Consumer Cash Usage: A Cross-Country Comparison with Payment Diary Survey Data*

John Bagnall† David Bounie‡ Kim P. Huynh§ Anneke Kosse¶

Tobias Schmidt‖ Scott Schuh** Helmut Stix††

March 19, 2014

Abstract

We measure consumers' use of cash by harmonizing payment diary surveys from seven countries: Australia, Austria, Canada, France, Germany, the Netherlands and the United States (conducted during 2009 and 2012). Our paper finds important cross-country differences such as the level of cash usage differs across countries. However, cash has not disappeared as a payment instrument, especially for low-value transactions. We also find that the use of cash is strongly correlated with transaction size, demographics and point-of-sale characteristics such as merchant card acceptance and venue.

Key words: Money Demand, Payment Systems, Harmonization.
JEL Codes: E41, D12, E58.

*The figures and tables are derived from payment diary survey data and may differ from previous published work from each respective country. Special thanks to Angelika Welte for constructing the programmes and routines to create many of the tables and figures in this paper. We would like to thank Tamás Briglevics, Sean Connolly, Chris Henry, Lola Hernández, Vikram Jambulapati for research assistance. We thank Nicole Jonker for her input on the early stages of the project. We thank participants of various conferences and seminars for their comments and suggestions. We thank Eugenie Foster of the International Association of Currency Affairs (IACA) for arranging the 2010 IACA meetings in Buenos Aires, Argentina. This venue facilitated early discussions of an international cash comparison. The views expressed are solely those of the authors and not those of the Bank of Canada, De Nederlandsche Bank, the Deutsche Bundesbank, the Federal Reserve Bank of Boston or the Federal Reserve System, the Groupement des Cartes Bancaires, the Oesterreichische Nationalbank, Reserve Bank of Australia, or the Eurosystem.

†Reserve Bank of Australia, 65 Martin Place, Sydney NSW 2000, Australia. Phone: +61 2 9551 8794. E-mail: BagnallJ@rba.gov.au.

‡Telecom ParisTech. 46, rue Barrault Paris Cedex 13, F-75634, France. Phone: +33 1 45 81 73 32. E-mail: david.bounie@telecom-paristech.fr.

§Bank of Canada, 234 Wellington St., Ottawa, ON K1A 0G9, Canada. Phone: +1 (613) 782 8698. E-mail: khuynh@bankofcanada.ca.

¶De Nederlandsche Bank, P.O. Box 98 1000, AB Amsterdam, The Netherlands. Phone: +31-(0)20-5242827. E-mail: j.c.m.kosse@dnb.nl.

‖Deutsche Bundesbank, Wilhelm-Epstein-Str. 14, 60431 Frankfurt am Main, Phone: +49 (0) 69 9566 3730. E-mail: tobias.schmidt@bundesbank.de.

**Federal Reserve Bank of Boston. 600 Atlantic Avenue, Boston, MA 02210-2204, USA. Phone: +1 617-973-3941. Email: Scott.Schuh@bos.frb.org.

††Oesterreichische Nationalbank, POB 61, 1011 Vienna, Austria. Phone: +43 (0)1 40420 7211. E-mail: helmut.stix@oenb.at.

1 Introduction

During the past several decades, payment systems worldwide have become increasingly electronic, transformed by innovations in financial markets and information technology – even in less developed countries that reilies heavily on mobile phones, see Jack *et al.* (2010) for a discussion of Kenya. Now, these electronic innovations have spread to private virtual currencies, such as Bitcoin, see European Central Bank (2012) and Velde (2013). During this breathtaking transformation, relatively little research has been done comparing payment systems in different countries since the seminal work of Humphrey *et al.* (1996). In the rare instances were comprehensive data are available for comparison, usually cash is excluded, see the studies by Bolt *et al.* (2008) and Federal Reserve Payments Study (2013). However, new research is revealing the emergence of an ironic consensus: during the transformation of payments from paper to electronics, cash holding and use has not disappeared.[1]

Figure 1 depicts the surprising resilience of cash in the 21st century for a select group of industrial countries. In most of these countries, the ratios of currency in circulation (CIC) relative to nominal GDP generally declined at least through the 1980s or even early 1990s. Since then, however, these ratios have stayed flat or even increased. Likely, the CIC ratios for the United States (US) and the Euro area (Euro) have increased considerably because of strong foreign demand for the dollar and the euro (Fischer *et al.*, 2004; Judson, 2012). However, even the estimated domestic U.S. currency ratio has increased since 2000 and its behaviour is similar to that of the ratios in the other non-Euro countries.[2] The econometric evidence in Briglevics and Schuh (2013b) suggests that some of the recent U.S. increase may be the result of a decline in short-term interest rates to nearly zero. Nevertheless, persistent holding and use of cash in these industrial countries during the spread of electronic alternatives highlights a dire need for an updated comparative study of payments that includes the use of cash. Furthermore, evidence on *consumer* holding and use of cash is even rarer.[3]

[1] Examples include Amromin and Chakravorti (2009), Lippi and Secchi (2009) and Evans *et al.* (2013).

[2] The domestic currency ratio could still be driven by domestic hoarding. One indicator of transaction demand is given by the ratio of medium denomination banknotes to nominal GDP. (Judson, 2012) shows that the respective ratio for $20 has decreased in half for the U.S. and Canada since the 1970's but has remained fairly stable over the past 10 years.

[3] An early U.S. example is the Survey of Currency and Transactions Account Usage described in Avery *et al.* (1986).

This paper attempts to fill this gap in the literature by comparing the payment choices of consumers in the seven industrial countries portrayed in Figure 1 using a unique and growing data source.[4] The data are collected from large-scale payment diary surveys conducted in Australia (AU), Austria (AT), Canada (CA), France (FR), Germany (DE), the Netherlands (NL) and the United States (US).[5] Consumer payment diaries, which trace back at least to Boeschoten and Fase (1989) and Boeschoten (1992), feature rich information on individual payments collected over a fixed number of days paired with information on the detailed characteristics of individual consumers.[6] Payment diaries require consumers to record their transactions, so they should provide more accurate data than surveys that rely on consumer recall.

The present paper offers two contributions relative to previous work: 1) a careful, thorough harmonization and analysis of these international diary data; and 2) a relatively simple econometric analysis of the consumers' use of cash versus non-cash payment instruments that employs the microeconomic data from the payment diaries. We also provide a comprehensive review of other research that has used payment diary micro data, and assess opportunities for future research that could use or develop diary data.

As with most international data, harmonization is essential to be able to make valid and useful cross-country comparisons.[7] Although the diary surveys are similar across countries, direct comparisons of their respective statistics cannot be made without meticulous analysis and adjustment of the technical details of the diary survey design and concept definitions. Seemingly minor details, such as the inclusion of recurring bill payments (or not), can have substantial effects on the resulting statistics. Therefore, we have harmonized the underlying data sources and results from the seven individual country diaries so that the reported figures are comparable. In addition, we have harmonized the definition of socio-demographic variables and point-of-sale (POS) characteristics (e.g., card acceptance and the spending location) which

[4] Jonker *et al.* (2012) and Arango *et al.* (2013) provide complementary comparisons of subsets of these seven countries.

[5] The payment diaries from these seven countries do not form an exhaustive list of international sources of consumer payments data. Other sources include UK Payments Council (2013) and Danish National Bank (2013).

[6] The Austrian National Bank has the longest history of successive diaries in 1995, 2000, 2005 and 2011 starting with Mooslechner and Wehinger (1997).

[7] The efforts of harmonization of consumer payment diaries were inspired by international initiatives such as: the Penn-World Tables Summers and Heston (1991), International Trade and Foreign Direct Investment Feenstra *et al.* (2010) or the ECB wealth survey project Household Finance and Consumption Survey (2009).

permits a disaggregated view on payment behaviour. As a result, the statistics reported in this paper may not coincide exactly with analogous data from national statistics. One factor that cannot be harmonized, however, is the supply of services and providers across the national payment systems. For example, paper checks still are relatively common in France and the United States but not the other countries. Primarily for this reason, we do not attempt to model specific non-cash payment instruments in each country.

Using the harmonized data, we shed light on two empirical issues. First, we demonstrate the extent of consumer cash holding and use in each of the seven economies. Second, the micro data allows us to discover who uses cash, for which purchases, at which locations, and for what value of payment. These data may help us determine why cash is used and whether it is likely to continue to be used in the future and sustain its role as a payment instrument.

Our econometric analysis of consumer cash use follows in the tradition of the recent literature that seeks to understand the determinants of consumer payment behaviour more broadly. This literature extends back at least to Stavins (2001), which estimated the effects of consumer characteristics such as age, education, and income on consumer use of payment instruments and certain banking practices. More recent papers on this subject, such as Borzekowski *et al.* (2008), Ching and Hayashi (2010), Schuh and Stavins (2010), Arango *et al.* (2011) or von Kalckreuth *et al.* (2014b), inter alia, add a variety of other explanatory variables to such regressions. Unlike most studies, which use data usually from one country or only a few countries, we can assess the extent to which the determinants of payment choice are specific to a particular country or more general in nature.[8]

Although our econometric analysis is a simple first step toward what ultimately can be done with the diary data, it nevertheless generates a few notable results. In the logit estimation of cash versus non-cash use, we find a surprising degree of similarity in the significant marginal effects of determinants of payment use across countries, both qualitatively and quantitatively. Not surprisingly, the similarity is stronger for consumer payments made at grocery stores, which presumably are relatively homogeneous payment opportunities across countries in terms

[8]We do not attempt to estimate models of consumer demand for cash, which is the subject of another closely-related branch of the literature including Daniels and Murphy (1994), Mulligan and Sala-i-Martin (2000), Attanasio *et al.* (2002), Bounie and Francois (2008), Lippi and Secchi (2009), Briglevics and Schuh (2013b). These studies rely on consumer surveys, rather than diaries, to collect cash-related data on consumers and generally do not attempt to estimate consumer demand for other payment instruments.

of goods, transaction sizes, and merchant acceptance of payments. Much more econometric modeling could be done with this harmonized diary data base. In the penultimate section of this paper, we survey other research that has already used various forms of this diary data to study consumer payment choice in other contexts.

Using comprehensive, cross-country information on cash usage to develop a more refined understanding of consumer payment choices is important for policymakers and academics alike. In recent years, regulation of credit card and debit card interchange fees has come to the forefront in a number of countries. Better insight into consumer behaviour is essential for the determination and evaluation of these regulations. The study of cash demand and management also is important for evaluation of the cost of payments (see Schmiedel *et al.* (2013)), seigniorage revenue, central bank management of currency stocks, and the welfare costs of inflation. The use of payment instruments to access bank accounts is important for understanding bank supervision and regulation, and may provide insights into consumer welfare associated with liquid asset management. In the final section of this paper, we analyse the applicability of the consumer payment diary data to some frontier theoretical models in these areas. The breadth and importance of all of these topics underscore the puzzling deficiency of statistical evidence on cash use by consumers, and the importance of this new resource for future research.

The paper is organized as follows. Section 2 presents salient aggregate results regarding the payment behaviour in the seven countries, which provide a foundation for the subsequent analysis. Section 3 describes the payment diaries and steps taken to harmonize the data base. Section 4 presents the patterns of consumer expenditure patterns across countries, and Section 5 discusses the various factors that may affect the levels of cash usage across countries. Section 6 presents the estimation results for the econometric models of consumer choice between the use of cash versus non-cash payment instruments. Section 7 reviews the existing research that uses consumer payment diary data. Section 8 assesses the value of the diary data for a selected subset of the literature in a few fields to which the diary data are particularly well-suited for econometric application, and notes how diary data need to develop, improve, and expand to be useful to a wider variety of theoretical applications. Section 9 concludes.

2 Salient Results

Table 1 distills our findings concerning the payment structure in each of the seven countries. Although the harmonization of the data sources will be discussed in more detail in Section 3, at this point we note that the presented figures include basically all personal payments of respondents made either at a POS, for remote purchases or in-person to other persons. Recurrent transactions (e.g. rent, utility bills) are excluded. Our main findings are:

- Between 46 to 82% of the number of all payment transactions are conducted by cash.
- In value terms differences across countries are accentuated. In AT and DE cash dominates (over 50%) while in CA, FR and the US cash payments account for only about one fourth of the value of transactions.
- The composition of non-cash payments varies substantially across countries. In English-speaking countries (AU, CA and US) credit cards are more important, while they are of only minor relevance in the European countries considered, where debit cards are the chief electronic means of payments. Cheques remain an important payment instrument for FR and is a component of the *other* category for the US alongside prepaid cards.
- The overwhelming fraction of payments is conducted with only a few payment instruments: The accumulated cash, debit and credit share is above 95% in AU, AT, CA, DE and NL and above 88% in FR and the US.

The major question which emerges from these findings is how the levels of cash use in the various countries can be explained. As a first attempt, Table 1 summarizes information on three indicators about market structure. The results show that:

- Payment card ownership is high in all countries especially debit cards. However, there are large cross-country differences with respect to the dissemination of credit cards. This suggest that the use of cash may be correlated with the level of card ownership.
- Another indication about market structure can be obtained from average transaction values. In all seven economies the average value of cash transactions is lower than the

average value of card transactions. This results is consistent with prevalent transaction size models (i.e., Whitesell, 1989; Bouhdaoui and Bounie, 2012). Notably, in card-intensive countries, the average card transaction value is lower than it is in cash intensive economies.

- The acceptance of payment cards by merchants differs across countries. There is limited evidence from the surveys, but available evidence for AT, CA and DE indicate there is a correlation with cash usage.

- Survey responses suggest that cash balances are substantially higher in AT and DE than in the other countries. This result corresponds to the importance of cash for payments in these in these countries. This correlation may not be causal and there may be a simultaneity in cash management and payment behaviour. For example, the level of cash balances might affect consumers use of cash, but similarly, the use of cash may also be a determinant of the amount of cash consumers carry.

We will use the above findings to delve deeper into the levels in cash use across countries. To get a better grasp, we will also analyse cash use by looking at (1) the expenditure structure in the various countries, (2) whether cash usage differs across transaction types and POS characteristics (transaction value, type of expenditure, acceptance) and (3) whether the use of cash varies across socio-demographic factors. Similarly, we (4) further assess the interrelation between (4) cash holdings and payment behaviour by delving deeper into cash management practices of consumers. As a case in point, Table 1 highlights that all "non-cash intensive" countries have a rather similar median cash balance (around 30 PPP-USD). This suggests that consumers behave rather similarly in different countries. We will further exemplify and analyse this issue by looking at withdrawals and other aspects of cash management behaviour.

3 Consumer Payment Diaries – Validity and Harmonization

This section provides a short overview of the methodological features and key survey outcomes of the payment diaries included in the cross-country comparison. We will start with a more general discussion about the value of payment diary data, by contrasting diary stud-

ies with classical ways of collecting information, such as questionnaire surveys or macro-data analyses. The section concludes with a few remarks on the harmonization steps necessary to create comparable datasets.

3.1 Consumer Payment Diaries

Several types of data can be used to assess consumers' use of payment instruments. First, official transaction records of banks, card processors or retailers can be employed. The advantage of these data is that they are based on observed behaviour and that they provide a good basis for examining aggregate changes in payment use over time. However, often such data do not allow for an in-depth analysis of behaviour at the consumer level. Some data are proprietary so individual behaviour cannot be tracked. Scanner data does not usually provide info about the consumer and are focuse on only certain portion of consumer behaviour (i.e. grocery purchases).

Therefore, payment studies often take recourse to consumer survey data. Here a distinction can be made between data collected through consumer questionnaires versus consumer payment diaries. The advantage of questionnaires is that the burden to the respondent is limited to the time needed for completing the questionnaire at one moment in time. Whereas this collection method generates data that allows for thorough analyses of general behavioural patterns as well as the drivers underneath, it is less suitable for analysing the specificities of individual payments. For example, surveys may serve a valuable tool for measuring the adoption of payment instruments by consumers, while diaries are better for assessing their actual use.[9]

Collecting payment data through diaries has thus become popular in recent years.[10] The main benefits of using diary data, in particular in combination with questionnaire data, are obvious. Foremost, as consumers are stimulated to do this with a minimum of delay after each particular transaction, the probability of transactions being omitted or erroneously reported is lower than in questionnaire surveys. Payment diaries also allow for the collection of many

[9] In particular, when asking about individual payments, questionnaires may suffer from "recall bias" or underreporting of payments due to incomplete recall. Especially frequent and low-value payments are sensitive to being omitted, see Jonker and Kosse (2013).

[10] Collecting data using diaries has a long history in official statistics on expenditure, see McWhinney and Champion (1974). Earlier general surveys about payments were done by Avery *et al.* (1986) and Boeschoten (1992). Mooslechner and Wehinger (1997) conducted a payment diary in Austria in 1996.

details of individual transactions, such as the payment amount, the payment location, the acceptance of non-cash payments and surcharging, which enable to better understand the factors that drive consumer heterogeneity in payment behaviour. Insofar as payment diaries record cash balances over time, they also allow for an examination of the interaction between payment choice and cash management. When conducted for several days, a temporal sequence of actual payments and cash withdrawals can be created, which is useful for understanding within-consumer heterogeneities in payment instruments usage.

3.2 Validity of seven payment diaries

Our study utilizes payment diaries that were conducted independently in each country and hence were not harmonized. Differences pertain to the number of recorded days (from one to eight days), the mode of data collection (paper versus online), the scope of transactions covered (e.g. recurrent and remote transactions) and the level of detail regarding transaction characteristics (Table 2).[11] To account for these differences, we put a lot of effort into the harmonization of the variables and concepts and we are confident that the level of comparability is high enough to conduct our cross-country analysis. The next subsections discuss similarities and differences as well as the harmonization steps undertaken.

Despite the discussed advantages of diary surveys, the question arises as to the representativeness of recorded transactions. Under-reporting is one issue, as illegal transactions and transactions in the realm of the shadow economy will likely not be covered. But even for everyday expenditures, we do not know how well respondents record their transactions.

To ensure the efficacy of the seven payment diaries, we compare the diary outcomes to aggregate expenditure data from National Accounts statistics. For this sake, we extrapolate the survey outcomes by multiplying the average daily diary expenditure by 365 to obtain an annual figure. This value is compared with the average annual value of expenses as reported by the OECD (deducting expenses for housing, water, electricity and gas).[12]

The results of this exercise are presented in the last row of Table 2. For all diaries, the ratio

[11] The literature has shown that the specific design of a diary may impact the quality of the collected data, e.g. Crossley and Winter (2012), Jonker and Kosse (2013) or Sudman and Ferber (1971).

[12] We focus on the average annual expenses by the adult population only, since the samples used in the diary surveys also only targeted residents aged between 18 and 75 years.

of the extrapolated diary outcomes to the aggregate OECD POS consumption figures ranges from 0.72 to 1.16. Note that certain deviations are to be expected, as both the diary data and the data provided by the OECD are based on sampling-based survey estimates, and, hence, subject to certain degree of error. Also, due to differences in classifications, the diaries and national account figures are likely to differ regarding the sectors and types of payments included.

Therefore, we interpret the ratio's, which all vary around 1.00, as evidence that all individual surveys perform rather well in capturing the actual expenses made in these countries. Moreover, all countries undertook a number of plausibility checks. These comprised either comparison with population figures (if available, e.g. the average number and value of debit card payments or ATM withdrawals) or with other sources (such as other market research reports). Some countries could refer to earlier payment diary or questionnaire studies and check their stability over time.

3.3 Similarities

The seven diary surveys have a number of similarities, see Table 2. First, all seven diaries collect data on POS transactions. Each diary attempts to record non-business related personal expenditures of the respondent (being it for him or her or for other people). Second, the information collected for each transaction is similar. All respondents were asked to record: (1) the date (and sometimes even the time), (2) the transaction value, (3) the payment instrument used and (4) the merchant's sector where the purchase occurred. In AT, CA, DE and NL, the respondents were asked to assess whether the purchase could have been paid using payment instruments other than the one actually used. For cash withdrawals, all diaries collected information on the location (and in some cases the timing), as well as on the amount of the withdrawal. Each diary furthermore contained questions on consumers' cash balances either before the first recorded transaction or, for their typical average cash holdings.

Third, the seven diary studies are similar in that they were all conducted at the end of the year, i.e. between September and November. The fieldwork was conducted in 2009 (CA), 2010 (AU), 2011 (AT, FR, DE and NL) and 2012 (US).

Fourth, the seven diaries are similar with respect to the population being surveyed. Most targeted residents aged between 18 and 75 year, although some diaries were also distributed

among children and people aged over 75 years. However, as was discussed before in the expenditure ratio, all the analyses presented in this paper only focus on the payments made by adults. Finally, all diary surveys yielded datasets containing more than 10,000 transactions.

3.4 Differences

There are several differences amongst the diaries, which should be kept in mind when interpreting the results. First, some diaries asked respondents to fill out the diary by paper and pencil (AU, AT, DE, FR). The US and CA relied on a mix of paper and online questionnaires. In the NL, information was collected via an online tool or by phone if desired. Also, a difference relates to the selection of respondents. Most countries used random stratified or clustered sampling techniques, but they differed with respect to the frame from which the respondents were selected. In CA, NL and the US, for instance, respondents were randomly selected from an existing panel of consumers who regularly participate in surveys.

Online data collection methods and online panels may be sensitive to biases when particular population groups are excluded from participation because of not having access to the internet, and when the persons that do participate behave differently than those who do not, see Bethlehem (2008). Yet, given the high internet penetration in the CA, NL and US, the potential biases caused by the use of online methods and online panels can be expected to be limited. Jonker and Kosse (2013) demonstrate for the NL that drawing respondents from an online panel does not introduce pro-electronic biases reflected in an overestimation of card usage. Moreover, in order to prevent any such biases, the US provided all panellists with a computer or internet access.

Second, differences exist with respect to the length of the diaries ranging from: 1-day (NL), 3-day (CA, US), 7-day (AT, AU and DE) to 8-day (FR). Research by Ahmed *et al.* (2006); Jonker and Kosse (2013) and McWhinney and Champion (1974) has shown that longer diaries may lead to survey fatigue i.e. under-reporting of expenditures, especially small value transactions.[13] Despite these differences and its potential consequences, we believe that due to their richness, the seven datasets are well suited for answering the main questions of this

[13] Ahmed *et al.* (2006); Jonker and Kosse (2013) and Schmidt (2011) study the effect of survey fatigue and the efficacy of data collection via payment diaries.

paper. Moreover, as will be discussed later on, we conducted some robustness checks which confirmed that the differences in diary length do not sizeably affected our overall findings and conclusions.

3.5 Harmonization

We undertook the following harmonization steps to create seven datasets that are mutually comparable. In particular:

1. We distilled all payments from persons 18 years and above.

2. We only consider the payments made at the POS, for remote purchases via mail order, telephone, or internet and in-person person-to-person payments.Recurrent transactions (e.g. rents, utility bills) are excluded.

Also, a number of harmonization steps were conducted with respect to the reported results on card acceptance at the POS, consumer preferences and type of purchases made. The results with respect to the type of purchases, however, should only be taken as a rough indicator, due to the large national differences in number and size of categories used.[14] Finally, we harmonized the definitions and categories of the various socio-demographic characteristics (e.g. income, education).

4 Expenditure Patterns

Table 3 presents summary statistics about the total structure of recorded payments and thereby of expenditures of consumers.[15] It shows that the structure of payments is very similar across countries with respect to the time-of-the day, the day-of-the-week and the payment channel. About one third of transactions is conducted before noon, two thirds afterwards. As expected,

[14]Harmonization difficulties mainly arose because of (i) national differences in how the information was collected (from only a few broad categories of sectors in some countries to very detailed lists in other countries), (ii) differences in the categorization of expenditures (e.g., some countries recorded expenditures in restaurants and hotels in one category whereas other countries recorded hotel expenditures with other services) and (iii) differences in the structure of retail shops (e.g. in some countries newspapers and tobacco can be bought in grocery shops, while other countries have small special shops for these expenditures).

[15]Note that these are consumer expenditures and not consumption.

Sunday is the day with the lowest share of transactions, although some cross-country differences are discernible. For example, the Sunday share is slightly higher in AU and in the US, which is reasonable given cultural differences in store opening hours. Finally, in-person transactions make up the vast majority of payments. In AU and the US, internet/mobile payments at the POS account for a volume share that is higher than four percent while in all other countries it is almost negligible.

With respect to the type of the purchase or the sectoral composition, keeping the harmonization difficulties in mind, we find that groceries account for the majority of transactions in all countries (except in the US). The share of grocery expenditures is quite similar in AT, FR, DE and the NL. Also, the gas station expenditure share, which arguably constitute the most homogeneous type of expenditures, is similar across countries. Thus, taken together, these results provide evidence that shopping patterns are relatively similar across the seven countries.

More importantly, the diaries are also informative about some other payment characteristics about which relatively little is known, at least in a comparative perspective. This brings us to our first fact:

Fact 1 *The structure of consumer payments is rather similar across countries with respect to the number and the value of transactions: (i) Consumers conduct only a few payment transactions per day and (ii) most consumer expenditures are relatively small in value.*

The mean number of transactions per-person-per-day varies from 1.4 to 2.1 transactions across countries. The median person, which arguably is more robust to outliers, conducts only 1.3 transactions in CA, FR, DE and the US and 1.4 transactions in AT. The median amount spent per-person-per-day varies across countries, ranging from 20 to 41 PPP-USD.

Analysing individual transactions provides another angle to view the data. Table 3 reports the quartiles of transaction values. This analysis shows that the median transaction amount is around 12 PPP-USD in AU, CA, FR and the NL. In AT, DE and the US the value is higher at 17 to 22 PPP-USD. We also find that 75% of all recorded transactions are lower than 25 to 40 PPP-USD.

5 Cash Usage: Descriptive Evidence

Table 1 documented the outstanding importance of cash in all countries. In this section, we focus on the use of cash in terms of: transaction size, cash balances, socio-demographics (income, education, age and consumer preferences), cash card ownership and POS characteristics (acceptance of payment cards and type of economic activity). The selection of these factors rests on previous literature which, however has mostly been confined to the analysis of single countries.[16] Note however that the descriptive statistics presented in this Section only provide a first indication of the potential correlation with cash usage disregarding all other factors. A final answer on the role of each of these factors in explaining consumers cash usage can only be provided after controlling for these other variables using multivariate econometric estimations. These estimates are completed in Section 6.

5.1 Transaction Size

Numerous previous papers have shown that transaction size is highly correlated with the choice of payment instruments (e.g. Arango *et al.*, 2011; Bouhdaoui and Bounie, 2012; Klee, 2008; von Kalckreuth *et al.*, 2014a). Our analysis substantiates these findings.

Fact 2 *The use of cash decreases with transaction size. In all countries cash is predominant for the smallest 50% of transactions. For the largest 25% of transactions, the use of payment instruments is very heterogeneous across countries.*

Figure 2 depicts the payment instrument shares for cash, debit, credit and other payment instruments for each transaction value quartile. This figure confirms the dominance of cash for low transaction values in all countries. In the first transaction value quartile, debit only plays a minor role in CA, NL and US, while credit is only used in CA (share of 3%) and the US (share of 6%). Other payment instruments have a notable share for low value transactions only in NL (14%) and the US (6%). For all countries, we find that the cash share is higher than 50% up to the median transaction value. In the third quartile, the dominance of cash fades. However,

[16] One shortcoming of our analysis is that our data is not informative about pricing issues (e.g., Borzekowski *et al.*, 2008; Simon *et al.*, 2010). Moreover, whenever we analyse POS characteristics, we assume that these are fixed.

in this transaction value range, cash has a higher share than debit or credit in three countries and a share which is about equal to the share of debit in CA, FR, NL and the US. In the fourth quartile, the full heterogeneity across countries becomes evident: the importance of credit card payments in English-speaking countries, the importance of cheques in FR and the US and the relative importance of debit versus credit in all European countries.

5.2 Cash Balances

Withdrawal innovations such as ATM terminals have affected the demand for cash. For instance, Alvarez and Lippi (2013b) show that free and random withdrawal opportunities can give rise to a precautionary motive for holding cash meaning that agents withdraw cash even if they have some cash on hand. Several empirical studies suggest that higher cash holdings is correlated with higher use of cash in payments (Arango *et al.* (2011), Eschelbach and Schmidt (2013), Bouhdaoui and Bounie (2012) and Arango *et al.* (2013)). Our findings provide support for a relationship between cash usage and cash balances.

Fact 3 *Austria and Germany, relative to other countries, are cash-intensive with large cash balances and large average withdrawal amounts.*

Table 4 reports statistics on individuals' cash management patterns. The average cash balances (M) in AT (148 USD) and DE (123 USD) are two times greater than those in other countries (from 51 for NL to 74 USD for US). These statistics are in line with the greater use of cash in payments in AT and DE, where the share of cash by volume exceeds 80%, whereas it reaches 65% at the maximum in other countries. As a consequence, the sample mean of the ratio M/e, where e denotes daily expenditure, varies from 1.5 for AU to 4.8 for AT. The gaps between countries persist even if we abstract from extreme values: the sample median equals 0.6 in the US while it reaches 3.4 for AT. It remains however unclear to what extent the suggested relationship between cash balances and cash usage is causal. That is, the level of cash balances might affect consumers use of cash, but similarly, the use of cash may also be a determinant of the amount of cash consumers carry. Hence, it is not clear whether cash management causes cash usage or vice versa.

Cash is obtained from ATMs, bank tellers and other sources (family, cashbacks, etc.). Except in the US, the main source of cash is the ATM; the share of people withdrawing at least once a month from ATMs exceeds 70% in all countries. However, the median number of monthly ATM withdrawals greatly varies across countries, from 2 in DE to 4 in CA and AT. These withdrawal patterns seems to be directly correlated with the typical cash withdrawal amounts at ATMs. Looking at the median sample withdrawal amount, we observe that it is by far higher for DE and AT (238 and 172 USD) than that for the other countries (from 50 for FR to 82 USD for AU).[17]

The overall picture which emerges from these figures is that respondents in cash intensive economies do not economize on cash balances by withdrawing more often. Instead, it seems that they prefer to hold higher cash balances. There are several reasons that could rationalize this behaviour. One is that people in AT and DE hold larger cash balances because of the risk that lumpy purchases can only be conducted in cash (Alvarez and Lippi, 2013b). This would imply that precautionary balances are higher in these two countries than in other countries. However, the evidence on this issue is not conclusive. Cash balances at withdrawals are larger in AT and DE than in CA but not larger than in the US.

These descriptive statistics can be further exploited to examine the empirical performance of the Baumol (1952) and Tobin (1956) model (BT, hereafter) on cash management. Following Alvarez and Lippi (2009), two statistics are worth discussing. The first is the ratio between cash holdings at the time of a withdrawal ($\overline{M}$) and average/median currency holdings (M). This statistic provides a measure of precautionary balances. While this ratio is zero in the BT model, its sample median in the data ranges from 0.2 for CA to 0.5 for the US.

The second interesting statistic is the ratio between the withdrawal amount (W) and the average currency holdings (W/M). This ratio equals 2 in the BT model. The sample mean of this ratio is greatly higher in the data (from 3.8 for the CA to 16 for DE) but if we take the median to eliminate extreme cash withdrawal values, the ratio is relatively close to 2 in most cases. These results are suggestive of a precautionary motive for holding cash. However, to draw any structural interpretations more work is required.

[17] As previously outlined, the US stands out in this respect: the share of people obtaining cash from other sources at least once a month (90%) is above that of ATMs and tellers (70% and 40%, respectively) and the average withdrawal frequency is far above the other sources (3.3 compared to 1.3 for ATMs and 0.7 for tellers).

5.3 Socio-Demographic Characteristics

In the following part, we present evidence on cash usage along socio-demographics characteristics and we inquire into consumers' preferences by analysing survey evidence about perception of cash. We find that:

Fact 4 *Cash usage decreases with education and income but varies across age categories.*

5.3.1 Age, Income and Education

The role of age is of interest because one could argue that the enduring importance of cash could be due to habit persistence. Indeed, previous literature indicates that older people hold and use more cash while young consumers are more likely to use new payment technologies (e.g., Daniels and Murphy, 1994; Boeschoten, 1998; Carow and Staten, 1999; Stavins, 2001; Hayashi and Klee, 2003).

Our results in Figure 3 reveal that "older" people use significantly more cash than younger people except for the US where younger individuals use more cash than older individuals. Note again, that these descriptive statistics assume all other factors to be fixed. These figures regarding age do not control for differences in for example expenditure patterns or other personal characteristics. For example, younger consumers may buy different product and/or services and at different venues than older individuals. Therefore, a final answer on the role of age can only be given with estimations that control for these other variables, which will be focus of the next section.[18]

Income and education have been cited in the literature as important factors, with cash usage declining with higher income and education (e.g. Arango *et al.* (2011) for CA, von Kalckreuth *et al.* (2014b) for DE and Schuh and Stavins (2010) as well as Cohen and Rysman (2013) for the US). Figure 3 confirms differences along income terciles with less cash usage by higher income respondents. Even stronger differences are found along education. Notably, these differences pertain to all analysed countries: In DE and CA, the difference in the value share of cash between low educated and high educated is more than 26 percentage points while in

[18] von Kalckreuth *et al.* (2014a) find no evidence in favour of strong habit persistence. Instead, they attribute higher cash usage of older people to their differential characteristics, e.g. lower opportunity costs of time or lower income.

the remaining countries this difference ranges between 9 and 18 percentage points.[19]

von Kalckreuth *et al.* (2014a) provide evidence that cash is used to monitor expenditures. In particular, their prediction is that cash will be used for this purpose by individuals that face financial constraints and that have difficulties with other monitoring techniques (like online accounts, etc.). The pattern of results obtained for income and education are in line with this proposition.[20]

5.3.2 Consumer Preferences

One could argue that consumers are using cash because they have no choice, e.g., because payment cards are not accepted or because of costs, safety or convenience reasons. We can analyse this issue by looking at consumers' rating of certain payment instrument attributes, which can be viewed as broad proxies for consumer preferences and which have been found to affect payment choice (e.g., Borzekowski *et al.*, 2008; Ching and Hayashi, 2010; Schuh and Stavins, 2010; Arango *et al.*, 2011).

To a varying degree, the seven diaries contain information on preferences which we have attempted to harmonize. However, the harmonization was difficult due to how the preferences were formulated by different countries. Moreover, responses were measured in different ways with some countries using Likert scales and other binary responses. In face of these obstacles, we were able to successfully harmonize only responses concerning perceived acceptance, cost and ease of use of cash. Figure 4 shows a normalized comparison of consumers' rating of cash versus debit.[21] The depicted measures are scale free with a positive (negative) value implying that cash is rated better (worse) than debit (a value of zero means that cash is rated the same as debit). Similarly, we show results of a comparison of cash with credit and of debit with credit.

Fact 5 *Cash is generally valued by consumers for its perceived acceptance, costs and ease of use.*

[19] In many respects these findings mirror the pattern observed for card ownership which tends to vary along the same socio-demographic lines (Table 6). However, the case of NL where debit card ownership does not vary across income or education while the cash shares do suggests that income and education exert an autonomous effect on cash usage which is independent from card ownership.

[20] The role of using debit cards for spending restraint reasons has been recently analysed by Fusaro (2013).

[21] See Arango *et al.* (2011) and Jonker (2007) for a description of the normalization. Variables are defined in Table A.1

Concerning consumer perceptions of acceptance, we can compare results from five countries. Cash is rated higher than debit in AT, CA and DE. In the US, cash is rated the same as debit and in NL, cash is rated worse than debit. In CA and the US, we find that results concerning cash versus debit and cash versus credit are very similar, mirroring that both cards are perceived to have a similar acceptance. In the other countries credit cards are seen as worse than debit cards, corresponding with the authors' perception of the acceptance of credit cards in countries like NL, AT and DE.

With respect to perceived cost, we find that cash is rated better than debit in AT, CA, DE and the US, and rated similarly in NL. Again, the difference is more pronounced in favour of cash when it comes to a comparison of cash versus credit. Finally, regarding the ease of use, debit is rated higher and lower than cash in three countries, respectively.

Overall, this evidence is suggestive that cash usage by consumer is not the sole result of a lack of alternatives. To the contrary, cash is valued by consumers because it is perceived more positive or as positive as credit and debit cards with respect to cost. Also, the assessment shows that in particular in those countries with relatively high cash use, ease of use may be an important driver.

5.4 Card Ownership

Cash usage may be influenced by differences in the dissemination and use of payment cards.

Fact 6 *Whereas the levels of card ownership differ across countries, overall card ownership is rather high. Consumers only use few payment instruments alongside cash.*

Table 5 shows that in each country the vast majority of consumers hold payment cards: For AT with its high cash share, we observe the lowest card dissemination share of 86 percent. In NL, virtually all consumers are in possession of a payment card.

The most striking difference in card ownership can be seen in the dissemination of credit cards. Table 6 presents disaggregated evidence on card ownership by socio-demographics showing that differences in credit card ownership prevail along all age, income and educational groups. These differences suggest that there are factors related to the market structure which affect credit card dissemination.

There are significant differences in the number of cards owned or used (multi-homing).[22] CA and US consumers have, on average, 3.5 and 4.2 payment cards in possession. For all other countries the respective value is below 2. The median number of payment cards is 3 in CA and the US, 2 in AU and NL and only one in AT, DE and FR.

Table 5 also presents evidence on the number of payment instruments used in the diary period. Our findings indicate that the median consumer uses two payment instruments (including cash) over the diary recording period.[23] Although these results are influenced by the length of the diary period, it suggests that the median consumer uses only a few payment instruments alongside cash, which is in line with results of Cohen and Rysman (2013) utilizing a dataset that follows consumers over a much longer period of time.

5.5 POS characteristics

Finally, we discuss two types of POS characteristics: (i) card acceptance at the POS and (ii) the type of economic activity in which transactions occur.

Fact 7 *Higher usage of cash is associated with lower levels of card acceptance at the POS.*

Fact 8 *Cash usage varies across types of purchases and venues.*

5.5.1 Card Acceptance

The role of card acceptance at the POS can be approached by using direct survey evidence from AT, CA and DE. In particular, the respective payment diaries recorded whether a transaction could have been made in cashless form. On the basis of this information, we may analyse whether high cash usage is attributable to insufficient payment card acceptance. However, when interpreting results, it should be kept in mind that results are based on the subjective assessment of respondents.

Table 7 which tabulates the consumer's self-stated acceptance of cards at the POS by transaction values, confirms that the acceptance of payment cards is much lower for small-value

[22] Rysman (2007) discusses the issue of multi-homing or respondents who hold or use more than one payment card. In our analysis, we focus on card use on the extensive margin (number of cards) not the intensive margin (how much is the card used).

[23] In NL the median is one payment instrument which is to be explained by the fact that respondents only recorded their payments for one single day.

amounts than for large-value amounts. For transaction values in the first quartile, DE stands out with low acceptance. Furthermore, a comparison across countries indicates that (i) CA has the highest acceptance values in each quartile and that (ii) the difference, interestingly, is not strong for higher transaction amounts. This evidence is roughly consistent with cash usage. However, note again, that these descriptive statistics assume all other factors to be fixed. Therefore, in order to analyse the real effect of card acceptance, econometric analyses will be used in Section 6 to account for all other potential factors.

5.5.2 Type of Purchase

The diaries allow to analyse cash usage in different sectors/for different types of expenditures. We have calculated payment instrument shares for cash, debit and credit for all sectors, summarized in Table 8. Given country specific differences in sectoral definitions we stress that harmonization is only incomplete, in particular for services and "other sectors" such that results should be taken with caution.

Cross-country differences in payment patterns across different sectors could be driven by differences in transaction values, card acceptance, behavioural patterns or cultural differences. Accordingly, Figure 5 depicts three sectors which we consider interesting with regards to these factors.

First, we suspect that card acceptance at gas stations is almost universal or at least very high in all countries. At the same time, the typical expenditure value should be of roughly equal size across countries. This implies that an analysis of cash usage at gas stations should give an indication about the role of acceptance and transaction sizes for explaining the levels of cash usage. That is, if acceptance and transaction sizes were the only factors driving payment behaviour, we would expect to find fairly equal levels of cash usage in gas stations across all countries. Indeed, our results suggest that cross-country differences in cash usage are significantly smaller at gas stations than for all expenditures. In particular, we find that the cash share at gas stations in AT and DE drops significantly relative to the overall cash share. This provides a strong indication about the effects of acceptance and transaction sizes. However, despite this finding, we note that sizeable differences across countries still prevail, showing that acceptance and sizes are not the only factors driving cash usage.

Second, expenditures at bars and fast food restaurants could be cash intensive due to convenience. Indeed, the descriptive results show that the cash share for these transactions is substantially higher than the overall cash share in all countries except FR where cheques account for more than 40% of the expenditure value share in this sector. It is notable that this can also be observed in countries that have a high card acceptance rate. Again, this result is an indication that consumers differentiate in their payment behaviour depending on the spending location, which is not only to be explained by levels of card acceptance and transaction sizes.

6 Choosing Cash versus Non-Cash

This section investigates the usage of cash versus non-cash in a multivariate setting. We estimate the choice probability of cash versus non-cash alternatives (either debit or credit) at the POS using the following logit model:

$$U_j^* = X_j\beta + \epsilon_j, \text{ where } j = \text{ Cash, Non-Cash,} \tag{1}$$

where U_j^* is the utility of choice j as a function of observables X_j and a logit error ϵ_j. The variables, X_j, used in the regression are: (1) transaction size (2) cash balances, (3) socio-demographic characteristics (age, income, education), (4) consumer perceptions of ease of use, acceptance and cost and (5) POS transaction characteristics (card acceptance, type of purchase). Variables are defined in Table A.1. The sample contains all individuals (also those without payment cards) and all transactions that are conducted by cash, debit or credit.

The goal of these estimations is twofold. First, we would like to quantify which factors exert an impact on consumers' choice whether or not to pay in cash, even when controlling for other potential factors. Second, we would like to study whether the use of cross-country data unravels some patterns that are common to all countries.

6.1 Results

Table 9 contains the marginal effects on the probability of using cash. Overall, the findings are fairly and highlight that demographics play a major role across countries. Even when controlling for transaction size and other characteristics, we find that higher income and higher education is associated with lower cash use. The quantitative impact of these factors ranges

from 4 (NL for income) to 19 percentage points (pp) (US for education). Regarding age, we find that persons above 25 use significantly more cash that person below 25. Also, the results provides support for a certain habit persistence in some countries (AT, AU, DE, NL), where cash increases homogeneously with age: people aged 60 and more are more likely to use cash than people between 25 and 59.

For three countries that collected data on consumer perceptions towards payments instruments (AT, CA and the US), the perceived ease of using cash was highly significant and positive. This shows that consumers who rate cash high with regard to ease of use do conduct more cash transactions. The effect of security perception was different, positive versus negative, between AT and CA. The other perceptions with respect to cost and overall perceived acceptance were not significant. These results are in line with previous research, see Schuh and Stavins (2010), Arango *et al.* (2011) and von Kalckreuth *et al.* (2014b).

The strongest effect on consumers' choice between cash and non-cash is obtained for transaction values where the estimation results confirm that the probability of using cash decreases homogeneously with the transaction value quartile. These results hold across all countries. In the fourth transaction value quartile, the probability of cash is lower by 42 (NL) to 63 pp. (FR) relative to the first transaction value quartile.

The results also confirm an independent effect of the purchase location/the type of the purchase. For expenditures at gas stations and for purchases of semi-durables the marginal effects were universally negative (with the exception of NL) while for services, entertainment and groceries it was positive. These results confirm previous results which were based on data from single countries (e.g., Klee, 2008; Cohen and Rysman, 2013).

Another finding of the logit is that people who hold higher cash balances on average use cash more often than people with lower cash balances. We note, however, that we treat this as indicative only because of the likely presence of reverse causality.[24] Although we tried to alleviate this issue by using average cash balances of individuals and not cash balances before each transaction, we are aware that this does not completely solve the problem. For deeper analyses of this issue, we refer to Eschelbach and Schmidt (2013), Bouhdaoui and Bounie

[24]Applying an instrumental variable approach that is common to all countries was impossible because the survey questionnaires differed too much across countries. Omitting cash balances from the regressions, however, does not affect the other findings.

(2012) and Arango *et al.* (2013) who arrive at similar findings even when accounting for the possible endogeneity of cash balances.

Several results from our descriptive analysis have indicated that card acceptance is likely to be important in consumers' choice between cash and non-cash. This result is confirmed in Table 9, which shows that the rate of acceptance of cards at the POS has a significant negative effect on the probability of using cash (results are only available for AT, CA, DE and, with limitations, NL). In order to understand the quantitative impact of this factor, and to study by how much it contributes to the level of cash usage across countries, we have conducted a scenario analysis. In particular, we compare the baseline probabilities i.e. the observed frequencies from the data with the hypothetical values obtained by assigning each person the maximum group acceptance observed in the sample. Note that this does not necessarily mean that acceptance is raised to one because this would imply a far stretch from reality. Thus, the question we ask is by how much cash usage would decline if acceptance was as high as it is for the income/age group that reports the highest rate of acceptance.[25]

Figure 6 summarizes the results for the first and fourth transaction value quartile. For TV Q1 the effect on payment choice is trivial for AT, DE and NL while for CA it is significant. There is almost 10 percent point increase in card usage for low value transactions if payment cards were universally accepted. However, at TV Q4 the effect is similar across countries as the probability of card payment increases relative to cash. This would imply that Canadians are more likely to pay with cards at all transactions if cards are universally accepted. High acceptance of cards will only increase card use in AT and DE when the transaction values are high. In NL, the effect would be minimal, which indicates that current levels of acceptance are already relative high at all transaction quartiles. These results highlights that country differences remain substantial.

6.2 Robustness: Groceries and Gas

As one important robustness check, we focus on transactions completed at groceries and gas stations only. The results are contained in Table 10. Focusing on this sub-sector reduces the

[25]This also implies that we do not expect country differences to vanish, as the maximum rate of acceptance can still differ across countries. All other variables are evaluated at the their sample means.

sample by about half to two-thirds.

The results again confirm the role of demographics and of transaction value. These results are consistent with the findings of Klee (2008) and Cohen and Rysman (2013) uses scanner data from groceries and gas stations.[26] In addition, we find that the results for the other variables do not change; we still find an independent effect of preferences, cash on hand, and payment location/type of the product.

Finally, we perform two additional robustness checks. We estimated the logit using the transactions conducted at the first day of each diary, so to be comparable to the Dutch payment diary which only collected data per respondent for one day. We also have generated estimates using only the first three days to be comparable to CA and US. Neither of these modifications have an affect on the main results.

7 Payment Diaries: Past and Present

The usage of consumer payment diaries to understand monetary and payment economics is in the nascent stage. This section provides a brief summary of how payment diaries have been used to understand cash usage, determinants of payment instrument choice and how market structure may matter for payment choice.

7.1 Consumer cash usage

A key advantage of payment diaries is the proper accounting of cash payments relative to all methods of payments. Stix (2004), Jonker and Kettenis (2007) and Bounie *et al.* (2013) demonstrate that cash demand is affected by debit card usage in Austria, Netherlands and France. von Kalckreuth *et al.* (2014a) demonstrates that the presence of credit cards are relatively interchangeable to debit cards for the usage of cash in Germany. Further work by von Kalckreuth *et al.* (2014b) uses payment diary data from Germany to show that cash is used as a method to monitor expenditures (*pocket-watching*). Research by Fung *et al.* (2012) investigates the effect of retail payment innovations (i.e. contactless-credit cards and stored-value cards) on cash

[26] Klee (2008) focuses mainly on the value of time while controlling for census-tract averaged demographics. Her analysis does not have individual demographics, perceptions or acceptance of cards. Cohen and Rysman (2013) analyse rich data on grocery purchases and allows to follow consumers over a longer time period. This paper highlights the role of the transaction size.

usage and find that there is a reduction. Finally, Bounie *et al.* (2013) and Huynh *et al.* (2014) study the impact of acceptance of cards on cash usage. They find that lack of card acceptance is a reason for precautionary cash balance.

7.2 Consumer adoption and usage of payment instruments

The study by Bounie and Francois (2006), based on the 2005 French payment diary, was an early attempt to disentangle the role of demographics versus payment characteristics such as transaction value on payment choice. Further work by Bouhdaoui and Bounie (2012) propose a cash holding model as an alternative to transaction size explanation for payment choice.[27] Kosse (2013) focuses on the perception of safety aspects for cash versus debit while Kosse and Jansen (2013) demonstrates that variation in demographics such as foreign background has a strong effect on payment choice in the Netherlands.

Simon *et al.* (2010) (Australia), Arango *et al.* (2011) and Wakamori and Welte (2012) (Canada) extend the analysis beyond demographics and payment characteristics to the pricing incentives such as card affinity programs (rewards) and acceptance of payment cards. The analysis by Briglevics and Schuh (2013a) estimates a structural inventory model of cash holdings and finds a significant effect on payment choice.

7.3 Merchant steering

The payment diaries have been used to study the effect of market structure on payment choice. Recent work by Shy and Wang (forthcoming) investigates the effect of the debit card interchange fees and to sort out the transaction value at which interchange fees become higher or lower due to the new rule. Briglevics and Shy (2012) use the payment diaries to understand the merchant steering. They compute the expected net cost of discounts on cash and debit card payments and find that for the most part it is unprofitable. Welte (2014) studies the Canadian case and extends the steering exercise by embedding a consumer choice into the expected net cost calculations.

[27] Arango *et al.* (2013) extend this work by conducting the test for Canada, France, Germany and Netherlands.

7.4 Scanner data projects

Scanner data has been touted as an alternative to payment diaries as a method of data collection on payments. Klee (2008) using data from the United States, illustrates that payment choice is a function of the amount of time spent processing the items purchased. Research by Polasik *et al.* (2012) in Poland demonstrates the usage of chronometric methods to enumerate the processing time of payments. Recent work by Wang and Wolman (2014) extends the work of Klee (2008) by using scanner data from a large discount retailer.

These scanner data studies have rich detailed information including the opportunity cost of time. However, a drawback of these scanner data projects is that direct demographic data is not collected. Therefore, it is hard to infer the role of consumer demographics on payment choice. Recent work by Cohen and Rysman (2013) avoids this criticism by obtaining demograhic information with their scanner data.

8 Payment Diaries: Going Forward

This section discusses possible future use of payment diaries. We focus our discussions on three main points: structural models of cash and alternative means of payments, high-frequency consumption and savings and the study of two-sided markets. We also discuss some caveats and ideas to improve the collection of data.

8.1 Structural models of cash and alternative method of payments

The estimation of money demand has relied mostly on the workhorse Baumol-Tobin model. However, this model was constructed in the absence of payment cards. The presence of payment cards or the extensive margin have been exploited to understand household money demand elasticities, see Mulligan and Sala-i-Martin (2000) or Attanasio *et al.* (2002). These studies also document that consumers do not wait until a zero cash balance before withdrawing. This inspired Alvarez and Lippi (2009) who explain this puzzle by introducing a positive probability of a *free withdrawal*. Another salient feature is that some consumers hold large amounts of cash. Alvarez and Lippi (2013b) rationalize this feature by modeling the large and lumpy purchases that require cash. Further, Alvarez and Lippi (2013a) allow for merchant

non-acceptance of cards as a reason to hold precautionary cash balances.

Most payment diaries contain information about cash management behaviour but little is known about the rationale for such holdings. Most diaries do not include questions on precautionary motives or the need to make lumpy purchases. Therefore, it is hard to distinguish between cash management versus acceptance of payment cards as a reason to hold cash. Further, care must be taken to the statistical sampling behind these questions. The diaries rely on a short-term window to focus in on behaviour that may be infrequent.

Nosal and Rocheteau (2012) contains an extensive discussion of the new monetarist approach which has stressed various real trading frictions to explain the co-existence of cash with cards payments. For example, Telyukova and Wright (2008) explain why households hold cash while having a credit balance with a rate of return dominance puzzle i.e. cash is held for liquidity reasons to settle claims. The current payment diaries focus mainly on payment choice and expenditures. There is scant information about credit arrangements i.e. an indicator whether a household has carried a balance from month-to-month or revolving credit. Therefore, to empirically validate these models would require detailed household balance sheet information.

8.2 High-frequency consumption and saving

Recent work by Aruoba *et al.* (2009) highlights the usefulness of real-time monitoring of consumption for business cycles. Private and public sector forecasters spend enormous resources to understand consumption as it is a large component of GDP. Galbraith and Tkacz (2013) demonstrate the utility of using network data on debit and credit card payments to understand consumption. The recent financial crisis has highlighted the need to understand these high-frequency movements in consumption and consumer confidence, see Parker *et al.* (2013) and Lachowska (2013).

Payment diaries could be a useful method to track high-frequency consumption and/or expenditures of households. They could be used to understand the effect of fiscal policy on consumption. Agarwal and McGranahan (2012) argue that sales tax holidays have an effect on consumption but the timing of these effects cannot be cleanly identified. Also, Mastrobuoni and Weinberg (2010) demonstrates that exact pay dates have an impact on consumption especially for social security recipients. However, payment diaries would need to be re-designed to

incorporate questions to tease out these effects.

8.3 Two-sided markets and regulation

Rochet and Tirole (2002) and Julian and Wright (2003) discuss the theoretical nature of two-sided markets for the payments literature. However, the work on estimation of these two-sided markets with the exception of Rysman (2007), uses network data to study the usage of credit cards, network externalities and the issue of multi-homing. There is also recent work by Shy and Wang (2011) discussion why interchange fees are proportional.

Payment diaries contain detailed data on consumer payments but only a few questions on merchant characteristics (i.e. venue and acceptance of cards). Recent work by Bounie *et al.* (2014) match payment diary data to a nation-wide French merchant survey to investigate that the probability the merchant will accept cards. Future payment diaries could attempt to collect or at least link their data to merchant costs or expand the supply-side information. However, work by Shy and Stavins (2013) illustrate the difficulty of this task as they attempt to embed questions about merchant steering into the US payment diaries. Their results were inconclusive and they discuss the challenges and pitfalls of this exercise. Future improvements to payment diaries should bear this in mind.

9 Conclusions

Many have predicted and espoused the view that cash is increasingly disappearing as a payment instrument, see Wolman (2012). However, to paraphrase Mark Twain, we would say that *"the reports of the death of cash has been greatly exaggerated*!" This paper shows that in all seven countries, considered, cash is still used extensively – in particular for low-value transactions. In some European countries such as Austria and Germany, cash even still dominates consumer payment choices in terms of value of transactions.

Apart from transaction sizes and consumer preferences for ease of use, this paper demonstrated that the use of cash is strongly correlated with demographics and point-of-sale characteristics such as merchant card acceptance and venue. This largely confirms the results of earlier studies that were based on data from only one or a small number of countries. Our find-

ing that these results can be observed for all seven countries, assures us that these are universal driving factors of cash use.

Our paper does however signal the importance of cross-country differences. First, the level of cash usage differs across the various countries. Also, differences can be found in terms of the type of alternatives used for cash. Some countries are found to often use credit cards as a substitute, whereas in other countries debit cards are mainly used. One explanation for these cross-country differences could be found in differences in market structures and the pricing policies of retail payments. Rysman (2009), for instance, highlights how market structure affects payments, or vice-versa. Finally, we point at an important correlation between cash use and the amount of cash balances consumers carry. The direction of the correlation, however, remains unclear. Therefore, as country differences are still substantial and given the remaining questions on the role and effect of cash balances, further work is to be desired to further flesh out the underlying drivers of consumers use of cash and alternative payment methods.

References

AGARWAL, S. and MCGRANAHAN, L. (2012). Spending responses to state sales tax holidays. *Working Paper, Federal Reserve Bank of Chicago, No. 2012-10*.

AHMED, N., BRZOZOWSKI, M. and CROSSLEY, T. (2006). *Measurement errors in recall food consumption data*. IFS Working Papers W06/21, Institute for Fiscal Studies.

ALVAREZ, F. and LIPPI, F. (2009). Financial innovation and the transactions demand for cash. *Econometrica*, **77** (2), 363–402.

— and — (2013a). *Cash Burns*. mimeo.

— and — (2013b). The demand of liquid assets with uncertain lumpy expenditures, http://dx.doi.org/10.1016/j.jmoneco.2013.05.008.

AMROMIN, G. and CHAKRAVORTI, S. (2009). Whither loose change? the diminishing demand for small-denomination currency. *Journal of Money, Credit and Banking*, **41** (2-3), 315–335.

ARANGO, C., BOUHDAOUI, Y., BOUNIE, D., ESCHELBACH, M. and HERNÁNDEZ, L. (2013). *Cash Management and Payment Choices: A Simulation Model with International Comparisons*. Working Papers 13-53, Bank of Canada.

—, HUYNH, K. and SABETTI, L. (2011). *How Do You Pay? The Role of Incentives at the Point-of-Sale*. Working Paper 11-23, Bank of Canada.

ARUOBA, S. B., DIEBOLD, F. X. and SCOTTI, C. (2009). Real-Time Measurement of Business Conditions. *Journal of Business & Economic Statistics*, **27** (4), 417–427.

ATTANASIO, O. R., GUISO, L. and JAPPELLI, T. (2002). The demand for money, financial innovation, and the welfare cost of inflation: An analysis with household data. *Journal of Political Economy*, **110** (2), 317–351.

AVERY, R. B., ELLIEHAUSEN, G. E., KENNICKELL, A. B. and SPINDT, P. A. (1986). The use of cash and transaction accounts by American families. *Federal Reserve Bulletin*, (Feb), 87–108.

BAUMOL, W. (1952). The transactions demand for cash: An inventory theoretic approach. *Quarterly Journal of Economics*, **66**, 545–556.

BETHLEHEM, J. (2008). Representativity of web surveys - an illusion? In I. Stoop and M. Wittenberg (eds.), *Access panels and online research, panacea or pitfall?*, Amsterdam, Aksant: Proceedings of the DANS symposium, pp. 19–44.

BOESCHOTEN, W. (1992). *Currency Use and Payment Patterns*. Kluwer Academic Publishers.

BOESCHOTEN, W. C. (1998). Cash management, payment patterns and the demand for money. *De Economist*, **146** (1), 117–142.

— and FASE, M. M. G. (1989). The way we pay with money. *Journal of Business & Economic Statistics*, **7** (3), pp. 319–326.

BOLT, W., HUMPHREY, D. and UITTENBOGAARD, R. (2008). Transaction Pricing and the Adoption of Electronic Payments: A Cross-Country Comparison. *International Journal of Central Banking*, **4** (1), 89–123.

BORZEKOWSKI, R., KISER, E. K. and SHAISTA, A. (2008). Consumers' use of debit cards: Patterns, preferences, and price response. *Journal of Money, Credit and Banking*, **40** (1), 149–172.

BOUHDAOUI, Y. and BOUNIE, D. (2012). Modeling the share of cash payments in the economy: An application to france. *International Journal of Central Banking*, **8** (4), 175–195.

BOUNIE, D. and FRANCOIS, A. (2006). Cash, check or bank card? the effects of transaction characteristics on the use of payment instruments, mimeo.

— and — (2008). Is Baumol's 'square root law' still relevant? evidence from micro-level data. *Applied Financial Economics*, **18** (13), 1091–1098.

—, — and HOVE, L. V. (2014). Merchant acceptance of payment cards in france: "le client est roi!", http://ssrn.com/abstract=2405361.

—, — and WAELBROECK, P. (2013). Debit card and demand for cash, http://dx.doi.org/10.2139/ssrn.2084641.

BRIGLEVICS, T. and SCHUH, S. (2013a). This is what's in your wallet...and how you use it, mimeo.

— and — (2013b). U.s. consumer demand for cash in the era of low interest rates and electronic payments.

— and SHY, O. (2012). *Why dont most merchants use price discounts to steer consumer payment choice?* Public Policy Discussion Paper 12-9, Federal Reserve Bank of Boston.

CAROW, K. A. and STATEN, M. E. (1999). Debit, credit, or cash: Survey evidence on gasoline purchases. *Journal of Economics and Business*, **51**, 409–421.

CHING, A. T. and HAYASHI, F. (2010). Payment card rewards programs and consumer payment choice. *Journal of Banking & Finance*, **34** (8), 1773–1787.

COHEN, M. and RYSMAN, M. (2013). Payment choice with consumer panel data, http://dx.doi.org/10.2139/ssrn.2308121.

CROSSLEY, T. F. and WINTER, J. K. (2012). Asking households about expenditures: What have we learned? In *Improving the Measurement of Consumer Expenditures*, NBER Chapters, National Bureau of Economic Research, Inc.

DANIELS, K. N. and MURPHY, N. B. (1994). The Impact of Technological Change on the Currency Behavior of Households: An Empirical Cross-Section Study. *Journal of Money, Credit and Banking*, **26** (4), 867–74.

DANISH NATIONAL BANK (2013). Rapport om nye betalingsl øsninger, http://goo.gl/ruzBdq.

ESCHELBACH, M. and SCHMIDT, T. (2013). *Precautionary motives in short-term cash management: Evidence from German POS transactions*. Discussion Papers 38/2013, Deutsche Bundesbank, Research Centre.

EUROPEAN CENTRAL BANK (2012). Virtual currency schemes, http://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf.

EVANS, D. S., WEBSTER, K., COLGAN, G. K. and MURRAY, S. R. (2013). Paying with cash: A multi-country analysis of the past and future of the use of cash for payments by consumers, http://dx.doi.org/10.2139/ssrn.2273192.

FEDERAL RESERVE PAYMENTS STUDY (2013). The 2013 federal reserve payments study: Recent and long-term payment trends in the united states: 2003 2012, http://www.frbservices.org/files/communications/pdf/research/2013_payments

FEENSTRA, R. C., LIPSEY, R. E., BRANSTETTER, L. G., FOLEY, C. F., HARRIGAN, J., JENSEN, J. B., KLETZER, L., MANN, C., SCHOTT, P. K. and WRIGHT, G. C. (2010). *Report on the State of Available Data for the Study of International Trade and Foreign Direct Investment*. NBER Working Papers 16254, National Bureau of Economic Research, Inc.

FISCHER, B., KÖHLER, P. and SEITZ, F. (2004). *The demand for euro area currencies: Past, present and future*. Working Paper Series 330, European Central Bank.

FUNG, B., HUYNH, K. and SABETTI, L. (2012). *The Impact of Retail Payment Innovations on Cash Usage*. Working Papers 12-14, Bank of Canada.

FUSARO, M. A. (2013). Why do people use debit cards: Evidence from checking accounts. *Economic Inquiry*, **51** (4), 1986–2001.

GALBRAITH, J. W. and TKACZ, G. (2013). Analyzing Economic Effects of September 11 and Other Extreme Events Using Debit and Payments System Data. *Canadian Public Policy*, **39** (1), 119–134.

HAYASHI, F. and KLEE, E. (2003). Technology adoption and consumer payments: Evidence from survey data. *Review of Network Economics*, **2** (2), 175–190.

HOUSEHOLD FINANCE AND CONSUMPTION SURVEY (2009). *Survey data on household finance and consumption - research summary and policy use*. Occasional Paper Series 100, European Central Bank.

HUMPHREY, D. B., PULLEY, L. B. and VESALA, J. M. (1996). Cash, paper, and electronic payments: A cross-country analysis. *Journal of Money, Credit, and Banking*, **28** (4), 914–939.

HUYNH, K. P., SCHMIDT-DENGLER, P. and STIX, H. (2014). Whenever and wherever: The role of card acceptance in the transaction demand for money, mimeo.

JACK, W., SURI, T. and TOWNSEND, R. (2010). Monetary theory and electronic money : reflections on the Kenyan experience. *Economic Quarterly*, (1Q), 83–122.

JONKER, N. (2007). Payment instruments as perceived by consumers results from a household survey. *De Economist*, **155** (3), 271–303.

— and KETTENIS, T. (2007). *Explaining cash usage in the Netherlands: the effect of electronic payment instruments*. DNB Working Papers 136, Netherlands Central Bank, Research Department.

— and KOSSE, A. (2013). Estimating cash usage: The impact of survey design on research outcomes. *De Economist*, **161**, 19–44.

—, — and HERNÁNDEZ, L. (2012). *Cash usage in the Netherlands: How much, where, when, who and whenever one wants?* Occasional studies, De Nederlandsche Bank.

JUDSON, R. (2012). *Crisis and Calm: Demand for U.S. Currency at Home and Abroad from the Fall of the Berlin Wall to 2011*. International Finance Discussion Papers IFDP 1058, Board of Governors of the Federal Reserve System.

JULIAN and WRIGHT (2003). Optimal card payment systems. *European Economic Review*, **47** (4), 587 – 612.

KLEE, E. (2008). How people pay: Evidence from grocery store data. *Journal of Monetary Economics*, **55** (3), 526–541.

KOSSE, A. (2013). The Safety of Cash and Debit Cards: A Study on the Perception and Behavior of Dutch Consumers. *International Journal of Central Banking*, **9** (4), 77–98.

— and JANSEN, D.-J. (2013). Choosing how to pay: The influence of foreign backgrounds. *Journal of Banking & Finance*, **37** (3), 989–998.

LACHOWSKA, M. (2013). Expenditure, confidence, and uncertainty: Identifying shocks to consumer confidence using daily data. *Upjohn Institute working paper; 13-197*.

LIPPI, F. and SECCHI, A. (2009). Technological change and the households' demand for currency. *Journal of Monetary Economics*, **56** (2), 222–230.

MASTROBUONI, G. and WEINBERG, M. C. (2010). Do social security recipients smooth consumption between checks? evidence using new data with variation in pay dates. *Working Paper*.

MCWHINNEY, I. and CHAMPION, H. E. (1974). The canadian experience with recall and diary methods in consumer expenditure surveys. *Annals of Economic and Social Measurement*, **3** (2), 411–435.

MOOSLECHNER, P. and WEHINGER, G. (1997). Aspekte des Zahlungsverhaltens privater Haushalte in Österreich. *Berichte und Studien*, **4**, 44–65.

MULLIGAN, C. B. and SALA-I-MARTIN, X. (2000). Extensive margins and the demand for money at low interest rates. *Journal of Political Economy*, **108** (5), 961–991.

NOSAL, E. and ROCHETEAU, G. (2012). *A Search Approach to Money, Payments, and Liquidity*. Princeton University Press.

PARKER, J. A., SOULELES, N. S., JOHNSON, D. S. and MCCLELLAND, R. (2013). Consumer spending and the economic stimulus payments of 2008. *American Economic Review*, **103** (6), 2530–53.

POLASIK, M., GÓRKA, J., WILCZEWSKI, G., KUNKOWSKI, J., PRZENAJKOWSKA, K. and TETKOWSKA, N. (2012). Time efficiency of point-of-sale payment methods: The empirical results for cash, cards and mobile payments, http://dx.doi.org/10.2139/ssrn.1769922.

ROCHET, J.-C. and TIROLE, J. (2002). Cooperation among competitors: Some economics of payment card associations. *RAND Journal of Economics*, **33** (4), 549–570.

RYSMAN, M. (2007). An empirical analysis of payment card usage. *Journal of Industrial Economics*, **55** (1), 1–36.

— (2009). The economics of two-sided markets. *Journal of Economic Perspectives*, **23** (3), 125–43.

SCHMIDT, T. (2011). *Fatigue in payment diaries - empirical evidence from Germany*. Discussion Paper Series 1: Economic Studies 2011,11, Deutsche Bundesbank Research Centre.

SCHMIEDEL, H., KOSTOVA, G. and RUTTENBERG, W. (2013). The social and private costs of retail payment instruments: a european perspective. *Journal of Financial Market Infrastructures*, **2** (1).

SCHUH, S. and STAVINS, J. (2010). Why are (some) consumers (finally) writing fewer checks? the role of payment characteristics. *Journal of Banking & Finance*, **34** (8), 1745–1758.

SHY, O. and STAVINS, J. (2013). *Merchant Steering of Consumer Payment Choice: Lessons Learned From Consumer Surveys*. Public Policy Discussion Paper 13-1, Federal Reserve Bank of Boston.

— and WANG, Z. (2011). Why do payment card networks charge proportional fees? *American Economic Review*, **101** (4), 1575 – 1590.

— and — (forthcoming). Measuring some effects of the 2011 debit card interchange fee reform. *Contemporary Economic Policy*.

SIMON, J., SMITH, K. and WEST, T. (2010). Price incentives and consumer payment behaviour. *Journal of Banking and Finance*, **34** (8), 1759 – 1772, new Contributions to Retail Payments: Conference at Norges Bank (Central Bank of Norway) 14-15 November 2008.

STAVINS, J. (2001). Effect of consumer characteristics on the use of payment instruments. *New England Economic Review*, **3**, 19–31.

STIX, H. (2004). How do debit cards affect cash demand? survey data evidence. *Empirica*, **31** (2), 93–115.

SUDMAN, S. and FERBER, R. (1971). Experiments in obtaining consumer expenditures by diary methods. *Journal of the American Statistical Association*, **66** (336), 725–735.

SUMMERS, R. and HESTON, A. (1991). The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988. *The Quarterly Journal of Economics*, **106** (2), 327–68.

TELYUKOVA, I. A. and WRIGHT, R. (2008). A model of money and credit, with application to the credit card debt puzzle. *Review of Economics and Statistics*, **75**, 629–647.

TOBIN, J. (1956). The interest elasticity of transactions demand for money. *Review of Economics and Statistics*, **38**, 241–247.

UK PAYMENTS COUNCIL (2013). Trends in consumer holdings and the use of different payment methods, http://www.paymentscouncil.org.uk.

VELDE, F. (2013). Bitcoin: a primer. *Chicago Fed Letter*, (Dec).

VON KALCKREUTH, U., SCHMIDT, T. and STIX, H. (2014a). Choosing and using payment instruments: evidence from German microdata. *forthcoming Empirical Economics*.

—, — and STIX, H. (2014b). Using cash to monitor expenditures – implications for payments, currency demand and withdrawal behaviour. *forthcoming Journal of Money, Credit and Banking*.

WAKAMORI, N. and WELTE, A. (2012). *Why Do Shoppers Use Cash? Evidence from Shopping Diary Data*. Working Papers 12-24, Bank of Canada.

WANG, Z. and WOLMAN, A. L. (2014). Payment choice and the future of currency: Insights from one billion retail transactions.

WELTE, A. (2014). Merchant payment steering: Evidence from the 2009 bank of canada method of payments survey, mimeo.

WHITESELL, W. C. (1989). The demand for currency versus debitable accounts: A note. *Journal of Money, Credit and Banking*, **21** (2), 246–57.

WOLMAN, D. (2012). *The End of Money: Counterfeiters, Preachers, Techies, Dreamers–and the Coming Cashless Society* . Da Capo Press, 1st edn.

Table 1: Salient Results

	AU	AT	CA	FR	DE	NL	US
Payment share by volume							
Cash	0.65	0.82	0.53	0.56	0.82	0.52	0.46
Debit	0.22	0.14	0.25	0.31	0.13	0.41	0.26
Credit	0.09	0.02	0.19	0.01	0.02	0.01	0.19
Total	0.96	0.98	0.97	0.88	0.97	0.95	0.91
other most important payment instrument (share > 5%)	.	.	.	0.09[a]	.	.	.
Payment share by value							
Cash	0.32	0.65	0.23	0.15	0.53	0.34	0.23
Debit	0.32	0.25	0.30	0.43	0.28	0.60	0.27
Credit	0.18	0.05	0.41	0.03	0.07	0.04	0.28
Total	0.82	0.95	0.94	0.60	0.89	0.97	0.78
other most important payment instrument (share > 5%)	0.12[b]	.	.	0.30[a]	.	.	0.14[a]
Ownership of payment cards							
Debit share	0.93	0.85	0.97	0.83	0.94	0.99	0.76
Credit share	0.47	0.24	0.81	0.36	0.33	0.62	0.67
Average transaction values							
Cash	15.2	24.7	12.9	10.9	25.0	17.4	17.8
Debit	43.3	55.6	37.6	56.6	75.7	39.1	37.3
Credit	60.0	85.9	64.7	92.5	160.5	95.6	56.4
Acceptance of alternatives to cash[c]							
Share	.	0.63	0.73	.	0.57	.	.
Average cash balances in wallet							
mean	59	148	64	70	123	51	74
median	32	114	38	30	94	28	37

[a] Cheques.
[b] Internet/telephone banking.
[c] Acceptance as perceived by consumers.

Notes: Own calculation based on questionnaire and diary surveys. Nominal values are expressed in PPP-adjusted USD. PPP exchange rates are taken from the OECD: `http://www.oecd.org/std/pricesandpurchasesingpowerparitiesppp/PPP_OECD.xls`.

Table 2: Survey Design Summary

	AU	**AT**	**CA**	**FR**	**DE**	**NL**	**US**
Year	2010	2011	2009	2011	2011	2011	2012
Month(s)	Oct-Nov	Oct-Nov	Nov	Oct-Nov	Sep-Nov	Sep	Oct
Data collection	Paper	Paper	Online Paper	Paper	Paper	Online Phone	Online Paper
Sampling Frame	18+	15+	18 - 75	18+	18+	18+	18+
Diary Length (Days)	7	7	3	8	7	1	3
Respondents	1,240	1,165	3,283	1,106	2,098	7,175	2,468
Total Transactions	18,110	12,970	15,832	10,759	19,601	11,877	13,942
Diary to Aggregate Expenditure Ratio	1.11	0.92	0.99	0.88	0.97	1.16	0.72

Notes: For these Diary-to-Aggregate Expenditure Ratio we calculate the total annual per person expenditure in local currency, by multiplying the average per person per day expenditure figure from each diary with 365 days. We compare this estimated annual consumption figure with national accounts data from the OECD website. We start with the time series labeled "P31NC: Final consumption expend. of res. households on the territory and abroad" and subtract "P33: Final consumption expenditure of resident households abroad." We also subtract "P31CP040: Housing, water, electricity, gas and other fuels" to arrive at a concept of consumption expenditure more comparable to what we have in the diaries. The diaries do not cover recurrent payments and most of the payments for housing and utilities are recurring. Finally, we divide the calculated consumption expenditure by the total adult population, implying that we assume that the responses to our diaries do not include consumption expenditure for minors. To harmonize the transaction values in this study we use PPP-adjusted USD. PPP exchange rates are taken from the OECD:

`http://www.oecd.org/std/pricesandpurchasesingpowerparitiesppp/PPP_OECD.xls`.

Table 3: Structure of Consumer Payments

	AU	AT	CA	FR	DE	NL	US
Transactions Volume PPD							
mean	2.1	1.6	1.7	1.5	1.4	1.8	1.6
median	1.9	1.4	1.3	1.3	1.3	1.0	1.3
Expenditures PPD							
mean	63	50	50	43	48	52	62
median	41	34	28	27	35	20	31
Distribution of transaction values							
25-th percentile	5.1	7.1	4.4	2.9	7.0	5.1	12.3
median	12.0	16.7	11.9	12.5	17.8	11.3	22.7
75-th percentile	25.3	37.3	30.3	35.0	42.6	28.4	39.8
Transactions Volume Shares							
Day of the week							
Monday	0.14	0.15	0.11	0.12	0.14	0.12	0.16
Tuesday	0.13	0.14	0.15	0.15	0.15	0.13	0.16
Wednesday	0.14	0.14	0.17	0.15	0.15	0.13	0.16
Thursday	0.16	0.15	0.19	0.16	0.15	0.19	0.13
Friday	0.16	0.16	0.14	0.16	0.17	0.18	0.13
Saturday	0.16	0.16	0.15	0.17	0.17	0.17	0.14
Sunday	0.11	0.09	0.09	0.08	0.08	0.07	0.12
Time of the day							
AM	.	0.38	0.33	.	.	.	0.31
PM	.	0.62	0.67	.	.	.	0.69
Payment Channel							
In person	0.952	0.985	1.000	0.954	0.977	1.000	0.936
Internet/Mobile	0.044	0.011	.	0.015	0.015	.	0.051
Mail-order/Phone	0.003	0.004	.	0.017	0.009	.	0.013
Sectoral composition							
Groceries	0.31	0.42	0.33	0.46	0.46	0.44	0.20
Gasoline	0.07	0.06	0.08	0.03	0.08	0.09	0.08
(Semi)durables	0.18	0.13	0.15	0.12	0.06	0.18	0.12
Services	0.15	0.09	0.04	0.14	0.07	0.09	0.30
Restaurants/drinks	0.21	0.17	0.22	0.09	0.16	0.13	0.27
Other	0.07	0.14	0.19	0.15	0.16	0.08	0.03

Notes: Own calculation based on diary surveys. PPD refers to per-person-per-day. Nominal values are expressed in PPP-adjusted USD. To harmonize the transaction values in this study we use PPP-adjusted USD. PPP exchange rates are taken from the OECD:
`http://www.oecd.org/std/pricesandpurchasesingpowerparitiesppp/PPP_OECD.xls`.

Table 4: Cash Management

	AU	AT	CA	FR	DE	NL	US
Cash balances							
In the wallet (M)	59[a]	148	64	70	123	51 [a]	74
mean M/e	*1.48*	*4.78*	*4.38*	*4.13*	*4.15*	*2.87*	*2.44*
median M/e	*0.69*	*3.36*	*1.01*	*1.30*	*2.61*	*1.00*	*0.62*
Withdrawals (# per month)							
ATM	.	3.48	4.98	3.70	3.08	2.45	1.31
Teller	.	1.07	1.83	2.21	0.99	0.02	0.65
Other sources	.	1.31	4.05	2.09	0.70	0.40	3.29
Share of respondents withdrawing:							
ATM (at least once a month)	.	0.79	0.73	0.95	0.85	.	0.69
Teller (at least once a month)	.	0.28	0.41	0.70	0.22	.	0.41
Other source (at least once a month)	.	0.11	0.56	0.71	0.03	.	0.92
Avg. withdrawal amount (W)							
ATM (W)	138	224	86	89	256	102	103
Teller	668	511.13	225	224	539	75	219
Other sources	51	559	52	122	125	53	95
W/M	*5.80*	*3.86*	*3.77*	*6.25*	*15.96*	*8.71*	*14.05*
median W/M	*2.33*	*1.42*	*1.67*	*1.72*	*2.11*	*2.50*	*2.31*
Precautionary balances							
Cash balance before withdrawal ($\overline{M}$)	.	58	22	.	43	.	67
mean $\overline{M}/M$	.	*0.84*	*0.46*	.	*1.66*	.	*2.29*
median $\overline{M}/M$	.	*0.25*	*0.20*	.	*0.32*	.	*0.73*

[a] Values for AU and NL from questionnaire ("typical" average cash balance), all other values from diary (cash balances at the beginning or end of the diary).

Notes: Own calculation based on questionnaire and diary surveys. M/e is the ratio of cash balances to daily expenditures from the diary. All values represent sample means, except otherwise indicated. Nominal values are expressed in PPP-adjusted USD. To harmonize the transaction values in this study we use PPP-adjusted USD. PPP exchange rates are taken from the OECD:

`http://www.oecd.org/std/pricesandpurchasesingpowerparitiesppp/PPP_OECD.xls`.

Table 5: Card Ownership and Multihoming

	AU	AT	CA	FR	DE	NL	US
Share of respondents with							
payment card	0.95	0.86	0.99	0.92	0.94	1.00	0.88
debit card	0.93	0.85	0.97	0.90	0.94	0.99	0.76
credit card	0.47	0.24	0.81	0.31	0.33	0.62	0.67
# of payment cards in possession							
mean	1.93	1.77	3.51	1.61	1.85	1.63	4.23
median	2.00	1.00	3.00	1.00	1.00	2.00	3.00
# of payment instruments used in diary							
mean	2.23	1.75	1.79	2.37	1.88	1.56	2.28
median	2.00	2.00	2.00	2.00	2.00	1.00	2.00
Share of respondents who revolve or overdraft							
Revolvers	0.29	.	0.26	.	.	.	0.33
Overdraft	.	0.33	.	.	.	.	0.28

Notes: Payment card is defined as those with either a debit or credit card. Own calculation based on questionnaire and diary surveys. Revolvers are those who do not pay off their total credit card balances each month and incur interest/finance charges. Overdraft refers to persons who at least sometimes overdraw their checking account

Table 6: Card Ownership by Socio-Demographics

	AU	AT	CA	FR	DE	NL	US
Debit card ownership by socio-demographics							
age							
18-35	0.96	0.95	0.97	0.91	0.96	1.00	0.77
36-60	0.94	0.89	0.98	0.91	0.95	0.99	0.79
60+	0.88	0.69	0.94	0.86	0.91	0.99	0.69
education							
low	0.94	0.79	0.89	0.81	0.86	0.99	0.71
medium	0.86	0.91	0.98	0.90	0.98	0.99	0.86
high	0.91	0.96	0.97	0.96	0.99	0.99	0.80
income							
low	0.88	0.78	0.96	0.83	0.89	0.98	0.62
medium	0.95	0.90	0.97	0.93	0.96	0.99	0.82
high	0.94	0.93	0.97	0.96	0.97	0.99	0.82
Credit card ownership by socio-demographics							
age							
18-35	0.33	0.21	0.76	0.25	0.31	0.60	0.52
36-60	0.57	0.28	0.84	0.36	0.43	0.62	0.69
60+	0.46	0.20	0.83	0.29	0.24	0.62	0.84
education							
low	0.48	0.13	0.62	0.22	0.16	0.44	0.56
medium	0.41	0.31	0.77	0.31	0.39	0.55	0.81
high	0.45	0.42	0.91	0.36	0.68	0.75	0.92
income							
low	0.27	0.11	0.64	0.23	0.20	0.36	0.36
medium	0.53	0.20	0.84	0.32	0.27	0.60	0.75
high	0.54	0.42	0.95	0.52	0.54	0.86	0.91

Notes: Payment card is defined as those with either a debit or credit card. Own calculation based on diary and questionnaire surveys.

Table 7: Perceived Acceptance by Transaction Value

	AT	CA	DE
Quartile 1	0.48	0.53	0.28
Quartile 2	0.63	0.71	0.48
Quartile 3	0.68	0.80	0.69
Quartile 4	0.75	0.89	0.87
Overall	0.63	0.73	0.57

Notes: The table shows the share of transactions in a given transaction value quartile for which respondents answered that cards were accepted.

Table 8: Payment Instrument Value Shares by Type of Purchase

	Groceries	Gasoline	(Semi)durables	Service	Restaurant/drinks	Other
			Cash			
AU	0.40	0.30	0.21	0.29	0.73	0.21
AT	0.71	0.48	0.43	0.69	0.93	0.78
CA	0.28	0.29	0.12	0.11	0.45	0.24
FR	0.25	0.09	0.09	0.12	0.16	0.12
DE	0.68	0.34	0.26	0.56	0.81	0.42
NL	0.38	0.20	0.27	0.36	0.56	0.39
US	0.21	0.31	0.12	0.16	0.47	0.40
			Debit			
AU	0.43	0.47	0.43	0.25	0.19	0.14
AT	0.26	0.36	0.41	0.14	0.03	0.12
CA	0.42	0.27	0.29	0.21	0.26	0.35
FR	0.40	0.60	0.41	0.25	0.40	0.09
DE	0.30	0.55	0.51	0.14	0.09	0.06
NL	0.61	0.67	0.65	0.50	0.33	0.53
US	0.44	0.38	0.32	0.14	0.23	0.08
			Credit			
AU	0.16	0.19	0.25	0.24	0.08	0.07
AT	0.01	0.12	0.11	0.04	0.02	0.01
CA	0.29	0.41	0.56	0.54	0.28	0.26
FR	0.06	0.03	0.06	0.01	0.00	0.00
DE	0.01	0.10	0.12	0.13	0.09	0.10
NL	0.00	0.00	0.00	0.01	0.02	0.02
US	0.25	0.28	0.43	0.25	0.26	0.06
			Other payment instrument (if share $>$ 0.1)			
AU	.	.	0.11	0.21	.	0.58
AT	.	.	.	0.13	.	.
CA	.	.	.	0.14	.	0.15
FR	0.29	0.28	0.44	0.62	0.44	0.79
DE	.	.	0.10	0.17	.	0.43
NL	.	0.12	.	0.13	.	.
US	0.10	.	0.13	0.44	.	0.46

Notes: Own calculation based on diary surveys. Shares are in percent. Sectoral harmonization across countries is only approximate.

Table 9: Cash versus Non-Cash Payment Choice (Marginal Effects)

	AT	AU	CA	DE	FR	NL	US
Medium Income	-0.031	-0.068**	0.021	-0.005	-0.046**	0.006	-0.119***
	(0.017)	(0.024)	(0.021)	(0.011)	(0.017)	(0.016)	(0.020)
High Income	-0.035	-0.067**	0.014	-0.013	-0.071*	-0.009	-0.119***
	(0.019)	(0.025)	(0.027)	(0.012)	(0.031)	(0.016)	(0.025)
Aged 36-59	0.071***	0.022	0.041*	0.024*	0.051**	0.043**	0.091***
	(0.017)	(0.018)	(0.019)	(0.010)	(0.017)	(0.016)	(0.023)
Aged over 60	0.112***	0.057*	0.026	0.047**	0.042	0.061**	0.073*
	(0.027)	(0.024)	(0.031)	(0.018)	(0.028)	(0.020)	(0.029)
Medium Education	-0.040*	0.047	-0.106**	-0.034***	-0.045*	0.005	-0.126**
	(0.020)	(0.029)	(0.039)	(0.010)	(0.022)	(0.016)	(0.047)
High Education	-0.080***	0.011	-0.134***	-0.085***	-0.097***	-0.037**	-0.194***
	(0.015)	(0.022)	(0.040)	(0.014)	(0.027)	(0.014)	(0.046)
Not home owner	0.012		0.027				0.010
	(0.014)		(0.022)				(0.021)
Perceptions of:							
Ease	0.123***		0.170***				0.212***
	(0.037)		(0.045)				(0.035)
Cost	-0.046		0.082				0.037
	(0.025)		(0.043)				(0.045)
Security	0.082***		-0.054**				0.064***
	(0.016)		(0.020)				(0.014)
Acceptance	-0.023		-0.080				0.054
	(0.042)		(0.045)				(0.045)
Card acceptance share	-0.104***		-0.480***	-0.105***		-0.546***	
at the POS	(0.025)		(0.033)	(0.016)		(0.041)	
Cash on Hand	0.002	0.038***	0.005***	0.002***	0.001***	0.006***	0.003***
	(0.001)	(0.010)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Gasoline	-0.071***	-0.056***	-0.008	-0.098***	-0.161***	-0.046*	0.020
	(0.014)	(0.015)	(0.028)	(0.007)	(0.027)	(0.022)	(0.019)
Semi-durables	-0.047***	-0.039**	-0.036*	-0.082***	-0.098***	0.060***	-0.060**
	(0.012)	(0.012)	(0.017)	(0.008)	(0.016)	(0.014)	(0.019)
Services	0.080**	0.053***	0.031	0.048***	-0.029*	0.054*	0.138***
	(0.025)	(0.012)	(0.029)	(0.011)	(0.014)	(0.027)	(0.019)
Entertainment	0.167***	0.156***	0.109***	0.081***	-0.098***	0.269***	0.090***
	(0.021)	(0.013)	(0.017)	(0.012)	(0.018)	(0.017)	(0.016)
Other (not groceries)	0.075***	0.122***	0.084***	0.061***	0.040**	0.161***	0.409***
	(0.017)	(0.023)	(0.018)	(0.010)	(0.015)	(0.022)	(0.040)
TV Q2	-0.168***	-0.248***	-0.254***	-0.117***	-0.241***	-0.110***	-0.178***
	(0.022)	(0.015)	(0.016)	(0.021)	(0.035)	(0.016)	(0.016)
TV Q3	-0.263***	-0.372***	-0.397***	-0.243***	-0.454***	-0.264***	-0.305***
	(0.023)	(0.015)	(0.015)	(0.020)	(0.033)	(0.015)	(0.015)
TV Q4	-0.364***	-0.541***	-0.549***	-0.373***	-0.629***	-0.417***	-0.462***
	(0.023)	(0.013)	(0.015)	-0.020	(0.028)	(0.016)	(0.017)
Observations	7841	17303	12652	18676	7549	8233	10671

Notes: The dependent variable takes a value of 1 if a payment is made by cash and zero if it is made by debit or credit. Results for location (urban/rural), marital status, gender, employment status and family size are not shown. Variables are defined in Table A.1. Standard errors are in parentheses and the 1, 5, and 10 percent levels of significance are denoted by ***, **, *, respectively.

Table 10: Cash versus Non-Cash Payment Choice at Gas and Groceries (Marginal Effects)

	AT	AU	CA	DE	NL	US
Medium Income	-0.025	-0.072*	0.042	-0.009	0.007	-0.133***
	(0.024)	(0.033)	(0.029)	(0.014)	(0.017)	(0.027)
High Income	-0.039	-0.080*	0.002	-0.012	-0.023	-0.162***
	(0.029)	(0.034)	(0.037)	(0.015)	(0.018)	(0.038)
Aged 36-59	0.086***	0.017	0.077**	0.026	0.025	0.105***
	(0.023)	(0.026)	(0.024)	(0.014)	(0.017)	(0.032)
Aged over 60	0.127***	0.040	0.080	0.069**	0.019	0.059
	(0.039)	(0.036)	(0.043)	(0.022)	(0.021)	(0.040)
Medium Education	-0.069*	0.056	-0.073	-0.043***	-0.005	-0.138*
	(0.028)	(0.045)	(0.051)	(0.013)	(0.016)	(0.061)
High Education	-0.102***	0.004	-0.123*	-0.118***	-0.030*	-0.210***
	(0.021)	(0.037)	(0.052)	(0.019)	(0.015)	-0.060
Not home owner	0.035		0.046			0.053
	(0.020)		(0.029)			(0.029)
Perceptions of:						
Ease	0.212***		0.161**			0.240***
	(0.055)		(0.055)			(0.048)
Cost	-0.077*		0.108			0.000
	(0.037)		(0.061)			(0.061)
Security	0.114***		-0.055*			0.045*
	(0.024)		(0.026)			(0.020)
Acceptance	-0.134*		-0.051			-0.008
	(0.056)		(0.076)			(0.057)
Card acceptance share	-0.178***		-0.561***	-0.080***	-0.565***	
at the POS	(0.032)		(0.036)	(0.018)	(0.040)	
Cash on Hand	0.003*	0.053**	0.006***	0.003***	0.006***	0.002**
	(0.001)	(0.017)	(0.001)	(0.001)	(0.001)	(0.001)
Gasoline	-0.088***	-0.071***	-0.011	-0.114***	-0.036	0.024
	(0.017)	(0.017)	(0.028)	(0.008)	(0.020)	(0.020)
TV Q2	-0.201***	-0.273***	-0.284***	-0.189***	-0.094***	-0.176***
	(0.029)	(0.025)	(0.025)	(0.028)	(0.018)	(0.027)
TV Q3	-0.302***	-0.409***	-0.409***	-0.340***	-0.207***	-0.336***
	(0.030)	(0.023)	(0.023)	(0.028)	(0.018)	(0.024)
TV Q4	-0.420***	-0.586***	-0.572***	-0.481***	-0.316***	-0.466***
	(0.029)	(0.021)	(0.025)	(0.027)	(0.021)	(0.024)
Observations	3875	6569	5079	10364	4184	3688

Notes: The dependent variable takes a value of 1 if a payment is made by cash and zero if it is made by debit or credit. Results for location (urban/rural), marital status, gender, employment status and family size are not shown. Variables are defined in Table A.1. Standard errors are in parentheses and the 1, 5, and 10 percent levels of significance are denoted by ***, **, *, respectively.

Figure 1: Ratios of Currency in Circulation to Nominal GDP

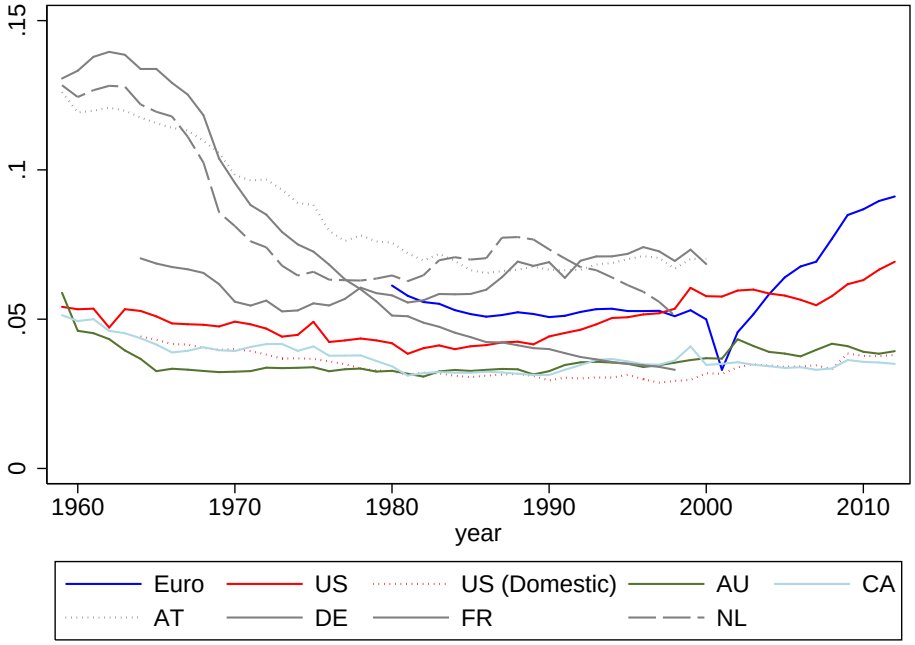
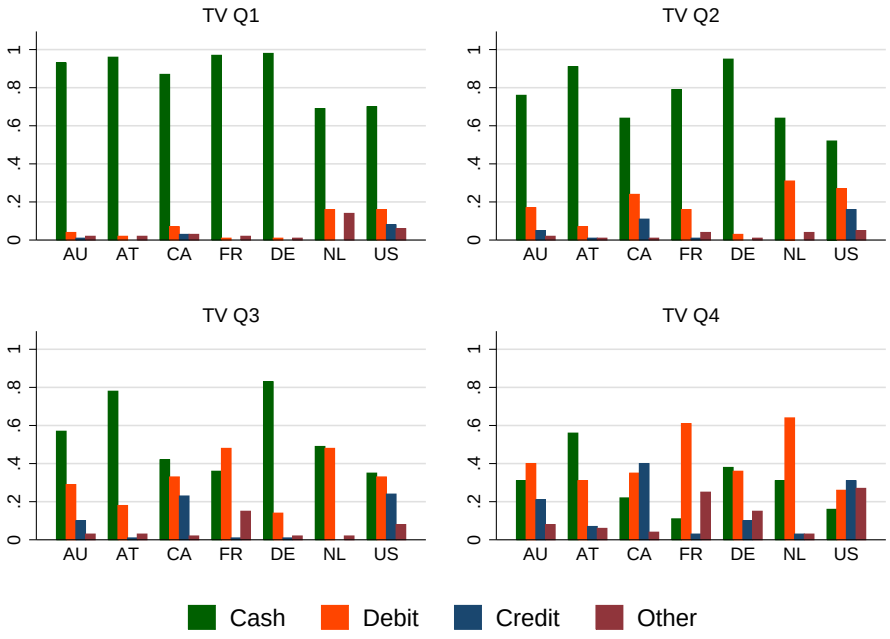
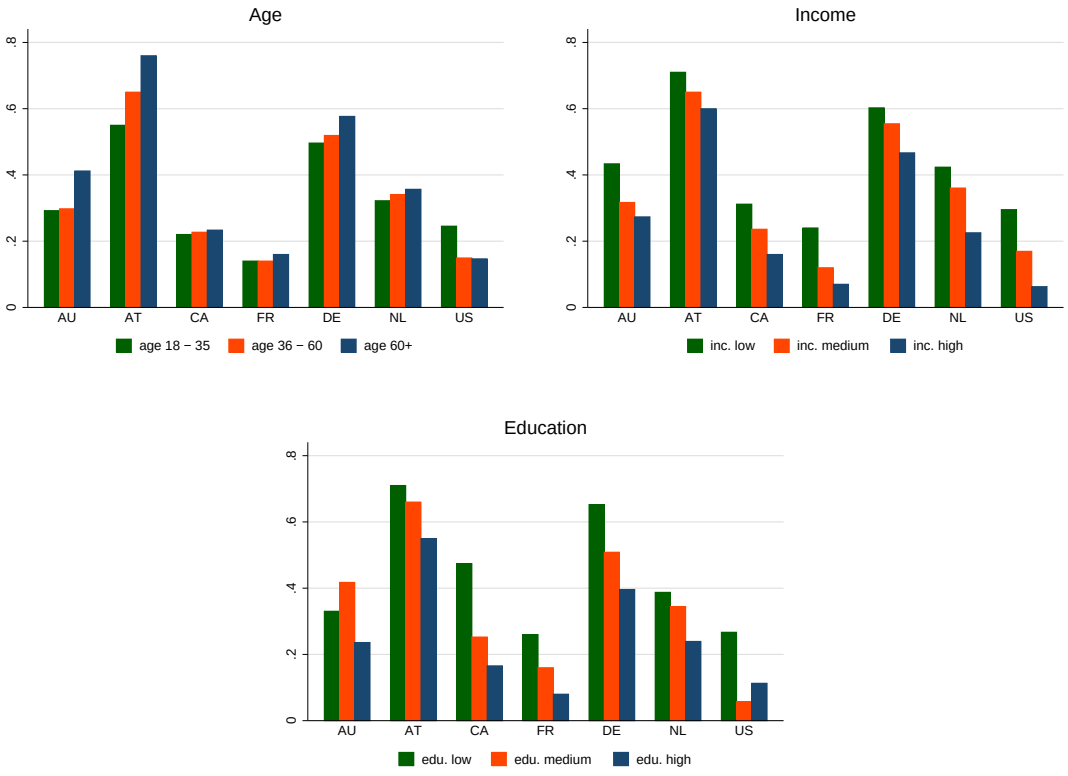


Figure 2: Value Share of Cash by Transaction Value Quartiles



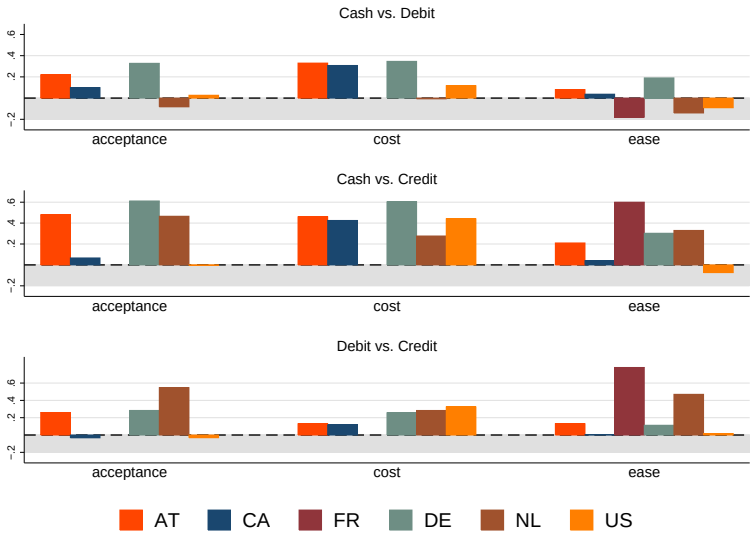
Source: Own calculation based on diary surveys.

Figure 3: Value Share of Cash by Age, Income and Education



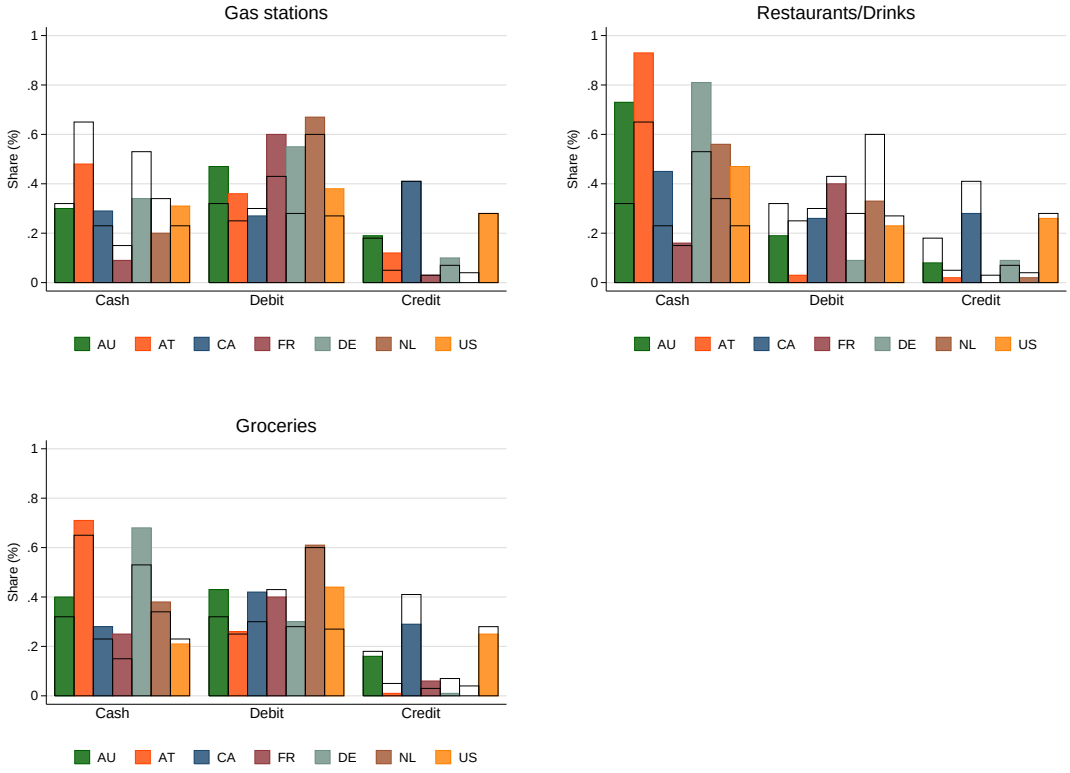
Notes: The figures depict the shares of cash (in value terms) in percent for the respective subgroup. Source: Own calculation based on harmonized diary surveys.

Figure 4: Perceptions of Cash



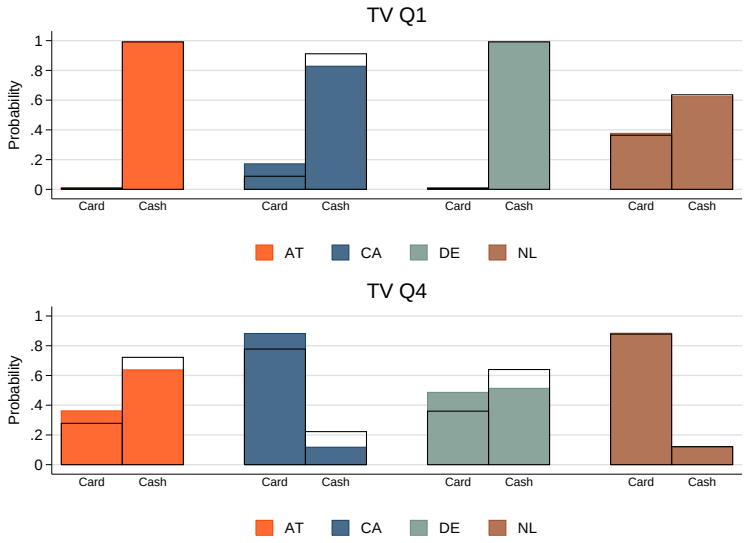
Note: The figure shows normalized perceptions of cash relative to debit and credit. A positive (negative) value indicates that cash is perceived better (worse) than the respective payment card. Due to differences in the wording of survey questions, the harmonization is only approximate. Values for acceptance and costs are not available for FR. For DE, values are taken from the 2008 payment diary. Own calculation based on questionnaire and diary surveys.

Figure 5: Value Share of Cash by Location/Activity



Note: Sectoral harmonization across countries is only approximate. The shaded area shows the shares for the respective location/activity, the transparent bar depicts the shares for all consumer expenditures.

Figure 6: Scenario Analysis: High Acceptance



Note: The figure compares the unconditional predicted probabilities of cash use (transparent bars) with a scenario in which acceptance is set to the maximum observed group acceptance (and all other explanatory variables evaluated at the sample mean). The upper (lower) panel refers to transaction values in the first (fourth) quartile.

A Appendix

Table A.1: Definition of Variables

Income	3 dummy variables; 1 if income is in the highest income tercil (High Income), lowest income tercil (Low Income) or in the middle income tercil (Medium Income), 0 else.
Age	3 dummy variables; 1 if age of respondents is above 60 (Aged over 60), between 36 and 59 (Aged 36 to 59) or between 18 and 35 (Aged under 36), 0 else.
Education	3 dummy variables: Low Education, Middle Education and High Education. Although the exact definitions depend on the country the definitions are about based on whether a respondent has finished mandatory schooling, secondary schooling and some post-secondary education.
Not home owner	Dummy variable; 1 if respondent does not own his place of residence.
Perceptions	The analysis employs perceptions on Ease of Use, Cost, Security and Acceptance. These are derived from question abot how much cash fulfills the listed attributes. The values are normalized by results for other methods of payment, such that a positive (negative) value implies that cash is valued better (worse) than cash or credit. The normalization is described in Arango *et al.* (2011).
Cash on hand	Defined as the usual (average) cash holdings on person. This is taken from survey questionnaires and not from the diaries. We drop all observations above the 99.5 percent mark and normalize this variable. As a consequence Cash on hand is unitless scalar.
Type of purchase	Several dummy variables; 1 if purchase is classified as Grocery, Gas Station, (Semi-)Durable, Services or Entertainment, 0 else.
Transaction value quartiles	Quartiles are fomed from all observed transaction values. 4 dummy variables which are 1 if a transaction falls in Transaction Value Quartile 1 to 4 (TV Q1 to TV Q4), 0 else.
Card acceptance share	Respondents indicate whether a transaction could have been conducted by card. From these observations we calculate the share of transactions with card acceptance for each individual. To avoid endogeneity, we then calculate the mean of individual card acceptance shares for nine pre-specified population groups that are formed from three income and three age groups. Acceptance Group thus reflects the mean acceptance of the income/eduation population group that a respondent belongs to.