The Costs of Paying – Private and Social Costs of Cash and Card

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Abstract

Despite the central role of payments in theoretical and policy oriented economics, there is surprisingly little known about the costs of different payment instruments. We estimate social and private costs of cash, debit and credit card payments in Sweden in 2002. The combined social cost of providing these payment services is approximately 0.4 per cent of GDP. Debit and credit cards are socially less costly than cash for payments above EURO 8 and EURO 18, respectively. Corresponding thresholds for consumers' private costs are somewhat higher. Data indicate a too extensive use of cash relative to card payments in terms of both private and social costs.

Keywords: Cash payments, Card payments, Social costs, Private costs

JEL classifications: D12; D23; D24

1. Introduction

The existence of an efficient method of making payments is often an unspoken presumption in economics. Yet surprisingly little is known about the private and social costs of different payment methods and thus about how efficiently our payment system is used. Humphrey, Pulley and Vesala (2000) estimate the cost of payments in U.S. to be as high as 3 percent of GDP. However, there are large differences in payment patterns between countries and there is a rapid technological development that may affect the relative effectiveness of different payment methods. In this study we estimate the private and social costs for cash and debit and credit card payments in Sweden in 2002. We also calculate value thresholds above which card payments are privately and socially cheaper to produce and use. Finally we compare these thresholds with the observed payment pattern.

We find that the total costs of cash and card payments in Sweden amounted to approximately 0.4 per cent of GDP in 2002. This is only 1/8 of the share found by Humphrey et al. (2000). However, our study does not consider all payment instruments, only those used at the point of sale. In terms of social costs, cash is the most expensive payment instrument, with a per transaction cost of SEK 4.7 (EURO 0.52), closely followed by credit card payments (SEK 4.5 or EURO 0.50). Debit card payments are the least costly, with a unit social costs of SEK 3.1 (EURO 0.34). These unit costs were calculated at actual average transaction amounts, estimated to be SEK 165 for cash payments and SEK 620 for card payments. For low-value payments, however, we find that cash is more cost efficient than debit cards; the break-even point is estimated to SEK 72 (EURO 7.8). The value threshold below which cash is to be preferred before credit cards is SEK 159 (EURO 17.6). Our analysis of actual behaviour, however, suggests that the average consumer will prefer cash well above these value thresholds. Using unique survey data, we estimate the probability that a consumer will pay with a card rather than with cash. This probability reaches 50 per cent for payments in the range SEK 150-200 for a "typical" middle-aged male consumer. The value increases to around SEK 450 for a 60–years-old consumer, while a 20-years-old male is predicted to pay with a card with a probability of at least 50 per cent, no matter how small the purchase value. Thus, we observe that age strongly influences the payment choice and that younger consumers are more likely to choose a card payment for low-value payments. Also, we find that consumers with university education are more likely to pay with cards, while those with relatively little formal schooling are more likely to pay with cash.

The costs of different payment instruments and cost recovery from the perspective of the banks have been investigated in a few earlier studies. The Nederlandsche Bank (2004) investigated the social cost of cash, and debit, credit, and prepaid cards. In terms of total cost per transaction, cash was shown to have the lowest costs (EUR 0.3) followed by the debit card (EUR 0.486). In terms of variable costs per average transaction, prepaid cards clearly had the lowest costs (EUR 0.03). However, the costs for

consumers were disregarded as they do not face any direct transaction fees for the use of these instruments. Our study shows that even when not paying explicit fees for payments, consumers do incur substantial costs and that these costs are higher for cash than for card payments. This may explain the difference in result between our study and the Nederlandsche Bank. Garcia Swartz, Hahn and Layne-Farrar (2006a, 2006b) develop a methodology for a cost-benefit analysis of payment instruments. Their method builds on a comparison of the social marginal cost of the payment services in question, i.e., on the net welfare effect of making one more payment using method B and one less payment using method A. Specifically, they study whether the increased use of payment cards has resulted in welfare gains. Using U.S. data they conclude that shifting payments from cash to cards results in net benefits for society as a whole, but also that the payment services that have low social costs are expensive for the merchants. Their methodology differs from ours in that they analyse the effect of incremental changes in payment patterns. Their study may therefore not cover larger changes in the payment pattern which may also affect costs presumed to be fixed.

In line with the two studies cited above, Brits and Winder (2005) estimate the costs incurred by the banks and the retailers involved in a transaction, but ignore the non monetary costs of the customers, e.g. time costs and shoe leather costs.[1] They find that the overall costs for payments at the point of sale (POS payments) in the Netherlands amount to 0.65 per cent of GDP, or about twice as high as our estimate. They show also that in the choice between cash and debit card, the former is more cost efficient for purchases below EURO 11.63 (SEK 105). Thus, compared to our findings, the threshold value above which debit cards are more cost efficient is somewhat higher.

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 transactions costs favour currency for small transactions, while low variable transaction costs favour debit card payments for large transactions. The break even point is EURO 30 or EURO 13 if the hidden costs of cash are included.[2]

Humphrey et al (2006) estimate the cost differences between two hypothetical situations: a banking system with only paper-based transactions and a banking system with only electronic transactions. According to the study, the cost-saving potential from such a shift amounts to approximately 1 per cent of GDP. The study is based on banking cost data and data on the relative frequency of different types of payment, aggregated to country levels, for a panel of countries. The parameter estimates are used to extrapolate from the actual sample data to the two hypothetical cases.

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[1] They use the results of the cost survey from the De Nederlandsche Bank (2004).
[2] Hidden costs include the central bank's and other banks' subsidies to cash payments. .

The Norwegian payment system has been extensively studied over the last two decades. The most recent contribution is made by Gresvik and Øwre (2003) in a descriptive cost study where they use an activity-based rule for allocating fixed costs. Compared to the previous studies by Robinson and Flatraaker (1995a, 1995b)[3], Gresvik and Øwre show that unit costs associated with the provision of payment services have decreased over time and the income that banks derive through direct pricing of these services has risen. This is mainly due to the shift from paper-based to electronic payments.

Pricing of payment services is one important factor determining the use of these services. In this context, Guibourg and Segendorf (2007a) estimate private costs in the Swedish banking sector for the production of payment services and investigate to what extent the price structure reflects the estimated cost structure. They find that (i) banks tend to use two-part tariffs but (ii) variable costs are poorly reflected in transaction fees towards both consumers and corporate customers and that (iii) there exist large cross subsidies between different payment services, foremost from acquiring card payments to cash distribution to the public, while payment services as a whole are not subsidized.[4]

This paper is organised as follows: Section 2 describes the conceptual framework; in particular the differences between the different cost estimates used; Section 3 and 4 present private and social cost estimates for cash and card payments, respectively; Section 5 discusses the division between fixed and variable costs for the different payment instruments in terms of value of purchases and presents the value thresholds between cash, debit and credit cards payments from both a social and a private perspective. Section 6 presents the results from the survey studying consumers' actual behaviour and compares with the results obtained in Section 5; Section 7 summarises and discusses the results.

2. Private and social costs of payment transactions in principle

When analyzing the costs of an industry, a distinction must be made between private and social costs. The former are the costs that individual participants incur while the latter are the total costs to society reflecting the real use of resources in the production of the industry's output. Since payment services are produced in a supply chain, simply adding all participants' private costs will overestimate social costs. For example, retailers' private costs include fees paid to the banks to cover their production costs. The banks' production costs, in turn, will include payments from the banks to their suppliers, such as cash transporters. Hence, the cost of transport will appear three times as a private cost in this example. In a perfectly competitive market without externalities, the price will correspond exactly to social costs. Thus prices can be used as estimates of social costs. However, this simple approach cannot be applied to the payment-services market, e.g., since the production of payment services is

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[3] There are also two related but older studies by Fidjestøl et al. (1989a and 1989b).
[4] In relation to the shadow economy, Guibourg and Segendorf (2007b) further investigate the use of cash.

subject to economies of scale and cross subsidies between different payment services are frequently observed. Furthermore, some actors do have substantial market power.[5] In practice, it is also difficult to separate the production of payment services from other types of related services, e.g., to separate costs for account-based payment services from credit and saving services.[6]

Figure 1 provides a schematic representation of the costs and payments in the payment services supply chain. Regular arrows represent fees and other payments for services, block arrows represent other costs, such as the cost of salaried staff or of time, and dashed arrows represent cross subsidies (deficits or profits that accrue in the production of the relevant service). For example, the private cost of the banks of providing payment services is given by $B+D$, corresponding to costs for purchase of input services and for staff and employed capital, respectively. We will calculate the total social cost of a payment instrument by first calculating the private cost of each participant and then subtract those private costs that are merely transfers from one market participant to another, i.e., all regular arrows in the figure. This can be done in two alternative ways, which will yield the same end result but which will provide different insights into the cost structure of the industry. Using the banks as the example once more, the banks' contribution to total social costs can be calculated as either their private costs minus the payments they *receive* from other participants or as their private costs minus the payments they *make* to other participants. Referring to the figure, the first measure yields $(B+D)-E-F$ which we call the banks' *net private costs*, i.e., negative profit, from that payment service. If the net private cost is positive, this loss has to be covered by a cross subsidy (G). Similarly, a negative net private cost is a profit that can be used to subsidize other (payment) services produced by the bank. The second measure yields $(B+D)-B = D$ and captures the banks' *own production cost* or, alternatively, the *value added* contributed by the banks. After summation across all market participants, both of these methods yield a social cost (before correction, see below) equal to the sum of the block arrows, $A+D+H+J$. In this context, note that both counterfeit cash and card fraud are to be considered as private 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 of the markets participants and in that sense changes their use of real resources through, e.g. measures undertaken to prevent fraud.

Finally, we must correct the calculations for seigniorage, i.e., the private cost of holding cash, which is the foregone interest on cash holding. The seigniorage is a pure transfer from banks, consumers and sub-contractors to the central bank. Such a transfer does not represent a use of real resources and

should not be included in the calculation of social costs. [7] In terms of Figure 1, seigniorage is a part of the block arrows and in Table 1 it is denoted S. The social cost of cash- and card payments is thus $A+D+H+J-S$.

Figure 1. Private and social costs of payment transactions
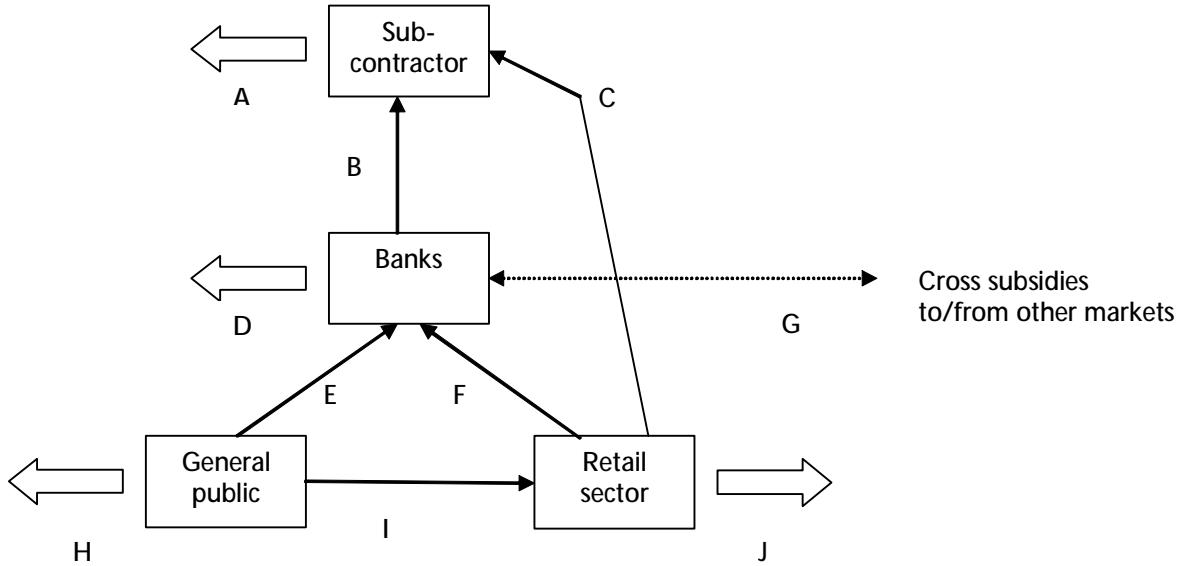
Comment. Since the regular arrows represent payments, s ervices will be delivered between the participants in the opposite direction.

Table 1. Calculation of private cost, net private cost, own production cost and social cost.

	Private cost	Net private cost	Own production cost
Sub-Contractors	A	$A-B-C$	A
Banks	$B+D$	$(B+D) - E - F$	$(B+D) - B$
Retail sector	$C+F+J$	$(C+F+J) - I$	$(C+F+J) - C - F$
General Public	$E+H+I$	$(E+H+I)$	$(E+H+I) - E - I$
Sum		$A+D+H+J$	$A+D+H+J$
Correction for seignorage		$-S$	$-S$
Social costs		$A+D+H+J-S$	$A+D+H+J-S$

Although there are important differences between the markets for cash and card payments, in terms of Figure 1 and Table 1 these differences will only be reflected in different sub-contractors in the two markets. We describe each market shortly in the section in which it is analysed. More extensive descriptions are given in Appendix 1 and Appendix 2.

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[7] A calculation of social costs should in principle include an estimation of externalities. If, for example, the production of payment services gave rise to negative externalities, then private costs would underestimate the costs to society. In retail payments, network externalities between the customers are likely to be substantial. Since these externalities are positive rather than negative, however, they will appear on the benefit side and will therefore be irrelevant in an estimation of the costs of the payment systems. Instead, the price charged for the payment service will tend to underestimate the social marginal willingness to pay for the service.

2.1. The Swedish market for card and cash payments

Transactions at the point of sale (henceforth POS) are made either by cash, cards or checks, although the latter are used very rarely. In terms of number of transactions, cash payments constitute the majority of POS payments. However, it is typically used for low-value payments, so that in terms of total turnover at the POS, the share of card payments is larger. The number of transactions and turnover in 2002 are given by Table 5.

The basic difference between cash and card payments is that the former are immediately settled by the exchange of banknotes and coins. The settling of the latter requires intermediaries such as banks. However, although cash payments are settled without intermediaries, the distribution of cash to users and the devolution of excess cash to banks and cash deposits require a logistical system. With the exception of what in Figure 1 is called subcontractors, the main actors are the same in both markets: the general public, the retailers and the banks. In short, cash requires a central bank that issues notes and coins and subcontractors that logistically handle the physical transportation of these. Card payments are essentially information processing and here the subcontractors, like switches and clearing houses, handle and process information.

3. Cash payments

The main actors in the cash market are the central bank, cash deposits, transporters, banks and post offices, retailers and the general public. In short, the central bank issues, and redeems, notes and coins that are distributed to regional and local cash deposits. These deposits supply cash to banks, post offices and sometimes directly to large retailers. Banks and post offices supply the general public and the retail sector. There are also flows of cash between different banks and between different deposits. The main aspects of the cash–distribution model are described in Appendix 1.

The value of notes and coins in circulation (M0) was SEK 107 bn in 2002.[8] We have, in a previous study Guibourg & Segendorf (2007b), estimated that the value of cash-financed consumption in the retail sector in 2002 was SEK 235 billion. The value of cash withdrawn by the public through the ATM system amounted to SEK 269 billion.[9]

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[8] Annual Report (2003), Riksbanken. Measured as value of notes and coins in circulation, December 31. Measured as the average value over the year results in a somewhat lower number.

[9] Sveriges Riksbank (2006). Our estimate of the value of cash-financed consumption in the retail sector in 2002 does not comprise all cash transactions. Transactions in the shadow economy, which are mostly cash based, are not included. Legal, but non-recorded cash transactions between individuals, for example transactions in second hand markets are not included either. This may explain why we observe a difference between the value of cash withdrawn over the ATM-system (data on cash withdrawn at bank branches is not included) and the value of cash spent in retail transactions.

The logistics involved in the distribution of cash to the public underwent large changes in the period 1998-2004. The changes introduced were meant to increase the efficiency in the distribution of cash and also to make necessary adjustments to changing patterns of use. A direct consequence of this is that the cost data of the Riksbank from 2002 is not representative. For the Riksbank, we therefore use data from 2003 that is deflated to the price level of 2002. All other data is from 2002.

3.1 Private costs of cash

For the production and distribution of cash the Riksbank incurred a cost of SEK 268 million in 2003. This is equivalent to 0.25 percent of the value of currency in circulation.[10] Of the total cost, SEK 241 million was for the issuing of notes and coins, SEK 5 million was for security and cash transport services between the head office and the cash deposits, and SEK 22 million was for personnel and administration.

In addition to the costs mentioned above, the Riksbank incurred, through its subsidiary, a cost of SEK 82 million for its cash deposits. This includes rent, insurance, security, operation and maintenance of machines, personnel, accountant services, IT etc.[11]

The cost of cash transportation and counting services including related logistics and security amounted to approximately SEK 1.03 billion or, equivalently, 1 percent of the value of currency in circulation in 2002.[12]

Cash is distributed to the general public mainly via the ATM system or over the counter at bank or Postal offices. Transactions over the counter comprise not only withdrawals but also deposits of cash by the public. These transactions give rise to mainly fixed costs in terms of office space and personnel. ATM terminals are also associated with high fixed costs, but there are also variable costs that arise for refilling of cash of the terminals and bilateral bank interchange fees. The latter, however, are pure transfers between banks and do not represent a real use of resources even though they give rise to private costs and revenues for individual banks. In 2002, the total number of withdrawals was 321 million, of which 90 percent were ATM withdrawals and 10 percent were made over the counter.[13] Postal offices do not only distribute cash to the public over the counter but, in rural areas, also through the mailman. Banks and postal offices also incur costs for cash- storing and cash-counting

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[10] Annual Report (2003), Riksbanken
[11] Annual Report (2003), Svensk Kontantförsörjning AB (SKAB) complemented by direct information given by accountants at the Riksbank
[12]Information from annual reports from the three large cash transportation firms:
- Annual Report (2003), Pengar I Sverige AB (PiS) complemented by direct information given by PiS' chief accountant in 2002.
- Annual Report Securitas Värde (2002).
- Annual Report Falck Security (2002).
Both Securitas and Falck have provided other security services besides cash transportation. In the case of Securitas we had the annual reports for both the cash transportation subsidiary and the parent company. In the case of Falck we only had the annual report for the parent company. We computed Securita's cash transport shares of the parent company's total costs and revenues, assumed that the same shares applied for Falck, and used these shares to estimate Falck's costs and revenues for cash transportation services.
[13] In terms of value, SEK 269 billion were withdrawn over the ATM network. Assuming that the shares of number of withdrawals from ATM and over the counter at bank branches also apply for the value of withdrawals, this means that SEK billion 296 were withdrawn from both channels and SEK 30 billion over the counter.

services and transportation of cash between branches and between branches and cash deposits. In total, banks' costs related to cash distribution amounted to SEK 2.4 billion in 2002 and the corresponding costs for the Postal offices amounted to SEK 1.8 billion.[14] For the rest of this paper, the category of banks and postal offices will be called banks and thus be assigned the cost SEK 4.2 billion. To this figure we add banks' seigniorage costs for cash holdings at the ATMs or at the branch. These were estimated to SEK 30 million in 2002.[15] An additional cost is the cost for switching and authorisation services related to ATM withdrawals. These costs amounted to SEK 23 million in 2002.[16] [17]

Swedish consumers almost never pay any fees for the withdrawal of cash and the only explicit cost that consumers have in the use of cash is the fixed annual fee that they pay for the card that they use for ATM withdrawals. Guibourg and Segendorf (2004) estimated the fixed fee per transaction that users incur for a debit, a credit or a withdrawal transaction. Using this data, we compute the total fixed fee paid by Swedish consumers for cash withdrawals, SEK 457 million, as the product of the per-transaction fixed fee and the number of ATM-withdrawals. However, consumers also incur implicit costs related to cash payments. These are i) the cost of holding liquidity which here is calculated as the interest rate cost on the average holdings of cash for transaction purposes, calculated as half of the average ATM withdrawal ii) the shoe-leather cost of going to the closest ATM to withdraw cash, and iii) the time costs at the cash register. Under the assumption that consumers minimise total costs by choosing an optimal number of ATM withdrawals, we can use an inventory-theoretic model to calculate the consumers' cost per withdrawal (Baumol, 1952 and Tobin, 1956). [18] Given the observed number of ATM withdrawals per capita and year (43), the average withdrawn amount (SEK 833) and the interest rate (5.15 per cent), the model yields an annual per-capita cost of SEK 43.2 corresponding to SEK 321.1 millions in total for all consumers. Half of the cost is the actual withdrawal cost ("shoe leather costs" and withdrawal fees, if such are used) and half of the cost is foregone interest on the average cash holding. In other words, the per-withdrawal cost is estimated to approximately SEK 0.5.

The inventory-theoretic approach used here underestimates withdrawal costs if consumers perceive carrying cash as risky. We have no means of directly estimating these risk costs, but as an alternative, we can also base our calculation on a direct estimate of the time cost of ATM withdrawals. According to earlier studies by the Swedish Bank Association, a cash withdrawal takes on average 50 seconds – from the moment the card is inserted in the ATM until the withdrawal is completed.[19] To this we add an assumed average queuing and walking time of one minute. As users' time cost we use the same after-tax hourly wage as in the time-cost studies at the cash register (see below). This gives us an

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[14] Data on banks costs see Guibourg and Segendorf (2007a). Data on costs and revenues for the Postal offices from Annual Report Posten (2002) complemented by direct information from Patrik Högberg, Posten's CEO.
[15] Guibourg and Segendorf (2007a).
[16] These are the costs reported by the user-owned switch Cekab. One of the large banks has a switch of its own, but these costs are already included in the owner bank's costs.
[17] Annual Report Cekab (2002) complemented by direct information from Cekab's CEO
[18] See Appendix 3 for the details of the calculation.
[19] Direct information from Leif Trogen, Head of the Board of the Swedish Banking Association.

alternative estimate of the consumers' per-withdrawal cost: between SEK 1 (0 seconds queuing/walking time) and SEK 2.2 (one minute queuing/walking time). According to the inventory-theoretic approach, the total annual cost will be twice the product of the number of withdrawals and the per-withdrawal cost, since in optimum half of the total cost will be the cost of foregone interest. (See Appendix 3.) The corresponding total private costs are SEK 0.642 billion and SEK 1.53 billion. Backing out the perceived interest rate from eq. (2) in Appendix 3 gives interest rates in the range 10.3 to 22.5 per cent for withdrawal costs of SEK 1 to 2.2. The difference between the actual interest rate (5.15 per cent) and the perceived interest rate can be interpreted as the per-year risk cost of carrying cash. The cost component due to the actual interest rate is part of the seigniorage – hence it does not represent a social cost. The risk cost of carrying cash, however, is a social cost.

Thus, the inventory-theoretic and the time-cost-estimation approaches used in combination give an interval for the users' cost of withdrawals of SEK 0.642 – 1.53 billion and a subjective risk cost of 0-17.5 per cent on top of the explicit interest. Below, will base our calculations on the more conservative estimate obtained from the inventory-theoretic approach in order not to over estimate the cost of cash. However, we will comment on the consequences of the higher per-withdrawal cost that results from also considering the time cost of withdrawals.

In addition, consumers as well as retailers also incur a time cost at the cash register. In order to estimate these costs we use the time studies and the average hourly wages reported in Svensk Handel (2004).[20] We make the simplifying assumption that the value of time is equal to the average wage before tax during working hours and average wage after tax at other times. This is justified if individuals can freely chose their working hours and if the direct (non-monetary) utility of waiting and queuing time is equal to the direct utility of working; i.e., if working and waiting/queuing are equally pleasant activities, except for the wages earned by working. Here we assume that consumers make their purchases after working hours.[21] Thus for individuals we use the hourly wage after tax as the alternative cost for standing in line at the cashier (SEK 0.49 per transaction). According to a user survey conducted on behalf of the Riksbank[22], the average value of a cash transaction at the point of sale amounts to SEK 165 in 2006 (see Table 2 above). Assuming that the size of this average cash payment has not changed much, this indicates that the number of cash transactions in the retail sector to be approximately 1.4 billion. Using this estimate, the total time cost of cash payments in 2002 incurred by consumers at the cash register amounted to SEK 0.69 billion. Adding the fixed annual fees, liquidity and shoe-leather costs mentioned above we find that consumers' private costs of cash amounting to SEK 1.47 billion in total.[23]

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[20] Wherever necessary, we have used a price deflator to convert wages and costs to 2002 prices.
[21] See Mackie et al. (2001) for a discussion.
[22] See section 6 below.
[23] If we consider the time-cost of using ATMs, the corresponding cost range would be SEK 1.8-2.7 billion.

The retail sector bears a large share of costs associated with cash transactions. Svensk Handel (2004) provides data on transaction costs for retailers associated with cash and card payments, respectively. These costs were reported separately for different types and sizes of retail shops. We use this data to calculate the average cost using the relative shares of these shops of the total turnover in the retail sector as weights.[24] According to this, a retailer incurs a cost of SEK 2.61 on average for a cash transaction; 73 per cent of which is fees for transport services of daily takings and costs relating to the extra work that cash transactions demand before and after the transactions occur, such as putting orders of cash, assisting in the transport of cash, sorting of coin and counting of cash in the registers. The latter is calculated as the product of the average time these activities take and the average hourly wage before tax and including social insurances.[25] The remaining 27 percent of the cost (SEK 0.70) is related to the average time, also multiplied with the hourly wage that a cash transaction takes at the cash register. Multiplying the merchants' average cost with the estimated number of cash payments (1.4 billion) gives a total private cost for the retail sector of SEK 3.65 billion. To this we have to add the cost of forgone interest income cost of holding cash (SEK 30 million).[26]

Lastly, the costs of counterfeit cash may be borne by any of the participants in the cash market. However these costs are relatively low. In Sweden, there are approximately 110 counterfeit banknotes per million inhabitants, which is a low figure in an international comparison. In 2006 there were 996 counterfeit banknotes amounting to a total value of SEK 339 thousands. These low counterfeit costs can partly be explained by the Swedish krona being a small currency but they may also be explained by advanced and continuously upgraded security measures.[27]

The sum of private costs and the costs of each participant in the distribution and use of cash are summarised in the first column of Table 3 where users' costs of cash withdrawals are estimated according to the inventory-theoretic approach.

3.2 Social costs of cash

As described in the Section 2 and above, the participants in the market for cash pay fees for the services of other participants. These fees are important parts of the private costs and revenues of the participants but they do not reflect a real use of resources at that stage of production. Instead, they are meant to cover costs that arise at another stage of production of the service. Neither does seigniorage represent a real use of resources – it is merely a transfer from other participants to the central bank. Consequently, we subtract fees and seigniorage from private costs. This gives us the

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[24] The turnover data for the different categories of shops is taken from Statistics Sweden, SNI 92.
[25] 160 SEK/hr.
[26] Our previous estimates of sales in cash for 2002 amounted to SEK 235 billion. Daily takings are collected approximately 320 days per year (estimate by CashGuard- a cash management systems firm). Thus, the average daily taking is SEK 734 million for the retail sector in total. We make the simplifying assumption that this amount reflects the average cash holding in the retail sector. Then, since the average repo interest rate was 4.0705 per cent in 2002, the total anual seigniorage cost for the retail sector amounted to SEK 34million.
[27] Riksbank, Verksamhetsrapport för Enheten för kontantförsörjning 2006/2007.

own production cost of each participant; these are added to obtain total social cost. Table 3 summarises these calculations.

Net private costs are defined as a participant's private costs minus fees received by the same participant. By construction, the sum of net private costs equals social cost plus seigniorage. Table 3 shows the shares of social costs borne by the participants. We observe that own production costs' shares, which can be interpreted as value added at each stage, differ from the shares of private net costs borne by the participants. In particular, this is the case for merchants and banks: 50 per cent (15 per cent) of total social cost arises at the bank level (merchant level) while merchants (banks) bear 56 per cent (16 per cent) of the actual cost burden, once fees received are deducted. They are thus not fully compensated for the value they contribute. In practice, this means that banks subsidise cash use at an annual rate of almost SEK 1.4 billion, while merchants must use part of their gross margin to cover their total annual cost of close to SEK 4 billion, since consumers are not directly charged for payment costs. The social costs include costs for measures against counterfeit.

Table 2. Private costs, fees paid, social costs, fees received and net private costs in the distribution and use of cash, SEK billion

	private cost SEK billion (a)	fees paid SEK billion	own production cost SEK billion	own production costs' shares of total social costs	fees received SEK billion (b)	net private costs (a)-(b)	shares of net private costs
Riksbanken & deposits	0.35	0,00	0.35	5%	0.04	0.31	5%
Transport	1.03	0.04	0.99	15%	0.94	0.09	1%
Bank & Post	4.24	0.97	3.27	49%	3.16	1.37	16%
Switches	0.02		0.02	0%	0.03	-0.01	0%
Retail sector	3.68	2.7	0.98	15%		3.68	56%
General Public	1.47	0.46	1.01	15%		1.47	22%
Total	10.79	4.79	6.62	100%	4.79	6.62	100%
		seigniorage costs	-0.06				
		Social costs	6.56				

We estimate the social cost of cash to be SEK 6.56 billion in total, corresponding to 6.1 per cent of M0. Considering that the number of cash transactions was estimated to be 1.4 billion, the social cost is approximately SEK 4.7 per transaction. Using the time-cost approach to estimate withdrawal cost raises social costs to SEK 6.88 – 7.77 billion and unit costs to SEK 4.91 – 5.55

4. Card payments

A card payment involves at least three parties: the cardholder (payer), the merchant (payee) and one or two intermediaries: the cardholder's bank (card issuer) and the merchant's bank (acquirer), which may or may not be the same. Besides users and intermediaries, card payments require the involvement of processors of payment information; switches, clearinghouses etc. We describe the card payment process and the main players involved in Appendix 2.

4.1 Private costs of cards

The costs of card payments for users, intermediaries and processors differ for different types of cards. Credit card payments are more costly for users and intermediaries. However, for the switches, credit card payments are not more expensive to process than debit card payments.

Bank costs for card payments consist of switching, clearing and settlement fees, interchange fees[28], administration costs and costs for procurement of cards. In Sweden, these costs are the same for debit, deferred debit and credit cards. In order to simplify, deferred debit cards will in the following be considered to be a type of credit card. To the card issuer, credit-card payments also impose costs related to the credit given to the consumer, e.g. foregone interest and credit risk. The costs reported by banks include the fees that banks pay for switching, clearing and settlement services.[29] Administrative costs were allocated based on the relative activity of the different payment instruments; see Guibourg and Segendorf (2007a). Interchange fees are not explicitly included in the analysis, since they are payments between banks and hence represent neither a social cost of a private cost for the collective of banks. Banks' total cost for card payments amounted to SEK 0.98 billion or, alternatively, SEK 1.7 per card payment. Of these costs, SEK 0.73 billion (SEK 0.25 billion) were due to transactions with debit (credit) cards.[30] Using the volume given in Table 2, the cost of a debit or credit card payment is SEK 1.4 and 3.1 respectively.

Regarding users' costs we use the same method as for cash withdrawals to estimate users' fixed costs for card transactions, i.e., we multiply the annual fee per card transaction by the number of card transactions of each type. This yields SEK 0.83 billion. Users face no other pecuniary costs for card payments, but they have a variable cost of card payments in terms of time costs at the cash register. As in the case of cash, we use the data reported by the Swedish Trade Federation (2004) and calculate the total variable cost for users as the product of time costs per payment and the number of payments with each type of card.[31] Users' total variable cost amounts to SEK 0.32 billion. Hence, users' total costs for card payments amounted to SEK 1.15 billion or SEK 2.0 per transaction.

Merchants have costs for card terminals, transaction fees and time costs at the cash register. Svensk Handel (2004) reports the transaction cost for a card payment divided into time costs at the cash register and other costs. The latter consist almost entirely of merchant fees which, deflated to 2002 price level, amounted to SEK 1.17 (SEK 11.75) per debit (credit) card transaction or SEK 1.54 billion in

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[28] Interchange fees are fees paid by the acquiring bank to the card issuing bank in order to reimburse it for the costs associated with a card payment.

[29] The costs for switching services are mainly fixed and associated with buildings and equipment. Variable costs amount to no more than 1-2 per cent of total costs Source: Annual Report Cekab (2002) complemented by direct information from Eva Menzing, Cekab's CEO.

[30] Data on bank costs in 2002 is taken from Guibourg and Segendorf (2007a).

[31] Sveriges Riksbank (2006). Since data is from 2004 we used a price deflator to convert costs to their 2002 values.

total.[32] To this we have to add the time costs at the cash register, which are equal for both types of card transactions. The (deflated) time cost for the average card payment is SEK1.15 which, multiplied with the number of card transactions, gives a total time cost of SEK 0.68 billion. Adding the different types of costs gives merchants' total transaction cost, SEK 2.15 billion (SEK 3.7 per transaction) of which SEK 1.15 billion can be assigned to debit card transactions and SEK 1 billion to credit card transactions.

The overall private costs to participants are presented in Table 4. However, there are large differences between debit card payments and credit card payments. For banks, the unit cost of the latter is twice as large as the unit cost for debit card payments and for retailers it is more than five times higher. Notice that these costs do not include card fraud. The main reason is that there is no data on fraud that covers the entire card market but even with conservative estimates this would add substantial amounts to the private costs, e.g. a fraud rate corresponding to 0.01 per cent of the turnover would increase private costs with nearly SEK 36 million.[33]

4.2 Social costs of card payments

The social cost of card payments is calculated as total private cost minus the fees that merchants and cardholders pay to the banks for card payments and the fees that banks pay to the central switch for their services. The social costs include measures against fraud. It is, however, impossible to distinguish them from other types of costs.

Table 3. Private costs, fees paid, social costs, fees received and net private costs for card payments in 2002, SEK billion.

Tot card payments	private costs (a)	fees paid	own production cost SEK billion	own production costs' shares of total social costs	fees received SEK billion (b)	net private costs (a)-(b)	shares of net private costs
Banks	0.98	0.06	0.92	48%	2.37	-1.39	-73%
Switches	0.06		0.06	3%	0.06	0.0	0%
Retail Sector	2.15	1.54	0.61	32%		2.15	113%
General Public	1.15	0.83	0.32	17%		1.15	60%
Total	4.34	2.43	1.91	100%	2.43	1.91	100%
Social costs (SEK billion)			1.91				

We observe that the largest share, almost fifty per cent of total own production costs, arise at the bank level, while only around one third of all costs occur at the merchant level. In contrast,

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[32] Using data on value and volumes for different type of cards in combination with data fees for debit and credit cards (Guibourg and Segendorf (2007a)), we calculated the average fees for a debit card transaction (SEK 1.21) and for a credit card transaction (SEK 13.3).

[33] According to Jan-Olof Brunila, Head of Group Card Services, Swedbank, the fraud rate is relatively low in Sweden. Fraud costs for two of the large Swedish banks accounting for 70 per cent of the card market amount to 0.01 per cent of the turnover in the card market. According to Sven Estwall, General Manager Northern Europe (Visa Europe), the fraud rate with Visa cards in Sweden amounts to 0.018 per cent. This is approximately a third of the average rate in Visa Europe of 0.057 per cent. According to Electronic Payments International (2007), debit card fraud in the US amounted to USD 662 million in 2005. In the same year the value of debit-card transactions was USD 868 billion (BIS (2007). This makes a fraud rate of 0.075 per cent.

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merchants' total net costs are larger than total social costs. This is because merchants pay relatively high fees to banks for the acceptance of card payments, but rarely charges their customers directly for payment services. The banks, on the other hand, make a net profit from card payments. The combined profit, SEK 1.39 billion, almost exactly covers the losses banks incur from cash transaction.

5. Social costs – a comparison between cash and card payments

We can now compare the social costs of cash and card payments. Table 5 summarises our estimates of total social costs and unit social costs when users' costs are estimated according to the inventory-theoretic model. We observe that not only private but also social costs for cash payments are more than three times larger than for card payments. Total social costs for POS transactions, i.e., both cash and card payments, amounted to SEK 8.5 – 9.7 billion in 2002, which amounted 0.36 – 0.40 per cent of GDP the same year.[34]

Table 4. Total and unit social costs for cash and card payments in 2002

	Total social costs *SEK million*	Volumes *millon transactions*	Turnover *SEK million*	Unit social costs *SEK*
Cash	6 560	1 424	235 000	4,6
Tot card	1 910	589	365 000	3,2
-of which:				
Debit card	1 560	509	297 000	3,1
Credit card	350	80	68 000	4,4
Tot. POS trans.	8 470	1 989	600 000	

Considering the differences in volumes of payments, our estimates show that unit costs of cash payments are larger than unit costs of card payments. However, there are differences between different types of card payments. There is a small difference in unit social costs between cash and credit card transactions but those of debit cards are substantially smaller.

This does not mean that, from a social point of view, debit card payments are always to be preferred. The unit costs are calculated at the actual average transaction sizes, assumed to be 165 SEK for cash transactions and 620 SEK for card transactions. However, since the two technologies have different proportions of fixed and variable costs, the optimal choice will depend on the size of the transaction. It is reasonable to assume that a large share of the costs of a cash payment is variable, while the opposite applies for a card payment. By "fixed cost" we here 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. An example of a fixed cost is the switching cost of a card payment. 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, are referred to as sunk and are not

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[34] Table 5 uses the lower number, which is based on the pure inventory-theoretic estimate of cash withdrawal cost. The higher number includes withdrawal time costs; see Section 3.1.

considered below. We will also consider the consumers' annual card fee; the bank's cost of setting up the customer's account and the cost of issuing a payment card as sunk. All these costs are already incurred when the transaction occurs and thus do not affect the choice of payment instrument A variable cost is a cost that increases with the value of the transaction, e.g. the costs associated with counting, transporting, filling ATM terminals and or the bank's cost of granting credit in the context of a credit card transaction. The conceptual idea is thus to distinguish between sunk, fixed and variable costs and to focus on the two latter.

Data did not always allow for such a detailed division of costs as described above. Table 6 is based on a rough estimate of the share of fixed and variable costs for six categories of market participants.[35] For card payments, only the cost of credit embedded in credit card payments is variable in transaction value. However, since this is not a social cost we will in the following assume that 100 per cent of the social costs of a card payment are fixed, i.e., do not vary in the transaction amount. From the consumer's perspective, on the other hand, the period of free credit is a negative cost that does vary with the transaction amount.

Table 5. Shares of fixed and variable social costs for cash payments

Cash payments SEK billion	Social costs	Shares fixed costs	Shares variable costs	Fixed social costs	Variable social costs
Riksbank &Cash deposits	0.35	0.08	0.92	0.03	0.32
Transport	0.99	0.30	0.70	0.30	0.69
Bank & Post	3.27	0.40	0.60	1.31	1.96
Switches	0.02	1.00	0.00	0.02	0.00
Retail sector	0.98	0.30	0.70	0.29	0.69
General Public	1.01	0.70	0.30	0.71	0.30
Total	6.62			2.65	3.97
seigniorage	-0.06		Shares	0.4	0.6
Social costs	6.56				

The next step is to express the social cost of each payment instrument as a function of the transaction size. The intercept of the social cost functions is the fixed cost per transaction while the slope is given by the social cost per unit of value spent. Using the shares of fixed and variable costs for cash given by Table 6 and the assumption of no variable costs for card payments, we can express the cost function for card and cash payments as shown in equation (1):

$$\text{social cost of card payment} = \frac{\text{tot. social costs cards}}{\text{number of card payments}}$$

$$\text{social cost of cash payment} = \frac{(0.4 * \text{tot. social costs cash})}{\text{number of cash payments}} + \frac{(0.6 * \text{tot. social costs cash})}{\text{value of cash payments}} \times \text{value spent} \quad (1)$$

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[35] For each cost component incurred by each market participant, as discussed above, we made an assessment of the relative proportion of fixed and variable costs. These assessments where then aggregated into a total cost function for each market participant.

Equalizing the two expressions, we can find the transaction amount for which the social cost of cash and the social cost of a card payment are equal. If we consider card payments in general the value of such a transaction is SEK 82. Below that value cash is a more cost efficient alternative, while the opposite is the case for values above this figure. If we divide card payments into debit and credit card payments, we observe the break-even value between a cash payment and a debit-card payment (credit card payment) at a smaller (larger) transaction size. For transaction sizes above SEK 71 (SEK 157), a debit card (credit card) payment is socially preferable to a cash payment. Figure 2 illustrates the costs of these payments as functions of the transaction values, measured in SEK, and the break-even points between these different instruments. These point estimates are based on data from different sources and some assumptions. It is therefore important to investigate the robustness of the estimates. Below we do this for two particularly important factors; the division between fixed and variable costs and size of the average cash payment.

Figure 2. Social per-purchase cost of card- and cash payments as functions of purchase value, SEK
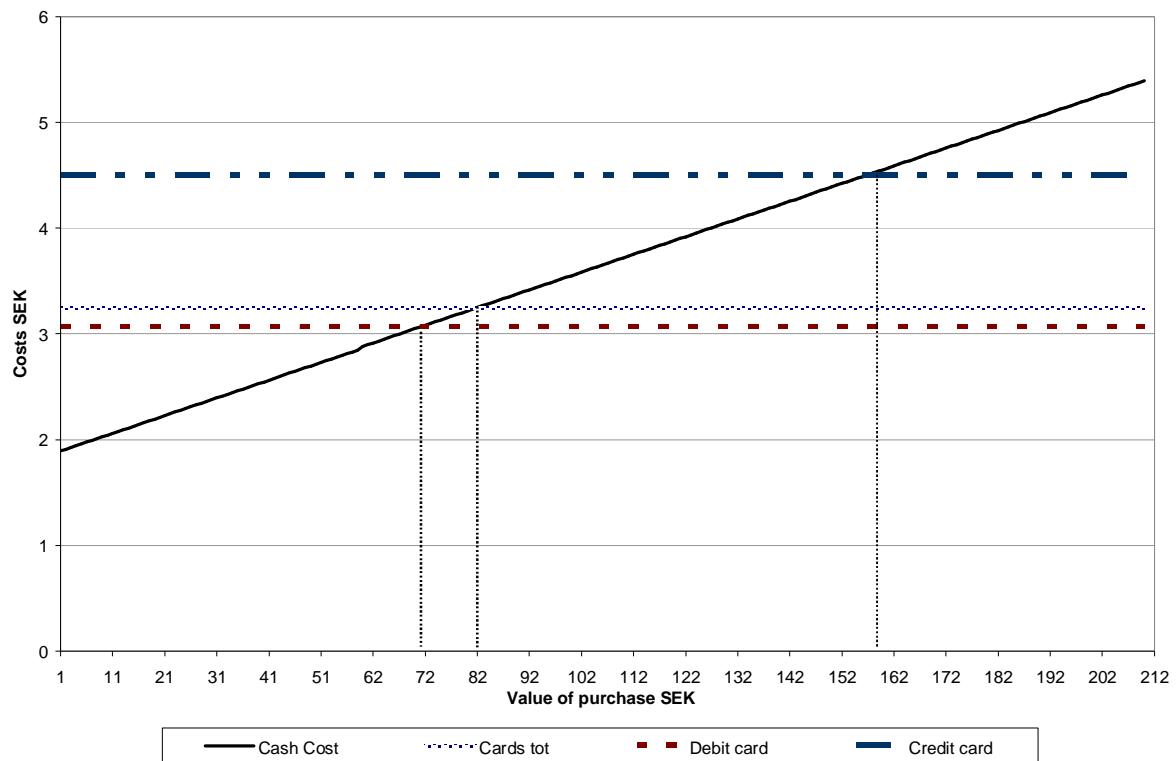
In terms of Figure 2, an increased share of fixed costs for cash increases the intercept on the vertical axis and lowers the slope of the cash cost function. The share of fixed social cost is here estimated to be 0.4. The effect of increasing or decreasing the share of fixed costs with 10 percentage units is shown in Table 7. In short, moderate variations in the assumptions on the shares of fixed and variable

social costs turns out to have a small effect on the break-even value between a cash and debit card and only a negligible effect on the choice between a cash and credit card.

Our estimate of the number of cash payments (see below) is uncertain. If the true size of the average cash payments differs from our estimate, this will to some extent affect the cost functions' intercept. However, most of the costs we depict as fixed in Figure 2 are fixed in the transaction amount but variable in the number of transactions (queuing time, for example). Hence, total fixed costs (the numerator) will increase almost in proportion to the number of transactions (the denominator). By similar reasoning, the slope of the cost function would remain the same, since our estimate of cash turnover does not depend on our estimate of the number of cash transactions.[36]

The average cash payment is computed using survey data. This enabled us to calculate a 95 per cent confidence interval for the average cash payment and corresponding intervals for the social break-even points, as shown in Table 7 (see Section 6 below). We conclude that the point estimates are fairly robust also against changes in the size of the average cash payment.

In Section 3.2 we presented alternative and higher estimates of the withdrawal cost. We treat the withdrawal cost as a component of the *variable* cost of paying with cash. It follows that a higher estimated withdrawal cost will not influence the intercept, but the paying-with-cash cost function will become steeper. Using the highest of the estimates presented in Section 3.2 would increase the slope approximately 30 per cent and would lower the social break-even points to approximately SEK 53 and SEK 120 for debit and credit cards, respectively, starting from the central point estimates.

Table 6. Robustness analysis of social break-even points

Fixed/Variable cost shares	Social break even points	
	Cash/Debit card	Cash/Credit card
0.1/0.9	103	160
0.2/0.8	95	170
0.3/0.7	85	158
0.5/0.5	52	155

In Table 7 we see how the social break points between cash and debit card and between cash and credit card are affected by different assumptions on the shares of fixed and variable costs.

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[36] Obviously, the estimated number of transactions *will* have an effect on the calculated unit costs.

6. Consumers' private costs and the actual choice between cash and card payments

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 of the two alternatives. When paying with a card, the main cost will be the time costs at the cash register, while a cash transaction will also result in costly time at the ATM.

As discussed in Section 5, the customer's choice between paying with cash and card will only depend on such costs as are variable in the number of transactions or the transaction amount. In particular, this means that annual card fees are irrelevant. In the choice between paying with a card that the consumer already possesses and paying with cash, the annual fees for cards should be considered as sunk costs. Disregarding annual card fees can also be motivated on the grounds that the same card is typically used both for ATM withdrawals and card purchases. Hence, we base our calculation on users' private costs of cash and card as reported in Tables 3 and 4, except annual fees, and the data on total volumes and value of transactions with cash and cards respectively (Table 5). Note that the period of free credit for credit cards (which in our terminology includes deferred-debit cards, which is the most common of the two) implies a *negative* cost component that varies with the purchase amount. Assuming an interest rate of 5 per cent implies that the consumer's private cost of paying SEK 120, for example, is SEK 0.5 less than the fixed per-purchase cost. It follows that the cost curve has a downward slope for credit (deferred-debit) card payments.

By applying Eq. (1) to these private costs, we can compute the users' private break-even point between cash and card payments, between cash and debit card payments and between cash and credit card payments. Below (above) the thresholds the user is expected to prefer paying with cash (cards).

Figure 3 illustrates consumers' private costs for cash and card payments as functions of the value spent. The intercept of the private card-cost function is given by consumers' per-transaction time costs at the cash register.[37] For cash payments the intercept is equal to our estimate of the time costs at the cash register, which are smaller than those for card payments. The per-value-spent variable costs of cash payments are given by total liquidity and shoe leather costs of cash withdrawals, divided by the total value of cash payments.

Figure 3. Users' private costs of cash and card payments

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[37] We used the same share for social costs. According to Table 6, for users' private costs of cash payments we used the shares 0.3 (0.7) fixed (variable)
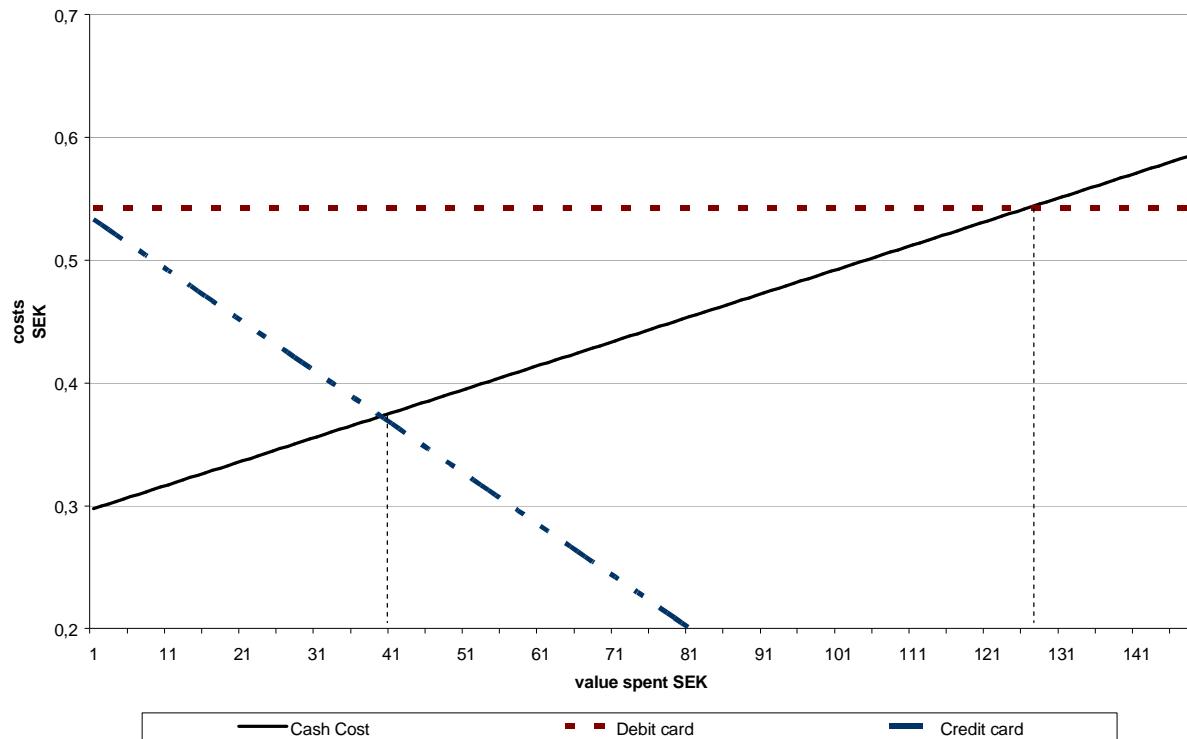
We find that the private break-even points are higher than the corresponding social break-even points for debit-card payments. Our results show that the break-even point occurs around SEK 125, which is considerably higher than the social break-even point between debit card and cash payments (SEK 71). Moreover, SEK 125 is outside the interval given by different assumptions on shares of fixed and variable costs in Table 7. However, the private break-even point for credit-card payments occurs already at SEK 40, far *below* our estimate of the social break-even point (SEK 157). Hence, consumers' private incentives lead to an under use of debit cards and an overuse of cash and, in particular, credit cards compared to the social optimum.[38]

As a final step in our analysis we confront our results so far with an empirical measurement of *actual* behaviour. We use a unique dataset on individuals' recent purchase behaviour, including the choice of payment technology.

The Riksbank conducted a telephone-based survey on the quality of cash and the use of cash and cards during two weeks in November 2006 (Synovate Temo, 2006). A representative gross sample of

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[38] For merchants the misalignment between private and social incentives to use (or accept) credit cards is even larger than for users, but in the opposite direction. Merchants' private break-even point between cash and credit cards is SEK 2269. Merchants' private incentives are, however, well aligned in the choice between debit card and cash payments, with a private break-even point of SEK 89. In Sweden, terminal density is high. The numbers of card-accepting terminals per million inhabitants amounted to 11 431 at the end of 2002 (source: BIS (2005)). This suggests that the vast majority of merchants do not try to influence the customers' choice by making card payments difficult. The large misalignment between merchants' incentives and the relative social costs of credit card payments may, however, explain the conflicts of interest manifested through the years between banks and the retail sector as regards fees for card payments. From our calculations, merchants do have reasons to dislike credit card payments, but there appear to be no argument against debit card payments from their perspective.

1760 persons was drawn from the adult Swedish population and the response rate was 57 per cent, resulting in a net sample of 1003 persons. The respondents were asked to report the size of their most recent point-of-sale purchase and whether they had paid with card or cash. The available control variables include sex, age (in years), educational background (in three categories), household income (in eleven categories) and household size (number of individuals).

According to the survey, cash and card purchases are approximately equally frequent, with 54 per cent of the respondents reporting that the most recent purchase was made with a card. The average size of a card purchase was SEK 563 (excluding the two purchases above SEK 20000), while the average cash purchase was SEK 245.[39] However, we know from other sources that the actual value of the average card purchase in 2005 was SEK 380.[40] We think the discrepancy is due to small purchases being more easily forgotten. To obtain an estimate of the average size of cash purchases, we multiply the sample average with the ratio between actual average card purchase and average card purchase in our sample. This yields an estimated average cash purchase of SEK 165 (= 245x380/563).[41]

Next, we sought a behavioural measure corresponding to the private break-even point illustrated in Figure 3. The measure we opted for was the point estimate of the transaction value that would make a card payment and a cash payment equally likely. In practice, we estimated Probit and Logit models of the individuals' choices between cash and card and calculated the transaction values for which the predicted probability would equal 50 per cent.[42] For the Probit model, we estimated the following equation:

$$\Pr(card) = F(a + bS + gX)$$

where S is the size of the purchase, X is a vector of control variables, F is the normal distribution, a, b and γ are the parameters to be estimated and $\Pr(card)$ is the probability of a card purchase. Table 8 reports the results. [43]

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[39] One card transaction was for a car purchase. The averages were calculated as the weighted averages of four age groups, with weights reflecting the groups' population shares, rather than their share among respondents.

[40] Since our cost data is from 2002, we mainly use the average card transaction value from that year (SEK 620). However, when we adjust our estimated average cash transaction amount, we rely on the most recently available value, from 2005. Implicitly, we assume that the average cash transaction has been constant in the 2002-2005 period, even though the average card transaction fell from SEK 620 to SEK 380.

[41] The 95 per cent confidence interval for the estimate of the average was approximately [185,304]. Adjusting the lower and upper ends of the interval in the same way as the average was adjusted yields the confidence interval [125,205].

[42] Unfortunately, the data did not differentiate between debit and credit card payments. According to annual data produced by the by the Riksbank, e.g. Sveriges Riksbank (2006), approximately 90 per cent of all card payments are made by debit card.

[43] We do not report the parameter estimates for the Logit model, since they were qualitatively very similar. However, we do report the break-even points corresponding to those estimates in the text. The statistical analysis was done in Stata, using the robust estimation procedure. There were 26 missing observations due to respondents not reporting their most recent purchase. An observation was considered correctly if the estimated probability of paying with a card was at least 50 % when a card was actually used and vice versa.

Table 7. Probit estimate of the probability of paying with card

Variable	Parameter estimate (t-value)	
Purchase value (SEK)	0.00037	(2.43)
Age (years)	-0.0071	(-2.66)
Household size	-0.035	(-0.91)
Household income (11 income intervals)	0.0031	(0.21)
Educational level (3 levels)	0.25	(4.43)
Woman	0.048	(0.58)
Constant	-0.19	(-0.82)
Number of observations	977	
Pseudo R2	0.056	
Correct predictions (per cent)	64	

The results show that the size of the transaction, the age and the educational background of the individual all significantly affected the choice, while the effect of household size and income, as well as the respondent's sex, are insignificant. The larger the value of the purchase and the higher the educational level of the consumer, the more likely it was that he or she would chose a payment card as the mean of payment. Age affected the choice of card payments negatively, i.e., younger consumers chose payment cards to a larger extent.

From the estimated model we can calculate the transaction amount for which the probability of paying with card is 50 per cent, for given values of the control variables. For a typical individual (a 41 years old male with upper secondary education, living in a two-person household earning SEK 350-400 thousand per year) we find that the probability of paying with a card reaches 50 per cent at a purchase value of SEK 79. [44] The corresponding value for a 60-year old is SEK 445, while the predicted probability that a 20-year old man pays with a card is always higher than 50 per cent, no matter how small the amount. If the 41-year old typical individual has a university background, he is always predicted to pay with a card, while if he has just primary education, the "equal-probability value" is calculated to be a little more than SEK 750.

The estimated equal-probability value appears to be sensitive to outliers; if the five reported payments above SEK 9999 are excluded, the typical individual is predicted to use a card with more than 50 per cent probability for payments above SEK 165. Removing five outliers increases pseudo R2 and the estimated importance of age and purchase amount, while reducing (slightly) the importance of educational background. Similarly, estimating a logit model with or without the possible outliers results in equal-probability values of SEK 168 and SEK 194, respectively, for the representative

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[44] The following calculations are based on these values, unless otherwise stated.

individual.[45] The equal-probability value for the whole population is not identical to the value for the typical (or average) individual, but we believe the results reported above indicate that our best empirical estimate of a what corresponds to a break-even point is somewhere in the range SEK 150-200. This suggests that actual debit-card use is reasonably consistent with the incentives created by cardholders' private costs, although with a tendency for older individuals and individuals with a low level of formal education to under-use cards and possibly a tendency for young and well-educated individuals to over-use cards.[46] However, users' private incentives suggests that credit cards should be the preferred means of payments for all payments exceeding approximately SEK 37, at least for those individuals that hold credit (deferred-debit) cards, and this is not what we observe.

7. Discussion

In this paper, we have investigated the private and social costs of cash and card payments at the point of sale. In total, the social costs amount to at least SEK 8.4 billion, according to our estimates, of which cash gives rise to approximately three quarters. The unit social costs are approximately SEK 4.7 and SEK 3.1 for a cash payment and a debit card payment, respectively.[47] However, for low-value payments, cash is more cost efficient, both from a social and from a private perspective. We estimate the threshold transaction value below which a cash transaction is less costly, from a social or from a private perspective, than a debit-card or a credit-card transaction. Our estimate suggests that cash is more efficient for payments amounting to approximately SEK 82 (EUR 8) or less.

We find that neither consumers' nor retailers' incentives are well aligned with the social optimum. For debit cards, the consumers' private-cost threshold is above the social-cost threshold. For credit cards, however, the consumers' private-cost threshold is below the social-cost threshold. In other words, consumers have private incentives to over-use credit cards and to under-use debit cards relative to cash. Retailers, on the other hand, have some incentives to under-use debit cards and strong incentives to discourage credit cards. Not surprisingly, it appears as if consumers act rationally in the sense of making choices that are more consistent with their own private costs. Consumers pay too little for cash and thus tend to use debit cards less than they should from a social perspective. Merchants, on the other hand, pay too much for credit-card payments. As pointed out in Section 4, Swedish banks use their profit from card payments to cross-subsidise cash handling. This situation could be improved if ATM withdrawal fees were introduced and interchange fees were lowered.[48] The

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[45] The logit model is known to perform better when there are many observations in the tails of the distribution.

[46] To obtain an estimate of the population's equal-probability value, we would have to simulate the behaviour of the population, for example by estimating the values for all individuals in a representative sample of the Swedish population. Since all individuals do not make an equal number of purchases per time period, we would have to make assumptions on how the number of purchases correlates with our explanatory variables. Such an exercise is outside of the scope of the present study.

[47] An alternative method results in a unit cost of SEK 5.5 for cash payments.

[48] With few exceptions, consumers pay no fees on their ATM withdrawals despite the fact that the banks jointly would gain from introducing such fees. See Guibourg and Segendorf (2007a) who suggests that the banks may be locked into a prisoners' dilemma

latter would lower the acquiring bank's marginal cost of a card payment which, in turn, would give incentives to lower the merchant fees.[49] Possibly, lower interchange fees and merchant fees could contribute to the introduction of withdrawal fees. Another obstacle is that merchants typically are prohibited, via the so-called no-discrimination rule, from surcharging consumers that pay with (expensive forms of) cards, which further contribute to eliminate price signals to consumers. If such surcharges were allowed, merchants could charge extra for low-value card payments or for credit-card card payments [50]

Our results also indicate that, in the choice between cash and debit-card payments, the behaviour of younger users lies closer to the social optimum. One possible interpretation is that the choice of payment instrument is not only influenced by cost incentives but also by payment habits. An alternative explanation to the seemingly non-rational choices of many consumers – in particular older and less educated consumers – would be that users experience risk costs in the use of card payments that are not included in our estimates of private costs. For example, there could be a perceived risk of having the card "skimmed".[51]

It is possible that it takes time for users to adapt their payment habits, perhaps because they do not in practice face monetary costs, only time costs, and because these possibly are more difficult to internalise. The above mentioned combination of withdrawal fees and lowered interchange fees in combination with allowing merchants to more directly pass on charges could in this sense contribute to make the adjustment process more rapid.

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situation where no bank wants to be the first to introduce withdrawal fees. The first mover may loose customers and market shares while explicit coordination between banks would violate anti-trust laws. Guibourg and Segendorf also offer the alternative explanation that banks may "…view payment services as complementary with other business areas that are more profitable, such as saving products, mortgage loans, etc."

[49] This is true in competitive market, as well as in markets where banks have market power or even monopoly.
[50] See Bergman (2003, 2006) for discussions of the competition-law aspects of interchange fees and related issues.
[51] For the choice between cash and debit card, also merchants' incentives seem to be well aligned with the social optimum, see footnote 38. Guibourg and Segendorf (2007a) show that also banks have an incentive to promote cards before cash. A perceived cost of approximately 1 SEK would be enough to explain a preference for cash payments up to around SEK 500.

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Appendix 1: Market players involved in the flows of cash

1) The Riksbank – the Swedish central bank: issues banknotes and coin

2) Cash deposits: four cash deposits owned by the central bank through a company called SKAB were in operation in 2003. Their function was to count and store notes and coin, operate the accounting system where cash balances are registered at the participants ' accounts, at the Riksbank, check the quality and the authenticity of notes and destroy old notes. There are also other smaller deposits for storing and counting cash throughout the country owned by private transportation companies, often also providing cash transport services, see below.

3) Cash transportation services: transport cash between cash deposits and banks, postal offices and the retail sector. They can also perform counting services. Three companies –Securitas, Falck and PiS -dominated the market for transportation services in 2003.

4) Distribution services to the public and to merchants: over the counter at bank branches and at postal branches and through ATM terminals. The ATM terminals are owned by the banks.

5) Switching, authorisation services and clearing services: when the cardholder holds his/her account at a bank other than the bank that owns the ATM terminal, the services of a central switch are required. The switch sends information on the cardholder and the amount of cash being withdrawn from the terminal to the card issuing bank, i.e., the bank where the account is held. The card issuing bank then checks the validity of the card and the sufficiency of funds in the account and sends the authorisation (or a refusal of withdrawal) to the ATM owner. There is one central switch in Sweden for ATM transactions: Cekab, a company that is jointly owned by some of the Swedish banks. In addition, three of the large Swedish banks own also their own switches. However they are all interconnected to the central switch. The central switch Cekab also provides clearing services which involves the compilation of transactions between the parties.

6) Use of cash by the public: cash flows back from the public to the retail sector and the excess cash are transported back to the banks and some of it flow back to the cash deposits. Cash may also flow back from the retail sector to the customer, so called cash back. In many grocery store chains the customers can withdraw cash over the counter at the point of sale. Customers pay their purchases with a card but the amount of the transaction is augmented with the value of cash the customer wants to withdraw and gets this amount of cash back. Figure A1 illustrates the cash distribution process.

Figure A1. The flows of cash
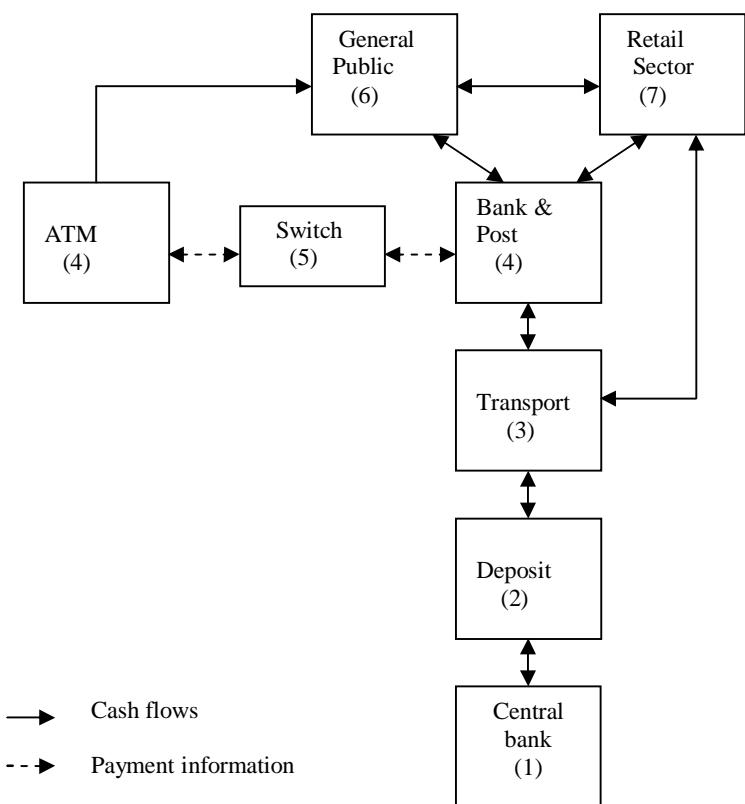
Appendix 2: Market players involved in a card payment

Contrary to the case with cash payments, when paying with a card, the cardholder does not transfer funds to the merchant directly. Instead, the merchant receives information imbedded in the card that is needed to process the payment. The actual transfer of funds goes from the cardholder to the cardholder's bank (debits the cardholder's account), from the cardholder's bank to the merchant's bank through the settlement system, and from the merchant bank to the merchant (credits the merchants account).

Besides users and intermediaries, card payments require the involvement of processors of payment information. As in the case with ATM withdrawals, there is also a switch, that forwards the payment information from the terminal to: i) the card issuing bank in order to control the validity of the card used, the legitimacy of the card holder and the sufficiency of funds in the card holder's account to cover the purchase amount, ii) the authorisation of the payment if the control is satisfactory and iii) the information on the amount to be credited to the merchant account in the acquirer bank. In Sweden there are two switches: the central switch Cekab that handles card payments as well as ATM withdrawals and a bank internal switch called Babs that, as a result of the bank's large share of merchant customers, handles a large amount of card payments. Both switches are interconnected. There is also a clearing house that compiles the amounts of funds to be transferred between the involved banks and of a settlement system that makes the actual transfers of funds between bank accounts. In Sweden, the clearing of card payments is done by two of the large international card associations' clearing networks. The settlement of funds is done either in the central settlement system at the central bank, or over the accounts of a private bank banks acting as settlement agent for the other banks.

Figure A2 illustrates the parties and processes involved in a card payment, from transaction to the settlement of funds when the cardholder and the merchant hold accounts in different banks.

Figure A2. The card payment process
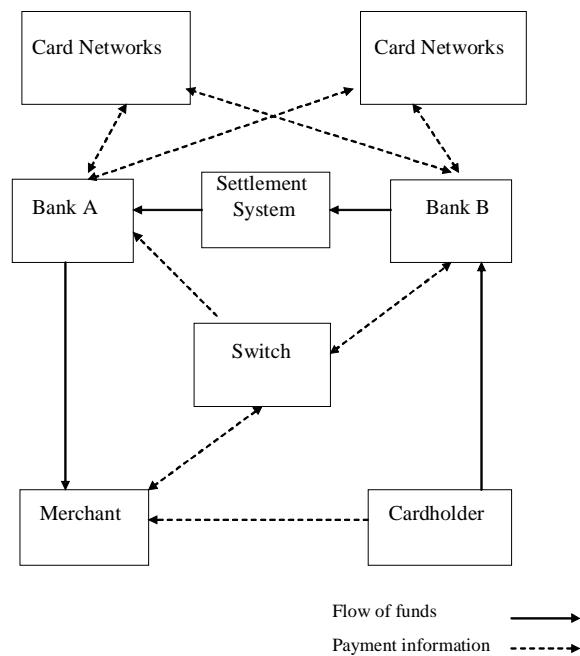
Appendix 3: Estimating users' costs of cash payments according to the inventory theoretic approach

The following variables are in annual, per capita terms

T_c : total annual costs of using cash payments

a_c : value of ATM withdrawals

a_k : value of card payments

W_c : number of ATM withdrawals

$a = a_c + a_k$: value of retail expenditures

In addition, let d represent the per-withdrawal cost ("shoe leather costs" and/or withdrawal fees) an led the share of retail expenditures paid in cash be:

$$w = \frac{a_c}{a_c + a_k} \tag{1}$$

Then a consumer's total annual costs of cash payments can be expressed as:

$$T_c = W_c T_c^* + \frac{rwa}{2W_c} \tag{2}$$

where the first term on the right hand side expresses the shoe leather costs of ATM withdrawals plus possible foreign fees and the second term expresses the interest rate costs on average per capita transactions cash balances. The consumer minimises the total annual costs of cash payments through the choice of an optimal number of ATM withdrawals, i.e. minimising T_c with respect to W_c gives:

$$d = \frac{rwa}{2W_c^2} \tag{3}$$

Substituting (2) into (1) and simplifying gives:

$$T_c = \frac{rwa}{W_c} \tag{4}$$

Implementing 2002 Swedish data in expression (3):

r	a_c	a_k	a	w	W_c
0.0515	36156	49167	85323	0.42	43

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