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Fatigue in payment diaries – empirical evidence from Germany

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Abstract:

In this paper we analyse whether the recording behaviour of consumers keeping a payment diary changes over the diary period. Using data from a large study on the payment behaviour of German consumers we find that individuals tend to report a higher number of transactions on the first day of the diary period than on subsequent days. Contrary to existing literature we also find that the number of small cash payments recorded does not decrease during the one-week diary period. Our findings indicate that short diaries may be enough to reflect adequately the payment behaviour of all consumers. However, the precision of the estimates increases with longer diaries, at small additional costs. Longer diaries are especially helpful when it comes to analysing subgroups of payment types or rare events.

Keywords: payment behaviour, survey design, diary studies

JEL-Classification: C81, D12, E41

Non technical summary

Knowing consumers' payment behaviour is important for central banks as well as for participants in the payment system. Surveys on payment behaviour therefore have a long tradition at several central banks around the globe. In recent years questionnaire-based surveys have been complemented by diaries in which respondents register information on individual payments for a certain period. The Bundesbank conducted a comparable study for the first time in 2008. Introducing the diary has increased not only the value of the payment data but also the costs of surveys. It is therefore essential to assess the data quality and biases of diary based approaches.

Our main objective is to analyse fatigue in payment diaries in order to give a recommendation on an "optimal" diary length. We are particularly interested in whether longer diaries improve the potential for the analysis of payment behaviour or whether fatigue with respect to recording payments leads to biases and distortions. The data we use to answer this question are from a large representative sample survey of adult consumers commissioned by the Bundesbank in 2008 ("Zahlungsverhalten in Deutschland"). The dataset comprises data from over 2,000 individuals on roughly 25,500 transactions.

Our results show that respondents do indeed become fatigued in filling in the diary, but the effect is less pronounced than expected, i.e. the number and value of recorded transactions do not decrease dramatically over the one-week diary period. Contrary to existing literature we find that the number of small cash payments recorded does not decrease during the one-week diary period. Furthermore, several properties like the share of cash payments in all transactions or the distribution of payments over transaction values are quite similar for each of the seven days. We interpret these findings as indicating that shorter diaries may be enough to adequately reflect important aspects of the payment behaviour of consumers. However, the precision of the estimates increases with longer diaries, at small additional costs. Longer diaries are especially helpful when it comes to analysing subgroups of payment types or rare events.

Nichttechnische Zusammenfassung

Informationen zum Zahlungsverhalten von Individuen sind ein wichtiger Input für Zentralbanken und andere am Zahlungssystem beteiligten Institutionen. Befragungen zum Zahlungsverhalten haben daher eine lange Tradition in vielen Zentralbanken der Welt. In den letzten Jahren gingen derartiger Studien dazu über, die Befragung mittels Fragebogen durch ein Zahlungstagebuch zu ergänzen. In einem solchen Tagebuch erfassen die Befragten über einen vorgegebenen Zeitraum alle ihre Transaktionen. Die Bundesbank führte erstmalig 2008 eine vergleichbare Erhebung durch. Die Daten der Tagebücher verbessern den Informationsgehalt der Studien wesentlich, führen aber auch zu höheren Befragungskosten. Es ist daher wichtig zu wissen, wie es um die Qualität der Tagebuchdaten bestellt ist und welchen Verzerrungen die Daten unterliegen.

Das Hauptziel unserer Untersuchung ist es Ermüdungserscheinungen beim Ausfüllen des Tagebuchs zu analysieren. Die Ergebnisse sollen eine Einschätzung bezüglich der „optimalen“ Länge eines Zahlungstagebuchs ermöglichen. Insbesondere ist zu prüfen, ob länger Tagebücher das Analysepotential der Daten erhöhen oder ob Ermüdung im Zusammenhang mit der Erfassung von Einteltransaktionen zu Verzerrungen führt. Die Daten für unsere Analyse entstammen einer großen repräsentativen Umfrage zum Zahlungsverhalten, die die Bundesbank im Jahr 2008 in Auftrag gab. Der Datensatz der Studie „Zahlungsverhalten in Deutschland“ enthält Informationen von mehr als 2,000 Befragten zu gut 25,500 Einzeltransaktionen.

Die Ergebnisse der Analysen zeigen, dass die Befragten tatsächlich ermüden, allerdings sind die Effekte kleiner als vermutet. Anders gesagt, die Anzahl und das Volumen, das die Befragten erfassen, gehen zwar von Tag zu Tag zurück, die Rückgänge sind aber relativ gering. Im Gegensatz zu anderen Studien finden wir keine erhöhte Untererfassung von Barzahlungen mit kleinen Beträgen im Lauf der einen Erfassungswoche. Auch der Barzahlungsanteil und die Verteilung der Zahlungshöhe sind von Tag zu Tag sehr ähnlich. Dies legt die Interpretation nahe, dass ein kurzes Tagebuch ausreicht. Allerdings zeigen sie auch, dass längere Tagebücher unverzerrte Daten liefern können und die Schätzgenauigkeit erhöhen.

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Fatigue in Payment Diaries – Empirical Evidence from Germany[1]

1. Introduction

Knowing consumers' payment behaviour is important for central banks as well as participants in the payment system. Surveys on payment behaviour therefore have a long tradition in several central banks around the globe. In recent years, questionnaire-based surveys have been complemented with diaries in which respondents register information on individual payments for a certain period. The Bundesbank conducted a comparable study for the first time in 2008. Introducing the diary has significantly increased the value of the payment data but also the costs of surveys. It is therefore essential to assess the data quality and biases of diary-based approaches.

Our main objective is to analyse fatigue in payment diaries in order to be able to give a recommendation on an "optimal" diary length. We are particular interested in whether longer diaries improve the potential for the analysis of payment behaviour or whether fatigue with respect to recording payments leads to biases and distortions. The data we use to answer this question are from a large representative sample survey of adult consumers, commissioned by the Bundesbank in 2008 ("Zahlungsverhalten in Deutschland"). The dataset comprises data from over 2,000 individuals on roughly 25,500 transactions. The diary lasts seven days, enabling us to analyse fatigue and measurement errors within this time frame.

Our results show that respondents do indeed become fatigued in filling in the diary, but the effect is less pronounced than expected, i.e. the number and value of recorded transactions do not decrease dramatically over the one-week diary period. Contrary to existing literature we

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also find that the number of small cash payments recorded does not decrease during the one-week diary period. Furthermore, several properties such as the share of cash payments in all transactions or the distribution of payments over transaction values are quite similar for each of the seven days. We interpret these findings as indicating that shorter diaries may be enough to adequately reflect the main features of payment behaviour of consumers. However, the precision of the estimates increases with longer diaries, at small additional costs. Longer diaries are especially helpful when it comes to analysing subgroups of payment types or rare events.

The next section will review the literature most closely related to our explorative analysis. We will cite studies dealing with measurement errors in diaries and develop research questions for the empirical part of the paper. In Section 3 we describe the data before we present results in Section 4. Based on our results we will draw conclusions and provide recommendations for future (payment) diary studies.

2. Literature and Research Questions

In this section we will review some of the papers on measurement error in surveys in order to develop questions and hypotheses to guide our empirical analysis below. We will focus on measurement error and fatigue in particular and not cover other survey errors.[2]

Our paper is closely related to a recent paper of Jonker and Kosse (2009) analysing payment diary data from the Netherlands. They conduct a true experiment by varying the diary length and the mode of diary (online, paper and pencil, etc.). Their main finding is that a one-day diary is least prone to measurement error. Although the Bundesbank did not conduct any experiments on the length of diaries, we are able to provide some indication of measurement errors in long versus short diaries by comparing the reporting behaviour of consumers for each day of the seven-day diary period[3]

[2] Jonker and Kosse (2009) write at the end of a section on survey errors: "However, measurement errors may be the most common and problematic type of error to arise in payment surveys." (p 4)

[3] It is worth noting that there is some evidence that even the prospects of having to complete a week-long diary may bias the results and lead to underreporting (Tincello et al. (2007)). However, this evidence is not on payment diaries.

A common measurement error in data collection based on surveys is fatigue or exhaustion, i.e. respondents tend to record fewer items or information as the diary progresses. This phenomenon has been well documented for expenditure surveys (McWhinney and Champion (1974); Ahmed et al. (2006)), a type of survey closely related to payment surveys. The drop in recorded expenditures is especially strong between the first and the second day. Stephens (2003) writes about the consumer expenditure data from the US Bureau of Labour Statistics: "An examination of the data indicates that expenditures are higher during the first diary week as well as on the first day of each diary week relative to the remaining days. These declines are likely attributable to 'survey fatigue'" (p 411). Similar results have been obtained for Canadian data (Statistics Canada (2001); Ahmed et al. (2006)). Our first research question is therefore: How strong is survey fatigue in payment diaries? To be more precise, are the number and volume of payments, as well as the share of cash payments declining over the one-week period?

Our second research question is motivated by the findings from the research on measurement errors in expenditure surveys as well. Ahmed et al. (2006) and Gibson and Kim (2007) document that consumers tend to forget about small purchases ("recall bias") and underreport them in (expenditure) diaries. Since most small purchases are paid in cash, this should lead to an underreporting of small cash transactions in payment diaries. Jonker and Kosse (2009) recently showed that this underreporting is stronger in payment diary surveys that last one week compared to diaries that run for only a few days. They argue that this is due to at least two effects: first, respondents postpone registration of payments (even for day one of the diary period) until the later days of the weekly diary, leading to higher recall bias, or stop recording payments completely. Our second research question is based on these findings: Does the number of small transactions recorded in the weekly diary decrease day by day?

When addressing these questions, we will also look at the impact of fatigue on key payment indicators, like the share of cash payments in total payments, to provide some insight into the "optimal" length of a payment diary. There is very little research on the optimal length of a payment diary (except for Jonker and Kosse (2009)) and, as a result, no clear recommendation on what length to use when designing a new study. We therefore finish this section by reporting some examples for the length of payment diaries actually implemented to give an impression of what survey designers in different countries currently think is an appropriate length. Payment diaries in Germany, France and Austria use a one-week period (see von Kalckreuth et al. (2009); Bounie and Francois (2006), Mooslechner et al. (2006)). Australia's

Consumer Payments Use Study now also belongs to this group, as the Reserve Bank of Australia reduced the diary length from two weeks in 2007 to one week in 2010. There are at least two new surveys using short diaries: the 2009 Method of Payments Survey of the Bank of Canada (Arango et al. (2011)) and the 2010 Boston Fed's Survey of Consumer Payment Choices Payment Survey, which both use three-day periods. To our knowledge, the Dutch National Bank's Payment Survey of 2010 is the only large-scale survey with the diary period restricted to a single day. At the other end of the spectrum is the UK Payments Council Survey with a four-week diary.

3. Data and Variables

We utilise data from a representative survey of adults living in Germany.[4] This survey, "Zahlungsverhalten in Deutschland" (Payment Behaviour in Germany), was conducted in 2008 by Ipsos on behalf of the Deutsche Bundesbank.[5] The survey consists of two parts, a face-to-face CAPI interview and a drop-off paper and pencil diary. The latter was supposed to be completed by the respondents in the seven days following the face-to-face interview. While the interviews contained questions on topics like the ownership and usage of certain payment instruments, cash withdrawal behaviour and respondents' demographics, the diary collected information on individual transactions. In sum, the 2,217 respondents completing the diary provide information on 25,970 transactions[6] with a total value of 782,531 euro. The information collected includes the euro amount of each transaction, the location where the transaction took place (shop, restaurant, internet, etc.) and the payment medium used to settle it (cash and a list of ten cashless payment methods, e.g. debit cards, credit cards, internet payment services, mobile phone payments, fingerprint payment).

[4] See Hoffmann et al. (2009) for details and results.

[5] When designing the random sample (random route), care was taken to ensure that consumers from all 16 Federal states (*Länder*) were included in the gross sample. Of the 3,612 individuals sampled, 2,292 completed the CAPI and 2,217 the CAPI and the diary.

[6] The diary specifically refers to direct payment transactions, i.e. all transactions apart from recurrent transactions like rent, insurance fees, telephone bills and utility bills.

Table 1 Summary statistics on transactions recorded in the diary (unweighted)

	Mean	SD
Number of payments (pppd)	1.66	0.88
Number of cash payments (pppd)	1.33	0.79
Total transaction amount in euro (pppd)	49.95	110.19
Total transaction amount cash in euro (pppd)	29.52	98.97
Value of individual transactions in euro	30.62	154.14
Value of individual cash transactions in euro	22.44	157.07

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"
Note: pppd = per person per day

Table 1 provides some summary statistics on the transactions.[7] The average value of an individual transaction recorded in the diary is 30.62 euro, with the median significantly lower at 12.20 euro.[8] Table 1 also shows that on average each person recorded 1.66 transactions per day, which add up to a total value of about 50 euro. Given the high prevalence of cash payments in Germany (Hoffmann et al. (2009)), it is not surprising that most of the transactions are cash payments.

Only few statistics from the diary can be validated against external figures. Basically, only the average value of debit card transactions in retail shops and at gas stations can be benchmarked against figures from the German Retail Institute (EHI - Rüter (2010)). Their figures for 2008 (see Table 5 below) show that the average value for retail transactions with debit cards is 61.50 euro compared with 62.30 euro for the same type of transactions in the diary. The corresponding figures for gas stations are 43.17 euro and 46.53 euro, respectively.

[7] All figures are calculated from the raw data and are unweighted.

[8] See Table 6 in the appendix for the distribution of payments across different transaction values.

From the data we can calculate the following indicators, which are used to analyse the impact of the length of the diary on respondents' recording behaviour:

- euro amount of all transactions and number of transactions per person,
- euro amount of all cash transactions and number of cash transactions per person,
- share of cash payments in total payments recorded and total value taken out in cash per person,
- number of transactions – by transaction size category,
- share of transaction size categories in total number of transactions.

By analysing the evolution of these indicators over the diary period we will be able to assess whether a survey that would have lasted only one or several days would have led to a different picture of consumers' payment behaviour than a seven-day diary.

4. Results

In this section we present results for the data from the diary by transaction and by consumer.

Payment patterns by consumer

To answer our first research question as to whether respondents exhibit survey fatigue, we analyse the diary data by consumer. Table 2 shows summary statistics for the average value of direct payments conducted by a respondent. The figures show that respondents recorded higher aggregate amounts on day one than on the other days of the diary, confirming the literature cited above. The pattern observed is in line with the fact that the average and total number of payments recorded are also higher on day one of the diary period (see Table 4 below and Table 7 in the appendix). A pair-wise comparison between the mean euro amounts spent on day one with each other day reveals that the differences are significant at least at the 90% level.

Table 2 Transaction amount of payments per person (unweighted)

	Euro amount of all payments recorded per person			Euro amount of all CASH payments recorded per person			Share of CASH amount in total amount spent per person	
	Mean	SD	Med.	Mean	SD	Med.	Mean	SD
Day 1 of diary p.	62.68	227.88	29.40	38.14	211.33	15.30	75.6%	38.9%
Day 2 of diary p.	47.26	127.90	21.64	27.13	106.95	11.85	77.0%	38.7%
Day 3 of diary p.	48.99	193.22	18.16	27.47	170.32	10.26	78.2%	38.2%
Day 4 of diary p.	50.63	266.74	18.80	31.51	257.50	10.00	77.2%	38.5%
Day 5 of diary p.	46.53	215.59	17.95	28.18	205.75	10.00	77.6%	38.6%
Day 6 of diary p.	42.94	200.94	15.60	27.53	194.96	9.50	78.5%	38.1%
Day 7 of diary p.	50.63	231.97	19.96	26.72	170.70	11.58	77.2%	38.8%

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Given that a key goal of the survey conducted by the Bundesbank in 2008 was to assess the importance of cash in direct payment transactions (see Hoffmann et al. (2009)), we also look at cash payments in particular. For cash payments the pattern is similar to the one observed for all payments. The value and number of payments recorded by an individual are higher for day one than for the following days. However, the average cash shares calculated from the diary data do not significantly differ across days, even though there is a slight increase in the average cash share calculated on the basis of the value of transactions from day one to day two and an even smaller increase for the number of transactions. This indicates that it is not only one type of transaction, i.e. cash transactions, that is responsible for the decline between days. On the contrary, the slight increase from day one to day two indicates that less (high value) non-cash payments are recorded on days two to seven. This is surprising given that consumers usually receive a receipt for card transactions. Receiving a receipt should reduce recall and underreporting biases usually associated with (small) cash payments. One explanation for our finding may be that most of the transactions which respondents in Germany conducted are cash transactions.

A multivariate analysis of consumers' recording behaviour provides further evidence on fatigue in payment diaries. The following table presents the key results of a probit model[9] with which we analyse how the day of recording influences the probability that a respondent does not report a single transaction or cash transaction, respectively, on a given day.[10] In column 1 and 3 we only included the day of the diary in our model. The results from these two estimations are in line with the descriptive statistics above; the probability of observing a day without a single (cash) transaction increases as the diary period progresses, just as the average number of transactions is lower on days two to seven compared with day one. The size of the coefficients indicates that the difference between day one and each of the days three to seven is larger than the difference between days one and two.

In columns 2 and 4 of Table 3 we include variables in the regression to control for factors that may influence the recording behaviour and/or the probability of a transaction occurring.[11] We include the day of the week, age (*P_AGE*), gender (*P_FEMALE*), education level (*P_EDU_UNI, P_EDU_HIGH*) and employment status (*P_EMPLOYED*) of the respondent, household size (*HH_SIZE*) and income (*HH_INC*), an indicator for whether the person reporting is responsible for (grocery) shopping for his or her household (*P_SHOPPER)* and whether the respondent lives in East Germany (*R_EAST*).

The results for our control variables are by and large in line with our expectations. While the results for the probability of observing a day without a single cash or non-cash transaction do not change, those for cash transactions do. Only days 4, 5 and 7 differ significantly from day one. For the probability to observe a day without a cash payment, other factors such as the day of the week seem to be more important (see Table 8 in the appendix). This provides further evidence that non-cash transactions are responsible for a large portion of the observed declines over the diary period.

[9] Results for the full model with all the control variables are included in the appendix (Table 8).

[10] Out of 15,415 days in the diaries, 2,489 (16.2%) do not contain a single transaction and 3,863 (25%) contain no cash transaction.

[11] When interpreting the results of the estimation, one has to bear in mind that we do not know whether the observed zero transactions are the result of a day on which no single transaction actually occurred or the result of underreporting. We hope to address this issue by adding controls. However, some controls like household income, for example, are ambiguous. It may influence the probability that purchases occur; however, it also impacts on the opportunity cost of time, which should *a priori* reduce the willingness to report.

Table 3 Coefficients from probit estimation (unweighted)

VARIABLES	Day without a transaction		Day without a CASH transaction	
	(1)	(2)	(3)	(4)
Day 2	0.269***	0.199***	0.177***	-0.004
	[0.055]	[0.059]	[0.043]	[0.042]
Day 3	0.483***	0.457***	0.312***	-0.014
	[0.048]	[0.051]	[0.040]	[0.042]
Day 4	0.519***	0.481***	0.342***	0.086**
	[0.048]	[0.051]	[0.040]	[0.041]
Day 5	0.551***	0.492***	0.379***	-0.122***
	[0.048]	[0.052]	[0.040]	[0.041]
Day 6	0.553***	0.499***	0.384***	-0.03
	[0.047]	[0.051]	[0.040]	[0.042]
Day 7	0.459***	0.491***	0.312***	0.592***
	[0.047]	[0.051]	[0.039]	[0.041]
Control Variables	excluded	included	excluded	included
Constant	-1.409***	-0.692***	-0.951***	-1.003***
	[0.039]	[0.262]	[0.032]	[0.252]
Observations	15415	14007	15415	14007
logl	-6729	-5707	-8616	-7631
Chi2	234.3	1001	145.3	586.8

Notes: Clustered standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Payment patterns by transaction

Concerning our second research question, our results paint a picture very much in concordance with the results for individual consumers presented above. Figure 1[12] and Table 4 show that more transactions are recorded on the first day of the diary than on the following days. Regardless of which day one might pick, however, the distribution across size categories would have been the same.

Table 4 Number of transactions for each day – by transaction size category (unweighted)

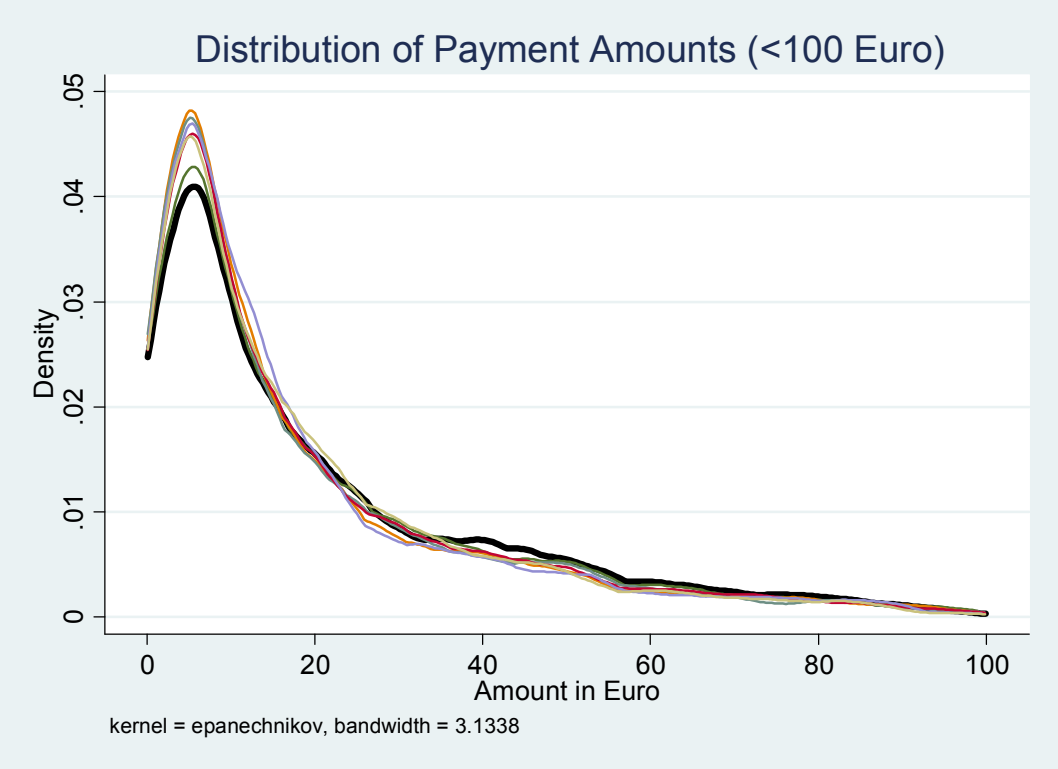
	below 5 euro	[5; 10[euro	[10; 15[euro	[15; 25[euro	[25; 50[euro	[50 ; 100[euro	100 + euro	Total
Day 1	1,052 (24%)	722 (16%)	528 (12%)	679 (15%)	771 (17%)	519 (12%)	174 (4%)	4,445 (100%)
Day 2	914 (24%)	653 (17%)	462 (12%)	568 (15%)	636 (17%)	412 (11%)	112 (3%)	3,757 (100%)
Day 3	895 (25%)	682 (19%)	480 (13%)	508 (14%)	559 (16%)	328 (9%)	133 (4%)	3,585 (100%)
Day 4	891 (26%)	643 (18%)	428 (12%)	501 (14%)	559 (16%)	330 (9%)	142 (4%)	3,494 (100%)
Day 5	822 (24%)	652 (19%)	436 (13%)	503 (15%)	564 (16%)	341 (10%)	126 (4%)	3,444 (100%)
Day 6	814 (25%)	618 (19%)	469 (14%)	511 (15%)	481 (15%)	306 (9%)	111 (3%)	3,310 (100%)
Day 7	855 (24%)	634 (18%)	437 (12%)	561 (16%)	597 (17%)	302 (9%)	133 (4%)	3,519 (100%)
Total	6,243 (24%)	4,604 (18%)	3,240 (13%)	3,831 (15%)	4,167 (16%)	2,538 (10%)	931 (4%)	25,554 (100%)

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

[12] For the sake of exposition we dropped the top 4% of the distribution. The density estimation for the full sample is available upon request.

Figure 1 below shows that the distribution of payments across transaction size (in euro) for each day is similar. However, day one (thick, black line) and day two (green line) are slightly different in that they have less distribution mass for payments of 5 to 10 euro and more for payments of 50 to 100 euro.[13] Similar results are obtained for cash payments only (see Figure 3 in the appendix), which is not surprising given that over 80% of transactions below 100 euro and over 90% of transactions below 25 euro are cash payments.

Figure 1 Distribution of payment values for transactions below 100 euro (unweighted)



Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

A formal statistical test of the difference between the two distributions, the Wilcoxon-Mann-Whitney test leads to similar results. It shows (see Table 9 to Table 11) that only day one and, to a lesser degree, day two differ from the other days and here only with respect to larger payments. For payments of 25 euro and less, no significant differences (with two exceptions) show up.

[13] A more detailed look at the distribution of transactions with relatively small values (Figure 2 in the appendix) reveals that, on these days, payments with a value of around 10 euro are less prevalent and those with values of 20 to 25 euro more prevalent.

Quality implications of fatigue and optimal diary length

We now turn to the quality implications of respondents' fatigue. Table 2 above reports shares, amounts and standard deviations for separate days. The results show that regardless of which day one might pick, the calculated average cash shares and associated standard deviations would have been very similar. In practice, however, the survey designer will be faced with the problem of deciding the "optimal" length of the survey based on cumulative results, unless the survey lasts only one day. For the cumulative shares we find a small decline. The figures are (share/SD): 75.6%/38.9% (day 1 only), 72.3%/37.4% (days 1 and 2), 71.0%/35.8% (days 1 to 3), 69.6%/34.7% (days 1 to 4), 68.7%/33.9% (days 1 to 5), 68.2%/33.1% (days 1 to 6), 67.6%/32.7% (days 1 to 7).[14] The estimated standard deviations decline as well, showing that the precision of the estimate increases, by 6 percentage points, between the one-day and seven-day diary. Over the last three days of the diary period, the standard deviation decreases by only one percentage point.

For retail transactions and transactions at gas stations, the findings from the study can be validated against external data. Table 5 shows a comparison between actual retail data and evidence from our survey. The fact that, overall, the data from the survey compare fairly well with data from the German Retail Institute (EHI) was mentioned when describing the database. No different conclusion would have been drawn had the diary period stopped after a single day. The mean from the diary would have been even closer to the actual EHI data for retailers. For gas stations the difference widens compared to the full diary period, but is only slightly (approx. 0.50 euro) higher. These results provide further evidence that the payments recorded on day one of the diary period do not differ greatly from the payments recorded in the subsequent days and that short diaries may be enough to adequately capture this key payment indicator.

[14] The cumulative shares do not have to lie between the estimated figures from Table 2, as they represent an average of a weighted average on the level of the individual, especially if many shares are at the extreme ends of the distribution, i.e. cash shares of 0% or 100% in our case. For day 1 of the diary period, almost 69% of respondents paid for everything in cash and an additional 10% paid for everything with cards. By way of an example, assuming there are only two consumers, one pays 100 euro in period one, of which 0 in cash, and the second consumer pays 150 euro and 150 in cash. The average cash share for period 1 is then (0+1)/2=0.5 In period 2 the first pays 100 euro and 100 euro in cash and the second pays 200 euro and 0 in cash, resulting in an average cash share for period 2 of (1+0)/2=0.5. Cumulative over the two periods, the cash shares are for consumer 1 (0+100)/200=0.5 and for consumer 2 (150+0)/350=0.43. Taking the average of the two consumers' shares yields (0.5+0.43)/2=0.47.

Table 5 Retail institution data vs diary (unweighted)

	External data (Mean)	Diary			
Avg. value girocard transactions		Mean (full)	Median (full)	Mean (day 1)	Median (day 1)
Retail 2008	61.50 euro	62.30 euro	44.23 euro	61.35 euro	47.35 euro
Gas stations 2008	43.17 euro	46.53 euro	46.12 euro	47.17 euro	45.91 euro

Sources: External data Rüter (2010) and diary data: author's calculations based on data from "Zahlungsverhalten in Deutschland"

5. Conclusions

Using data from a large diary study on payment behaviour, we show that survey fatigue does play a role in the reporting behaviour of consumers in Germany. Survey fatigue does not affect the validity of the results with respect to cash payment shares and comparable indicators, however. The distribution of payments on each day of the diary is very similar, with some exceptions for day one. This is also true of the standard deviations and means for the cash shares calculated for each day. The latter indicates that additional diary days only increase the sample size, rather than provide additional information that may alter the values of this key payment indicator. However, an analysis of cash shares calculated by cumulating payments over consecutive diary days shows that a longer diary leads to more precise estimates.

Contrary to Jonker and Kosse (2009), we find no bias with respect to the recording of low cash transaction values decreasing in longer surveys. Survey fatigue seems to affect the recording of cash and non-cash payments to a similar extent. Note that our study provides no evidence on whether small purchases are less likely to be recorded in general. It merely challenges the notion that the recording of small purchases suffers from particularly high survey fatigue.

The main conclusion for diary design that may be drawn from our findings is that short diaries are enough to reflect consumers' payment behaviour adequately. This conclusion would be similar to that drawn by Jonker and Kosse (2009). The analysis we present above is still at a fairly aggregate level, however. For example, we did not look at the payment behaviour of certain groups of consumers, such as older and younger groups. If the recording behaviour of these groups differs over the diary period, a short diary may not be sufficient. This is also the case if the behaviour of certain groups of customers or payments is under scrutiny. There may simply not be enough observations to conduct meaningful analysis. To give an example, if one wants to compare the behaviour of old and young individuals at gas stations, a short survey may result in very few observations on gas station payments by old consumers, whereas a longer survey will yield enough data. This can be countered to some degree by increasing the number of respondents.

We show that data from longer diaries are not significantly biased, and extending the diary period may therefore be a cost-effective way to increase sample and the precision of the estimated indicators. Usually, recruiting additional respondents (especially in purely random samples) is more expensive than a longer diary.

A caveat of our study is that it looks at very few indicators of interest to policy makers; the quality of other indicators may be affected differently by diary length. Further research on this issue is necessary.

Another avenue for future research is the distinction between survey fatigue and survey exuberance. The drop between the initial and the following diary days is usually interpreted as a sign of survey fatigue, it may however also be the case that day one recordings are subject to survey exuberance, ie. more payments are observed on day one than actually should have been recorded for this day. Survey exuberance may be an issue if respondents have a tendency to postpone the start of recording until a day with at least one transaction. Actually we see a lower number of respondents with zero (cash) transactions on day one and two than on any of the following days, but our data does not allow us to see whether this is the result of fatigue on days two to seven or exuberance on day one. To answer this question, an experiment or an ex-post interview on recording behaviour seems a necessity.

Payment diaries are a relatively new method of data collection. They are closely linked to expenditure surveys, however, that have been around for several decades. An exchange on methodological issues regarding both types of surveys may result in better data for both – researcher of payment behaviour and research on consumption spending.

6. Appendix

Table 6 Distribution of individual transactions by transaction size (unweighted)

Transaction size	Number of payments	Percent
Below 5 euro	6,243	24.4%
[5 euro; 10 euro[	4,604	18.0%
[10 euro ; 15 euro[	3,240	12.7%
[15 euro ; 25 euro[	3,831	15.0%
[25 euro ; 50 euro[	4,167	16.3%
[50 euro ; 100 euro[	2,538	9.9%
100+ euro	931	3.7%
Total	25,554	100%

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Table 7 Number of payments per person (unweighted)

	Avg. number of payments recorded per person		Avg. number of CASH payments recorded per person		Share of CASH payments recorded per person	
	Mean	SD	Mean	SD	Mean	SD
Day 1 of diary period	2.02	1.57	1.59	1.39	80.6%	32.8%
Day 2 of diary period	1.72	1.36	1.38	1.25	81.3%	33.2%
Day 3 of diary period	1.63	1.38	1.32	1.23	82.6%	32.7%
Day 4 of diary period	1.57	1.28	1.27	1.17	81.6%	32.9%
Day 5 of diary period	1.56	1.34	1.26	1.23	81.7%	33.4%
Day 6 of diary period	1.53	1.31	1.23	1.17	81.2%	33.7%
Day 7 of diary period	1.58	1.29	1.28	1.18	81.5%	33.4%

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Table 8 Result of probit estimation – Dependent variable: Day without a (cash) transaction

VARIABLES	Day without a transaction		Day without a CASH transaction	
Day 2	0.269***	0.199***	0.177***	-0.004
	[0.055]	[0.059]	[0.043]	[0.042]
Day 3	0.483***	0.457***	0.312***	-0.014
	[0.048]	[0.051]	[0.040]	[0.042]
Day 4	0.519***	0.481***	0.342***	0.086**
	[0.048]	[0.051]	[0.040]	[0.041]
Day 5	0.551***	0.492***	0.379***	-0.122***
	[0.048]	[0.052]	[0.040]	[0.041]
Day 6	0.553***	0.499***	0.384***	-0.03
	[0.047]	[0.051]	[0.040]	[0.042]
Day 7	0.459***	0.491***	0.312***	0.592***
	[0.047]	[0.051]	[0.039]	[0.041]
Tuesday		0.029		0.131***
		[0.050]		[0.045]
Wednesday		0.049		0.283***
		[0.050]		[0.042]
Thursday		0.169***		0.294***
		[0.047]		[0.042]
Friday		-0.156***		0.323***
		[0.051]		[0.042]
Saturday		-0.026		0.334***
		[0.050]		[0.042]
Sunday		0.823***		0.318***
		[0.044]		[0.042]

Table 8 (continued from page 16)				
P_AGE		0.004***		0.000
		[0.001]		[0.001]
P_EMPLOYED		-0.096**		0.031
		[0.039]		[0.036]
P_EDU_HIGH		-0.026		-0.021
		[0.053]		[0.048]
P_EDU_UNI		-0.118**		0.046
		[0.058]		[0.058]
P_SHOPPER		-0.111**		-0.025
		[0.046]		[0.044]
P_FEMALE		0.082**		0.061
		[0.041]		[0.039]
R_EAST		0.013		0.143***
		[0.046]		[0.043]
HH_SIZE		0.041**		0.039**
		[0.017]		[0.017]
HH_INC		-0.141***		-0.022
		[0.038]		[0.036]
Constant	-1.409***	-0.692***	-0.951***	-1.003***
	[0.039]	[0.262]	[0.032]	[0.252]
Observations	15415	14007	15415	14007
logl	-6729	-5707	-8616	-7631
Chi2	234.3	1001	145.3	586.8

Notes: Clustered standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Table 9 Distribution tests – Median test - Full sample

	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Day 1 of diary period	**	***	***	***	***	***
Day 2 of diary period		*	-	-	*	-
Day 3 of diary period			-	-	-	-
Day 4 of diary period				-	-	-
Day 5 of diary period					-	-
Day 6 of diary period						-

Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Table 10 Distribution tests – Median test - <100 euro

	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Day 1 of diary period	*	***	***	***	***	***
Day 2 of diary period		***	**	-	**	-
Day 3 of diary period			-	-	-	-
Day 4 of diary period				-	-	-
Day 5 of diary period					-	-
Day 6 of diary period						-

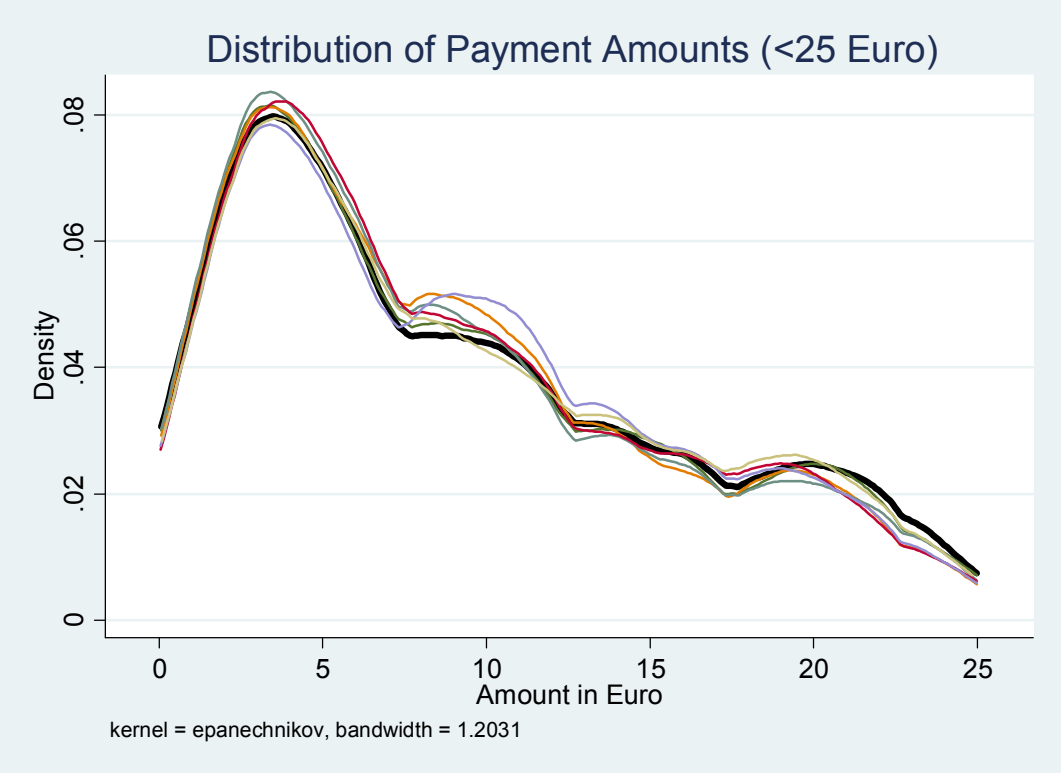
Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Table 11 Distribution tests – Median test - <25 euro

	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Day 1 of diary period	-	-	*	-	-	-
Day 2 of diary period		-	-	-	-	-
Day 3 of diary period			-	-	-	-
Day 4 of diary period				-	*	*
Day 5 of diary period					-	-
Day 6 of diary period						-

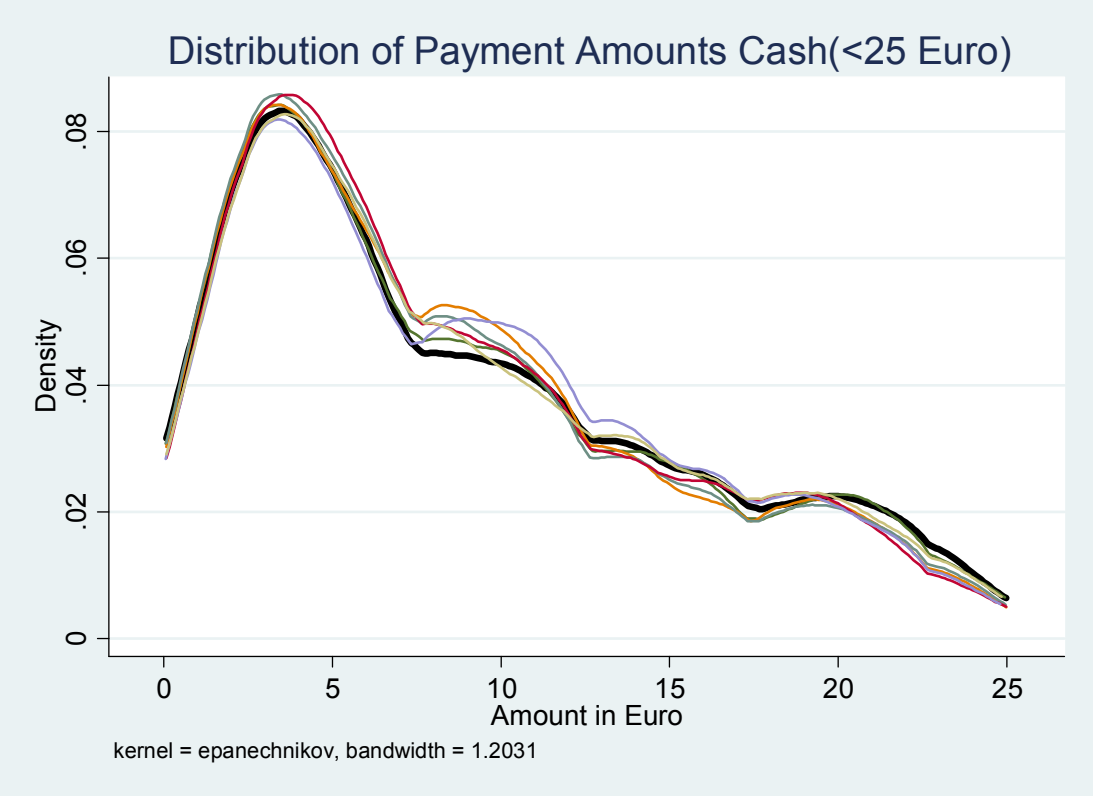
Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Figure 2 Distribution of payment values for transactions below 25 euro (unweighted)



Note: Day one – thick black line
Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

Figure 3 Distribution of payment values for cash transactions below 25 euro (unweighted)



Note: Day one – thick black line
Source: Author's calculations based on data from "Zahlungsverhalten in Deutschland"

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