

# 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, and Helmut Stix**

**Abstract:**

We measure consumers' use of cash by harmonizing payment diary surveys from seven countries. The seven diary surveys were conducted in 2009 (Canada), 2010 (Australia), 2011 (Austria, France, Germany, and the Netherlands), and 2012 (the United States). Our paper finds cross-country differences—for example, the level of cash use differs across countries. 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 Classifications:** D12, D14, E41

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John Bagnall is a manager, business analysis in the Payments Settlements Department of the Reserve Bank of Australia; David Bounie is a professor of economics at Telecom ParisTech; Kim P. Huynh is a principal researcher at the Bank of Canada; Anneke Kosse is a policy advisor at the Payment Systems Policy Department of De Nederlandsche Bank; Tobias Schmidt is a senior researcher at the Deutsche Bundesbank; Scott Schuh is the director of Consumer Payments Research Center and a senior economist and policy advisor in the research department at the Federal Reserve Bank of Boston; Helmut Stix is a research economist at the Oesterreichische Nationalbank. Their email addresses are [Bagnallj@rba.gov.au](mailto:Bagnallj@rba.gov.au), [david.bounie@telecom-paristech.fr](mailto:david.bounie@telecom-paristech.fr), [khuynh@bankofcanada.ca](mailto:khuynh@bankofcanada.ca), [j.c.m.kosse@dnb.nl](mailto:j.c.m.kosse@dnb.nl), [tobias.schmidt@bundesbank.de](mailto:tobias.schmidt@bundesbank.de), [scott.schuh@bos.frb.org](mailto:scott.schuh@bos.frb.org), and [helmut.stix@oenb.at](mailto:helmut.stix@oenb.at), respectively.

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# 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 rely heavily on mobile phones; see Jack, Suri, and Townsend (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, Pulley, and Vesala (1996). In the rare instances where comprehensive data are available for comparison, cash is usually excluded; see the studies by Bolt, Humphrey, and Uittenbogaard (2008) and the Federal Reserve System (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 have not disappeared.<sup>1</sup>

Figure 1 depicts the surprising resilience of cash in the 21st century in 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; see Fischer, Köhler, and Seitz (2004) and Judson (2012). However, even the estimated domestic U.S. currency ratio has increased since 2000 and its behavior is similar to that of the ratios in the other noneuro countries.<sup>2</sup> 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 an urgent 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 more scarce.<sup>3</sup>

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.<sup>4</sup> 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).<sup>5</sup> 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.<sup>6</sup> Payment diaries require consumers to record their transactions, so they should provide more accurate data than surveys, which rely on consumer recall.

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<sup>1</sup>Examples include Amromin and Chakravorti (2009), Lippi and Secchi (2009), and Evans et al. (2013).

<sup>2</sup>The domestic currency ratio could still be driven by domestic hoarding. One indicator of transaction demand is given by the ratio of medium-denomination bank notes to nominal GDP. Judson (2012) shows that the respective ratio for \$20 decreased by half for the United States and Canada since the 1970s but has remained fairly stable over the past 10 years.

<sup>3</sup>An early U.S. example is the Survey of Currency and Transactions Account Usage described in Avery et al. (1986).

<sup>4</sup>Jonker, Kosse, and Hernández (2012) and Arango et al. (2013) provide complementary comparisons of subsets of these seven countries.

<sup>5</sup>The payment diaries from these seven countries do not form an exhaustive list of international sources of consumer payments data. Other sources include Takács (2011), UK Payments Council (2013), and Danish National Bank (2013).

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

The current paper offers two contributions complementing previous work: (1) a careful, thorough harmonizing and analysis of these international diary data; and (2) a relatively simple econometric analysis of 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, it is essential to harmonize the data to be able to make valid and useful cross-country comparisons.<sup>7</sup> Although the diary surveys are similar across countries, it is impossible to make valid, direct comparisons of their statistics without meticulously analyzing and adjusting the technical details of the diary survey design and concept definitions. Seemingly minor details, such as the inclusion or exclusion of recurring bill payments, can have substantial effects on the resulting statistics. Therefore, we harmonized the underlying data sources and results from the seven individual country diaries so that the reported data are comparable. We also harmonized the definition of socio-demographic variables and point-of-sale (POS) characteristics (for example, card acceptance and the spending location), permitting a disaggregated view of payment behavior. As a result, the statistics reported in this paper may not coincide exactly with analogous data from national statistical sources. One factor that cannot be harmonized across the national payment systems, however, is the supply of services and providers. For example, paper checks are still relatively common in France and the United States but not in the other countries. Primarily for this reason, we do not attempt to model the adoption and uses of specific noncash 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 allow us to discover who uses cash, for which kinds of purchases, at which locations, and for what value of payment. These data may help us determine why cash is used and whether or not it is likely to continue to be used in the future.

Our econometric analysis of consumer cash use follows in the tradition of the recent literature that seeks to understand the determinants of consumer payment behavior more broadly. This literature extends back at least to Stavins (2001), who 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, Kiser, and Shaista (2008), Ching and Hayashi (2010), Schuh and Stavins (2010), Arango, Huynh, and Sabetti (2011), or von Kalckreuth, Schmidt, and Stix (forthcoming), among others, add a variety of other explanatory variables to such regressions. Unlike most studies, which usually use data from one country or only a few countries, this harmonized diary database makes it possible to assess the extent to which the determinants of payment choice are specific to a particular country or are more general.<sup>8</sup>

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<sup>7</sup>The efforts to harmonize 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).

<sup>8</sup>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, Guiso, and Jappelli (2002), Bounie and Francois (2008), Lippi and Secchi (2009), and 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.

Although our econometric analysis is a simple first step toward what can ultimately be done with the diary data, it nevertheless generates a few notable results. In the logit estimation of cash versus noncash 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 of goods, transaction sizes, and merchant acceptance of payments. Much more econometric modeling could be done with this harmonized diary database. In the penultimate section of this paper, we survey other research that has already used various forms of these diary data to study consumer payment choice in other contexts.

Using comprehensive, cross-country information on the use of cash 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 fore in a number of countries. Better insight into consumer behavior is essential for determining and evaluating these regulations. The study of the demand for cash and the management of cash is also important for evaluating the cost of payments,<sup>9</sup> 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 the management of liquid assets. In the final section of this paper, we analyze 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 underscores the puzzling deficiency of statistical evidence on the use of cash 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 payment behavior in the seven countries and serves as a foundation for the subsequent analysis. Section 3 describes the payment diaries and steps taken to harmonize the database. Section 4 presents the consumer expenditure patterns across countries. Section 5 discusses the various factors that may affect the levels of cash use across countries. Section 6 presents the estimation results for the econometric models of consumer choice between using cash or other noncash 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 point of sale (POS), for remote purchases, or in-person to other persons. Recurring transactions (for example, rent, utility

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<sup>9</sup>Schmiedel, Kostova, and Ruttenberg (2013) provide a summary of the ECB cost study.

bills) are excluded. Our main findings follow:

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

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

- Payment card ownership (especially debit card ownership) is high in all countries. However, there are large cross-country differences with respect to the prevalence of credit cards. This suggests that the use of cash may be correlated with the level of credit card ownership if cash and credit cards are substitutes in consumer payments.
- Another indication about market structure can be learned from average transaction values. In all seven countries, the average value of cash transactions is lower than the average value of card transactions. This result is consistent with prevalent transaction-size models (for example, Whitesell 1989; Bouhdaoui and Bounie 2012). Notably, in card-intensive countries, the average card transaction value is lower than in cash-intensive countries.
- 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 indicates that acceptance is correlated with cash use.
- Survey responses suggest that cash balances are substantially higher in AT and DE than in the other countries. This result corresponds with the importance of cash for payments in these countries. This correlation may not be causal and there may be a simultaneity in cash management and payment behavior. 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 use the above findings to delve deeper into the levels in cash use across countries. To get a better grasp, we also analyze cash use by looking at (1) the expenditure structure in the various countries, (2)

whether cash use 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 interrelationship between cash holdings and payment behavior by delving deeper into the cash management practices of consumers. As a case in point, Table 1 highlights that all “noncash-intensive” countries have a rather similar median cash balance, or about 30 purchasing-power parity (PPP-USD). This suggests that consumers behave rather similarly in different countries. We further exemplify and analyze this issue by looking at withdrawals and other aspects of cash management behavior.

### **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 start with a more general discussion about the value of payment diary data, by contrasting diary studies with classical ways of collecting information, such as questionnaire surveys or macro-data analyzes. The section concludes with a few remarks on the harmonization steps necessary to create comparable data sets.

#### **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 behavior and 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 behavior at the consumer level. Some data are proprietary, so individual behavior cannot be tracked. Scanner data do not usually provide information about the consumer and are focused on only a certain portion of consumer behavior (for example, grocery purchases).

Therefore, payment studies often have recourse to consumer survey data. Here a distinction can be made between data collected through consumer questionnaires and data collected through consumer payment diaries. The advantage of questionnaires is that the burden on the respondent is limited to the time needed to complete the questionnaire at one moment in time; diaries, in contrast, require respondents to report information over a number of days. While this collection method generates data that allow for thorough analyzes of general behavioral patterns as well as the underlying drivers, it is less suitable for analyzing the specificities of individual payments. For example, surveys may serve as a valuable tool for measuring the adoption of payment instruments by consumers, while diaries are better for assessing their actual use.<sup>10</sup>

Collecting payment data through diaries has thus become popular in recent years.<sup>11</sup> The main benefits of using diary data, in particular in combination with questionnaire data, are obvious. Foremost, as con-

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<sup>10</sup>In particular, when asking about individual payments, questionnaires may suffer from “recall bias” or under-reporting of payments due to incomplete recall. Frequent and low-value payments are especially sensitive to being omitted; see Jonker and Kosse (2013).

<sup>11</sup>Collecting data using diaries has a long history in official statistics on expenditure; see McWhinney and Champion (1974). Earlier general surveys about payments were conducted by Avery et al. (1986) and Boeschoten (1992). Mooslechner and Wehinger (1997) conducted a payment diary in Austria in 1996.

sumers are stimulated to record with a minimum of delay after each particular transaction, the probability of transactions being omitted or erroneously reported is lower than for questionnaire surveys. Payment diaries also allow for the collection of many details of individual transactions, such as the payment amount, the payment location, the acceptance of noncash payments, and surcharging, which enable better understanding of the factors that drive consumer heterogeneity in payment behavior.

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 use.

### **3.2 Validity of seven payment diaries**

Our study uses 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 (for example, recurrent and remote transactions), and the level of detail regarding transaction characteristics (Table 2).<sup>12</sup> To account for these differences, we put a lot of effort into the harmonizing 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 advantages of diary surveys described above, 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. To do this, we extrapolate the survey outcomes by multiplying the average daily diary expenditure by 365 to obtain an annual figure, and we compare this value with the average annual value of expenses as reported by the Organisation for Economic Co-operation and Development (OECD), deducting expenses for housing, water, electricity, and gas.<sup>13</sup>

The results of this exercise are reported in the last row of Table 2. For all diaries, the ratio 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 estimates, based on samples from surveys, and, hence, are subject to a 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 payment included.

Therefore, we interpret the ratios, which all vary around 1.00, as evidence that all individual surveys perform reasonably well in capturing the actual expenditures made in these countries. Moreover, all countries undertook a number of plausibility checks. These involved comparisons, either with population figures (if

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<sup>12</sup>The literature has shown that the specific design of a diary may affect the quality of the collected data; for example, Crossley and Winter (2012), Jonker and Kosse (2013), Sudman and Ferber (1971).

<sup>13</sup>We focus on the average annual expenses by the adult population only, since the samples used in the diary surveys also targeted only residents aged between 18 and 75 years.

available; for example, the average number and value of debit card payments or ATM withdrawals) or with other sources (such as other market research reports). Some countries were able to refer to earlier payment diary or questionnaire studies and check their stability over time.

### **3.3 Similarities**

The seven diary surveys share a number of similarities (see Table 2). First, all seven diaries collect data on POS transactions. Each diary attempts to record nonbusiness-related personal expenditures of the respondent (whether for the respondent 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. Respondents in AT, CA, DE, and NL were asked to assess whether the purchase could have been paid using payment instruments other than the one actually used. For cash withdrawals, all the diaries collected information on the location (and, in some cases, the timing) as well as 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, that is, 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 were between the ages 18 and 75 years, although some diaries were also distributed among children and people over 75 years old. However, as noted above in the expenditure ratio discussion, all the analyses presented in this paper focus only on payments made by adults. Finally, all diary surveys yielded datasets containing more than 10,000 transactions.

### **3.4 Differences**

Several differences among the diaries should be kept in mind when interpreting the results. First, some diaries asked respondents to fill out the diary using paper and pencil (AU, AT, DE, and FR). US and CA relied on a mix of paper and online questionnaires. For 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 countries differed with respect to the frame from which the respondents were selected. For CA, NL, and 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 they lack access to the Internet, and when the behavior of persons who do participate differs from the behavior of those who do not (see Bethlehem 2008). Yet, given the high Internet penetration in 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 NL that drawing respondents from an online panel does not introduce pro-electronic biases reflected in an overestimation of

card use. Moreover, in order to prevent any such biases, all panelists for US were provided with a computer or with Internet access.

Second, differences exist with respect to the length of the diaries, as follows: 1-day (NL), 3-day (CA, US), 7-day (AT, AU, and DE), and 8-day (FR). Research by Ahmed, Brzozowski, and Crossley (2006), Jonker and Kosse (2013), and McWhinney and Champion (1974) shows that longer diaries may lead to survey fatigue (that is, under-reporting of expenditures), especially for small-value transactions.<sup>14</sup> Despite these differences and their potential consequences, we believe that, due to their richness, the seven datasets are well suited to answer the main questions of this paper. Moreover, as discussed below, we conducted some robustness checks that confirmed that the differences in diary length do not sizably affect our overall findings and conclusions.

### 3.5 Harmonizing the data

We undertook the following harmonizing steps to create seven data sets that are mutually comparable. In particular:

1. We distilled all payments from persons aged 18 years and older.
2. We only considered the payments made at the POS; for remote purchases via mail order, the telephone, or the Internet; and in-person person-to-person payments. Recurrent transactions (for example, rents, utility bills) are excluded.

Also, we conducted a number of harmonizing steps 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 be taken as only a rough indicator, due to the large national differences in the number and size of categories used.<sup>15</sup> Finally, we harmonized the definitions and categories of the various socio-demographic characteristics (for example, income, education).

## 4 Expenditure Patterns

Table 3 reports summary statistics of the total structure of recorded payments and thus of consumer expenditures.<sup>16</sup> It shows that the structure of payments is similar across countries with respect to the time of day, day of the week, and payment channel, although some cross-country differences are discernible. About one-third of transactions are conducted before noon, and two-thirds after. As expected, Sunday is the day with the lowest share of transactions. The Sunday share is slightly higher for AU and US, which is reasonable given cultural differences in store opening hours. Finally, in-person transactions make up the vast

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<sup>14</sup>Ahmed, Brzozowski, and Crossley (2006), Jonker and Kosse (2013), and Schmidt (2011) study the effect of survey fatigue and the efficacy of data collection via payment diaries.

<sup>15</sup>Harmonization difficulties arose mainly because of (1) 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); (2) differences in the categorization of expenditures (for example, some countries recorded expenditures in restaurants and hotels in one category; other countries recorded hotel expenditures with other services) and (3) differences in the structure of retail shops (for example, in some countries newspapers and tobacco can be bought in grocery shops; other countries have small, special shops for these purchases).

<sup>16</sup>Note that these are consumer expenditures and not consumption.

majority of payments. For AU and US, the volume share of Internet/mobile payments at the POS account for a volume share that is higher than 4 percent, while in all other countries it is almost negligible.

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

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

**Observation 1** *The structure of consumer payments is similar across countries with respect to the number and value of transactions: (1) Consumers conduct only a few payment transactions per day and (2) most consumer expenditures are relatively small in value.*

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

Analyzing individual transactions provides another angle from which 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 NL. In AT, DE, and US, the value is higher, at 17 to 23 PPP-USD. We also find that 75 percent of all recorded transactions are lower than 25 to 43 PPP-USD.

## 5 Use of Cash: Descriptive Evidence

We noted the outstanding importance of cash in all countries, in Section 2, Table 1. 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 that has mostly been confined to the analysis of single countries.<sup>17</sup> Note that the descriptive statistics presented in this section provide only a first indication of the potential correlation with cash use, disregarding all other factors. A definitive finding on the role of each of the selected factors in explaining consumers' use of cash can only be provided after controlling for the other variables using multivariate econometric techniques. These estimates are presented in Section 6.

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<sup>17</sup>One shortcoming of our analysis is that our data cannot establish the causal link between payment choice and card pricing (for example, Borzekowski, Kiser, and Shaista 2008; Simon, Smith, and West 2010). Moreover, whenever we analyze POS characteristics, we assume that these are fixed.

## 5.1 Transaction size

Numerous previous papers have shown that transaction size is highly correlated with the choice of payment instrument (for example, Arango, Huynh, and Sabetti 2011; Bouhdaoui and Bounie 2012; Klee 2008; von Kalckreuth, Schmidt, and Stix 2014). Our analysis substantiates these findings.

**Observation 2** *The use of cash decreases with transaction size. In all countries, cash predominates for the smallest 50 percent of transactions. For the largest 25 percent 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 plays only a minor role in CA, NL, and US, while credit is used only in CA (share of 3 percent) and US (share of 6 percent). Other payment instruments have a notable share of low-value transactions only in NL (14 percent) and US (6 percent). In all countries, we find that the cash share is higher than 50 percent up to the median transaction value. In the third quartile, the dominance of cash fades. In this transaction value range, however, cash has a higher share than debit or credit in three countries and a share that is about equal to the share of debit in CA, FR, NL, and US. In the fourth quartile, the full heterogeneity across countries becomes evident: (1) the importance of credit card payments in AU, CA, and US, (2) the importance of checks in FR and US (evident in the “other” category), and (3) 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 are correlated with greater use of cash in payments: see Arango, Huynh, and Sabetti (2011), Eschelbach and Schmidt (2013), Bouhdaoui and Bounie (2012), and Arango et al. (2013). Our findings provide support for a relationship between cash use and cash balances.

**Observation 3** *Austria and Germany, are more cash-intensive than other countries 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 twice as great as those in other countries (from 51 in NL to 74 USD in US). These statistics are in line with the greater use of cash for payments in AT and DE, where the share of cash by volume exceeds 80 percent. It reaches a maximum of just 65 percent in other countries. As a consequence, the mean of consumer-level ratios of  $M/e$ , 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 for US, while it reaches 3.4 for AT. The extent to which the suggested relationship between cash balances and cash use is causal remains unclear. That is, the level of cash balances might affect

consumers' use of cash, but, similarly, the use of cash may determine the amount of cash that consumers carry. In other words, it is not clear whether cash management causes cash use or vice versa.

Cash is obtained from ATMs, bank tellers, and other sources (family, retail cashback, etc.). Except in US, where it is 69 percent, the main source of cash is the ATM; the share of people withdrawing at least once a month from ATMs exceeds 70 percent in all other countries. However, the median number of monthly ATM withdrawals varies greatly across countries, from 2 for DE to 4 for CA and AT. These withdrawal patterns seem to be directly correlated with the typical cash withdrawal amounts at ATMs.<sup>18</sup>

The overall picture that 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 possible explanations for this behavior. One is that AT and DE respondents 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 is not conclusive. Cash balances before withdrawals are larger in AT and DE than in CA but not larger than in US.

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

The second interesting statistic is the ratio of the withdrawal amount ( $W$ ) to average currency holdings ( $W/M$ ). This ratio equals 2 in the Baumol-Tobin model. The mean of this ratio is substantially higher in the data (ranging from 3.8 for 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 suggest a precautionary motive for holding cash. To draw any structural interpretation, however, more work is required.

### 5.3 Socio-demographic characteristics

This section presents evidence on cash use along socio-demographic characteristics, and analysis of survey evidence on consumers' perceptions of cash.

**Observation 4** *Cash use 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 might 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 (for example, Daniels and Murphy 1994; Boeschoten 1998; Carow and Staten 1999; Stavins 2001; Hayashi and Klee 2003).

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<sup>18</sup>As previously outlined, US stands out in this respect: the share of people obtaining cash from other sources at least once a month (90 percent) is above that of those withdrawing cash from ATMs and tellers (70 percent and 40 percent, respectively), and the withdrawal frequency at these other sources is far above that for ATMs and tellers (3.3 compared to 1.3 for ATMs and 0.7 for tellers).

Our results in Figure 3 reveal that “older” people use significantly more cash than younger people except in 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 expenditure patterns or other personal characteristics; for example, younger consumers may buy different products 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 are the focus of the next section.<sup>19</sup>

Income and education have been cited in the literature as important factors, with cash use declining with higher income and education (for example, for CA, Arango, Huynh, and Sabetti (2011); for DE, von Kalckreuth, Schmidt, and Stix (forthcoming); and for US, Schuh and Stavins (2010); Cohen and Rysman (2013). Figure 3 confirms differences along income terciles with less cash use by higher-income respondents. Even stronger differences are found along education. Notably, these differences pertain to all analyzed countries: in DE and CA, the difference in the value share of cash between low education and high education is more than 26 percentage points, while in the remaining countries this difference ranges from 9 to 18 percentage points.<sup>20</sup>

Recent work by von Kalckreuth, Schmidt, and Stix (2014) finds that cash is used to monitor expenditures. In particular, their prediction is that cash will be used for this purpose by individuals who face financial constraints and who have difficulties with other monitoring techniques (such as online accounts). The pattern of results obtained for income and education is in line with this proposition.<sup>21</sup>

### 5.3.2 Consumer preferences

One could argue that consumers are using cash because they have no choice; for example, because payment cards are not accepted or for reasons of costs, safety, or convenience. We can analyze this issue by looking at consumers’ ratings of certain payment instrument attributes, which can be viewed as broad proxies for consumer preferences and which have been found to affect payment choice (for example, Borzekowski, Kiser, and Shaista 2008; Ching and Hayashi 2010; Schuh and Stavins 2010; Arango, Huynh, and Sabetti 2011).

To a varying degree, the seven diaries contain information on preferences that we have attempted to harmonize. The harmonizing was difficult because the different diary surveys described and asked about preferences in different ways. Moreover, responses were measured in different ways, with some countries using Likert scales and others binary responses. In the face of these obstacles, we were able to successfully harmonize only responses concerning the relative perceived acceptance, cost, and ease-of-use of cash. Figure 4 shows a normalized comparison of consumers’ ratings of cash versus debit, cash versus credit, and debit versus credit.<sup>22</sup> The depicted measures are scale free, with a positive (negative) value in the first panel

<sup>19</sup>von Kalckreuth, Schmidt, and Stix (2014) find no evidence in favor of strong habit persistence. Instead, they attribute higher cash use of older people to their differential characteristics (for example, lower opportunity costs of time or lower income).

<sup>20</sup>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 cash shares do, suggests that income and education exert an autonomous effect on cash use that is independent of card ownership.

<sup>21</sup>The role of debit cards for spending restraint has been recently analyzed by Fusaro (2013).

<sup>22</sup>See Arango, Huynh, and Sabetti (2011) and Jonker (2007) for a description of the normalization. Variables are defined in

implying that cash is rated better (worse) than debit (a value of zero means that cash is rated the same as debit) and similarly for the other comparisons.

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

Concerning consumer perceptions of acceptance, we can compare results from five countries. For AT, CA, and DE, cash is rated higher than debit. For US, cash is rated the same as debit, and for NL cash is rated worse than debit. For CA and US, we find that results concerning cash versus debit and cash versus credit are very similar, reflecting the observation 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 such as AT, DE, and NL.

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

Overall, this evidence suggests that the use of cash by consumers is not solely the result of a lack of alternatives. On the contrary, cash is valued by consumers because it is perceived more positively than, or as positively as, credit and debit cards with respect to cost. Also, the assessment shows that especially in countries with relatively high cash use, ease of use may be an important driver.

## 5.4 Card ownership

Use of cash may be influenced by differences in the prevalence and use of payment cards.

**Observation 6** *Although the levels of card ownership differ across countries, overall card ownership is rather high across the board. Consumers use only a few payment instruments in addition to cash.*

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

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

There are significant differences in the number of cards owned or used by an individual (known as multi-homing when more than one card is owned and used).<sup>23</sup> CA and US consumers possess, on average, 3.5 and 4.2 payment cards. In all other countries, the value is below 2. The median number of payment cards is 3 in CA and US, 2 in AU and NL and only 1 in AT, DE, and FR.

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Table A.1.

<sup>23</sup>Rysman (2007) discusses the issue of multi-homing (that is, respondents' practice of holding or using more than one payment card). In our analysis, we focus on card use on the extensive margin (number of cards), not the intensive margin (the extent to which the card is used).

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.<sup>24</sup> Although these results are influenced by the length of the diary period, they suggest that the median consumer uses only a few payment instruments alongside cash, which is in line with the results of Cohen and Rysman (2013) using a data set that follows consumers over a much longer period.

## 5.5 POS characteristics

Finally, we discuss two types of POS characteristics: (1) card acceptance at the POS, and (2) the type of economic activity in which transactions occur.

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

**Observation 8** *Cash use 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 for AT, CA, and DE. Specifically, the payment diaries recorded whether a transaction could have been made in cashless form. On the basis of this information, we can analyze whether high cash use is attributable to insufficient payment card acceptance. When interpreting results, however, one should be keep mind that the results are based on respondents' subjective assessments.

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 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 (1) CA has the highest acceptance values in each quartile, and (2) the difference, interestingly, is not strong for higher transaction amounts than those in AT and DE. This evidence is roughly consistent with cash use. Note again that these descriptive statistics assume all other factors to be fixed. Therefore, to analyze the real effect of card acceptance, econometric analyses are presented in Section 6 to account for all other potential factors.

### 5.5.2 Type of purchase

The diaries allow the analysis of cash use in different sectors and for different types of expenditures. We calculated payment instrument shares for cash, debit, and credit for all sectors, summarized in Table 8. Given country-specific differences in industry sector definitions, we stress that harmonization is incomplete, particularly for services and "other sectors," so 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, or behavioral patterns, or by cultural differences. Accordingly, Figure 5 depicts three sectors that we consider interesting with regard to these factors.

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<sup>24</sup>For NL the median is one payment instrument, which is explained by the fact that respondents recorded their payments for only one day.

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

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 checks account for more than 40 percent of the payment 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 differ in their payment behavior depending on the spending location, and that this is not only to be explained solely by levels of card acceptance and transaction sizes.

Third, for the grocery sector the cash expenditure share is higher than the average for all countries except US. Interestingly, the debit share is higher in all countries except FR, where the credit share is slightly higher. We conjecture that this fact is associated with convenience and/or the market structure of the grocery sector. Regarding the first issue, cash could be considered a convenient and fast way to pay for purchases at (small) grocery stores. It may also be correlated with the size of the location and card acceptance. In most European countries, grocery stores are smaller than in AU, CA, and US. The grocery sector, often having low margins, may focus on the cost of payments, and this could explain the higher use of debit in that sector.

## 6 Choosing Cash versus Noncash

This section investigates the use of cash versus noncash in a multivariate setting. We estimate the probability of choosing cash versus noncash alternatives (either debit or credit) at the POS, using the following logit model:

$$U_j^* = X_j\beta + \epsilon_j, \text{ where } j = \text{Cash, Noncash}, \quad (1)$$

where  $U_j^*$  is the utility of choice,  $j$ , as a function of observables,  $X_j$ , and a logit error,  $\epsilon_j$ . 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 and 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 using 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 of 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 reveals patterns that are common to all countries.

## 6.1 Results

Table 9 reports the marginal effects on the probability of using cash. Overall, the findings are fairly consistent 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 are associated with lower cash use. Regarding age, we find that persons older than 36 use significantly more cash than persons younger than 36. Also, the results provide support for a certain habit persistence in some countries (AT, AU, DE, NL), where cash increases homogeneously with age: people aged 60 and older are more likely to use cash than people between 36 and 59.

For three countries that collected data on consumer perceptions regarding payment instruments (AT, CA, and 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 conduct more cash transactions. The perceptions regarding security were different, positive versus negative, between AT and CA. The other perceptions with respect to cost and overall acceptance were not significant. These results are in line with previous research; see Schuh and Stavins (2010), Arango, Huynh, and Sabetti (2011), and von Kalckreuth, Schmidt, and Stix (forthcoming).

The strongest effect on consumers' choice between cash and noncash was 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 using cash is lower by 36 (AT) to 63 pp (FR) relative to the first transaction value quartile.

Table 9 also confirms an independent effect of purchase location/type of purchase. For expenditures at gas stations and for purchases of semi-durables, the marginal effects were universally negative (with the exception of US for gasoline and NL for semi-durables), while for services, entertainment, and other (not groceries) they were positive (except in FR). These results confirm previous results that were based on data from single countries (for example, Klee 2008; Cohen and Rysman 2013).

Another finding of the logit model is that people who hold higher cash balances on average use cash more often than people with lower cash balances. Note, however, that we treat this as indicative only, because of the likely presence of reverse causality.<sup>25</sup> 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 (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 indicate that card acceptance is likely to be important in

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<sup>25</sup>It was impossible to apply an instrumental variable approach that is common to all countries, because the survey questionnaires differed too much across countries. Omitting cash balances from the regressions, however, did not affect the other findings.

consumers' choice between cash and noncash. This result is reported 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 use across countries, we conduct a scenario analysis. In particular, we compare the baseline probabilities, that is, 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. Therefore, the question we ask is by how much cash use would decline if acceptance were as high as it is for the income/age group that reports the highest acceptance rate.<sup>26</sup>

Figure 6 summarizes the results for the first and fourth transaction value (TV) quartile. For TV Q1, the effect on payment choice is trivial for AT, DE, and NL, while for CA it is significant. There is an almost 10 percentage point increase in card use for low-value transactions in the scenario in which payment cards are 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 would be more likely to pay with cards for all transactions if cards were universally accepted. High acceptance of cards will increase card use for AT and DE only if the transaction values are high. For NL, the effect would be minimal, which indicates that current levels of acceptance are already relatively high at all transaction quartiles. These results highlight that country differences remain substantial.

## 6.2 Robustness: Groceries and gas

As one important robustness check, we focus on transactions completed at grocery stores and gas stations only. The results are reported in Table 10. Focusing on these sectors reduces the sample by about one-half to two-thirds. The results again confirm the roles of demographics and transaction value. These results are consistent with the findings of Klee (2008), who use scanner data from grocery stores, and Cohen and Rysman (2013), who uses scanner data from grocery stores and gas stations.<sup>27</sup> In addition, we find that the results for the other variables do not change; we still find an independent effect for preferences, cash on hand, and payment location/type of product.

Finally, we perform two additional robustness checks. First, we estimate a logit using the transactions conducted on the first day of each diary to compare with the Dutch payment diary, which collected data per respondent for only one day. Second, we also generate estimates using only the first three days for AU, AT, DE, and FR, which are comparable to those for CA and US. Neither of these modifications affects the main results.

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<sup>26</sup>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 their sample means.

<sup>27</sup>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) analyze rich data on grocery purchases and are able to follow consumers over a longer time period. Their paper highlights the role of the transaction size.

## 7 Payment Diaries: Past and Present

The use 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 (1) cash use, (2) determinants of payment instrument choice, and (3) how market structure may matter for payment choice.

### 7.1 Consumer cash use

A key advantage of payment diaries is the proper accounting of cash payments relative to all methods of payment. Stix (2004), Jonker and Kettenis (2007), and Bounie, Francois, and Waelbroeck (2013) demonstrate that cash demand is affected by debit card use in AU, NL, and FR. In DE, credit cards are relatively interchangeable with debit cards for the use of cash; see von Kalckreuth, Schmidt, and Stix (2014). Further work by von Kalckreuth, Schmidt, and Stix (forthcoming) uses payment diary data for DE to show that cash is used as a method to monitor expenditures (*pocket-watching*). Fung, Huynh, and Sabetti (2012) investigate the effect of retail payment innovations (that is, contactless credit cards and stored-value cards) on cash use and find that there is a reduction. Finally, Bounie, Francois, and Waelbroeck (2013) and Huynh, Schmidt-Dengler, and Stix (2014) study the impact of card acceptance on cash use. They find that the lack of card acceptance is a reason to hold precautionary cash balances.

### 7.2 Consumer adoption and use of payment instruments

The study by Bounie and Francois (2006), based on a 2005 French payment diary, was an early attempt to disentangle the effect of demographics from the effect of payment characteristics such as transaction value on payment choice. Further work by Bouhdaoui and Bounie (2012) proposes a cash holding model as an alternative to a transaction-size explanation for payment choice.<sup>28</sup> Kosse (2013) focuses on the perception of safety aspects for cash versus debit, while Kosse and Jansen (2013) demonstrate that a variation in demographics such as foreign background has a strong effect on payment choice for NL.

Simon, Smith, and West (2010) (for AU), Arango, Huynh, and Sabetti (2011) (for CA) and Wakamori and Welte (2012) (for CA) extend the analysis beyond demographics and payment characteristics to 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 (2014) investigates the effect of debit card interchange fees and sorts out the transaction value at which interchange fees become higher or lower due to the new rule. Briglevics and Shy (2014) use the payment diaries to understand merchant steering. They compute the expected net cost of discounts on cash

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<sup>28</sup>Arango et al. (2013) extend this work by conducting the test for CA, FR, DE, and NL.

and debit card payments and find that, for the most part, steering is unprofitable. Welte (2014) studies and extends the steering exercise by embedding consumer choice into the expected net cost calculations for CA.

#### **7.4 Scanner data projects**

Scanner data have been touted as an alternative to payment diaries as a method of data collection on payments. For US, Klee (2008) uses data to show that payment choice is a function of the amount of time spent processing the items purchased. Research by Polasik et al. (2012) for Poland demonstrates the use 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 provide rich detailed information, including the opportunity cost of time. One drawback of these scanner data projects is that direct demographic data are 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 demographic information with the scanner data.

### **8 Payment Diaries: Going Forward**

This section describes possible future use of payment diaries. We focus on three main points: structural models of cash and alternative means of payment, high-frequency consumption/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 has been exploited to understand household money demand elasticities; see Mulligan and Sala-i-Martin (2000) or Attanasio, Guiso, and Jappelli (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 merchant nonacceptance of cards as a reason to hold precautionary cash balances.

Most payment diaries contain information about cash management behavior 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 conduct the statistical sampling behind these questions. The diaries rely on a short-term window to focus in on behavior that may be infrequent.

Nosal and Rocheteau (2012) offer an extensive discussion of the new monetarist approach, which has stressed various real trading frictions to explain the coexistence of cash with cards. For example, Telyukova and Wright (2008) argue that the need for liquidity can explain why households hold cash while having a

credit balance with a high borrowing rate. The current payment diaries focus mainly on payment choice and expenditures. There is scant information about credit arrangements, that is, an indicator of whether or not a household has carried a balance from month to month. Therefore, to validate these models empirically would require detailed household balance-sheet information.

## **8.2 High-frequency consumption and saving**

Recent work by Aruoba, Diebold, and Scotti (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 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 the 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 clearly identified. Also, Mastrobuoni and Weinberg (2010) demonstrate that exact pay dates have an impact on consumption, especially for social security recipients. Payment diaries would need to be redesigned to incorporate questions to determine these effects.

## **8.3 Two-sided markets and regulation**

Rochet and Tirole (2002) and Wright (2003) discuss the theoretical nature of two-sided markets for the payments literature. The work on estimating these two-sided markets, with the exception of Rysman (2007), uses network data to study the use of credit cards, network externalities, and multi-homing. Also, recent work by Shy and Wang (2011) discusses why interchange fees are proportional.

Payment diaries contain detailed data on consumer payments but only a few questions on merchant characteristics (venue and acceptance of cards). Recent work by Bounie, Francois, and Hove (2014) matches payment diary data to data from a nationwide French merchant survey to investigate the probability that 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) illustrates the difficulty of this task, as they attempt to embed questions about merchant steering into US payment diaries. Their results are inconclusive and they discuss the challenges and pitfalls of this exercise. Future attempts to improve 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 have been greatly exaggerated*. This paper shows that in all seven countries considered, cash is still

used extensively — particularly for low-value transactions. In some European countries such as Austria and Germany, cash even dominates consumer payment choices for all transaction values.

This paper demonstrates that, apart from transaction sizes and consumer preferences for ease of use, 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 finding that these results can be observed for all seven countries assures us that these are universal factors driving cash use.

Our paper signals the importance of cross-country differences. First, the level of cash use differs across the various countries. Second, differences can be found in the type of alternatives used for cash. Consumers in some countries often use credit cards as a substitute; in other countries, mainly debit cards are used. One explanation for these cross-country differences may 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. Third, we point to an important correlation between cash use and the amount of cash balances consumers carry. The direction of the correlation 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 required to more fully ascertain the underlying drivers of consumers' use of cash and alternative payment methods.

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Table 1: Salient Results

	AU	AT	CA	FR	DE	NL	US
<b>Payment share by volume</b>							
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
<i>Total</i>	0.96	0.98	0.97	0.88	0.97	0.95	0.91
<i>other most important payment instrument (share &gt; 5%)</i>							
	.	.	.	0.09 <sup>a</sup>	.	.	.
<b>Payment share by value</b>							
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
<i>Total</i>	0.82	0.95	0.94	0.60	0.89	0.97	0.78
<i>other most important payment instrument (share &gt; 5%)</i>							
	0.12 <sup>b</sup>	.	.	0.30 <sup>a</sup>	.	.	0.14 <sup>a</sup>
<b>Ownership of payment cards</b>							
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
<b>Average transaction values</b>							
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
<b>Acceptance of alternatives to cash<sup>c</sup></b>							
Share	.	0.63	0.73	.	0.57	.	.
<b>Average cash balances in wallet</b>							
mean	59	148	64	70	123	51	74
median	32	114	38	30	94	28	37

<sup>a</sup> Checks.

<sup>b</sup> Internet/telephone banking.

<sup>c</sup> Acceptance as perceived by consumers.

Notes: Authors' calculations 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](http://www.oecd.org/std/pricesandpurchasesingpowerparitiesppp/PPP_OECD.xls).

Table 2: Survey Design Summary

	<b>AU</b>	<b>AT</b>	<b>CA</b>	<b>FR</b>	<b>DE</b>	<b>NL</b>	<b>US</b>
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 Ratios we calculate the total annual per-person expenditure in local currency by multiplying the average per-person per-day expenditure figure from each diary by 365 days. We compare this estimated annual consumption figure with national accounts data from the OECD website. We start with the time series labelled “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
<b>Transactions Volume PPD</b>							
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
<b>Expenditures PPD</b>							
mean	63	50	50	43	48	52	62
median	41	34	28	27	35	20	31
<b>Distribution of transaction values</b>							
25th 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
75th percentile	25.3	37.3	30.3	35.0	42.6	28.4	39.8
<i>Transactions Volume Shares</i>							
<b>Day of the week</b>							
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
<b>Time of the day</b>							
AM	.	0.38	0.33	.	.	.	0.31
PM	.	0.62	0.67	.	.	.	0.69
<b>Payment Channel</b>							
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
<b>Sectoral composition</b>							
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: Authors' calculations 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
<b>Cash balances</b>							
In the wallet (M)	59 <sup>a</sup>	148	64	70	123	51 <sup>a</sup>	74
<i>mean M/e</i>	1.48	4.78	4.38	4.13	4.15	2.87	2.44
<i>median M/e</i>	0.69	3.36	1.01	1.30	2.61	1.00	0.62
<b>Withdrawals (# per month)</b>							
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
<b>Share of respondents withdrawing:</b>							
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
<b>Avg. withdrawal amount (W)</b>							
ATM (W)	138	224	86	89	256	102	103
Teller	668	511	225	224	539	75	219
Other sources	51	559	52	122	125	53	95
<i>W/M</i>	5.80	3.86	3.77	6.25	15.96	8.71	14.05
<i>median W/M</i>	2.33	1.42	1.67	1.72	2.11	2.50	2.31
<b>Precautionary balances</b>							
Cash balance before withdrawal ( $\bar{M}$ )	.	58	22	.	43	.	67
<i>mean <math>\bar{M}/M</math></i>	.	0.84	0.46	.	1.66	.	2.29
<i>median <math>\bar{M}/M</math></i>	.	0.25	0.20	.	0.32	.	0.73

<sup>a</sup> 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: Authors’ calculations 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, unless 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 Multi-Homing

	AU	AT	CA	FR	DE	NL	US
<b>Share of respondents with</b>							
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
<b># of payment cards in possession</b>							
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
<b># of payment instruments used in diary</b>							
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
<b>Share of respondents who revolve or overdraft</b>							
Revolvers	0.29	.	0.26	.	.	.	0.33
Overdraft	.	0.33	.	.	.	.	0.28

Notes: Payment card is defined as those with either a debit or a credit card. Authors' calculations 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
<b>Debit card ownership by socio-demographics</b>							
<b>age</b>							
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
<b>education</b>							
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
<b>income</b>							
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
<b>Credit card ownership by socio-demographics</b>							
<b>age</b>							
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
<b>education</b>							
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
<b>income</b>							
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 either a debit or credit card. Authors' calculations 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
<b>Cash</b>						
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
<b>Debit</b>						
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
<b>Credit</b>						
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
<b>Other payment instrument (if share &gt; 0.1)</b>						
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: Authors' calculations based on diary surveys. Shares are in percentages. Sectoral harmonization across countries is only approximate.

Table 9: Cash versus Noncash Payment Choice (Marginal Effects)

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

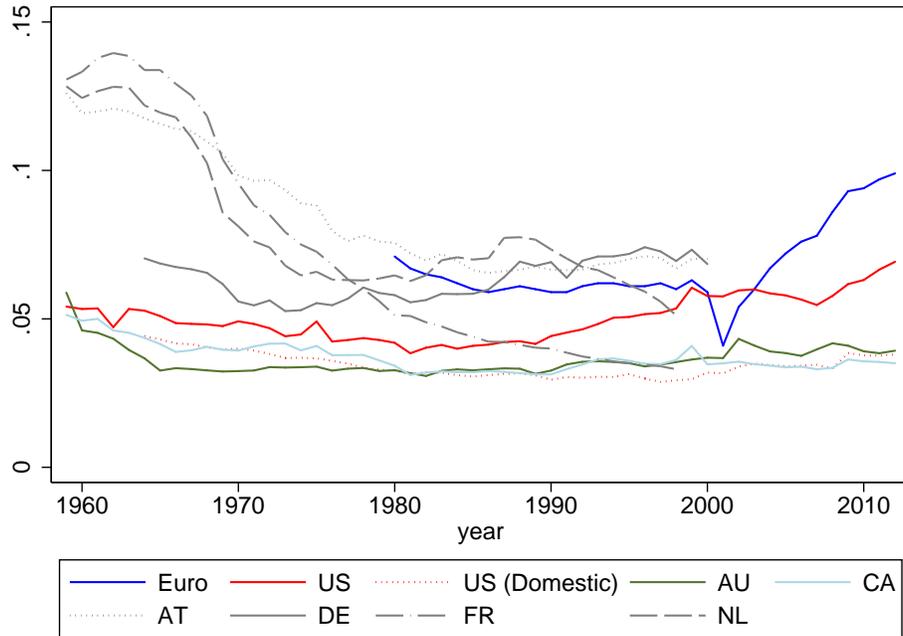
Notes: The dependent variable takes a value of 1 if a payment is made by cash and zero if it is made by debit or credit. Results for location (urban/rural), marital status, gender, employment status, and family size are not shown. Variables are defined in Table A.1. TV Q2, TV Q3, and TV Q4 denote the second to fourth quartile of transaction values. Standard errors are in parentheses and the 1, 5, and 10 percent levels of significance are denoted by \*\*\*, \*\*, \*, respectively.

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

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

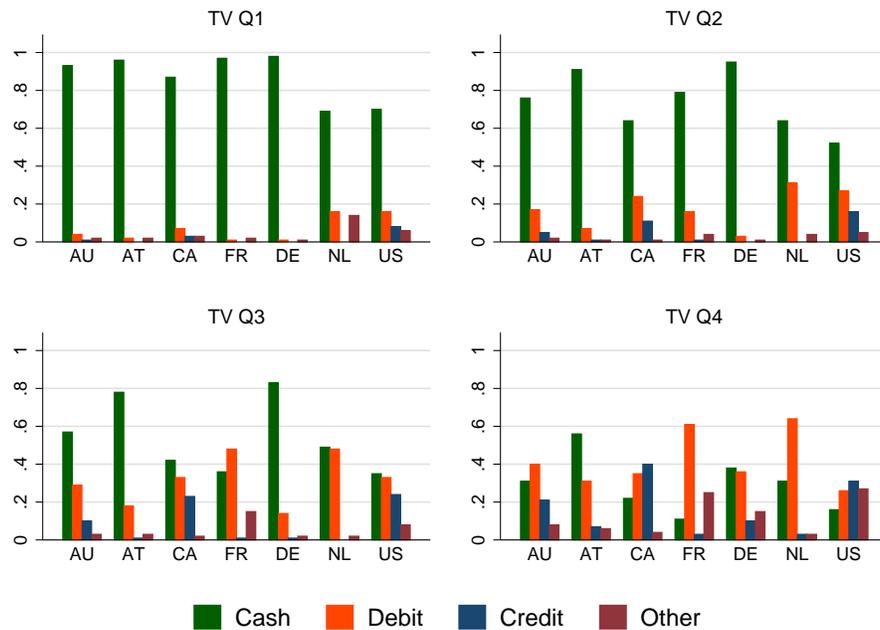
Notes: The dependent variable takes a value of 1 if a payment is made by cash and zero if it is made by debit or credit. Results for location (urban/rural), marital status, gender, employment status, and family size are not shown. Variables are defined in Table A.1. TV Q2, TV Q3, and TV Q4 denote the second to fourth quartile of transaction values. 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



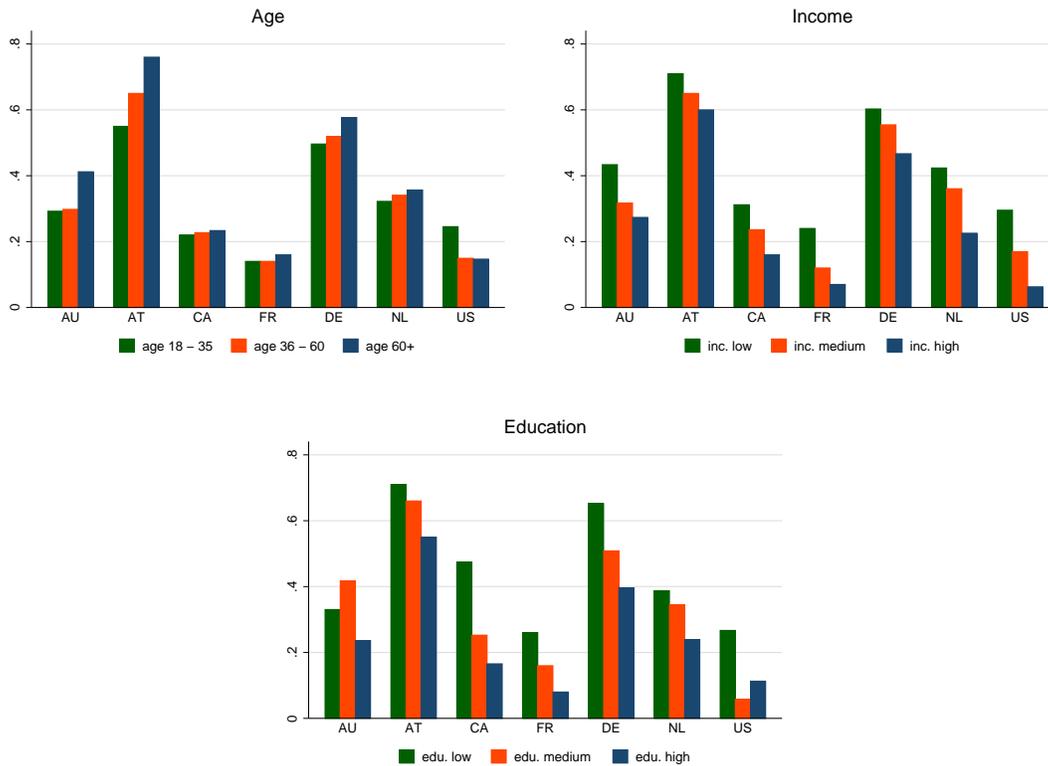
Source: Haver Analytics, International Financial Statistics, and authors' calculations.

Figure 2: Value Share of Cash by Transaction Value Quartiles



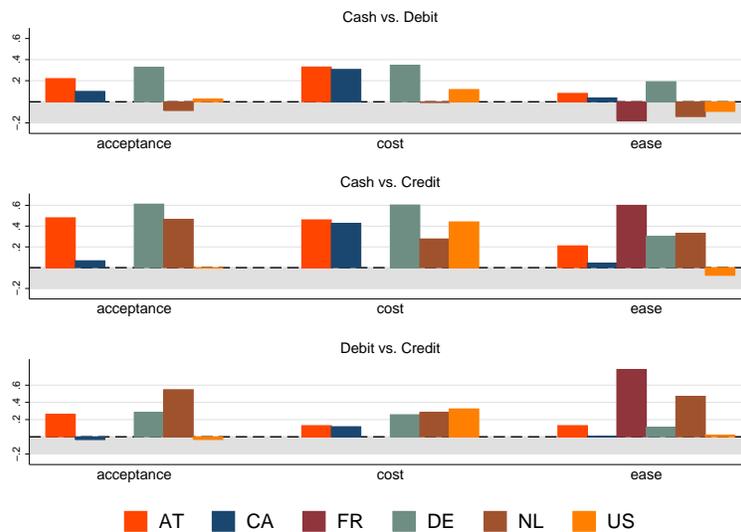
Source: Authors' calculations based on diary surveys.

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



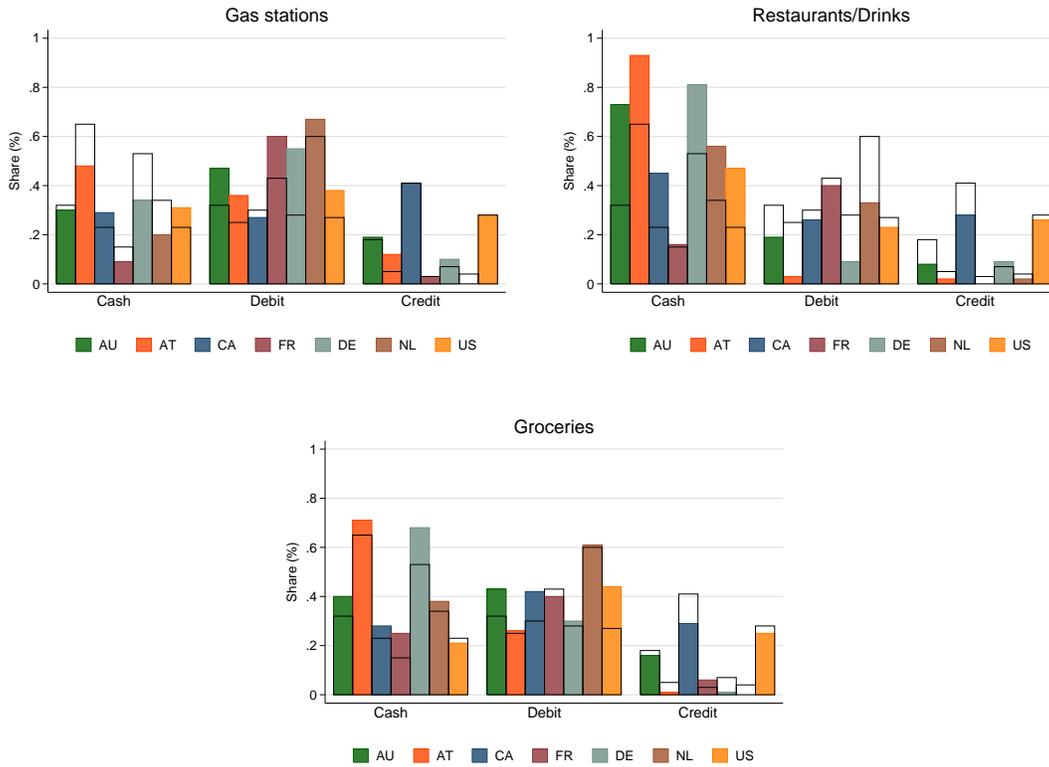
Notes: The figures depict the shares of cash (in value terms) in percentage terms for the respective subgroups.  
 Source: Authors' calculations based on harmonized diary surveys.

Figure 4: Perceptions of Cash



Notes: 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.  
 Source: Authors' calculations based on questionnaire and diary surveys.

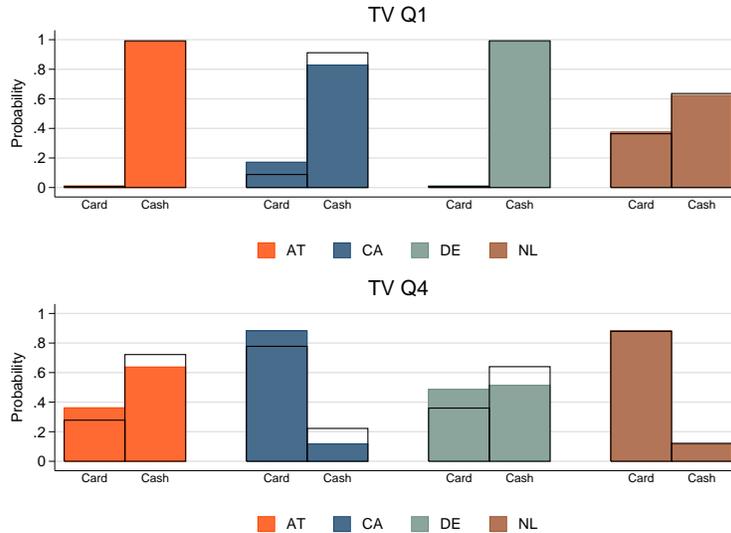
Figure 5: Value Share of Cash by Location/Activity



Notes: 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.

Source: Authors' calculations based on harmonized diary surveys.

Figure 6: Scenario Analysis: High Acceptance



Notes: 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.

Source: Authors' calculations.

## A Appendix

Table A.1: Definition of Variables

Income	3 dummy variables, one for each tercile (high, middle, low); Each dummy takes the value 1 if income is in the respective tercile, 0 else.
Age	3 dummy variables, one for each category (above 60, between 36 and 59, between 18 and 35); Each dummy takes the value 1 if age is in the respective category, 0 else.
Education	3 dummy variables, one for each category (low education, middle education, high education); Each dummy takes the value 1 if education is in the respective category, 0 else. Although the exact definitions depend on the country, the definitions are broadly 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 the question as to 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, Huynh, and Sabetti (2011).
Cash on hand	Defined as the usual (average) cash holdings of a 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 a unitless scalar.
Type of purchase	Several dummy variables, one for each location/type of purchase; Each dummy takes the value 1 if the location/type of purchase is indicated as Grocery, Gas Station, (Semi-)Durable, Services, or Entertainment, 0 else.
Transaction value quartiles	Quartiles are formed from all observed transaction values. 4 dummy variables, one for each quartile (TV Q1, TV Q2, TV Q3, TV Q4). Each dummy takes the value 1 if a transaction value is in the indicated quartile, 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/education population group to which a respondent belongs.