

How to measure the number of cash payments? A pilot study of seven possible methodologies*

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Nicole Jonker and Anneke Kosse

De Nederlandsche Bank

Abstract:

Cash payments differ from payments made by other payment instruments because of their anonymous character. As they are not centrally recorded, the total number of cash payments can only be estimated, for example by a consumer survey. In this study we show how consumers' registration of payments is influenced by the survey set-up. The results of seven pilot studies conducted in September 2007 reveal that the type of questionnaire, the registration period and the type of database from which a sample of respondents is drawn influence the estimation results significantly. Confronting our estimations with information supplied by retailers and the owner of the Dutch debit card scheme reveals that the best set-up is one in which consumers report their payments in a diary during a short period of time. These consumers should be drawn from a database of people only participating occasionally in telephone surveys instead of from an Internet panel. The results indicate that such an approach yields estimates that deviate only about 5-10% from the real number of cash payments.

Keywords: cash, efficiency, payment behaviour, survey design
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* Contact information: Nicole Jonker, phone: +31-20-5242759, e-mail: n.jonker@dnb.nl or Anneke Kosse, phone: +31-20-5242827, e-mail: j.c.m.kosse@dnb.nl, address: De Nederlandsche Bank, Cash and Payment Systems, P.O. Box 98, 1000 AB Amsterdam, The Netherlands. The authors like to thank Hans Brits, Maarten van Rooij, Peter Vlaar and other seminar participants at DNB for their comments, and especially Mustapha Setta and Richard Heuver for excellent research assistance. The views expressed in this paper are ours and do not necessarily reflect those of the Nederlandsche Bank or the European System of Central Banks. All remaining errors are our own.

1 INTRODUCTION

During the past 25 years, card payment usage at the point-of-sale (POS) has grown tremendously. The favourite payment card of the Dutch is the debit card: they used it for 1.6 billion POS payments with a total value of EUR 72 billion in 2007. The number of debit card payments is still growing steadily with yearly growth rates around 9%. This shows that the substitution process of cash by cards is not at its end yet. Next to debit card transactions, 175 million Chipknip e-purse transactions with a total value of EUR 475 million were made in 2007 and 26 million credit card payments representing a value of EUR 3 billion. The usage of payment cards can be monitored very accurately, since card transactions are centrally registered by Equens, the German-Dutch ACH. Cash payments on the other hand are not centrally registered. So, unlike card payments, there are no hard data on the number of cash payments. Therefore, we do not really know how often cash is used and, consequently, in what stage of the ‘cards for cash’ substitution process we precisely are.

Accurate information on the number of cash payments is relevant for a central bank for several reasons. First, one of its tasks is to promote a stable, safe and efficient payment system. Insight into current consumers’ payment behaviour and changes over time are essential for monitoring the substitution process of cash by cards and for examining the efficiency of the payment system. Especially for cost efficiency studies, an accurate estimate of the number of cash payments is of vital importance, since it has a strong impact on the estimated costs of cash payments (Brits and Winder, 2005, NBB, 2005, Bergman et al, 2007, Banco de Portugal, 2007). Second, central banks are responsible for the banknote circulation. In this respect it is useful to examine the demand for money for POS transactions, since it provides a strong indicator for the demand of transaction banknotes (i.e. banknotes with a face value up to EUR 50).

However, it has appeared to be quite hard to provide reliable estimates of something so ordinary as cash payments. The estimates found for the Netherlands range between 3 and 7 billion transactions. Close examination of the study designs reveals several possible causes. Some of the differences could be explained by differences in the scope of the study, such as the definition of the research population, the number and types of retail branches included, and the moment and duration of the data collection. However, some studies did not differ very much on these aspects and still yielded different estimates (TNS Nipo 2003, GfK/Interpay 2004). Here, the differences appeared to be merely caused by the way the payment data was collected from the consumers. The Dutch mainly use cash for small transaction amounts (GfK/Currence 2006, Bolt, Jonker and Renselaar, 2008). These payments may easily be overlooked when filling in a survey or answering a questionnaire. Therefore, the way the survey is designed is of vital importance, as it might considerably affect the ability of consumers to recall all their cash payments.

In this study, we want to shed some light on this issue. We conducted seven pilot studies to investigate whether and, if yes, how the survey set-up influences consumers’ registration of cash

payments. In addition, we have tested several hypotheses and have confronted the pilot estimates with 'hard' data on cash and debit card usage, in order to find out what methodology yields the most reliable estimates of the number of cash payments. The findings can be useful for researchers who want to investigate consumer payment behaviour and who are especially interested in small value payments.

Our findings show that consumer surveys can be used to collect reasonably accurate data on cash and card payments. However, one should keep in mind that error ranges between 5-10% are possible. People especially tend to forget small value payments. The set-up of the survey clearly influences the outcomes. Evidence has been found that the registration of cash payments by consumers benefits from the usage of a diary in which payments can be registered immediately after they have taken place. Registration at the end of the day results in less registered payments. Especially small payments may be easily overlooked. The duration of the registration period should be short in order to keep people motivated to fill in the diary after each payment. Finally, the source used to draw a sample is of influence. Usage of an Internet panel leads to biased results: less cash payments and more debit card payments. Payment data supplied by people who usually participate in telephone surveys turns out to be significantly better.

The structure of this article is as follows. Section 2 provides an overview of the empirical literature on measuring consumer payments. These findings guided us to formulate seven research questions on the possible factors influencing consumers' payment registration, which form the basis of the set-up of the seven pilot studies as described in section 3. Section 4 presents some descriptive statistics on the Dutch payment behaviour as estimated by the seven pilots. We have found some remarkable differences with respect to the number and the value of estimated payments. In order to find an answer on the seven research questions, we have tested several hypotheses. The results are discussed in section 5. In section 6, the results from the pilot studies are confronted with hard data on consumer purchases provided by Currence, the owner of the Dutch debit card and e-purse scheme, and by retailers to find out what methodology performs best in approximating real payment behaviour. Section 7 summarises and concludes.

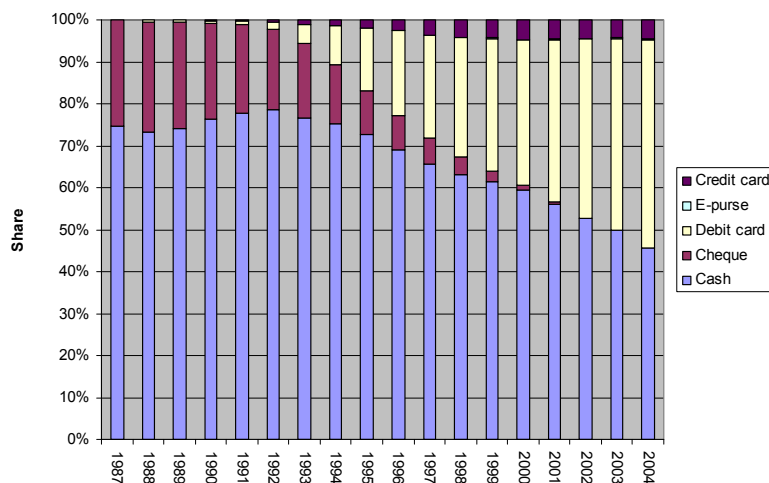
2 LITERATURE

In the past three decades the academic interest in payment behaviour has grown considerably. This development is driven by several factors. First, the introduction of electronic payment instruments for POS payments, which are currently widely adopted by consumers. Second, by the increasing awareness of the relatively high costs related to the usage of paper payment instruments such as cash compared to electronic payment instruments. See for instance Humphrey *et al* (2001), the cost study of Brits and Winder (2005) for the Netherlands, Banco de Portugal (2007) for Portugal, of Bergman *et al* (2007) for Sweden and of NBB (2005) for Belgium. In this section we will first summarise the existing literature on how Dutch payment behaviour developed over time and on the factors determining payment choice. Then we will turn to discussing some studies providing estimates for the number of cash payments made and the factors that might possibly introduce biases when estimating the number of cash payments.

2.1 Dutch payment behaviour over time

The first empirical studies examining the demand for money in the Netherlands were published in the 1970s. Fase and Van Nieuwkerk (1977) were the first to estimate currency demand functions. Their study revealed that the introduction of a new payment instrument, the guaranteed cheque, acted as a substitute for cash. At the end of the 1980s the debit card was introduced. During its first years it mainly replaced cheque payments, but in 1993/1994 the debit card started to substitute for cash (Boeschoten, 1995). Recent studies on Dutch payment behaviour over time are Gfk/Currence (2005, 2006, 2007) and Jonker and Kettenis (2007). They both support the findings of Boeschoten of cash being substituted by the debit card. The study of Jonker and Kettenis focuses on the value share of

Figure 1 Value shares of POS payment instruments



Source: Jonker and Kettenis (2007)

POS payment instruments in total sales (see figure 1). It shows that in 2004 the value share of debit card payments (EUR 57 billion) surpassed that of cash payments (EUR 52 billion). In 2007 the total value of debit card payments amounted EUR 72 billion, indicating that the debit card is still gaining terrain.

2.2 Factors influencing payment choice

Next to studies analysing the development of cash demand and electronic payment instrument usage, various studies have been conducted explaining the choice of payment instrument at the counter. Most of them made use of consumer surveys. Attention is paid both to the influence of consumer characteristics and merchant characteristics, and to features of the transaction itself. With respect to consumer characteristics the empirical findings unanimously show that demographic factors such as age, gender, income and education strongly influence consumers' payment choice (Boeschoten and Fase 1989, Boeschoten 1992, Borzekowski *et al*, 2007, Hyytinen and Takalo 2004, Van Hove *et al*, 2005, Jonker, 2007, Klee, 2006, Mot and Cramer, 1992, Stavins 2001). The results with respect to age indicate that a further substitution of cash by electronic payment cards is to be expected.

The studies analysing the impact of transaction specific features demonstrate that payment choice is strongly influenced by the transaction amount. Consumers tend to use cash for low value purchases and payment cards for the higher transaction amounts (Boeschoten and Fase, 1989, Bolt, Jonker and Renselaar, 2008, Bounie and François, 2006, Gfk/Currence 2005, 2006, 2007, Jonker 2007, Klee 2004, Mot and Cramer, 1992). This correlation may explain to a certain extent the variation in payment behaviour across different POS locations. However, the attitude of retailers towards payment instruments, with respect to the acceptance of different payment instruments and pricing might play a role here as well (Jonker, 2007, Bolt, Humphrey and Uittenbogaard, 2008, Borzekowski *et al*, 2007).

2.3 Estimating the number of cash payments

Studies providing estimates of the number and share of cash payments are rather scarce. As far as we know, APACS (2007), the UK trade association for payments, is the only entity that publishes yearly estimates of the number of cash transactions. Their publications show that from 2000 onwards, the number of cash payments in the UK fell from 27.9 billion in 2000 to 24 billion in 2005. As the total number of payments slowly declined from 41 to 40.4 billion transactions, the share of cash in total POS transactions fell from 67% to 59% in six years time. Recently, estimations for the number and/or the share of cash payments have been published for Austria (cash share 86% in 2005), Belgium (3 billion cash payments in 2003, cash share 81%), Portugal (cash share 89% in 2005) and Sweden (1.4 billion cash payments in 2002, cash share 72%). Most of these estimates were used as input for cost efficiency studies of the POS payments market and were based on information collected from consumer surveys.

Also in the Netherlands, several attempts have been made to estimate the number and share of cash payments. The results however greatly vary. Table 1 summarises the results of these studies and provides information about their scope and set-up. The results with respect to the estimated *share* of cash payments in the total number of POS payments ranges from 63% to 85%. The dispersion in the estimated *number* of cash payments however is much larger and ranges between 3 billion and 7 billion. So, although all studies demonstrate the popularity of cash, there is still great uncertainty about the extent in which it is used.

2.4 Factors possibly introducing biases when estimating the number of cash payments

The studies conducted in the Netherlands considerably differed in the way the payments data was collected. Three of the studies (Boeschoten, 1992, GfK/Currence, 2004-2006, and TNS Nipo, 2003) used consumer surveys, three (Brits and Winder, 2005, HBD, 2002 and EIM, 2007) were (partly) based on information supplied by retailers and one (Kippers, 1999) posted registrars near the counter recording the characteristics of all payments made. As a result, several factors might have contributed to the variation in the estimation results. First, the *scope* of the transactions. Kippers (1999) and HBD (2002) focus on payment behaviour in the retail trade and find cash shares around 80%. The other studies however also include payments made in the catering industry, vending, public transport and at petrol stations and find lower cash shares of around 70%. A second possible source of the measurement differentials may be related to the *period* in which the surveys were held. The surveys conducted in spring or in summer show a relatively larger cash share compared to the surveys covering an entire year. A third possible source might be the *research population*. By collecting payment data via the retailers, Brits and Winder (2005), Kippers (1999) and HBD (2002) capture all types of consumers. The studies using consumer surveys however, only catch a subset of the Dutch population. Especially frequent cash users are missing, such as children, the elderly, non-Dutch inhabitants and travellers, leading to lower estimated cash shares.

Next to differences in scope, research population and research period, the three studies based on consumer surveys also vary in the way the payment data were gathered. To begin with, they differ in the *number of days* consumers had to recall and report their payments. It might be expected that the longer the registration period, the more difficult it is to recall one's payments. Especially small value payments may easily be forgotten, leading to a lower number of reported cash payments and a lower cash share. One-day registration on the other hand may lead to an over-reporting of payments. People participating in one-day payment registration surveys may (unintentionally) make more payments on that specific day, than they would have done otherwise. The relatively high number of debit card payments in the study of TNS Nipo (2003) may support this hypothesis. The consumer surveys also differ with respect to the *moment* at which the consumers had to report their payments; either immediately after the transaction using a payments diary, or at the end of the day by filling in a questionnaire. The diary-method may lead to a more accurate payments registration, since, in theory,

Table 1: Summary of recent surveys assessing the usage of cash for POS purchases in the Netherlands

	HBD	Brits and Winder	Kippers	EIM	Boeschoten	GfK/Currence	TNS Nipo	
Year	2001	2002	1998	2006	1990	2003	2006	2003
Estimated no. cash payments (bln)	4.2	7.9	na	Retail trade: 3.0 Total POS: 5.5	na	2.7	3.2	7.6
Estimated no. debit card payments (bln)	0.8		na	Retail trade: 1.1 Total POS: 1.5	na	1.1	1.5	2.4
Cash share	85%	85%	85%	Retail trade: 72% Total POS: 75%	64%	67%	65%	
Research method	Questionnaires amongst retailers	Estimation using different sources, including a survey amongst retailers	Payment registration at the counter	Questionnaires amongst retailers	Consumer survey	Consumer survey		Consumer survey
Scope of transactions	Retail trade	All POS transactions plus P2P	Retail trade	All POS transactions	All POS transactions	All POS transactions.		All POS transactions plus P2P.
Research period	One year	One year	One week in April	One year	No specific period	Week 2 – 51		2 – 8 April
Research population	All clients visiting the POS's	Differed per source	All clients visiting the POS's	All clients visiting the POS's	Dutch consumers aged 18+	Dutch consumers aged 12-74 years		Dutch consumers aged 12-74 years
Consumer surveys:								
Registration period	-	-	-	-	Unclear	One week		One day
Moment of reporting	-	-	-	-	End of day	During the day		End of day
Sample selection	-	-	-	-	AGB consumer panel	GfK consumer panel		Internet panel
Method of trans. registration	-	-	-	-	Paper-based questionnaire	Paper-based diary		Internet survey

each payment is immediately registered. Finally, the consumer studies differ with respect to *the way in which the samples are drawn*. TNS Nipo made use of a panel consisting of PC-owners, a so-called Internet panel, whereas GfK (2003 – 2006) and Boeschoten (1990) drew their sample from a regular database. The usage of Internet panels may cause selection bias, as people not having a personal computer are excluded from participation. This may lead to under-representation of certain population groups, such as the elderly and people with a low income. Furthermore, people participating in Internet panels may have a more positive attitude towards electronic means of payment compared to average Dutch consumers. The relatively high number of debit card payments in the TNS Nipo survey might suggest the presence of such a selection bias. Using other selection methods that are less sensitive to the exclusion of certain population groups may therefore be preferable (e.g. addresses in the phone book, etc.). Finally, the *method of transaction registration* might have introduced some measurement differentials. Internet based questionnaires might

lead to an electronic bias, resulting in an overrepresentation of card payments compared to alternatives such as paper questionnaires or telephone interviews. On the other hand, telephone surveys might make respondents recall their payments better due to the personal contact with the interviewer, as the interviewer can specifically ask about certain transactions which might easily be forgotten.

The aim of our study is to assess the impact of the above mentioned survey characteristics on the estimation results, and to find out what methodology is most suited to approximate the real number of cash transactions.

3. METHODOLOGY

In this study we use multiple consumer survey techniques to assess which technique yields the smallest gap between true and stated payment behaviour. In this section we explain our choice for using the consumer approach to estimate cash usage, we discuss the design of the pilots and we present the key statistics of the pilots.

3.1 The retailer versus the consumer approach

The literature demonstrates that roughly speaking two different approaches can be used when estimating the number of cash payments: the retailer approach and the consumer approach. Regarding the former, there are two ways in which data can be collected. First, retailers can be asked to give an estimate of how their clients pay for their purchases. These estimates can be rather precise, as many merchants keep record of their daily transactions using special electronical equipment. Secondly, researchers can be placed at different points of sale in order to register all the transactions. The advantage of these retailer approaches is that they allow for a relative high number of observations and that there is essentially no measurement error. An important restriction of the two retailer approaches however, is that it requires a representative sample of all possible places where consumers could possibly make a transaction. This is a very heterogeneous group including street traders, caterers, public transport, culture and recreation, collections and offertories and vending machines. As they are not centrally recorded as one coherent group, it requires huge efforts to draw a representative sample including them all. In addition, using data gathered from purchase recording systems may limit the range of merchants, purchases and transactions surveyed, since these systems are mainly used by large retailers. Moreover, the retailer approach limits itself to points of sale payments only. As a result, transactions made amongst consumers, person-to-person transactions, are not included.

As it is less hard to draw a representative consumer sample, we believe the problem of estimating cash usage can be tackled best from a consumer perspective. Another advantage of this approach where consumers are asked about their payment behaviour, is that person-to-person transactions can be measured as well. The main drawback of this method is that there is always a certain degree of inaccuracy. Due to several reasons, there might exist a certain disparity between stated and true payment behaviour. People might be reluctant to be entirely transparent about their true payment behaviour. In addition, consumers might unintentionally forget some of their transactions. This miss-out-effect is expected to be highest with respect to cash payments. This is because many cash transactions often involve small transaction amounts and therefore hardly affect the consumer's budget. As a result, these transactions may easily be forgotten. Moreover, cash transactions can not be verified at bank statements or via Internet banking. Another drawback of the consumer oriented approach is that the transaction registration might influence one's purchasing behaviour. Previous research (TNS Nipo 2003) showed that the estimated number of card

payments in one-day registration surveys can be much higher than the realized number of debit card transactions.

Given the drawbacks of using the consumer oriented approach, consumer surveys should be accurately designed in order to fully exploit their advantages. The survey should be designed in such a way so to maximally reduce the discrepancy between true and stated payment behaviour. In order to find out what methodology minimises possible measurement errors when measuring cash usage, several pilots have been run.

3.2 Set-up pilot studies

In section 2 several potential sources of measurement error have been identified for consumer survey methods, referring to the way in which the sample is drawn and the way in which consumers' payment data is gathered. In order to investigate how consumers' stated payment behaviour is really influenced by these factors and what methodology generates the most reliable estimates, seven pilot studies have been conducted. The pilots are designed in such a way that answers can be found to the seven questions listed below. Questions 1, 2, 3, 6 and 7 refer to the possible impact of the way the sample is drawn and to the way transactions are recorded by consumers. The objective of questions 4 and 5 is to assess alternative ways to aid consumers to recall and record their small value payments.

- Q1: Can consumers' payments registration be improved by asking them beforehand to record their payments for a specific day?
- Q2: Is consumers' purchase behaviour affected when respondents are asked beforehand to record their payments for a specific day?
- Q3: Does the duration of the registration period affect the recording of payments by consumers?
- Q4: Does a telephone reminder after 3-4 days improve consumers' payments registration when participating in a one-week survey?
- Q5: Is payment registration improved when consumers are asked to fill in a questionnaire in addition to keeping a transaction diary?
- Q6: Does the usage of a telephone survey make respondents better recall their payments?
- Q7: Does the usage of Internet panels lead to a certain selection bias manifested in a higher usage of electronic payment instruments?

All pilots were conducted from August 30 until September 29 2007. In addition, the pilots equalled with respect to the type of payments included (see appendix 2 for a list) and the research population (Dutch consumers aged 12 to 75 years). These three factors are kept constant across the pilots in order to rule out any possible variation in the estimation results due to differences in these factors. Five pilot studies were based on a one-day payment registration survey and carried out by the research bureau TNS Nipo. The two

Table 2: Summary set-up pilot studies

	One-day registration surveys					One-week registration surveys	
	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
May give answer on:	Q5 & Q6	Q6 & Q7	Q 1 & Q2	Q1 & Q2 & Q3 & Q5	Q7	Q4	Q 3 & Q4
Diary							
End of day Internet survey							
End of day telephone survey (sample from Internet panel)							
End of day telephone survey (sample from telephone database)							
Interim reminder after 3-4 days							

pilots using a one-week diary method were conducted by GfK. Pilot 1 is considered to be the base pilot. In this pilot consumers were asked beforehand to record their payments during one specific day. They received a small diary to record the amount, the payment instrument used, and the type of spending place of each transaction made. At the end of the day, they were asked to fill in an Internet survey on all the payments made during the day, using their diary as a reminder. The other six pilots are variations on this base pilot (see table 2). Pairwise comparison of the results of the individual pilots provides us with answers to one of the above defined questions. For example, the results of pilot 4 and pilot 7 are compared in order to examine whether a one-day survey performs differently from a one-week survey.

3.3 Key statistics of the seven pilot studies

Table 3 presents the key statistics of the seven pilots. The total number of reported payments varies between 1,279 in pilot 3 and 4,369 in pilot 7. The average number of payments recorded per day in pilot 1 – pilot 5 varies between 2.6 and 2.9 and is about twice as high as the average number of payments made per day in pilot 6 and pilot 7. This result is rather striking. It suggests that the registration period (one-day or one-week) is one of the most important sources of measurement differential. In the remainder of this paper attention will be paid to this issue.

Table 3: Key statistics pilots studies (unweighed data)

	One-day registration surveys				One-week registration surveys		
	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot5	Pilot 6	Pilot 7
Number of respondents	845	1017	638	1077	831	499	494
Share of respondents that at least paid once	80%	75%	76%	81%	79%	97%	97%
Number of respondents that at least paid once	676	763	485	872	656	485	481
Number of payments recorded	1926	2129	1279	2427	1827	4368	4321
Avg. number of payments recorded per paying respondent per day	2.9	2.8	2.6	2.8	2.8	1.3	1.3

4. EXPLORING THE RESULTS

4.1 Total number and shares of payment instruments used estimated for September 2007

Table 4 and 5 summarise the pilot results with respect to the total number and share of transactions estimated for the Netherlands in September 2007. To this end the survey results have been weighted and extrapolated in order to generate a representative picture of the payment behaviour by the Dutch (see appendix 1 for detailed information on the weighting and extrapolation methods used).

The estimation results significantly vary between the different pilots. Pilot 1, pilot 2, pilot 4 and pilot 5 (each using a one-day diary) report a relatively high number of transactions, varying between 602 and 625 million. Pilot 6 and pilot 7 (using a one-week diary) on the other hand have the lowest estimates. As a result, the estimates of the average number of transactions made per person per day are considerably lower: according to the one-day diary pilots, this estimate fluctuates between 1.76 and 1.83 transactions per day, whereas pilot 6 and pilot 7 report estimates of 1.28. The results of pilot 3 (based on a questionnaire only) appear to lie between the results of the one-day pilots and the one-week diary pilots.

When looking at the estimated cash and debit card shares, the differences between pilot 6 and pilot 7 on the one hand, and pilot 1, 2 and 4 on the other hand, are not that large. Pilot 5 and pilot 3 however, do significantly deviate from the others. The share of cash payments in total payments is relatively high in pilot 5 in which the sample was drawn from a regular database (74%), whereas in pilot 3 which was based on a questionnaire only, it only amount to 56%.

Table 4: Total number of transactions estimated for September 2007

	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
Total number of trx. (mln)	624	602	562	625	619	439	437
<i>Of which:</i>							
Cash (mln)	426	389	317	427	456	292	290
Debit card (mln)	161	175	204	154	138	126	118
E-purse (mln)	26	24	23	24	15	9	13
Credit card (mln)	6	4	7	8	4	2	3
Average number of trx per person per day *	1.82	1.76	1.64	1.83	1.81	1.28	1.28

* based on a population of 11,4 million persons aged between 12 and 75 years which were able to make any purchase.

Table 5: Total number of transactions by payment instrument

In percentages

	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
Cash	68	65	56	68	74	67	66
Debit card	26	29	36	25	22	29	27
E-purse	4	4	4	4	2	2	3
Credit card	1	1	1	1	1	1	1
Other	1	2	2	2	1	1	3
Total	100	100	100	100	100	100	100

(All reported shares significantly differ from each other at a 99% confidence level)

4.2 Average transaction value by payment instrument

Table 6 shows that the estimates of the average value of cash transactions come close to each other, fluctuating between EUR 10.75 and EUR 13.69. Pilot 3 and pilot 7 however, report a significantly higher estimate of respectively EUR 18.89 and EUR 17.61 per transaction. The variation between the different pilots is less with respect to debit card transactions. Here, the results vary between EUR 37.02 and EUR 40.05 per transaction. Contrary to debit card payments, the average value of credit card transactions appears to fluctuate considerably across the different pilots. These results should however be considered to be indicative, because the number of credit card observations in the pilots is relatively low.

Table 6: Average transaction value by payment instrument

In EUR

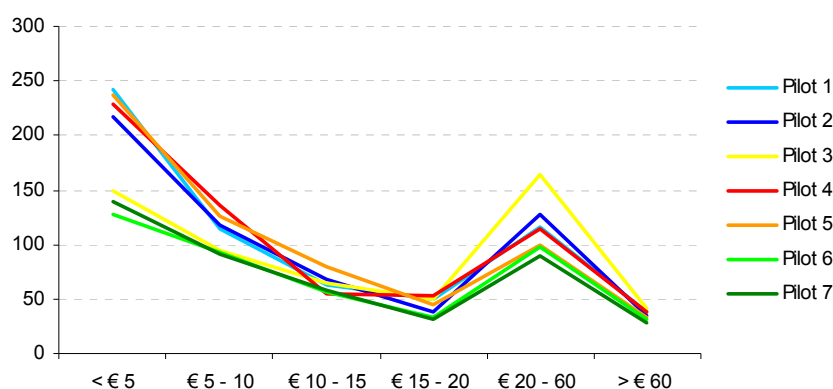
	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
Cash	10.93	10.75	18.89	11.85	13.43	13.96	17.61
Debit card	37.19	39.64	38.49	36.72	40.05	39.33	37.02
E-purse	2.76	2.45	10.29	3.90	3.13	4.19	4.05
Credit card	36.92	63.02	125.33	91.73	41.42	117.51	112.20

4.3 Distribution of payments by transaction value

One of the main problems with estimating the number of cash payments using consumer surveys, is the estimation of small cash purchases, which are easily forgotten. In order to find out which methodology performs best on this aspect, the distribution of the payments over the different transaction values is analysed. Graph 1 shows that the deviation between the estimates of pilot 1, pilot 2, pilot 4 and pilot 5 (using a one-day diary) on the one hand, and pilot 6 and pilot 7 (using a one-week diary) on the other hand, is largest for the transactions lower than 5 euro. The higher the transaction amount, the more the pilot results correspond to each other. The differences between the pilot estimates seem to be mainly caused by the estimation of low value cash purchases (see graph 2).

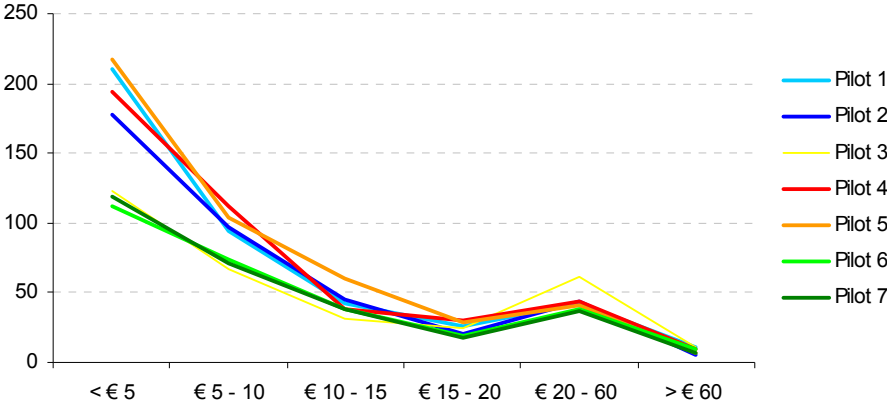
Graph 1: Total number of POS transactions by transaction amount

In millions



Graph 2: Total number of cash payments by transaction amount

In millions



4.4 Median transaction value by payment instrument

Unlike the average transaction value, the median transaction value is not affected by extremely high or low transaction amounts in the tails of the transaction amount distribution. It might provide an alternative, more robust way of assessing which survey design helps consumers memorising their small transactions best. Pilot 1, pilot 2, pilot 4 and pilot 5 (the one-day diary pilots) report a median cash transaction value of EUR 5 and EUR 5.50 (see table 10). According to pilot 3, pilot 6 and pilot 7 the median cash value is significantly higher, varying between EUR 6.00 and EUR 7.50, implying that significantly less very small cash purchases

Table 10: Median transaction value by payment instrument

In EUR

	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
Cash	5.00	5.50	7.50	5.00	5.00	6.47	6.00
Debit card	24.45	26.10	27.98	25.20	23.87	25.95	23.98
E-purse	2.3	1.60	5.95	2.72	1.65	2.59	2.60
Credit card	40.40	65.00	71.00	44.13	40.00	59.90	51.95

have been reported. When looking at the other payment instruments, the picture is not that unambiguous. However, pilot 5 (in which the sample is taken from a regular database) appears to report the smallest median transaction values for all payment instruments. This could suggest its capacity of measuring small purchases. Pilot 3 (using a questionnaire only) on the other hand seems to have difficulties with this, irrespective of the payment instrument used.

4.5 Distribution of payments during the week

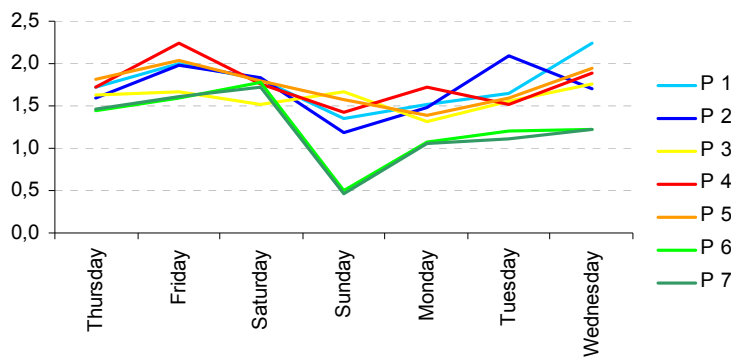
The previous results suggest that the registration of payments is influenced by the duration of the registration period. In this section we try to gain insight in the possible causes by taking a closer look at the intra-week differences.

Average number of payments per day

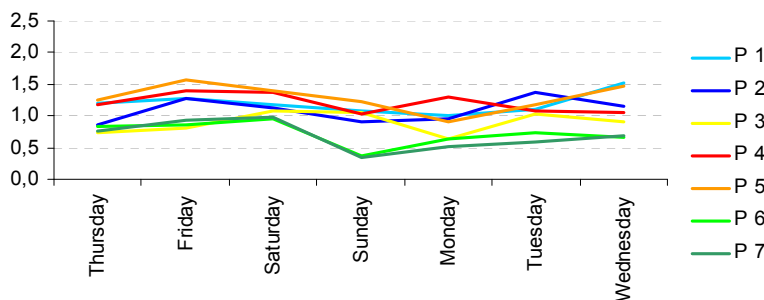
Graph 3a shows the pilot estimates of the average number of payments made per capita per day. It shows that the average number of payments varies over the week. Most payments are made on Fridays and Saturdays, whereas on Sundays, when most shops are closed, least payments are made. From Monday onwards, the number of payments steadily increases again. For all days of the week, the estimates of the one-week pilots, pilot 6 and 7, lie below the estimates of pilot 1- pilot 5, except for Saturdays. The differences between the one-day and one-week pilots seem to manifest in the second half of the registration week, starting at Sunday. This might suggest that after a couple of days some of the one-week respondents stop with consistently filling in their diary on a daily basis and consequently start to forget certain transactions. The interim reminder used in pilot 6 seems to slightly reduce this miss-out effect, given the growing differences with pilot 7 during the second half of the week.

When focussing on cash payments, more or less the same picture emerges (see Graph 3b). The respondents registering their payments during an entire week report relatively few cash payments in the second half of the registration week with the largest difference occurring on Sundays. During the second half of the week, the estimates of pilot 6 exceed the estimates of pilot 7. This suggests that the reminder leads to a higher number of registered payments.

Graph 3a: Average number of payments made per capita per day



Graph 3b: Average number of cash payments per capita per day

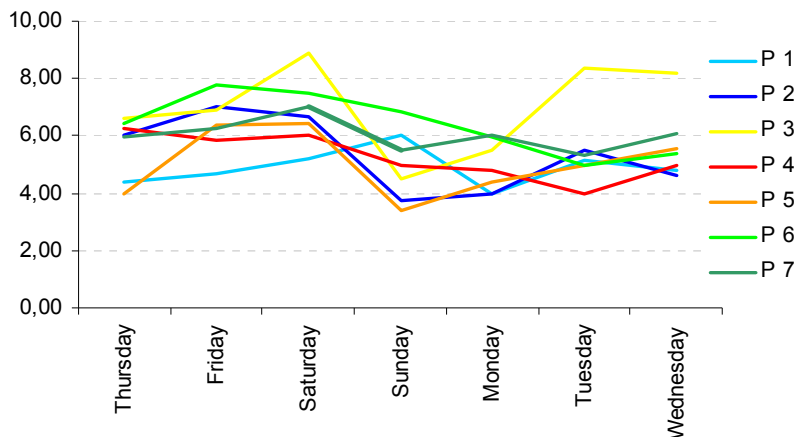


Median transaction values per day

Graph 4 shows the estimated median cash prices for each day of the week. They considerably differ across the pilots. The median price is highest in pilot 3, followed by pilot 6 and pilot 7. Except for pilot 3, a general downward trend can be observed for all pilots. Apparently, the largest cash purchases are made on Thursdays, Fridays and Saturdays. Note that from Sunday onwards, the median value of pilot 6 lies below the estimate of pilot 7, suggesting that the interim reminder does stimulate immediate reporting.

Graph 4: Median cash prices

In EUR

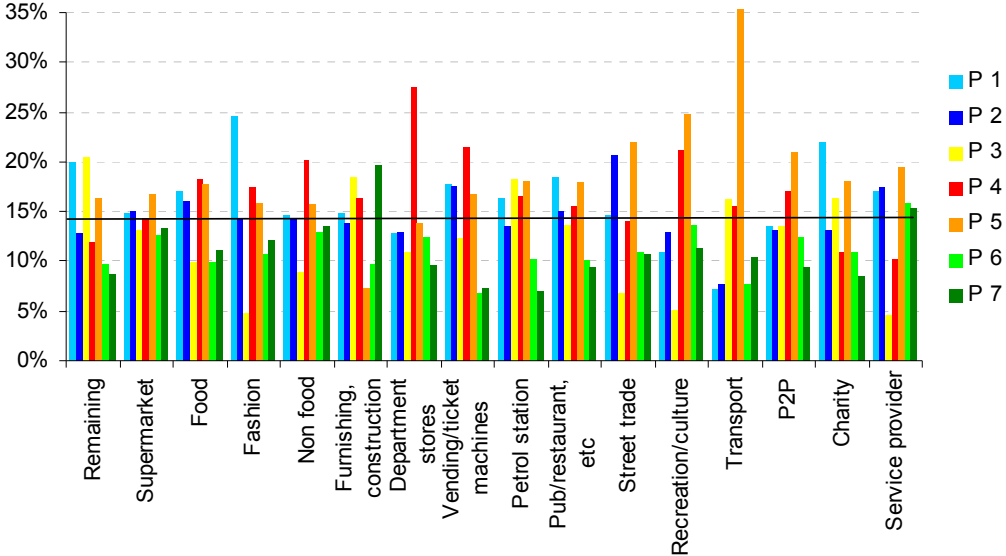


4.6 Distribution of payments by branch

Graph 5 depicts the estimates of the share of reported cash payments for each specific branch on the total number of reported cash payments in those branches by all pilots together. The horizontal black bar in the graph is drawn at 1/7. If all pilots would yield an equal estimate for each branch, all estimates would amount up to this line. So, the bars lying below this line point at a relatively low number of reported cash transactions.

With respect to supermarkets, the estimated cash shares of the seven pilot studies are almost the same, with pilot 5 yielding the highest estimates. At the other spending places the differences are more pronounced. Especially where the average transaction amount is relatively low (such as specialised food stores and the catering industry) and where cash is the dominant payment instrument (such as vending/ticket machines, street trade, P2P payments and charity) pilot 6, 7 and 3 report relatively few cash payments. This corresponds to our earlier findings regarding the one-week diary and the questionnaire method. They seem to have difficulties aiding consumers to recall all their cash transactions. When comparing the results of pilot 6 and 7, relatively more cash payments can be observed in the catering industry, P2P and charity in pilot 6. This again suggests that using a reminder may help consumers to recall their smallest cash payments.

Graph 5: Share of cash payments by branch



5. HYPOTHESES TESTING

In section 2 we identified several factors which may cause measurement errors when conducting a consumer survey to measure the total number of (cash) transactions. These factors refer to the source used to draw the sample, to the way and moment of transaction registration and to the duration of the registration period. In addition, two possible ways have been proposed that might aid consumers in recalling all their payments. This has led us to formulate seven research questions in section 3. The descriptive analyses presented in the previous sections already gave us some insight into the possible answers to these questions. In this section however, the pilot results are analysed in more detail using statistical hypothesis testing. For each research question, several hypotheses are defined to analyse whether the observed differences in the total number, share, average and median values of cash and debit card transactions are statistically significant. For every test, the results of two pilots are compared using the following hypothesis formulation:

The null hypothesis H_0 : There is no difference in the (...) between pilot X and pilot Y
The alternative hypothesis H_a : The (...) is higher/lower in pilot X than in pilot Y

A summary of the different hypotheses tested can be found in table 11

Question 1: Can consumers' payment registration be improved by asking them beforehand to record their payments for a specific day?

This question is formulated based on the belief that some payments, especially small cash payments, are easily forgotten, as a result of which respondents have great difficulties quoting all their transactions from memory at the end of the day. The test results reveal that the total number of transactions and the share of cash transactions are significantly higher in pilot 4 compared to pilot 3, and that the latter one yields higher average and median cash transaction values. These results imply that asking respondents beforehand to register their payments during a specific day using a diary, does increase the number of registered payments, and especially that of small cash payments, compared to an end-of-day survey.

Answer: Yes

Question 2: Is consumers' purchase behaviour affected when respondents are asked beforehand to record their payments for a specific day?

We expect that real payment behaviour might be affected when respondents are asked to keep a one-day diary, in the sense that they are going to use their debit card more often. This might have different causes. First, they might do so because they believe this behaviour is desired by the researchers. Secondly, having to keep a diary might be a reason of doing some large-value purchases which would have been postponed otherwise. The test results of the comparison between pilot 3 and pilot 4 show that the usage of a diary does

not lead to a higher number and share of debit card transactions. So knowing in advance when to keep track on one's payments does not alter the respondents' attitude towards electronic payment means.

Answer: No

Question 3: Does the duration of the registration period affect the recording of payments by consumers?

We expect that some respondents postpone the registration of their transactions with several days when having to keep a diary for more than one day. As a consequence, some transactions, in particular small cash transactions, may easily be forgotten. The test results reveal that the duration of the registration period indeed influences the registration of payments. As expected, the respondents in pilot 7, who record their payments for one entire week, report significantly less (cash) payments than the respondents in pilot 4, who only participate for one day. The cash share is significantly higher in pilot 4 than in pilot 7, whereas the average and median cash transaction amounts are significantly lower. This supports our view that longer registration periods lead to postponement of registration and the miss out of small (cash) payments.

Answer: Yes

Question 4: Does a telephone reminder after 3-4 days improve consumers' payment registration when participating in a one-week survey?

The interim reminder was used to yield a higher number of recorded (cash) transactions in the one-week method, as it was expected to possibly reduce the suggested 'postponing' and 'miss-out' effect. The results of the comparison between pilot 6 and pilot 7 indeed show that the usage of a telephone reminder after 3 or 4 days improves the registration of small cash payments. The total number of transactions and the cash share are significantly higher in pilot 6 in which the reminder was used. In addition, the average cash transaction value is significantly lower in pilot 6 than in pilot 7.

Answer: Yes

Question 5: Is payment registration improved when consumers are asked to fill in a questionnaire in addition to keeping a transaction diary?

The test results of the comparisons between pilot 1 and pilot 4 demonstrate that using an additional questionnaire next to a diary, does not help people to recall small cash payments which they had initially forgotten to register in their diary. Although the average and median cash value reported in pilot 1 are significantly lower than in pilot 4, the total number of transactions does not significantly differ from each other. Moreover, not in pilot 1 but in pilot 4, the respondents reported a higher cash share. Our conclusion is therefore that using an additional questionnaire supplementary to a one-day diary does not significantly improve consumers' payment registration.

Answer: No

Question 6: Does the usage of a telephone survey make consumers better recall their payments?

Using a telephone survey might possibly make respondents recall more transactions than using an Internet survey, because of the personal contact with the interviewer. The personal contact with the interviewer might stimulate respondents to do their best to remember all their payments. In addition the interviewer can specifically ask about transactions which might easily be forgotten. The hypotheses tests however do not provide us with convincing evidence that an additional telephone survey does indeed perform better than an Internet survey. The average cash transaction value is higher in pilot 1 which is based on an Internet survey than in pilot 2 in which a telephone survey is used. However, contrary to our expectations, the number of payments and the cash share are significantly higher in pilot 1 than in pilot 2.

Answer: No

Question 7: Does the usage of Internet panels lead to a certain selection bias manifested in a higher usage of electronic payment instruments?

This research questions is based on the idea that people participating in Internet panels are more ‘electronically’ oriented and therefore more inclined to use electronic means of payments, such as the debit card. The test results reveal that the usage of Internet panels indeed introduces pro-electronic biases in payments research. The significant higher number and share of debit card transactions and the lower average transaction values in pilot 2 compared to pilot 5, indicate that people in an Internet panel use relatively less cash than people not participating in Internet panels. Instead, they use their debit card more often. Cash is only used for the smallest transaction amounts.

Answer: Yes

Table 11: Hypothesis testing; summary of hypotheses and results

Research question	Transaction features tested	Results
1.	Total number of transactions (pilot 3 and 4)	4 > 3**
	Cash share in total transactions (pilot 3 and 4)	4 > 3**
	Mean cash transaction value (pilot 3 and 4)	4 < 3**
	Median cash transaction value (pilot 3 and 4)	4 < 3**
2.	Total number of debit card transactions (pilot 3 and 4)	4 < 3**
	Debit card share in total transactions (pilot 3 and 4)	4 < 3**
3.	Total number of transactions (pilot 4 and 7)	4 > 7**
	Cash share in total transactions (pilot 4 and 7)	4 > 7**
	Mean cash transaction value (pilot 4 and 7)	4 < 7**
	Median cash transaction value (pilot 4 and 7)	4 < 7**
4.	Total number of transactions (pilot 6 and 7)	6 > 7**
	Cash share in total transactions (pilot 6 and 7)	6 > 7**
	Mean cash transaction value (pilot 6 and 7)	6 < 7**
	Median cash transaction value (pilot 6 and 7)	6 = 7**
5.	Total number of transactions (pilot 4 and 1)	1 = 4**
	Cash share in total transactions (pilot 4 and 1)	1 < 4**
	Mean cash transaction value (pilot 4 and 1)	1 < 4**
	Median cash transaction value (pilot 4 and 1)	1 < 4**
6.	Total number of transactions (pilot 2 and 1)	2 < 1**
	Cash share in total transactions (pilot 2 and 1)	2 < 1**
	Mean cash transaction value (pilot 2 and 1)	2 < 1**
	Median cash transaction value (pilot 2 and 1)	2 = 1**
7.	Total number of debit card transactions (pilot 2 and 5)	2 > 5**
	Debit card share in total transactions (pilot 2 and 5)	2 > 5**
	Mean cash transaction value (pilot 2 and 5)	2 < 5**
	Median cash transaction value (pilot 2 and 5)	2 = 5**
	Mean debit card transaction value (pilot 2 and 5)	2 < 5*
	Median debit card transaction value (pilot 2 and 5)	2 = 5**

* denotes significance at the 10 % level, ** denotes significance at the 5% level,

6. COMPARISON WITH REAL TRANSACTION DATA

Section 5 showed that the survey design influences consumers' transaction recording. Respondents using a diary to record their payments during one day appear to report the highest number of payments. Especially, the smallest payments are memorised best with this method. In this section we confront the pilot results with real transaction data in order to assess which survey design is estimating the true number and value of cash and card transactions best. We have used debit card and e-purse data for the month September 2007 delivered by Currence, the owner of the Dutch debit card scheme PIN and e-purse scheme Chipknip. Furthermore, we have used transaction data of several Dutch chain stores. Unique about this latter dataset is that it they also contain reliable data on cash usage.

However there are two annotations to keep in mind when comparing the pilot results with the real transaction data. First, the transaction data from our pilots and the information supplied by the retailers will not perfectly match, even if all respondents would have registered all their payments accurately. The reason for this is that the retailers' data include payments made by consumers who are not included in the pilot studies, such as people older than 75, children, tourists and non-western inhabitants. These people may use cash relatively more often than the respondents of the pilot studies. Therefore, the pilots might underestimate real cash usage and overestimate real debit card usage. Second, some inequalities might be due to different reference periods. The data of the pilots are from September 2007, whereas the retailer data refer to 2006. Given the ongoing substitution of cash by card payments in the retail trade and in catering it seems only natural that the pilot results with respect to the number of cash payments, the cash share and the average cash transaction amounts might be somewhat lower than the retail figures.

6.1 Debit card transactions from Currence

Table 12 summarises the pilot results and the data supplied by Currence with respect to the total number and value of debit card payments. The pilots using a one-day diary or a questionnaire (pilot 1 – pilot 5) appear to overestimate the total number of debit card transactions, whereas the two one-week diary pilots (pilot 6 and pilot 7) yield estimates below the real number. When looking at branch level, the picture is slightly different. All pilots seem to overestimate the total number of debit card payments made in supermarkets and in the retail trade as a whole. The deviation is smallest in pilot 6 and 7. The number of debit card payments made in the catering however, is best approximated by pilot 5 and pilot 2. Pilot 6 and pilot 7 highly underestimate the number of debit card transactions in this branch in which relatively many small payments are made. Also with respect to the total value, the one-day diaries overestimate the real value, whereas the one-week diaries underestimate reality. However, the results of pilot 4 and pilot 5 approximate the real data best. Finally, all pilots seem to underestimate the average transaction value, with pilot 5 yielding the best approximation.

Table 12: Debit card usage in the Netherlands, September 2007

	Currence	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
Total number of debit card transactions (mln)	129	161	175	204	154	138	126	118
- <i>Supermarket</i>	45.5	56.2	69.6	82.7	54.8	58.8	55.9	49.3
- <i>Total retail trade (incl. supermarkets)</i>	90.5	115.1	135.3	142.6	109.5	105.8	99.3	94.2
- <i>Catering</i>	4.5	7.4	4.8	10.7	5.8	4.1	2.6	3.7
Total value of debit card transactions (bln euro)	5.7	6.0	6.9	7.9	5.7	5.6	5.0	4.4
Average debit card transaction value (euro)	44.23	37.19	39.64	38.49	36.72	40.05	39.33	37.02

6.2 Transaction data from chain stores

Supermarkets

All respondents were asked to indicate the branches in which the payments had been made. This allows us to validate the pilot estimates on a supermarket and total retail trade level. For the validation on supermarket level, actual payment data supplied by some large supermarket chains have been used. These supermarkets represent the Dutch supermarket branch fairly well, and therefore serve as a good point of reference with respect to the cash and debit card share in total payments and the average transaction amounts. Table 13 shows that in all pilots the cash share is lower than the actual share, whereas the share of the debit card is overestimated. Pilot 5 however seems to approximate reality best on these aspects. In addition, all pilots overestimate the average cash transaction amount. The differences however are smallest in pilot 1 and pilot 5. These two pilots also perform best with respect to the average debit card transaction amount, yielding estimates only slightly deviating from the real value.

Table 13: Cash and debit card usage in supermarkets, September 2007

	Retailers	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
Cash share in total transactions	70%	59%	55%	45%	58%	60%	54%	59%
Debit card share in total transactions	29%	40%	45%	51%	40%	38%	45%	39%
Avg. transaction amount cash (euro)	8.90	9.17	11.51	15.41	13.02	12.08	12.54	12.73
Avg. transaction amount debit card (euro)	32.60	32.34	27.82	28.29	34.10	33.45	30.13	30.00

Table 14: Cash and debit card usage in total retail trade, September 2007

	EIM monthly average	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7
<i>Total number cash payments (mln)</i>	246.0	214.7	204.8	153.4	238.3	219.7	170.5	179.0
<i>Cash share in total payments</i>	72%	64%	59%	49%	66%	67%	65%	66%
<i>Debit card share in total payments</i>	26%	34%	39%	46%	30%	32%	32%	30%
<i>Avg cash transaction (euro)</i>	9.60	12.26	11.28	14.48	11.50	9.71	12.55	14.59
<i>Avg debit card transaction (euro)</i>	40.10	38.30	41.95	38.14	36.66	35.52	36.43	36.15

Retail trade

In order to validate the pilot results with respect to the total retail trade, the pilot results are confronted with payments data collected by EIM (2007). The results are presented in Table 14. The picture arising corresponds to our other findings. Again, all pilots underestimate the total number and share of cash payments, overestimate the share of debit card payments, and consequently yield a too high (too low) approximation of the average cash (debit card) transaction amount. It is pilot 5 however that approximates reality best regarding the usage of cash.

Pilot 5 performs best. But does it perform well enough?

Combining the above discussed results with the results of the hypothesis testing, we conclude that the total number of cash payments made in the Netherlands is best approximated by pilot 5, in which the sample is drawn from a regular database in which the respondents are asked to report their payments for one day and are contacted at the end of the day to report their transactions by telephone. But how large are the deviations between the estimates and reality, and does this research methodology performs well enough? Table 15 summarises once again the most relevant estimates yielded by pilot 5, together with the real transaction data and the size of the deviations.

With respect to the number of cash transactions, the differences between the pilot estimates and the retailers' data ranges between 4 and 11%. The deviation from the real number of total debit card payments is about 7%. According to us, these deviations are acceptable, since part of the overestimation of debit card payments and the underestimation of cash usage can be explained by differences in scope, as referred to in the beginning of this section. Therefore, our conclusion is that future research on measuring the number and value of cash payments along the lines of pilot 5 and taking account of possible missing population groups, is likely to yield accurate estimates.

This study started because we wanted to know how many cash payments are made in the Netherlands. Based on the estimated number of cash payments in 2007 of pilot 5 and assuming that September represents the other months of the year fairly well, we get a preliminary estimate of 5.5 billion cash payments (456 million cash payments times 12). Assuming an error range of 10% the real number of cash payments is likely to lie between 5 and 6.1 billion.

Table 15: Payment behaviour in the Netherlands, September 2007

	Pilot 5	Currence	Supermarkets	EIM study	Deviation
Total number of debit card trx. (mln)	138	129			7.0%
Total value of debit card trx.(bln euro)	5.7	5.6			1.8%
Average debit card transaction value (euro)	40.05		44.23		-9.5%
<i>Supermarkets:</i>					
Share of cash payments	60%		70%		-14.3%
<i>Retail trade (incl. supermarkets):</i>					
Total number of cash payments (mln)	219.7			246	-10.7%
Share of cash payments	67%			72%	-6.9%

7. CONCLUSION

Seven pilot studies have been conducted in order to investigate how the registration of payments by consumers is influenced by the survey set-up and what methodology is best suited to estimate the total number and share of cash payments in an economy. Both the mutual comparison of the pilot results and the validation with real transaction data show that the instruments used to gather consumers' payment information, the sampling method and the duration of the registration period, significantly affect consumers' ability to recall and record their purchases.

Mutual comparison of the pilot results using statistical hypothesis testing shows that the one-day diary method leads to the highest number of recorded transactions, particularly small cash transactions, without affecting people's purchase behaviour. Using an additional questionnaire does not evidently stimulate people to recall payments which are initially missed out, irrespectively of the way the questionnaire is held (Internet or by telephone). On the other hand, we demonstrate that a week registration leads to a lower number of recorded cash transactions. However, the 'postponing' and 'miss-out' effect of the week method can be partly reduced by using an interim reminder. Finally, proof has been found that using an Internet survey may introduce biases in the survey results, in the sense that Internet panel members report a relatively higher debit card usage than respondents who participate occasionally in surveys in which they are interviewed by phone.

Validation of the pilot results with real transaction data in order to assess which survey design yields the most reliable estimates, shows that the one-week diary methods perform best in estimating the total *number* of debit card transactions, whereas the one-day diary methods approximate the total *value* of debit card transactions best. When validating the pilot results on branch level, the pilots using a one-day diary method, and especially the one in which the sample is drawn from a regular database instead of from an Internet panel, appear to approximate the real transaction data best, both for cash and debit card transactions.

The differences between the estimated number and estimated transaction amounts for cash and debit card payments in the best performing pilot and the information on cash and debit card payments from retailers, are acceptable. They range between 4-11% and in reality the differences might be even smaller. A first estimate based on the payments data collected in pilot 5 suggests that the number of cash payments in the Netherlands in 2007 amounted 5.5 billion.

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APPENDIX 1 WEIGHTING AND EXTRAPOLATION METHOD

In order to guarantee the representativeness of the samples, the pilot results have been weighted to correct for possible biases related to the characteristics of the sample:

- a) The one-day diary and questionnaire-only samples have been weighted by total observations per day, in order to prevent that the days with many participants would weight more heavily compared to the days with less participants. The same correction has been made to the two one-week diary samples on a weekly-basis.
- b) The one-day diary and questionnaire-only samples have been weighted by gender, age, education, region and Internet usage, using the Gouden Standard and TNS NIPO data on Internet usage. Weighting by income, position in the family and activity appeared not to be necessary.
- c) The one-week diary samples have been weighted by gender, age, education, family situation, family size, position in the family, activity, region and credit card possession, using the Gouden Standaard and TOF Particulier.
- d) Finally, a correction has been made to all samples with respect to non-buyers. Experience has shown that part of the non-response is caused by persons believing that participation is not useful because they did not make any payments during the registration period. Therefore, in order to prevent any possible underestimation, the samples are adjusted, based on the assumption that each day 35% of the total population does not make any transaction.

In order to approximate the total number of transactions made in the Netherlands, the weighted survey results have been extrapolated to the total Dutch population aged between 12 and 75 years who were able to make any purchase during the specified research period (11.4 million). To this end, the total Dutch population aged between 12 and 75 years (12.8 million) is cut down by the number of people that are expected not to be able to make any transaction in the Netherlands in September 2007 (1.4 million¹).

¹ The sum of invalids (0.5 mln), people living in an institution/special home (0.2 mln), the seriously physically and mentally handicapped living at home (0.2 mln) and people being abroad (0.5 mln) (Source: TNS Nipo).

APPENDIX 2

Respondents were asked to record all the payments they made. The payments included payments in retail trade, the catering industry, petrol stations, at vending or ticket machines, admission tickets for cultural or recreational events (museum, cinema, exhibition, swimming pool, etc), non business payments to other persons. Table A1 shows a complete listing of the spending purposes distinguished in this study.

Table A.1. Spending purposes

1	Supermarket
2	Retail trade: food, beverages and tobacco
3	Retail trade: fashion and shoes
4	Retail trade non food (excl fashion and shoes)
5	Home furnishing, builder's merchant, white goods
6	Department stores
7	Vending and ticket machines
8	Petrol stations
9	Hotel and catering industry
10	Street vending
11	Amusement, culture, sports
12	Transport
13	To family members, friends, colleagues or acquaintances
14	Charity
15	Service providers (incl. travel agencies)
16	Other
