**Estimate**	**Chi-Square**	**Pr > ChiSq**
Intercept	-1.5572	32.12	<.0001
Log(amount)	0.3095	69.34	<.0001
Age	-0.0129	22.05	<.0001
Household size	0.0801	3.92	0.0478
College	0.1177	1.76	0.1845
Income group	0.2126	12.15	0.0005
Female	0.3560	18.33	<.0001

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[33] See Figures A6:1 and A6:2 in Annex 6 for the relationship between purchase amount and the share of purchases that is made with a debit or credit card.

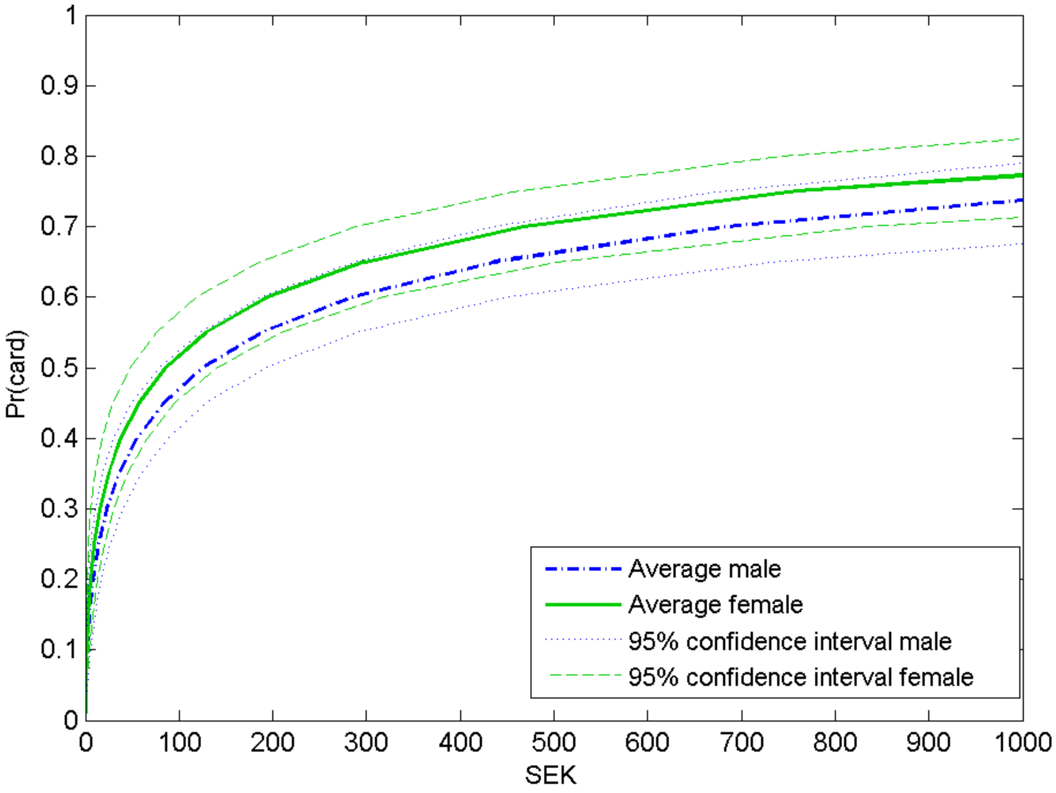
[34] A logit model is also estimated, and it turns out to be very similar to the probit model.

[35] To test our hypotheses empirically, we make some small initial adjustments to our data. We exclude 40 individuals who used neither cash nor a debit or credit card to pay for their latest purchase, 31 individuals who were not willing to report their income levels, and the top and bottom one per cent with regard to the purchase amount. Our final sample consists of 1,127 purchases, of which 40% were made with cash and 60% with a debit or a credit card. Summary statistics are provided in Table A6 in Annex 6.

Using the coefficients from the probit regression model, we can estimate the probability that an average individual in the population pays with a card instead of cash for different purchase amounts. Using data from Statistics Sweden, we find that the average woman (man) in the population turns out to be 49 (47) years of age, with an annual income in the range of SEK 1 - 240,000 (240,000-360,000), with no (no) college/university education, and who lives in a household of three (three).

Figure 5 plots the probability of paying with a card at different purchase amounts. The probability that a payment of, say, SEK 100 is paid with a card is 52% for the average woman and 47% for the average man. More importantly, we find that the threshold amount, i.e. the purchase amount where the probability of paying with a card equals the probability of paying with cash, is obtained at SEK 86 for the average woman and at SEK 126 for the average man. The lower and upper 95% confidence levels around these thresholds are SEK 48 and 140 for the average woman and SEK 78 and 191 for the average man.

Figure 5. Probability of paying with a card instead of with cash at different purchase amounts.



Using the estimated thresholds and the confidence intervals we can test the hypotheses outlined above. From Section 3.4, we know that from a social point of view cash should be preferred to debit cards for transactions below SEK 20 (see Figure 2). Since SEK 20 is below the lower confidence interval for both the average man and the average woman, we can reject the hypothesis that the average individual uses cash and debit cards in accordance with what is socially optimal at the 95% level. In plain text this means that we show that consumers use too much cash from a social point of view.

In Section 5.2, the private economic threshold between cash and a debit card is estimated to be SEK 173 (see Table 14 and Figure 3). SEK 173 is within the 95 per cent confidence intervals for the average man in the population, but outside the confidence intervals for the average woman. Hence, we can reject the hypothesis that the average woman uses cards and cash in accordance with the economic incentives she is exposed to. This means that she uses her card more often than expected, given the economic incentives. Men, on the other hand, seem to use cards in accordance with the economic incentives. This result is, however, sensitive to the assumption regarding the minimum time needed to make the smallest cash payment. Here we have assumed that it is zero. If we instead use 5 or 10 seconds we get other private thresholds (see Table 15). If the minimum time is assumed to be 5 seconds, then the threshold would be within the confidence intervals for both men and women. If the minimum time is set to 10 seconds we would have to conclude that men do not act in accordance with economic incentives while women seem to do so.

The main conclusions are that consumers do not act in accordance with what is socially optimal and that there is an unexplained difference in the use of cash and cards between men and women.

6 Discussion and conclusions

We estimate the social and private costs of consumer-to-business payments in Sweden in 2009. The combined social cost for these payments was 0.68 per cent of GDP. This is rather low in an international comparison, which is partly a function of the high degree of electronic payments in the economy. Economies of scale are a decisive factor for the social cost. The higher the number of transactions with a certain payment instrument, the lower the unit cost tends to be. The social unit cost of cash (EUR 0.78, SEK 8.30) was almost twice as high as for debit cards (EUR 0.42, SEK 4.50) but substantially lower than for credit cards (EUR 1.10, SEK 11.70). The social unit cost for credit transfers was EUR 1.03 (SEK 10.90) and for direct debits EUR 0.31 (SEK 3.30). For cash and credit transfers, where precise data on the number of transactions is unavailable, we may have underestimated the number of transactions and consequently somewhat overstated the social unit cost. However, correcting this potential error requires reliable information on the distribution of respective types of payment and this is something we do not have. Card transaction fees may also have been underestimated but this is a pure transfer between different actors and it does not affect the social cost. The results are relatively robust with respect to different ways of aggregating costs and variations in consumers' valuation of time (see Annex 5).

We have identified threshold transaction values below which cash from a social perspective is preferred to debit cards (EUR 1.88, SEK 20) and credit cards (EUR 42.37, SEK 450). Corresponding thresholds for the individual consumer are higher for debit cards and much lower for credit cards. Using unique survey data we show that the consumers' choice of payment method is not consistent with what is socially optimal. Consumers pay too high values in cash and therefore use cash too often and cards too seldom. Women's choices are also inconsistent with their economic incentives, while this cannot be shown for men. One possible reason for the observed behaviour is that we have not taken preferences over the payment method as such into account, e.g. how secure consumers perceive cards to be compared to cash etc. Such factors may also provide an insight into the use of credit cards in Sweden, which is low compared to what one would expect from the economic incentives of the consumer. On the other hand, experience from Norway (Humphrey et al. (1998)) suggests that consumers are sensitive to economic incentives in their choice of payment method. In Sweden, Bergman et al. (2007) find that consumers' choices between cash and cards are in line with their economic incentives. Our result is therefore somewhat surprising and may from a policy perspective indicate that transaction fees may have to be complemented by other measures, possibly contingent on gender, age etc., if one would like to reduce the social cost of retail payments. Further research on what governs the consumers' choice of payment method is certainly needed.

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Annex 1 – Volume and value of person-to-business payments

The value, volume and average transaction value for different P2B payment methods in Sweden in 2009. (Table 2 from Section 2.1).

		Cards				
	Cash	Debit	Credit	Total	Credit transfers	Direct debits
Value (SEK, billions)	261	550	123	673	491	232
volume (million)	1034	1337	240	1577	274	190
Average transaction value (SEK)	252	411	513	427	1792	1221

Source: Sveriges Riksbank (2011) and own estimations.

The use of payment instruments is usually reported on an aggregated level where person-to-person, person-to-business, person-to-government, business-to-business, business-to-government, etc. have been added up. This is also typically how they are reported to the central bank and other authorities. In this study we are interested in the subset of payments constituted by person-to-business payments and some assumptions have had to be made in the calculations. They are accounted for under each payment instrument.

Cash

In Sweden, it is unusual for business-to-business payments to be made by cash and we assume that cash used at the point-of-sale is only used for person-to-business payments and person-to-person. Cash is not used for remote payments. ATMs are the main distribution channel of cash to the general public. Withdrawals and deposits over the counter are relatively small and cancel each other out. Consequently, the retail channel is the only channel through which households divest themselves of cash. Assuming that households' cash buffers are held constant, the cash turnover at the point of sale should equal ATM withdrawals and cash withdrawn at the point of sale. In 2009, ATM withdrawals amounted to SEK 229 billion and withdrawals at the point of sale (in Sweden called "cash back") were approximately SEK 31 billion.[36] The estimated cash turnover was thus SEK 260 billion. According to our consumer survey data, the average transaction amount was approximately SEK 252. Dividing the turnover by the average value gives the volume of cash transactions; 1.034 billion. This may understate the true volume somewhat because cash payments are likely to be Chi-square distributed, but the relatively small size of the sample did not allow for an accurate estimation of the distribution. We therefore decided to use the mean rather than the median value.[37] This average value was also very close to the value used by Danmarks Nationalbank (2012). It is also close to the experience of Svensk Handel (Swedish Trade Federation); they say that approximately 30 per cent of the payments are made by cash. In the household survey, approximately 40 per cent of the respondents reported that their latest payment was made by cash. Our estimated 1 034 million cash payments constitute approximately 37 per cent of the payments at the POS, i.e. all credit-card payments included.

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[36] For ATM withdrawals, see Sveriges Riksbank (2011), Table Y. The estimate of cash back is based on a consumer survey described in Section 2.2.

Debit cards

Debit cards are seldom used by businesses and we assumed that all debit card transactions were person-to-business payments. The turnover, volume and average transaction value are found in Sveriges Riksbank (2011), Table X.

Credit Cards

Here both delayed debit cards and credit cards are counted as credit cards. The difference is that even though the consumer is billed the total amount at the end of the month in both cases, a pure credit card allows for rolling the credit over while a delayed debit card does not. Credit cards are held by households, businesses and authorities. Consequently, they are not only used for person-to-business transactions. Aggregate annual data is found in Sveriges Riksbank (2011), Table X. According to Statistics Sweden, approximately 2/3 of the credit card debt is held by households.[38] We therefore assume that 2/3 of the credit card payments are made by households, both in terms of value and volume.

Direct Debits

The Swedish banking system has two different types of direct debits. The first is one that is intended solely for person-to-business payments and the other is intended for business-to-business payments. The value and volume of direct debit transactions in Table 2 is thus only for the former type of direct debits, and was reported by the banks in a questionnaire within the cost study presented here.

Credit transfers

Household income in 2009 was SEK 1608 billion and total household expenditure amounted to SEK 1533 bn.[39] Subtracting the values of transactions made by cash, debit cards, credit cards, and direct debits gives an estimate of the value of person-to-business credit transfers, i.e. SEK 491 billion. The most common type of credit transfers (giro payments) can be both electronic or paper based. There are no data on the average value of an electronic person-to-business credit transfer, not least because of the problem of accurately distinguishing them from other credit transfers. However, paper-based credit transfers are mostly used by households. Assuming that the average value of a paper-based credit transfer is representative for credit transfers at large gives an average value of SEK 1792 which, in turn, implies a volume of 274 million credit transfers. As with cash payments, we expect the distribution of payments to be chi-square distributed but lack information on the distribution and therefore use the mean value to calculate the number of payments which consequently may be underestimated.

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[37] The median value was SEK 93.

[38] Financial Market Statistics, Table 4.22. MFIs' lending in the form of convenience credit card and extended credit card credit.

[39] Statistics Sweden, National Accounts, Disposable income of households incl. NPISH, final consumption expenditure and savings 1993-2011.

Annex 2 – SNI codes and construction of sub sectors

Three different methods were used to construct subsectors and weights.

Method 1 – payment-pattern constructed subsectors

Using Statistics Sweden (2010) we grouped the consumption categories as follows depending on the expected payment pattern, e.g. large, medium or small payments, paid at the point of sale or by card or cash or remote payment (credit transfer or direct debit).

Table A2:1. Payment pattern determined subsectors and their share of total household consumption.

<table>
<tr><td colspan="2">Gambling and sports
Other recreation activities
Light vehicles; sale,
Cars & light vehicles; maintainance & repair
Housing; mainainance & repair</td><td>Clothes & shoes</td><td>Food & beverage service
Travels, hotels</td><td>Public transport
Transport services</td><td>Food & beverage incl. Alcohol
Tobacco
Consumption goods</td><td>Furniture
Durable goods
Household equip.
Radio & TV</td><td>Watches, camera & photography
Amusement & culture
Books, subscriptions etc.
Telecommunication services
Other services excl. Household services</td><td>Electricity, water etc.
Insurance
Rental & leasing
Child care
Household services
Cars; sale</td></tr>
<tr><td>Size:</td><td>0,19</td><td>0,05</td><td>0,11</td><td>0,02</td><td>0,20</td><td>0,08</td><td>0,08</td><td>0,28</td></tr>
</table>

We associated one or several firm in our sample with each subsector. The turnover of each firm was used to determine its size relative to its sector and any other firms assigned to the same subsector. Using these weights the cost data could be aggregated to country level costs and averages.

Method 2 – SNI-code constructed subsectors and turnover

SNI is the Swedish industrial classification standard (see Statistics Sweden (2004)). Using this standard to construct subsectors of the economy we used subsector turnover data to determine the relative size of each subsector, see Table A2:2. Each subsector was associated with one of our sampled firms - but each firm could be associated with more than one subsector – depending on the main business activity of the firm. As in Method 1, the size of each sampled firm was determined by its turnover.

Method 3 – SNI-code constructed subsectors and consumption

This method is basically the same as Method 2 but instead of using turnover to determine the size of each subsector we here used household consumption data. The size of the firms was determined by their turnover.

Table A2:2. The SNI-based subsectors and their size determined by turnover or household consumption

SNI-Code	Sub sector	Relative size Turnover	Consumption
36	Water collection, treatment and supply	0,002	-
53	Postal and courier activities	0,019	-
55	Accommodation	0,021	0,060
56	Food and beverage service activities	0,045	0,039
61	Telecommunications	0,069	0,020
75	Veterinary activities	0,002	-
77	Rental and leasing activities	0,022	-
79	Travel agency, tour operator and other reservation service and related activities	0,036	-
80	Security and investigation activities	0,010	-
92	Gambling and betting activities	0,025	-
95	Repair of computers and personal and household goods	0,004	-
96	Other personal service activities	0,014	0,081
353	Steam and air conditioning supply	0,028	-
471	Retail sale in non-specialised stores	0,165	0,185
472	Retail sale of food, beverages and tobacco in specialised stores	0,034	-
473	Retail sale of automotive fuel in specialised stores	0,043	0,085
474	Retail sale of information and communication equipment in specialised stores	0,029	0,017
475	Retail sale of other household equipment in specialised stores	0,065	0,023
476	Retail sale of cultural and recreation goods in specialised stores	0,023	0,027
477	Retail sale of other goods in specialised stores	0,119	0,086
491	Passenger rail transport, interurban	0,006	-
493	Other passenger land transport	0,040	0,016
501	Sea and coastal passenger water transport	0,008	-
503	Inland passenger water transport	0,001	-
511	Passenger air transport	0,020	-
932	Amusement and recreation activities	0,003	0,040
3513	Distribution of electricity	0,023	0,269
3522	Distribution of gaseous fuels through mains	0,001	-
4532	Retail trade of motor vehicle parts and accessories	0,020	-
6831	Real estate agencies	0,006	-
45110	Sale of cars and light motor vehicles	0,078	0,040
45192	Sale of caravans, motor homes, trailers and semi-trailers	0,017	-
45400	Sale, maintenance and repair of motorcycles and related parts and accessories	0,004	0,010
		1,000	1,000

Annex 3 - The Inventory Model Approach

The presentation in this annex closely follows Bergman et al (2007). Let

$$\omega = \frac{\alpha_c}{\alpha_c+\alpha_k} \qquad \text{(A3:1)}$$

denote the consumer's share of retail expenditures paid in cash where α_c is the combined value of her ATM withdrawals and cash back and α_k is the value of all her card transactions. Let T_c be the consumer's annual cost of using cash and let W_c be the number of ATM-withdrawals per year and per capita. Then a consumer's total annual cost of cash payments can be expressed as:

$$T_c = W_c d + \frac{r\omega\alpha}{2W_c} \qquad \text{(A3:2)}$$

where r is the deposit interest rate and $\alpha=\alpha_c+\alpha_k$ is the value of retail expenditures. In the first term on the right hand side, let d denote the shoe-leather costs of ATM withdrawals plus possible foreign fees. The second term expresses the interest-rate costs on average per capita transaction cash balances. The consumer minimizes the total annual costs of cash payments through the choice of an optimal number of ATM withdrawals, i.e. minimizing T_c with respect to W_c gives:

$$d = \frac{r\omega\alpha}{2W_c^2} \qquad \text{(A3:3)}$$

Substituting (A3:3) into (A3:2) and simplifying by using (A3:1) gives the annual per capita cost of using cash:

$$T_c = \frac{r\alpha_c}{W_c}$$

Table A3. The Inventory model applied to 2009 data and also at the actual interest rate of 0.27 per cent and at the alternative interest rate of 2.5 per cent.

	Total	**per capita**
Population	9 340 000	
ATM + cash back (SEK)	261 000 000 000	27 944
Card payments (SEK)	673 000 000 000	72 056
Number of withdrawals	365 000 000,00	39
Consumer time cost of cash per year		
at 0.27% interest rate (SEK)	18 032 597	1,93
at 2.5% interest rate (SEK)	166 968 493	17,88

Annex 4 – Fixed and variable costs

The social costs of cash, debit cards and credit cards have been divided into fixed costs, i.e. costs that do not vary with the use of the payment instrument, and variable costs that vary with the use of the payment instrument. The use of the payment instrument is captured by the volume of transactions with the payment instrument and the total value of those transactions. Annex 5 in Turjan (2011) lays out such a division of fixed and variable costs using the following categories:

1. fixed costs,
2. costs that change in equal proportion to volume,
3. costs that change less than in equal to volume,
4. cost that change in equal proportion to value,
5. costs that change less than in equal proportion to value,
6. costs that change in equal proportion to both value and volume, and
7. costs that change less than in equal proportion to both value and volume.

For the costs that change in equal proportion they assume a cost elasticity of 1, i.e. a 10 per cent change in value or volume induces a 10 per cent change in costs, and for the costs that change less than in equal proportion they assume a price elasticity of 0.5.

We find it difficult to distinguish between the effects of a change in volume and those of a change in value, e.g. an increased use of cash or debit cards tends to lead to a corresponding increase in the total value transacted. In the light of this interconnectedness of value and volume, we propose a somewhat less complex division of costs close to Bergman et al. (2007) and merge the cost categories 2 to 7 above into two categories; costs that change in equal proportion and costs that change less than in equal proportion. Table A4:1 illustrates the cost division for cash when we used the same cost elasticities as Turjman et al. (2011). The only variable cost that changes in equal proportion to value or volume is the time cost in the cashier line. All other variable costs change less than in equal proportion. We also introduce a new item called “residual”. For those variable costs that change less than in equal proportion there will be a part that is fixed. As an example, consider collection and transportation costs. This includes the depreciation costs of vehicles and wages for personnel, which to some extent can be regarded fixed. The residual is the sum of all such fixed parts for each sector.

Table A4:1. Fixed and variable costs for cash (SEK million).

	Riksbank	CITs	Banks	Retailers	Consumers	Total
Fixed costs						
Management, monitoring			55			55
Clearing, settlement	6					6
Banknote development	15					15
Preparation of cash registers				88		88
Maintenance				236		236
Other		99	114			213
						-
Residual	121	829	1 610	1 086		3 646
Total fixed costs	**142**	**928**	**1 779**	**1 410**	**-**	**4259**
Variable costs						
Withdrawals			562			562
Deposits			67	22		89
Customer service			48	22		70
Collection, transport		485		22		507
Handling, processing,…		152	19			171
Safekeeping, storage	14	30				44
ATM, deposit machines,…		14				14
Procurement	54					54
Time cost of payment				1 745	18	1 763
Emptying, balancing cash registers				1 064		1 064
Fraud prevention, money laundering		14	1			14
Total variable costs	**68**	**695**	**695**	**2 875**	**18**	**4351**
Total social costs	**210**	**1 622**	**2 474**	**4 285**	**18**	**8609**

Threshold values at different shares of fixed and variable costs

Table A4:2. The table describes how the social threshold values (SEK) under which cash is preferred to debit cards and credit cards, respectively, vary with the distribution of fixed and variable social costs.

Cost shares		**Threshold value (SEK)**	
fixed	**variable**	**Debet card**	**Credit card**
0,7	0,3	-138,74	586,09
0,6	0,4	-41,19	502,43
0,5	0,5	17,34	452,23
0,4	0,6	56,36	418,77
0,3	0,7	84,23	394,87

Annex 5 – Summary of social costs with different weights and time valuation

This annex provides an overview of the social costs under different sets of aggregation weights and assumptions concerning the households' valuation of time. The sets of weights are those accounted for in Section 2.2 and Annex 2. The first two columns in Table A5:1 account for the two SNI-code based sets of aggregation weights that differ in how the size of the individual sectors has been determined; by their turnover or household consumption directed toward each sector. None of these weights has been used in the calculations in Chapters 3 and 4. The last three columns utilize the same set of payment-pattern based aggregation weights that was used in Chapters 2 and 3 but differ in the assumption concerning the households' valuation of time. In the columns with an interest rate in the heading the value of time has been determined by the inventory model described in Annex 3. The shaded column (r=0.27%) contains the results accounted for in the main text. The next column (r=2.5) describes the social cost in a situation with more normal interest rates. The last column (w(1-t)) uses the income after taxes to valuate time. The reason why the social costs of credit transfers and direct debits do not vary with the household valuation of time is that households' cost of time is not included because no reliable estimates on the time needed to complete a payment were available.

Table A5:1. The social cost of different payment instruments under alternative sets of aggregation weights and time valuation.

	SNI-code based		Payment pattern based		
	Consumption	Turnover	$r=0.27\%$	$r=2.5\%$	$w(1-t)$
Cash					
Social cost (SEK bn)	11.1	9.8	8.6	8.8	10.0
Share of GDP (%)	0.36	0.32	0.28	0.28	0.32
Social unit cost (SEK)	10.72	9.46	8.32	8.47	9.64
Debit card					
Social cost (SEK bn)	5.8	6.0	6.0	6.1	7.0
Share of GDP (%)	0.19	0.19	0.19	0.20	0.23
Social unit cost (SEK)	4.35	4.47	4.45	4.55	5.24
Credit card					
Social cost (SEK bn)	2.8	2.8	2.8	2.8	3.0
Share of GDP (%)	0.09	0.09	0.09	0.09	0.1
Social unit cost (SEK)	11.55	11.67	11.65	11.76	12.44
Credit transfer					
Social cost (SEK bn)	3.9	3.8	3.0	3.0	3.0
Share of GDP (%)	0.13	0.12	0.1	0.1	0.1
Social unit cost (SEK)	14.23	13.80	10.93	10.93	10.93
Direct debet					
Social cost (SEK bn)	0.6	0.6	0.6	0.6	0.6
Share of GDP (%)	0.02	0.02	0.02	0.02	0.02
Social unit cost (SEK)	3.28	3.28	3.28	3.28	3.28
Total					
Social cost (SEK bn)	24.2	23.0	21.0	21.3	23.6
Share of GDP (%)	0.78	0.74	0.68	0.69	0.76
Social threshold values (SEK)					
Cash/Debit card	-57.71	-22.81	19.84	25.49	54.99
Cash/Credit card	290.16	370.32	450.09	434.59	368.38
Private threshold values (SEK)					
Cash/Debit card	172.86	172.86	172.86	176.79	149.37
Cash/Credit card	4.03	4.03	4.03	21.57	102.35

We note that even though weights and the time valuation may change considerably, the variation in social costs is more limited, especially on the aggregated level. Our conclusion is that the estimates are fairly stable and that the cost of person-to-business payments lay in the interval of 0.68 – 0.78 per cent of GDP in Sweden in 2009.

Annex 6 – Consumer survey data

Table A6. Summary statistics

Parameter	**Mean**	**Std Dev**	**Min**	**Max**
Purchase amount	423.42	754.18	10	8000
Age	48.24	16.18	16	81
Household size	2.51	1.10	1	4
College	0.39	0.49	0	1
Income group	1.80	0.74	1	3
Female	0.50	0.50	0	1

Note: The number of observations is 1,127. There are 3 income groups: SEK 0-120,000, SEK 120,000-240,000 and SEK 240,000-.

Figure A6:1. Sample distribution of purchase amounts and the use of cash, debit cards and credit cards

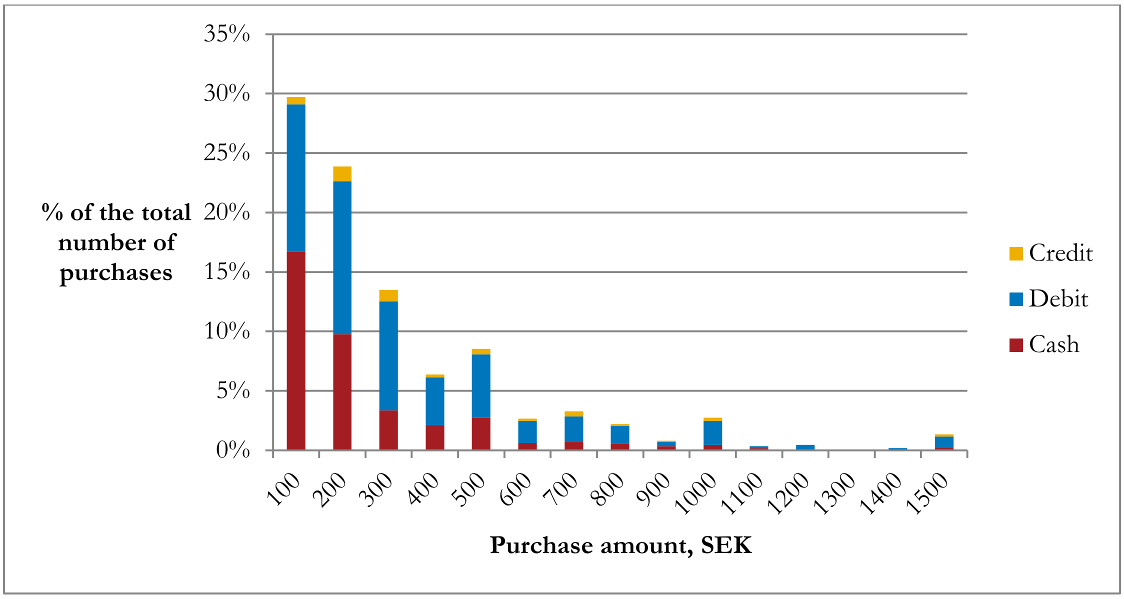
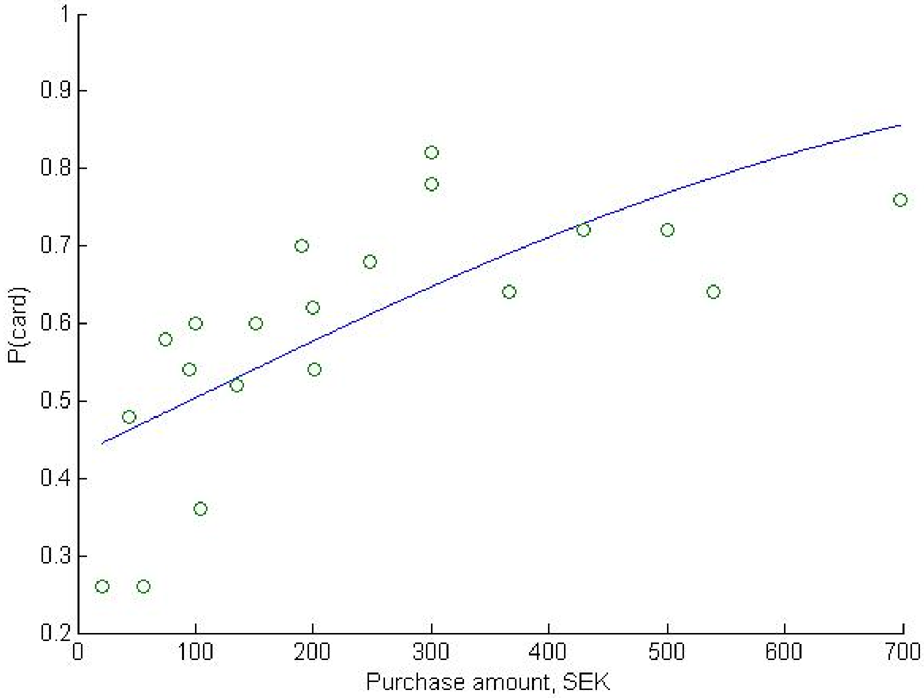


Figure A6:2. Relationship between purchase amount and the share of purchases made with a debit or credit card**.**



Note: By sorting the data by purchase amount, we construct small bundles consisting of 50 purchases each. For each bundle, we estimate the average purchase amount and the share of purchases in that bundle that is made with a debit or credit card. [40]

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[40] The relationship seems to be in the shape of a probit or a logit model. Hence, let us assume a model which has the following general form of a logit model:

$$\mathrm{P(card)} = 1 - \frac{\mathrm{c}}{\mathrm{c} + \mathrm{d} * \exp(\mathrm{a} + \mathrm{b} * \mathrm{x})},$$

where a, b, c and d are constants, and x is the purchase amount. When fitting the model to the data we get the following results: a = -0.0882, b = 0.0030, c = 1.0643 and d = 0.8781. The fitted line from this estimation is added to Figure A6:2.

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Optimal Monetary Policy in an Operational Medium-Sized DSGE Model *by Malin Adolfson, Stefan Laséen, Jesper Lindé and Lars E. O. Svensson*	2008:225
Firm Default and Aggregate Fluctuations *by Tor Jacobson, Rikard Kindell, Jesper Lindé and Kasper Roszbach*	2008:226

Re-Evaluating Swedish Membership in EMU: Evidence from an Estimated Model *by Ulf Söderström*	2008:227
The Effect of Cash Flow on Investment: An Empirical Test of the Balance Sheet Channel *by Ola Melander*	2009:228
Expectation Driven Business Cycles with Limited Enforcement *by Karl Walentin*	2009:229
Effects of Organizational Change on Firm Productivity *by Christina Håkanson*	2009:230
Evaluating Microfoundations for Aggregate Price Rigidities: Evidence from Matched Firm-Level Data on Product Prices and Unit Labor Cost *by Mikael Carlsson and Oskar Nordström Skans*	2009:231
Monetary Policy Trade-Offs in an Estimated Open-Economy DSGE Model *by Malin Adolfson, Stefan Laséen, Jesper Lindé and Lars E. O. Svensson*	2009:232
Flexible Modeling of Conditional Distributions Using Smooth Mixtures of Asymmetric Student T Densities *by Feng Li, Mattias Villani and Robert Kohn*	2009:233
Forecasting Macroeconomic Time Series with Locally Adaptive Signal Extraction *by Paolo Giordani and Mattias Villani*	2009:234
Evaluating Monetary Policy *by Lars E. O. Svensson*	2009:235
Risk Premiums and Macroeconomic Dynamics in a Heterogeneous Agent Model *by Ferre De Graeve, Maarten Dossche, Marina Emiris, Henri Sneessens and Raf Wouters*	2010:236
Picking the Brains of MPC Members *by Mikael Apel, Carl Andreas Claussen and Petra Lennartsdotter*	2010:237
Involuntary Unemployment and the Business Cycle *by Lawrence J. Christiano, Mathias Trabandt and Karl Walentin*	2010:238
Housing collateral and the monetary transmission mechanism *by Karl Walentin and Peter Sellin*	2010:239
The Discursive Dilemma in Monetary Policy *by Carl Andreas Claussen and Øistein Røisland*	2010:240
Monetary Regime Change and Business Cycles *by Vasco Cúrdia and Daria Finocchiaro*	2010:241
Bayesian Inference in Structural Second-Price common Value Auctions *by Bertil Wegmann and Mattias Villani*	2010:242
Equilibrium asset prices and the wealth distribution with inattentive consumers *by Daria Finocchiaro*	2010:243
Identifying VARs through Heterogeneity: An Application to Bank Runs *by Ferre De Graeve and Alexei Karas*	2010:244
Modeling Conditional Densities Using Finite Smooth Mixtures *by Feng Li, Mattias Villani and Robert Kohn*	2010:245
The Output Gap, the Labor Wedge, and the Dynamic Behavior of Hours *by Luca Sala, Ulf Söderström and Antonella Trigari*	2010:246
Density-Conditional Forecasts in Dynamic Multivariate Models *by Michael K. Andersson, Stefan Palmqvist and Daniel F. Waggoner*	2010:247
Anticipated Alternative Policy-Rate Paths in Policy Simulations *by Stefan Laséen and Lars E. O. Svensson*	2010:248
MOSES: Model of Swedish Economic Studies *by Gunnar Bårdsen, Ard den Reijer, Patrik Jonasson and Ragnar Nymoen*	2011:249
The Effects of Endogenuos Firm Exit on Business Cycle Dynamics and Optimal Fiscal Policy *by Lauri Vilmi*	2011:250
Parameter Identification in a Estimated New Keynesian Open Economy Model *by Malin Adolfson and Jesper Lindé*	2011:251
Up for count? Central bank words and financial stress *by Marianna Blix Grimaldi*	2011:252

Wage Adjustment and Productivity Shocks *by Mikael Carlsson, Julián Messina and Oskar Nordström Skans*	2011:253
Stylized (Arte) Facts on Sectoral Inflation *by Ferre De Graeve and Karl Walentin*	2011:254
Hedging Labor Income Risk *by Sebastien Betermier, Thomas Jansson, Christine A. Parlour and Johan Walden*	2011:255
Taking the Twists into Account: Predicting Firm Bankruptcy Risk with Splines of Financial Ratios *by Paolo Giordani, Tor Jacobson, Erik von Schedvin and Mattias Villani*	2011:256
Collateralization, Bank Loan Rates and Monitoring: Evidence from a Natural Experiment *by Geraldo Cerqueiro, Steven Ongena and Kasper Roszbach*	2012:257
On the Non-Exclusivity of Loan Contracts: An Empirical Investigation *by Hans Degryse, Vasso Ioannidou and Erik von Schedvin*	2012:258
Labor-Market Frictions and Optimal Inflation *by Mikael Carlsson and Andreas Westermark*	2012:259
Output Gaps and Robust Monetary Policy Rules *by Roberto M. Billi*	2012:260
The Information Content of Central Bank Minutes *by Mikael Apel and Marianna Blix Grimaldi*	2012:261

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