Explaining cash usage in the Netherlands: the effect of electronic payment instruments
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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.
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Abstract
Since the mid-nineties, usage of the debit card by Dutch consumers has increased considerably. While accounting for three quarters of the total value of retail sales in the early nineties, in 2004 the value share of cash payments had fallen to about two quarters. If the cash to payment card ratio in 2004 had been the same as in 1990, the social costs of retail payments would have come out almost EUR 200 million higher. Consumers will have benefited from these savings through lower consumer prices and bank fees. Estimates indicate that the share of cash (in value terms) will decline further from 46% to about 20% in 2015. Changes in the payment infrastructure can yield even higher cost savings. This appears from the outcomes of fictitious scenarios in which the use of electronic means of payment is promoted by increasing the growth rate of the number of EFTPOS terminals and keeping the number of ATMs at their end-2004 level. The outcome in question is indicative of the effectiveness of any efficiency-enhancing measures that may be taken within the scope of the November 2005 Payment Covenant between banks and retailers. An increase in the number of EFTPOS terminals turns out to be especially effective.

Keywords: cash usage, retail payments, cost efficiency
JEL-codes: E41, E50, H21

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1 INTRODUCTION

During the past 17 years, the use of the debit card by consumers for making point-of-sale (POS) payments has grown considerably in the Netherlands: in 2005 about 1.3 billion debit card payments were made with a total value of EUR 60 billion. This was about one third of the total value of private consumption (excluding rents, water and electricity) and represented about half of the total turnover in POS payments. These figures show that in a rather short period the use of electronic payment instruments has expanded enormously and cash has been partially substituted by the debit card and, to a much lesser extent, the e-purse. This process is still going on, and it will be stimulated further in the future by both demographic and technological developments regarding new electronic payment instruments. This view is supported by recent empirical studies (Borzekowski & Kiser 2006a, Borzekowski et al. 2006b, HBD 2002, Van Hove et al. 2005, Jonker 2005, Hyytinen & Takalo 2004, Klee 2004, Stavins 2001, Schuh & Stavins 2006 and Zinman 2005) in which payment choice of consumers was examined. The picture emerging from these studies is that the use of electronic payment cards (debit and e-purse) is negatively related to age and positively to the educational level of consumers.

The aforementioned developments and findings indicate that the end of the “cards for cash” substitution process is not yet in sight. The question, however, is within what time-span and to what extent payment cards will take the place of cash in retail payments. To gain more insight into this replacement process, we looked into the development of the share of cash payments (in value terms) in total POS sales and we made an estimate of the future value share of cash up to 2015. To this end, we also calculated the effects of scenarios with different payment infrastructures (ATMs, EFTPOS terminals etc.) on the use of cash by consumers. An important contribution of this paper compared to earlier studies on cash substitution is that it provides rough indications of past and future “social” cost savings (net costs for the Dutch society as a whole) resulting from the increasing use of payment cards, based on the cost findings in the DNB study “Payments are no free lunch” by Brits & Winder (2005). New as well is that we that we pay attention to the influence of the increased use of payment cards on the demand for transaction banknotes and, related to that, its effect on seigniorage revenues.

Insight into future payment behaviour of consumers is relevant for a central bank for several reasons. First, one of the tasks of the Dutch central bank is to promote a stable, safe and efficient payment system. Insight into changes in consumers’ payment behaviour is essential to monitoring the efficiency of the payment system and possible consequences for banks and merchants. Brits & Winder (2005) estimated the social costs of point-of-sale (POS) payments in the Netherlands at EUR 2.9 billion, i.e. 0.65% of GDP in 2002. They found that these costs could be reduced if consumers were to use the e-purse more often or pay by debit card instead of in cash for transaction amounts above EUR 11.63. Second, DNB is part of the Eurosystem and issues euro banknotes. In this respect it is useful to examine the future demand for euro transaction banknotes (i.e. banknotes with a face value up to EUR 50), the value of the euro
banknote circulation and, related to that, future seigniorage revenues. A reduction in cash usage in POS situations leads to a lower demand for transaction banknotes but may not influence the demand for high denomination banknotes mainly used for saving. This suggests that even a strong reduction in cash payments will only lead to a moderate decline in the value of the banknote circulation.

In mapping out the usage of cash in POS payments over time a problem presents itself. While the use of debit cards, e-purses, credit cards and (in the past) cheques has always been monitored by banks and the automated clearing house Equens, structural registration of transactions in cash is impossible. Exact figures on the number and value of cash payments for consecutive years are therefore not available.

Collecting information on the number of cash payments by means of a survey does not yield accurate estimates on the number of cash payments in POS situations. For the Netherlands, estimates range from 3 billion to 7 billion cash payments. Because of the estimation problems regarding the number or share of payments, we use an indirect method to assess the value share of cash in POS payments. This method is proposed by Humphrey et al. (2000) and is also used by Paunonen & Jyrkönen (2002). The ratio of the value of cash payments to the total value of POS consumption is an indicator of the importance of cash in POS payments compared to card payments. A declining value share indicates that cash payments are substituted by card payments. In Norway, the share of cash in POS payments declined from 90% in the 1980s to 50% in the 1990s, with the sharpest decline taking place between 1995 and 1999 (Humphrey et al., 2000), whereas in Finland the share steadily dropped from about 80% in 1984 to 54% in 2000 (Paunonen & Jyrkönen, 2002). Forecasts for the cash share in Norway in 2015 range from 5 to 15% whereas the cash share for Finland is estimated at about 30% in 2010. The findings presented in this study are in line with Finnish and Norwegian results. The cash share in the Netherlands is expected to be 20% in 2015.

The remainder of this article is organised as follows: Section 2 starts by outlining how the use of cash and other payment instruments in retail payments has evolved in the Netherlands from 1987 onwards. Within this context, it also dwells on the effect of the declining use of cash on the present banknote circulation, seigniorage income and the social costs of retail payments. Section 3 moves on to discuss the time series model that explains the share of cash (in value terms) in retail sales and also serves as a basis for the projection of the future use of cash. Section 4 discusses the baseline projection and also takes in the effects on future banknote circulation and cost savings arising from a reduced use of cash. Section 5 sets out three scenarios, each based on a different payment infrastructure adjustment designed to promote the use of payment cards and section 6 winds up by summarising the main results.

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1 In 2006 the Dutch ACH Interpay merged with German Transaktionsinstitut für Zahlungsverkehrsdienstleistungen. Its new name is Equens.
2 The seigniorage figures used in this article reflect the return on the outstanding banknote circulation.
DEVELOPMENTS IN POS PAYMENTS IN THE NETHERLANDS

This section provides an overview of the evolution of consumers’ payment habits at points of sale since 1987, one year before the introduction of debit cards in the Netherlands. Subsequently, in order to determine to what extent cash payments can further be substituted by electronic payments, some light is shed on the way Dutch consumers pay at different points of sale and the grounds underlying their decision to do so.

2.1 Developments in general POS payment behaviour

Cash

Developments in the usage of cash are hard to monitor. The reason is that the vast majority of cash payments are not registered. Exact figures on the number and the value of cash payments are therefore not available. However, surveys show that, notwithstanding the substantial rise in the use of electronic payment instruments, by far most transactions in the Netherlands are carried out in cash, with estimates ranging from 3 to 7 billion transactions. The differences may have several causes, for example seasonal effects when the observation period is short; selectivity bias when only (small) parts of all possible POS situations are considered; the accurateness of the respondents’ answers being influenced by the research method, by the questionnaire but probably above all by their memory (forgetting POS payments, especially small purchases).

Beside the problems mentioned above, another disadvantage of the surveys is that they have been conducted irregularly, which makes it impossible to analyse developments over time. In order to nonetheless gain insight into the relative importance of cash transactions compared to card payments, we use an indirect method to assess the value of cash in total POS payments, proposed by Humphrey et al. (2000) for Norway and also deployed by Paunonen & Jyrkönen (2002) for Finland. The method is intuitively appealing: purchases at POS situations are paid with cash, (in the past) cheques or payment cards. The total value of card and cheque payments in POS situations is registered; the total value of consumption in POS situations can be derived using consumption statistics from the National Accounts. The difference between POS consumption and the value of all card and cheque payments in POS situations gives an approximation of the nominal value of cash POS transactions.
Figure 1 shows the estimates from 1987 (the year before the introduction of the debit card in the Netherlands) to 2004. It turns out that the value of cash POS payments rose rapidly until 1992, when the use of the debit card in the Netherlands took off (see next subsection). After a fairly stable period which lasted until 1998, the value of cash increased again moderately during the booming economic circumstances at the end of the previous millennium. It is also conceivable that consumers changed their payment behaviour in anticipation of the introduction of the euro coins and notes in 2002, which prompted them to spend their stored guilders. In 2001, the value of cash in POS payments began to decline rapidly. For this trend, two explanations are possible. Firstly, growth in consumer expenditures flattened in this period of bad economic performance. But more important, in this period the Dutch seem to have substituted to some degree cash by their debit card (and to a lesser extent e-purse). The next subsection discusses this issue in more detail.

*Alternative POS payment instruments*

Unlike data regarding payments in cash, records on the use of alternative payment instruments (cheques and cards) are readily available, both with respect to numbers and values. Figures 2 and 3 depict them respectively for the years 1987-2005. To facilitate comparison, the latter contains the figures for cash from Figure 1 as well. As can be seen from both graphs, the use of the debit card (“PIN”) boomed in the first part of the 1990s after a slow start. Since then, the volume of debit card transactions and their value have been rising continuously and rapidly. The average yearly growth rates since the introduction in 1988 were 40 and 44 percent respectively. From

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3 Section 3 explains the derivation of cash POS payments in more detail.
2002 onwards though, the growth pace levelled off slightly, both in number and in value, probably as a consequence of a general decline in consumer spending. This effect of the economic slow-down on debit card transactions was dampened by the cash substitution process.

In 2005, debit cards accounted for more than 1.3 billion transactions amounting to nearly EUR 60 billion. In 2004, the value of debit card payments surpassed the value of cash payments for the first time. The rapid growth in debit card payments in the Netherlands may be explained by the promotional campaigns and by the perceived convenience, time-efficiency and safety of this payment instrument. Simultaneously, cheques became less popular. The number of bank and postal cheques with payment guarantee declined from 278 million (to an amount of over EUR 16 billion) in 1988 to almost zero in 2002, when they were abolished altogether and banks no longer guaranteed payments made by cheque.

In the second half of the 1990s, Dutch banks introduced the pre-paid, reloadable e-purse as an alternative for low-value cash payments. Use of this payment instrument has remained very modest. However, in 2002 the growth rate in the number of e-purse payments did increase compared to the years before (see Figure 2). This is probably due to the fact that some cities and merchants replaced their old guilder-based parking meters or vending machines by ones accepting e-purse payments only.

Figure 2  Number of POS payment transactions by instrument
Consumers used their e-purses for 147 million payments in 2005 – only one tenth of the number of debit card transactions. Compared to debit card payments, the value of the prepaid e-purse transactions is negligible (EUR 0.4 billion). Apart from the fact that the e-purse is not (yet) well-established, this is largely due to the fact that e-purses are intended to facilitate small payments. Contrarily, the number of credit card transactions is rather small, whereas their value is significant, due to the high average transaction amounts. Consumers used their credit card 45 million times in 2005, spending about EUR 4.4 billion.

Figure 4 shows the shares of the different payment instruments in total POS transaction value. The rise in the relative importance of the debit card and the decrease in cheque use are clearly noticeable. Quite peculiar however is the rise in cash share between 1988 and 1992 from 72% to 79%. This increase was also found by Boeschoten (1994). It can be explained as follows. Banks already started to discourage the use of cheques when the debit card was introduced in 1987, which meant that cash became more attractive as an alternative. In addition, the new product, combined with the explosive growth of the number of ATMs, made withdrawing cash much easier. Also, the presence of EFTPOS terminals in the retail sector was still far from wide-spread in those days. Only after the adoption of debit card terminals in the early nineties by petrol stations and Albert Heijn, the Netherlands’ largest chain of supermarkets (see section 2.2), the debit card really took off, instigating a steady decline of the cash share in the years after. As mentioned earlier, the decline of the cash share has accelerated since the introduction of the euro. In 2001 the cash share was 57% and three years later it dropped 11 percentage points to 46%.

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4 Including delayed debit cards.
2.2 Developments at different POS categories

It is difficult to analyse the evolution of payment habits at different POS categories, as these developments over time have not been monitored in a consistent way. Boeschoten (1994, 1995) investigated the way consumers paid at different categories of POS each year between 1990 and 1994. GfK/Currence conducted similar surveys in recent years, including 2004. For categories of POS that have been researched by both, the figures are presented in Table 1 below. Only figures with regard to the value of payments are available. It must be stressed though, that comparisons should be made with care, as the POS definitions and research methods of both studies vary. This caution should particularly be born in mind with respect to “clothing” and “restaurants”, as the GfK data refer to their classes “clothing and shoes” and “restaurants and sleeping accommodation” (in the latter category credit card payments probably play a more prominent role than in restaurants alone).

Except in bars, which is the only category where cash is still dominant, it turns out that in all presented sectors the value share of cash payments has declined substantially. It is clear that electronic payment instruments (debit, credit, loyalty and tank cards) are now used much more than cheques were in the past, causing the reduction of the cash share. However, the speed of this development differs among the categories.
Table 1  Value shares of payment instruments at different POS categories (in percent)

<table>
<thead>
<tr>
<th>POS</th>
<th>Cash 1990</th>
<th>1994</th>
<th>2004</th>
<th>Cheques</th>
<th>Debit Card</th>
<th>Credit card</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supermarkets</td>
<td>73</td>
<td>72</td>
<td>36</td>
<td>25</td>
<td>14</td>
<td>63</td>
<td>0</td>
</tr>
<tr>
<td>Department stores</td>
<td>57</td>
<td>52</td>
<td>34</td>
<td>37</td>
<td>21</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Clothing</td>
<td>36</td>
<td>32</td>
<td>17</td>
<td>60</td>
<td>31</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Petrol stations</td>
<td>45</td>
<td>30</td>
<td>16</td>
<td>22</td>
<td>7</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Restaurants</td>
<td>43</td>
<td>54</td>
<td>49</td>
<td>47</td>
<td>29</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bars</td>
<td>96</td>
<td>96</td>
<td>93</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Public transport</td>
<td>77</td>
<td>76</td>
<td>18</td>
<td>19</td>
<td>8</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

In supermarkets, clothing stores, petrol stations and public transport (trains) the substitution of cash and cheques by cards takes place at fast pace. For the former three, the popularity of cards is probably due to the relatively high amounts paid; for the latter, the fact that since 2004 the main Dutch railway company has levied a surcharge of fifty cents on tickets sold at counters and the replacement of many counters by vending machines may play a role.

Restaurants show a somewhat unusual trend as the cash share actually increased between 1990 and 1994; moreover, the last ten years have seen only a marginal decrease of cash share in this category. The figures show that the substitution of cheques by cash, which lasted till 1992 in general (see table 1), took longer in restaurants: in 1994, the value share of cheques had fallen 28 percentage points in four years, whereas debit and credit card payments had jointly gained a mere 7 percentage points. This finding may stem from the relatively low adoption rate of POS terminals by the restaurant sector (particularly the lower segment, including for example pubs serving meals) up till today. In 2002, only 17 percent of small restaurants accepted debit cards (Bedrijfschap Horeca en Catering, 2003). Recent data from Currence, owner of several Dutch payment brands including the debit card scheme PIN, show that the number of terminals in restaurants is rising more rapidly than in other types of business these days. It is to be expected that a broader acceptance of cards in the future should bring debit card figures in line with these of other POS categories.

In addition to the statistics presented above, the GfK/Currence (2005) survey shows that the e-purse has now come to play a significant role in several sectors, but only in places where its use is mandatory (e.g. in certain vending machines and canteens) or where the advantages are beyond dispute (e.g. in parking machines, which generally only accept correct change). For these categories, the value share of the e-purse is 13, 17 and 51 percent, respectively.

2.3 Effects of a diminishing use of cash

It is among a central bank’s chief duties to see to a secure, smooth and efficient payment system. Changes in consumers’ payment behaviour have a bearing on the efficiency of retail payments.

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5 According to the yearly GfK survey, cash share of payments for public transport dropped from 37 percent in 2003 (i.e. before the railways started adding counterhandling fees) to 18 percent in 2004.
As a result of the increasing use of payment cards by consumers, for example, the volume of banknote circulation is smaller than it would have been if consumers had not had these payment instruments at their disposal. This in turn has had an effect on the social costs of retail payments and on seigniorage.

**Banknote circulation and seigniorage**

In 2004, approximately EUR 23.5 billion worth of banknotes in circulation were distributed by DNB, for which the central bank received EUR 460 million in seigniorage. The various denominations of euro banknotes can be broken down by the way they are used by the public. Consumers use the transaction denominations (EUR 5-EUR 20) primarily for effecting payments and the other denominations (EUR 100-EUR 500) mostly for hoarding. The EUR 50 note is used for both transactions and hoarding. Since the introduction of the euro, transaction denominations have accounted for approximately 30% of the value of the euro banknote circulation (see Figure 5). We assume that only demand for transaction banknotes will fall when consumers replace cash payments by card payments.

The effects of an increase in electronic payments on the value of the banknote circulation and on seigniorage will be limited. Since the total value of hoarding banknotes make up almost 70% of the value of the banknote circulation, even a complete replacement of transaction banknotes by electronic payment instruments would reduce the value of the banknote circulation and seigniorage revenues by at most 30%. Rough estimates show that if in 2004 consumers’ payment behaviour had been the same as in 1990, when cash payments made up 76% of retail sales, the value of the transaction banknotes would have been 65% higher than it actually was in 2004. The value of the entire banknote circulation (transaction and hoarding notes together) would have come out about 19% higher than the actual values recorded for 2004. DNB’s seigniorage revenues would also have been 19% higher since they depend nearly linearly on the value of the banknote circulation.

**Cost savings**

Brits & Winder (2005) showed that an increase in debit card and e-purse use may yield savings in social costs. In 2002, the total costs of POS payments in the Netherlands amounted to EUR 2.9 billion of which EUR 2.1 billion was related to cash and EUR 0.8 billion to the electronic payment instruments credit card, e-purse and the debit card. Tentative estimates, based on the findings of Brits & Winder, GfK/Currence (2005) and the assumption that their estimates are also valid for 2004 indicate that if consumers’ payment behaviour in 2004 had been the same as in 1990, the costs of retail payments in 2004 would have exceeded the actual costs by nearly EUR

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6 In this article it is assumed that half the number of EUR 50 banknotes in circulation is used for transactions.

7 GfK/Interpay provides 2004 estimates of the value and number of cash, debit card, e-purse and credit card payments, broken down by the amount paid. The GfK/Currence estimates for the value and number of card payments are quite accurate. The precision and accurateness of the number of cash payments are unknown. Our assessment of the substitution rate of cash by payment cards merely gives an indication of the number of substituted cash payments.
200 million. Between 1990 and 2004, the increase in the use of payment cards brought down the costs of retail payments by 6%. Rough estimates, also based on results of the consumer payment behaviour survey conducted by GfK/Currence in 2005 suggest that in 2004 approximately 11% of cash payments were replaced by debit card, e-purse or credit card payments.

Figure 5  Breakdown by denomination of hoarding and transaction notes in the euro area in 2005

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Cost calculations are based on marginal cost savings. Changes in fixed costs due to changes in payment infrastructure enabling more transactions are not taken into account.
This section contains the model used to explain the change in value share of cash in POS payments and its outcomes. Subsequently, some light is shed on the dependent and the explanatory variables constituting the input. The section concludes with the results of the estimation.

2.1 Regression model

Following Jyrkönen (2004), we use an error correction (or equilibrium correction) model in which the cash share in POS payments is forecasted by exogenous variables. This kind of dynamic regression model allows for the dependent variable (value share of cash in POS payments) to move towards its long-run equilibrium over time. This approach intuitively makes sense here because the acceptance of electronic payment instruments by merchants and consumers has occurred step by step and can be expected to reach a saturation point in the future.

The error correction term can be derived from a linear dynamic regression model, by subtracting the lagged term \( y_{t-1} \) from both sides. After rearranging, this process yields the following equation:

\[
\Delta y_{t-1} = \alpha + \beta_1 \Delta x_t + (\beta_2 - 1)(y_{t-1} - \gamma x_{t-1}) + \epsilon_t
\]

In this model, the term \( \beta_1 \Delta x_t \) reflects the short-term impact of the independent variable, whereas \( y_{t-1} - \gamma x_{t-1} \), which is the error correction term, indicates how far the relationship between \( y_t \) and \( x_t \) deviates from its long-term equilibrium. The negative of its coefficient, \( 1 - \beta_2 \), shows how much of this deviation on average is corrected in one period. Because of this property, it is called the “adjustment parameter”. In order for this error correction model to be valid, \( x_t \) and \( y_t \) must be integrated of order 1, so that they are (weakly) stationary in differenced form.

The model presented above contains only one explanatory variable (\( x_t \)), but it is obviously possible to add other factors. For the purpose of this study, the above-mentioned equation can be extended so that it incorporates the influence of each of the independent variables and thus explains the degree of cash usage, assuming there is a long-term equilibrium in the relationship between the value share of cash in POS payments and the parameters explaining it. This is shown in equation (2), below which the variables are clarified and their incorporation is justified.

\[
\Delta C = \alpha + \beta_1 \Delta T + \beta_2 \Delta A + \beta_3 \Delta i + \beta_4 \Delta Y + \beta_5 \Delta U + \\
... + (\beta_6 - 1)(C - \gamma T - \gamma_2 A - \gamma_3 i - \gamma_4 Y - \gamma_5 U)_{t-1} + \epsilon_t
\]
\( C \): Value share of cash in POS payments. As explained in Section 2, expenditures in cash have been derived by subtracting remote transactions and estimates of amounts paid with other POS payment instruments from total consumer expenditures. However, because \( C \) is defined as a share, it is restricted to values between 0 and 1, whereas the independent variables below can take any value. Therefore it is necessary to transform \( C \) into an unrestricted variable (\( C' \)), which can be done as follows:

\[
C_i' = \log \frac{C_i}{1 - C_i}, \tag{3}
\]

\( T \): number of EFTPOS terminals for debit cards. Its coefficients, \( \beta_1 \) and \( \gamma_1 \), are expected to be negative, since a broader availability of these terminals would further enable debit card transactions, thereby having a negative impact on cash usage.

\( A \): number of ATMs. This factor’s influence seems ambiguous. On the one hand, ATMs facilitate access to cash money, which could indicate a positive relationship between \( A \) and \( C \). On the other hand, the ease of withdrawing money at an ATM might take away the need to withdraw large amounts at one time. Consumers would thus choose to retain lower cash balances, which could cause situations where they have to rely on other payment instruments because the amount of cash in their wallets is insufficient. Indeed, most earlier studies found that cash share and the number of ATMs were negatively correlated.

\( i \): the interest rate on current accounts. Although by far most transaction accounts in the Netherlands do not bear interest, holders must pay interest when their balance is negative. In order to minimize interest expenditures, (almost) negative balances would stimulate consumers to withdraw money from their accounts as late as possible – for example by paying with debit or credit card. This kind of behaviour would be an indication of a negative relationship between cash share and interest.

\( Y \): gross domestic product (GDP). It is commonly argued that consumers tend to pay less in cash when their income rises, because they consider it less necessary to monitor their expenses stringently. It is therefore expected that \( C \) and \( Y \) are negatively related (\( Y \) being a proxy for consumer income).

\( U \): Like income, unemployment is a variable which designates the level of wealth, though in a slightly different manner. Whereas GDP immediately reflects variations in wealth, the (un)employment rate, which is supposed to have a much larger impact on consumers’ expenditures, typically adjusts later. In order to take the effects of this lag into account, the unemployment rate (which should be positively related to cash share) is included in the equation.
For completeness, the number of e-purse funding terminals and transfer terminals should be included in the model as well. Time series on these variables are incomplete though, which makes their inclusion impossible. This omission is unlikely to have much influence, since the e-purse only plays a very minor role in payments in the Netherlands, as mentioned earlier. The same holds for the pricing of different payment instruments, which obviously could have great impact on the choice made by consumers (see e.g. Bolt, Humphrey & Uittenbogaard, 2005). With regard to this variable there is a lack of data as well, but since consumers in the Netherlands have hardly ever been directly confronted with payment transaction tariffs (one exception being a surcharge for small amounts paid by debit cards in small or medium-sized stores) that does not seem to be a problem in this case either.

An assumption of the model presented above is that variables $T$ and $A$ (EFTPOS terminals and ATMs) are exogenous. Consumers can only start using them once they are installed by banks and retailers. One could however argue that these factors are also partly endogenous, as an expansion of their number might be a consequence of a rise in demand, represented by an increasing number of debit card payments and cash withdrawals. This possibility is not taken into account here.

2.2 Data

The first year of the research period is 1987 – the year before the introduction of the debit card in the Netherlands. The last year of the observation period is 2004. Since the timeframe is only eighteen years, we used quarterly data (72 observations) to obtain an acceptable level of statistical relevance of the estimation.

Detailed yearly data on consumption in different expenditure categories were available from the National Accounts (table G13), compiled by Statistics Netherlands. We computed yearly POS payments as the final consumption expenditure of all residents in the Netherlands after deducting consumption of goods and services which are typically paid for by means of remote transaction instruments (e.g. credit transfers, “acceptgiro” and direct debits). These include home furnishing (except lighting articles), vehicles, energy, housing, air transport, travel agencies, communication, medical service, financial and business services and education.

In order to obtain quarterly POS sales, we applied the share of POS expenditures in the yearly data to the quarterly overall consumption data for the years 1995 to 2004. For years prior to 1995, for which quarterly data were not available, we constructed quarterly time series by applying the seasonal pattern in later years to the yearly data.

The value of cash payments was constructed by subtracting non-cash payments from total POS expenditures. For this purpose, quarterly data regarding the different alternative payment instruments have been derived in the following way.
Debit card payments: for the years 1999-2004, Equens (the Dutch payment processor formerly known as Interpay) provided monthly data. For 1988-1998 we used figures, estimated by DNB for previous research.

E-purse transactions: Equens provided monthly data for 2002-2004. For 1996-2001, yearly data were transformed by applying the seasonal pattern of later years.

Cheque transactions: yearly transaction figures provided by Postbank and Equens were transformed into quarterly data by applying the seasonal pattern of debit card payments, assuming that debit cards have been the closest substitute for cheques.

Credit card payments: quarterly data have been reconstructed by applying the seasonal pattern expenditures in restaurants and hotels on yearly data provided by credit card companies. We chose this method because research by GfK/Interpay (2004) showed that consumers use their credit card mainly in this kind of establishments.

Monthly data on EFTPOS terminals have been provided by Equens for the years 1999-2004; for 1988-1998 quarterly figures have been constructed based on yearly numbers by assuming an even growth pace. This method was also applied to yearly data on the number of ATMs, obtained from the Netherlands Bankers’ Association. Since records on current account interest rates are not available, one-month Aibor and Euribor have been used as a proxy for the periods 1987-1998 and 1999-2004, respectively. Quarterly figures on nominal gross domestic product and unemployment have been taken from Statistics Netherlands.

2.3 Estimation results

Table 2 contains the estimation results for equation (2). Of the short-term parameters, only the factors related to the number of ATMs and unemployment (β₂ and β₅) are statistically significant. The negative sign of β₂ reveals - in line with earlier research - that with an increase of the number of ATMs, the reduction of the need to keep large stocks of cash exceeds an increased use of cash thanks to greater availability. The sign of the unemployment factor β₅ is a surprise. Whereas we had expected it to be positive, it turns out to be negative. It is hard to give a plausible explanation for this finding. It is not due to multicollinearity with the other variable expressing economic conditions (change in GDP), as the correlation between the two is only -0.1. Removing unemployment from the model does not alter coefficients and t-values of the other factors in a material way. The other short-term factors have the expected signs, but are statistically insignificant, which is particularly remarkable regarding the change in the availability of EFTPOS terminals.

Considering the long-term part of the equation, the coefficients β₁ (number of EFTPOS terminals), β₂ (number of ATMs), β₃ (interest level) and β₅ (unemployment level) are highly

Table 2 Estimation results.
significant. Signs are in accordance with expectations, again except for the level of unemployment. Once more, removing unemployment from the model has a negligible impact on the coefficients and \( t \)-values of the other factors. In the long run, the sign of the ATM variable is positive. This means that considering a larger period, given an increase in the number of ATMs, the rise in the use of cash attributable to greater availability surpasses the decrease in the need to hold large amounts of it. The number of EFTPOS terminals and the interest level turn out to matter, but only in the long run. GDP plays a role in neither the short nor the long run. Excluding it from the equation does not affect the results.

Coefficient \( \beta_6 - 1 \) is significant at the 1% level, indicating that an equilibrium state between share of cash in POS payments and EFTPOS terminals, ATMs, interest and unemployment is very likely to exist. The estimate of the adjustment parameter, \( 1 - \beta_6 \), is 0.58. This means that every period (quarter) 58 percent of the discrepancy to the equilibrium state is corrected. This result seems reasonable; it implies that any disequilibrium is almost completely eliminated (for 99.5 percent) after six years.

The Breusch-Godfrey test indicates that the estimation results suffer from a degree of autocorrelation. This could, at least partly, be due to seasonal effects, which seem to be present in the dependent variable and the series regarding GDP and unemployment. We have tried to correct for this by including three seasonal dummies. However, none of these were statistically significant, nor did they affect the other estimated parameters. For this reason they are not shown in the outcomes. Because of the serial correlation, the results presented above should be interpreted with prudence. The normality condition is not violated, as the Jarque-Bera statistic is not significant.

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>( t )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>1.08</td>
</tr>
<tr>
<td>( \beta_1 )</td>
<td>-4.87E-06</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>-2.83E-04*</td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>-0.02</td>
</tr>
<tr>
<td>( \beta_4 )</td>
<td>-5.81E-12</td>
</tr>
<tr>
<td>( \beta_5 )</td>
<td>-9.92E-07**</td>
</tr>
<tr>
<td>( \beta_6 - 1 )</td>
<td>-0.58***</td>
</tr>
<tr>
<td>( \gamma_1 )</td>
<td>-1.33E-05***</td>
</tr>
<tr>
<td>( \gamma_2 )</td>
<td>1.36E-04***</td>
</tr>
<tr>
<td>( \gamma_3 )</td>
<td>-0.05**</td>
</tr>
<tr>
<td>( \gamma_4 )</td>
<td>-3.37E-13</td>
</tr>
<tr>
<td>( \gamma_5 )</td>
<td>-1.10E-06***</td>
</tr>
</tbody>
</table>

\* : coefficient significant at 10% level, ** : coefficient significant at 5% level, *** : coefficient significant at 1% level.
Comparing the above to the outcomes of the earlier study conducted in Finland by Jyrkönen (2004), the results match for the long-term part of the equation (except for GDP). Regarding the short run, effects seem to differ though. The sign of the variable concerning ATMs is positive, whereas we found a negative relationship. Jyrkönen found a significant negative relationship between the number of EFTPOS terminals and cash share (while we did not find any) and the sign of the unemployment coefficient was positive, as would be expected. The findings concerning the influence of interest rate effects are identical (insignificant).
This section provides a forecast for the future value share of cash in POS payments. This is a baseline projection in which we assume a “stable” environment: a steady development of the Dutch economy and a payment infrastructure which continues its 2004-5 development with respect to the number of ATMs and EFTPOS terminals. Section 5 will explore the impact of changes in the policy of banks and merchants regarding the number of ATMs and the acceptance of electronic payment instruments on the value share of cash in POS payments.

4.1 Assumptions

The multivariate parametric forecast\(^9\) is built on the estimation results presented in section 3.3. Table 3 summarises the assumptions made for the development of the explanatory variables. These assumptions do not reflect any expectations regarding the development of these variables, but they are used as inputs for a forecast of the cash share if the macroeconomic environment remains steady (no economic booms or recessions) and both banks and merchants do not change their policy regarding the placement of ATMs or EFTPOS terminals. Projections for real GDP growth and unemployment for the period 2006-2007 are taken from DNB’s biannual economic forecast (DNB, 2005). The GDP growth figures for 2008-2015 are set at the expected 2007.

Table 3  Assumptions development explanatory variables 2005-2015

<table>
<thead>
<tr>
<th>Variable</th>
<th>realisation</th>
<th>projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP (real, in %)</td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td>Unemployment (*1000 persons)</td>
<td>78</td>
<td>15</td>
</tr>
<tr>
<td>Level interest rate (euribor, 1 month)</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>ATM(^10) (in %)</td>
<td>4.4</td>
<td>4.1</td>
</tr>
<tr>
<td>EFTPOS (in %)</td>
<td>4.7</td>
<td>5.9</td>
</tr>
</tbody>
</table>

\(^9\) In the empirical cash usage literature learning curve models have been used (Humphrey, Pulley & Vesala, 2000, Humphrey, Kaloudis & Øwre, 2000, Snellman, Vesala & Humphrey, Paunonen & Jyrkönen, 2002) with varying success. This model is not presented in this study since it led, like in Paunonen & Jyrkön, to unlikely results.

Learning curves are suitable for estimating time series processes following an S-shaped pattern over time i.e. a slow adoption at the start, then accelerating adoption rates after which the growth slows down. The adoption of electronic payment instruments is likely to follow this s-shaped pattern. However, in the Netherlands it is not known yet when the inflection point will be reached. The estimation of Logistic and Gompertz models turned out quite problematic, yielding an improbably rapid adoption of electronic payment instruments and a complete elimination of cash within 10 years.

\(^10\) The number of ATMs in the fourth quarter of 2005 was not available. The 2005 ATM growth rate is estimated, based on the realised growth rates in the first three quarters of 2005.
growth rate. Unemployment is assumed to remain constant. The interest rate (1-month euribor) is set at its December 2005 level, i.e. 2.4%, for the entire projection period. It is assumed that the numbers of ATMs and EFTPOS terminals grow 4% respectively 5% annually. These growth figures match the average growth rate of ATMs and EFTPOS terminals in 2004 and 2005.

4.2 Baseline projection

The “error correction” model described in section 3 is used for the projection of the share of cash (in value terms) in total POS sales in 2015. This so-termed “base-line” projection is shown in Figure 6. The share of cash estimated on the basis of the statistical model is 32% in 2010 and 20% in 2015. These estimates are similar to those for Finland and Norway. The value of 20% indicates that, as compared with the current rate, the substitution rate of cash by electronic payment instruments will slow down. For if the substitution rate for 2004/5 were extrapolated to 2015, the share of cash would be roughly 12% in 2015. The declining rate of the share of cash need not signify, though, that the growth in the number of electronic payments is levelling off as well. The number share of cash in POS payments could very well decline more rapidly than nowadays, since consumers increasingly use their debit cards instead of cash to pay small sums. This is clear from, for example, the decrease in the average amount paid by debit card from EUR 47 to EUR 44 between 2002 and 2005.

Figure 6 Projected development of the share of cash (in value terms) in total POS sales, 1987-2015
Per cent

![Figure 6 Projected development of the share of cash (in value terms) in total POS sales, 1987-2015](image-url)
4.3 Impact on banknote circulation, seigniorage and future cost savings

Banknote circulation and seigniorage revenues
An increase in the use of electronic payment instruments by consumers until 2015 will cause demand for transaction banknotes to decline. A decrease by approximately 55% in the share of cash (in value terms) in total POS sales, as projected for the period between 2004 and 2015, implies a proportional decline in demand for transaction banknotes from Dutch consumers. As a result, the value of the total euro banknote circulation in the Netherlands will be 17% lower than if the share of cash (in value terms) in POS payments were to remain at the level of 2004. Seigniorage revenues will also be about 17% less, since they depend linearly on the value of the banknote circulation. This finding is in line with previous findings by Hebbink (1997) who also found moderate seigniorage effects from cash substitution. According to Hebbink, a 40% lower demand for banknotes up to a value of ECU 50 in 1995 would have reduced the value of the Dutch banknote circulation and the central bank’s seigniorage revenues by at most 19%.

Social cost savings
From rough calculations, based on GfK/Currence (2005) and Brits & Winder (2005) it appears that a decrease in the share of cash (in value terms) in total POS sales from 46% in 2004 to 20% in 2015 may yield savings to the tune of several hundreds of millions of euro. The precise magnitude of the savings and the number of cash payments substituted by card payments depend on the extent in which cash payments are replaced by debit card payments or by e-purse payments. The more substitution takes place by means of the debit card the smaller savings will be and the less cash payments (measured in numbers) will be substituted. Depending on the kind of substitution cash payments will fall in number by 20-30%. This means that cash will continue to be the most popular means of payment measured in numbers. The sum of the numbers of debit card payments and e-purse payments will more than double.

In the first place, the savings will fall to the banking and retail sectors, but as a result of competition, consumers will also benefit from their more cost-efficient payment behaviour thanks to lower consumer prices and lower fees for banking services. In reality, savings may turn out higher because of economy-of-scale benefits and technological advances bringing down the costs of electronic retail payments further. However, these developments have not yet been taken on board in the present projection.

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11 Banknotes with a value up to ECU50 made up 48% of the Dutch banknote circulation.
12 The GDP growth figures for 2006 as presented here deviate from the estimate reported in the Quarterly Bulletin of December 2005. The adjustment is based on revisions by Statistics Netherlands.
In this section we discuss three scenarios in which the use of electronic payment instruments is stimulated and we present their impact on the value share of cash in total POS turnover from 2006 to 2015. The scenarios are an illustration of the effect of the POS payment infrastructure on payment choice of consumers.

There are multiple ways to stimulate the use of electronic payment instruments: the ease of use can be enhanced, the number of transfer terminals can be increased and the transaction speed can become shorter, etc. (see e.g. Jonker, 2005). Such measures act as an extra incentive for consumers to pay more cost-efficiently by adopting the habit of paying more often by e-purse or debit card. As a result, the share of cash (in value terms) will decline faster than projected in section 4 and the eventual savings will be higher as well. To explore the possible influence of non-financial incentives on consumers’ payment behaviour, the effect of a notional package of two measures on the share of cash (in value terms) in POS sales has been calculated using the statistical model presented in section 3.3. The first measure is designed to render paying in cash less attractive by keeping the number of ATMs at the level of 2005 instead of raising it each year by 4% (the ATM scenario). In this scenario, the eventual number of ATMs would be 32% lower than the number arrived at in the base line projection. The second measure (the EFTPOS scenario) proceeds from a higher growth rate for the number of EFTPOS terminals in 2006-2008 (quarter-on-quarter growth in 2006: 3%, in 2007: 2.5% and in 2008: 2%) after which quarterly growth will return to 1%, as assumed in the baseline projection. In this scenario, the number of EFTPOS terminals in 2015 exceeds the number assumed in the baseline by 16%. The two effects are combined in the ‘ATM+EFTPOS scenario’. Table 4 summarises the set-up of the scenarios and the base (section 4). The effect of the measures on the share of cash is depicted in Figure 7.

Table 4  Alternative assumptions development ATMs and EFTPOS terminals (three scenarios)

<table>
<thead>
<tr>
<th></th>
<th>realisation</th>
<th>projections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td><strong>BASE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATM (in %)</td>
<td>4.4</td>
<td>4.1</td>
</tr>
<tr>
<td>EFTPOS (in %)</td>
<td>4.7</td>
<td>5.9</td>
</tr>
<tr>
<td><strong>Scenario 1: ATMs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATMs (in %)</td>
<td>4.4</td>
<td>4.1</td>
</tr>
<tr>
<td><strong>Scenario 2: EFTPOS terminals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFTPOS terminals (in %)</td>
<td>4.7</td>
<td>5.9</td>
</tr>
<tr>
<td><strong>Scenario 3: ATM and EFTPOS terminals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATMs (in %)</td>
<td>4.4</td>
<td>4.1</td>
</tr>
<tr>
<td>EFTPOS terminals (in %)</td>
<td>4.7</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Both measures lead to an extra decline of the share of cash (in value terms) vis-à-vis the baseline. As a result of the stabilisation of the number of ATMs, cash payments will make up 14% of POS payments in 2015, instead of 20%. This corresponds with an “elasticity” between the number of ATMs and the share of cash (in value terms) of +1, i.e. 1% more ATMs will raise the share of cash (in value terms) of retail sales by 1%. The “correlation” between the share of cash payments and the number of EFTPOS terminals turns out to be closer yet. The extra increase in the latter between 2006 and 2008 will cause the value of cash payments in 2015 to fall by 9 percentage points to 11% of total retail sales. This implies an “elasticity” between EFTPOS terminals and the share of cash of -2.8, meaning that 1% more EFTPOS terminals in shops will reduce the value of cash payments (in value terms) in total sales by 2.8%. Combined, the two measures make for a share of cash (in value terms) that is 13 percentage points below the 20% assumed in the baseline projection.

Figure 7 Scenario analysis share of cash in POS payments

The outcomes of the extrapolations of the two measures show that adjustments to the infrastructure of retail payments can influence consumers’ payment behaviour considerably. Of these adjustments, raising the number of EFTPOS terminals proves the most effective way to promote electronic payments. From an earlier DNB study by Bolt et al. (2005)\(^\text{13}\) it likewise emerged that an increase in EFTPOS terminals will stimulate the use of payment cards appreciably, much more so than price stimuli such as levying fees for the use of ATMs.

The substitution process can be enhanced by mitigating other factors than the payment infrastructure which hamper paying electronically. Some shopkeepers in the Netherlands surcharge consumers on debit card payments for low transaction amounts. This gives consumers the notion that paying by debit card is expensive, whereas paying in cash is cheap (see Jonker

Consumers may use the debit card more often if these retailers would quit this practice. Moreover, incidental events might cause a sudden expansion of the use of electronic payment instruments, as they did in the past. An example is the earlier-mentioned take-off of the debit card in 1992 after the adoption in 1992 of POS terminals by Albert Heijn. On top of that, technological developments may give rise to further boosts, for example by including a payment functionality to the mobile phone. Finally, payment behaviour might be influenced by policy changes of market parties. In November 2005, Dutch retailers and banks agreed to start framing measures aimed at stimulating the use of electronic payment means, thereby cutting back the use of cash.
Coins and banknotes are increasingly losing ground to the debit card, e-purse and credit card. Since the early nineties, the share of cash payments (in value terms) in sales of the retail sector (shops, hospitality & catering, petrol stations etc.) has declined from three quarters to less than half in 2004. In that year the value share of the debit card in total POS sales exceeded 50%. If the cash/payment card ratio in 2004 had been the same as in 1990, the social costs of payments would have come out almost EUR 200 million higher. Consumers will have benefited from these savings through lower consumer prices and bank fees.

Time series analysis shows that over the next ten years the use of cash in retail payments may fall considerably further. The estimated regression models explaining the cash share in total POS turnover indicate that the POS payment infrastructure (ATMs and EFTPOS terminals) has played an important role in stimulating the usage of electronic payment instruments. Forecasts show that the cash share will continue to decrease from 46% in 2004 to around 20% in 2015. Numerically, cash payments will fall by several dozens of percentage points, while card payments will more than double in number. Banks and merchants will together realise savings worth several hundreds of millions of euro as a result.

A faster decline of consumers’ demand for cash to pay retail purchases is clearly possible. This appears from the outcomes of fictitious scenarios in which the use of electronic means of payment is promoted by adjustments to the payment infrastructure. The results of these scenarios are indicative of the effectiveness of any efficiency-enhancing measures that may be taken within the scope of the 2005 payment covenant. In particular an increase in the number of EFTPOS terminals turns out to be promising.
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