The impact of contactless payment on cash usage at an early stage of diffusion

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Abstract
This paper explores the impact of contactless payment on consumers’ demand for cash at an early stage of diffusion. The specific devices that are investigated are debit and credit cards, in which the feature is embedded. A novel balanced panel dataset drawn from representative surveys on consumer payment behavior in the USA from 2009 to 2013 is analyzed to account for unobserved heterogeneity in cash usage. The results show that contactless credit and debit cards exert no statistically significant effect on cash usage after controlling for unobserved heterogeneity. Consumers’ decision to use contactless payment is an endogenous choice. Card-affined individuals replace conventional card payments with contactless card payments. Hence, the overall effect on cash usage remains unaffected.

Keywords: Contactless payment, Money demand, Cash usage, Credit cards, Debit cards

JEL classification: C33, D12, E41, E42

1 Introduction
Cash is still the most prominent payment method at the point-of-sale (POS) in numerous developed countries, especially at low transaction values (e.g., von Kalckreuth et al. (2014); Bouhdaoui and Bounie (2012); Arango et al. (2015); Bagnall et al. (2016)). However, the promotion of various technological innovations in retail payment markets such as credit, debit, and prepaid cards has led to a decline in cash usage in recent years (e.g., Lippi and Secchi (2009); Amromin and Chakravorti (2009); Stix (2003)). Recent innovative payment means (e.g., contactless payment) attempt to mimic the desirable features of cash. They promise efficient and convenient payment services that may reduce the transaction costs of payment for consumers. Contactless payment is therefore seen as a more competitive payment alternative to traditional cash payments compared to conventional payment cards. Thus, discussing the prospects of cash usage is high on the agenda of central banks, which are responsible for cash distribution.
cards—due to their improved speed and convenience—are likely to substitute low cash value payments, which are high in frequency but have low budget impact.

Analyzing the effect of contactless payment on cash usage is relevant for three reasons. First, one of the main responsibilities of central banks is to provide efficient payment services to ensure financial system stability. The number and transaction size of cash payments affect the efficiency of payment systems, as expressed in social welfare costs. van Hove (2008) measured the costs of cash usage in the Netherlands as being 0.48% of GDP. Schmiedel et al. (2013) estimated the substantial costs of cash, which amount to one half percent of GDP for the EU-27 member states. Thus, understanding the demand for cash is crucial to evaluating the costs of payment systems.

Second, central banks are the sole institutions that are entitled to issue legal tender money. The assessment of future trends in cash demand is a relevant monetary policy issue. More contactless payment cards could imply lower cash in circulation and hence lower seignorage income.

Third, the literature has shown that money demand might react less sensitively to interest rates due to technological improvements in payment processing. This might result in lower welfare costs of inflation (Alvarez and Lippi 2009)).

Three papers have so far examined how contactless payment impacts cash demand. Fujiki and Tanaka (2014) found that average cash balances do not decrease with the adoption of contactless payment and under some specifications even increase. They used household-level survey data from Japan. Fung et al. (2014) showed that contactless credit and stored-value cards reduce average cash usage for transactions in terms of both value and volume. They analyzed consumer-level survey data from Canada. However, both studies failed to purge unobserved heterogeneity due to data restrictions. Chen et al. (2017) used household panel data from Canada to account for endogeneity. They encountered a high attrition rate of about 50%. However, they applied refreshment samples to account for this high attrition rate. They found no statistically significant impact of contactless credit cards on cash usage, neither in terms of value nor of volume after controlling for non-ignorable attrition and unobserved heterogeneity.

This paper contributes to existing literature in three respects. First, it is essential to control for unobserved heterogeneity when examining the effect of contactless payment on cash usage Chen et al. (2017). I draw on a unique balanced panel dataset from 2009 to 2013. Using such rich datasets represents a novel approach, which does not suffer from non-ignorable attrition. Second, I investigate the effect of contactless debit cards on cash demand and thereby fill an important gap in the literature. This is because debit cards are the most popular cashless payment method. Third, I analyze the impact of contactless payment on cash usage in the USA, one of the biggest payment markets. This is important as there is still missing empirical evidence of contactless payment in the USA payment landscape.

I find evidence that contactless credit and debit cards exert no statistically significant effect on cash usage in the early stage of diffusion. I account for unobserved heterogeneity in cash usage by using the fixed-effects model. Consumers’ decision to adopt contactless payment is an endogenous choice. Card-affined individuals replace conventional card payments with contactless card payments. The overall effect on cash usage therefore remains unaffected.

I proceed as follows. Section 2 reviews the relevant literature. Section 3 provides background information on the theoretical framework of the estimation strategy as well as the institutional background of contactless payment in the USA. The data are described in Section 4, followed by empirical specification in Section 5. Section 6 discusses the results while Section 7 draws conclusions and provides a research outlook.

2 Literature review

This paper is related to the literature of money demand and the future use of cash with regard to technological improvements. Efforts to estimate precise parameters of the traditional money demand function in light of technological change have produced an important body of literature (e.g., Attanasio et al. (2002); Lippi and Secchi (2009); Alvarez and Lippi (2009); Briglevics and Schuh (2013)).

Some scholars have estimated the share of cash transactions at the POS and its future usage with respect to payment enhancement. The effect of payment innovations on aggregate cash demand is not clear from an empirical point of view. Columba (2009) studied the effect of ATMs and POS terminals on the demand for currency and narrow money M1. He showed that the impact on cash in circulation is negative, whereas it positively affects narrow money.

Others have found that modern payment technologies have little effect on currency usage, mainly due to its superior characteristic of anonymity. Amromin and Chakravorti (2009) showed that demand for low denomination notes and coins decreases as debit card usage increases. This is because merchants need less purse
money for change. The demand for high denomination notes is less affected because individuals use them for non-transactional purposes such as hoarding and illegal activities. This was highlighted by Drehmann et al. (2004), who pointed out that POS terminals negatively and ATMs positively affect demand for small banknotes. Snellman et al. (2001) argued that debit and credit cards are the main drivers of substituting away from cash, while the effect of ATMs remains ambiguous (cf. Humphrey (2004)).

Another strand of the literature has employed household survey data to more precisely study cash usage. Stix (2003) found that debit cards negatively affect demand for purse cash in Austria. Von Kalckreuth et al. (2009) argued that credit cards have no impact on the number of cash transactions in Germany. However, Huynh et al. (2014) reported that merchants’ acceptance of payment cards has a substantial negative impact on the demand for cash in Austria and Canada.

3 Background information
3.1 Theoretical background
I derive the theoretical background for the estimation strategy and the empirical methodology used here from McCallum and Goodfriend (1987) framework. Attanasio et al. (2002) presented this framework as an extension of the traditional Baumol-Tobin model (Baumol (1952); Tobin (1956)). The extended model takes into account innovations in transaction technologies. Accordingly, individuals adopt payment innovations if the benefits of adopting the technology exceed the costs. Adoption costs of contactless payment may include (one-time) operational learning costs, monetary costs of using and adopting the payment card (e.g., annual fees, surcharges), and the availability of contactless terminals.

Benefits of payment innovations increase with improving transaction efficiency. This makes adopting contactless payment more likely since it allows for a fast payment process. Polasik et al. (2013) showed that contactless payment cards are the first payment method to be faster than cash. The transaction speed is one of the most important factors to determine the choice of a payment instrument (e.g., Klee (2006); Jonker (2007)). This is because it reduces queue lines and thus consumers’ payment costs (Brits and Winder (2005)). Younger consumers in particular react more negatively to longer payment processing than older consumers and are therefore more likely to adopt contactless payment (Borzekowski and Kiser (2008)).

Benefits also tend to rise with more consumption expenditures and higher transaction values because more spending is subject to longer transaction times. Consequently, the rate of adopting contactless payment varies by consumers’ demographic characteristics (e.g. income, age, education), which determine their opportunity costs of paying. High-income individuals are therefore more likely to adopt contactless payment to reduce their transaction costs of paying. This is because their opportunity costs of paying tend to be higher than for low-income individuals. For the same reason, cash demand tends to be lower for contactless adopters than non-adopters because cash payments take more time to settle than contactless payments (cf. Polasik et al. (2013)).

In general, individuals need time to undertake transactions. As a form of exchange and financial innovations, money reduces the transaction time (Attanasio et al. (2002)). In the traditional Baumol-Tobin setting, individuals face a trade-off between holding liquidity in form of money, in order to carry out transactions, and the forgone interest paid on deposited assets. However, in Attanasio et al. (2002) extended version of the model, consumers choose optimal money holdings to trade off transaction costs against the costs of holding cash. Transaction time costs originate from the shadow value of time and from the “shoe-leather” costs of withdrawing cash.

Hence, consumers demand optimal money holdings by minimizing both the transaction time costs and the forgone interest paid on deposited assets subject to their consumption expenditures. Improvements in transaction technology (e.g., contactless payment) and lower transaction costs therefore lessen the demand for cash. Contactless payment also enables instantly accessing liquid assets in accounts for making payments. This further reduces the demand for cash and maximizes the return of interest paid on deposited assets. Thus, higher interest rates on deposited accounts create more incentives to park money holdings that in turn reduce the demand for cash. Conversely, higher consumption expenditures increase the demand for cash.

3.2 Institutional background
Contactless payment was first launched in the USA in 2005 by only very few issuing banks. The survey data used in this study show that the rate of contactless card adoption for credit and debit cards remained relatively stable (at around 10%) between 2009 and 2013 (see Fig. 1). The low adoption rate approximately agrees with actual data about contactless card adoption provided by the Federal Reserve System for the year 2012 (see Table 1). The actual rate of contactless credit cards was 7%, that of debit cards 8%.

At the time, adopting contactless payment was an endogenous decision in the USA. Only a few banks re-issued contactless cards by default when traditional payment cards expired. Some issuers provided contactless cards only upon request or exclusively to new customers. These were not required to pay extra for the contactless feature (cf. Chai (2017)).

Compared to other countries like Canada or Australia, the adoption of contactless cards in the USA in the 2009–2013 period failed to take off for various reasons. First, the
US banking and merchants sectors were very fragmented. Both sectors pursued different contactless payment strategies (SPA (2016)). Second, banks were legally obliged to shift completely to EMV (Europay International, MasterCard and VISA) standard payment cards by 2015. These types of cards enable storing data on chips rather than on magnetic stripes. Banks incurred significant manufacturing costs to overhaul these card portfolios given the immense US market for payment cards. Therefore, most banks decided to issue single-interface chip cards with no contactless antenna for saving money. Third, and as a consequence, US retailers had never been eager to install contactless-enabled POS terminals due to lack of contactless card adopters. As a result of missing acceptance, individuals’ contactless payment adoption lagged behind and further led banks to slow down issuing contactless payment cards (SPA (2016)).

Figure 1 shows the very low level of contactless card acceptance at the POS during the years 2009–2013, ranging from roughly 0.02 to 2%. This goes hand in hand with actual usage of contactless cards (see Table 1): Only around 0.1% of all credit and debit card payments in the USA were made contactless in 2009 and 2012. Such payments accounted for approximately 0.1% of total transaction value. In other words, an average of less than one payment per card was made using contactless technology in 2012 (see Table 1). This made contactless payment a rare novelty in terms of usage.

4 Data
4.1 Source
Data are drawn from the Federal Reserve Bank of Boston, which has conducted the Survey of Consumer Payment Choice (SCPC) since 2008. The surveys are performed in autumn (fourth quarter)—primarily in October—by the RAND Corporation as unique, comprehensive, and representative online surveys using RAND’s American Life Panel (ALP). They provide detailed payment information about individuals with respect to nine payment instruments (including cash) used in the USA.

The ALP’s sampling unit is an individual US consumer older than 18 years, whose responses to each survey are weighted to represent all US consumers aged 18 years and older. The 2008 responses are not comparable due to major revisions in the questionnaire and methodology across years. The survey series aims to provide a consumer-level longitudinal dataset and forms a valuable longitudinal balanced panel from 2009–2013 with respect to payment choice. The surveys conducted after 2013 no longer include information about contactless payment. One thousand one hundred thirty-two respondents completed all five surveys, which included similar and identical questions (see Table 2).

Table 2 depicts the number of respondents per survey and the various panelists. It shows an annual rate of attrition of roughly 10% until 2012, whereas this increased to...
Table 1 Actual adoption and usage of contactless payment cards in the USA

|                     | 2009 in % | 2012 in % |
|---------------------|-----------|-----------|
| **Credit cards**    |           |           |
| Number of contactless cards (m) | n/a       | 23.35     | 7.0%       |
| Contactless transaction volume (m) | 20        | 0.10%     | 13         | 0.07%      |
| Contactless transaction value (m) | 1000      | 0.06%     | 600        | n/a        |
| **Debit cards**     |           |           |
| Number of contactless cards (m) | n/a       | 22.62     | 8.0%       |
| Contactless transaction volume (m) | 30        | 0.15%     | 27         | 0.07%      |
| Contactless transaction value (m) | 1000      | 0.08%     | 378        | n/a        |
| Average number of contactless transactions per |
| Credit card         | n/a       | 0.57      |
| Debit card          | n/a       | 1.19      |

Source: Federal Reserve System (cf. FED (2011; 2014). Newer data are not available. Contactless payments are labeled “chip” card payments in the report provided by the Federal Reserve in 2014. “m” is millions. The shares refer to the contactless data related to their corresponding total data. For instance, 0.1% of all credit card transactions in 2009 were made contactless. In other words, contactless credit card transaction volume is divided by the total credit card transaction volume around 35% in 2013. This is because the SCPC incorporated the novel payment diary in 2012, thus more strongly emphasizing demographic coverage (cf. Angrisani et al. (2015)). The retention rate between 2009 and 2012 was around 70% (1515 individuals). Around 90% of respondents who once participated in the SCPC before 2013 also participated in 2013 (Angrisani et al. (2015)). Among the 2169 individuals observed in 2009, 52% (1132) participated throughout (i.e., 2009–2013).

Tables 10 and 11 (see Appendix) provide first-year summary statistics of stayers participating for five consecutive years versus attritors, in order to check whether panel attrition is systematic. The statistics reveal that attrition is likely to be random, i.e. exhibiting no systematic pattern.

The SCPC asks consumers what payment instruments they have and how often they use these instruments. The survey employs a flexible reporting strategy to enhance recall and to optimize the accuracy of the number of payments. It also collects comprehensive data on consumer cash holdings and cash withdrawal behavior. Low-value payments tend to be more easily forgotten due to their high frequency and low budget impact. They are mostly effected in cash, which may lead to underreporting. Thus, cleaning procedures were applied to identify and edit invalid data entries for the number of monthly payments of all payment instruments and the typical value of cash withdrawals. The dataset also provides rich information about consumer demographic characteristics, financial status, and the rating of payment instrument attributes.

However, there are several limitations. The 2009–2013 estimates are not consistently adjusted for seasonal variation, inflation, or item non-response (missing values). The calendar time period of the 2009 survey also differs slightly from that of the 2010–2013 surveys. The latest surveys are very similar in terms of size, composition and timing of the sample. Survey comparability across years may suffer from different survey timing if crucial monthly seasonal differences occurred in individual payment behavior. Also, consumers may have underreported the number of payments and withdrawals in the years 2009–2010 (i.e., during the financial crisis and the corresponding severe recession). The rationale is that consumers generally relied more on cash payments in those days. These may be harder to recall due to their high frequency and low budget impact. Additionally, no longitudinal sample weights are available.

4.2 Description

This section describes the 2009–2013 panel dataset used here for estimation. The surveys specifically ask respondents if one of their credit and debit cards is equipped

Table 2 Panel data structure

|                  | 2009 | 2010 | 2011 | 2012 | 2013 |
|------------------|------|------|------|------|------|
| Nr. of respondents | 2173 | 2102 | 2151 | 2065 | 2089 |
| 2009–2010 panelists | 1913 | 1913 |      |      |      |
| 2010–2011 panelists | 1801 | 1801 |      |      |      |
| 2011–2012 panelists | 1926 | 1926 |      |      |      |
| 2012–2013 panelists | 1330 | 1330 |      |      |      |
| 2009–2012 panelists | 1515 | 1515 | 1515 | 1515 |      |
| 2009–2013 panelists | 1132 | 1132 | 1132 | 1132 | 1132 |

Source: Schuh and Stavins (2014) and Angrisani et al. (2015)
with the contactless feature. This estimate is likely to be fairly robust since the decision to adopt contactless payment is endogenous. Some consumers actively applied for contactless cards. Unfortunately, the surveys provide no information on the specific usage patterns of contactless payment. Contactless adopters are labeled as innovators, or as non-innovators, irrespective of having any payment cards. Non-innovators are a relatively homogenous group of payment card adopters. Roughly 76% of respondents owned a conventional credit card and 78% a debit card within the observed period (see Table 3). Credit and debit cards were used at least once a month by around 61 and 63% of all respondents between 2009 and 2013.

Around 10% of consumers in the overall period reported that one of their credit cards had the embedded contactless feature (see Table 3). Approximately 10% stated that they possess a contactless debit card.

The surveys also collect data on consumer cash withdrawal behavior. Consumers were asked about the amount of cash they most often withdraw and the number of withdrawals they usually make in a typical period (week, month, or year). Both questions were asked for two separate withdrawal locations: the primary one, where consumers most often obtain cash, and all other sources.

Like Briglevics and Schuh (2013), this study focuses on the figures for the primary location. These estimates tend to be more precise. Reporting the usual rather than the actual withdrawal amount reduces the mental burden to compute averages of potentially diverse cash withdrawals (cf. Briglevics and Schuh (2013)). The SCPC also states the number of cash payments and the total number of all purchases made in a typical month at the POS. Its ratio measures the cash share in terms of volume. This is a robust measure towards outliers.

Table 4 describes the summary statistics of the main cash measure variables in the panel dataset. The average amount of cash in wallet (73 USD) is roughly half of the average usual withdrawal amount (130 USD). The average number of withdrawals at the primary location per month amounts to around 4. Roughly 36% of all POS payments are made in cash (cash share in volume). Half of the consumers reported a cash ratio both lower and higher than 28.5%. Median values of the remaining cash measures were roughly half of the average values. This indicates that a small number of respondents relied heavily on cash, resulting in high standard errors. The maximum values of the cash variables support this finding (see Table 4).

For this reason, I winsorize the usual cash amount withdrawn, the number of withdrawals and the average cash value in wallet at the 99% level. This enables properly analyzing the mean difference between innovators and non-innovators. Tables 5 and 6 report (winsorized) statistics of the relevant cash measures distinguished by contactless credit and debit card innovators and non-innovators. I also provide univariate mean comparison tests and Wilcoxon rank-sum tests between innovators and non-innovators in order to detect statistically significant differences.

Table 5 shows that statistically contactless credit card adopters significantly make fewer cash withdrawals within a month than non-adopters (roughly 2.9 vs. 3.5). Another notable statistical difference is that adopters also have a 9 percentage point lower cash ratio in volume than non-adopters. Further, while their usual withdrawal amount tends to be smaller than that of non-innovators (around 8 USD), they carry slightly more cash in wallet (+1 USD). The Wilcoxon rank-sum test supports these results.

Statistically, contactless debit card innovators make significantly more cash withdrawals (+ 0.8) compared to non-innovators (see Table 6). However, they withdraw

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### Table 3 Adoption and usage rate of payment cards in the 2009–2013 surveys

| Variable               | Mean    | SD      | Obs. |
|-----------------------|---------|---------|------|
| Contactless credit cards | 0.095   | 0.294   | 5659 |
| Contactless debit cards | 0.103   | 0.304   | 5657 |
| Credit cards          | 0.759   | 0.428   | 5628 |
| Debit cards           | 0.78    | 0.414   | 5620 |
| Credit card usage     | 0.613   | 0.487   | 5625 |
| Debit card usage      | 0.63    | 0.483   | 5619 |

Usage describes the fact that respondents make the corresponding type of payment at least once in a typical month. Survey weights used

### Table 4 Summary statistics of cash measures

| Statistics | Usual withdraw | Nr. of withdrawals | Cash in wallet | Cash share in volume |
|------------|----------------|--------------------|----------------|----------------------|
| Mean       | 128.845        | 3.716              | 72.586         | 0.355                |
| SD         | 172.734        | 6.610              | 134.691        | 0.285                |
| Median     | 80.000         | 2.000              | 40.000         | 0.312                |
| Min.       | 0.000          | 0.000              | 0.000          | 0.000                |
| P-10%      | 20.000         | 0.833              | 1.000          | 0.000                |
| P-99%      | 850.000        | 26.089             | 500.000        | 1.000                |
| Max.       | 5000.000       | 434.821            | 3500.000       | 1.000                |
| Obs.       | 5561           | 5572               | 5577           | 5527                 |

Cash management measures are reported in USD except the number of withdrawals and cash share. The usual cash withdrawal amount and the number of withdrawals relate to the primary location. Cash share is the ratio of the total number of cash transactions in a typical month at the POS to the total number of all purchases in a typical month at the POS. Survey weights used.

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9 These numbers are higher in the estimation sample since only checking account holders is considered. Additionally, more than half of total payments in the survey were made by payment cards.

10 Cash withdrawal locations include ATMs, bank tellers, check cashing stores, cash back at retail stores, family or friends and others as well as being paid in cash.
Table 5 Cash Measures of Contactless Credit Card Innovators and Non-Innovators

| Variable          | Mean  | SD    | Med.  | Min.  | Max.  | Obs. | Mean     | SD    | Med.  | Min.  | Max.  | Obs. | Mean Diff | z-values |
|-------------------|-------|-------|-------|-------|-------|------|----------|-------|-------|-------|-------|------|-----------|----------|
| Usual Withdrawal  | 120.855 | 139.313 | 60.000 | 0.000 | 850.000 | 550 | 127.032 | 155.492 | 80.000 | 0.000 | 850.000 | 501 | -7.820 | 0.073*    |
| Nr. of Withdrawals | 2.934  | 2.872 | 2.000 | 0.000 | 21.741 | 549 | 3.494   | 3.505 | 2.000 | 0.000 | 21.741 | 502 | -0.551*** | 0.000*** |
| Cash in Wallet    | 68.860 | 92.425 | 40.000 | 0.000 | 500.000 | 554 | 67.282 | 90.598 | 35.000 | 0.000 | 500.000 | 502 | 0.871 | 0.048**   |
| Cash Share        | 0.275  | 0.234 | 0.229 | 0.000 | 1.000  | 544 | 0.363   | 0.289 | 0.319 | 0.000 | 1.000  | 4983 | -0.088*** | 0.000*** |

All variables are winsorized at the 99%-level except cash share. Cash management measures are reported in USD except the number of withdrawals and cash share. The usual cash withdrawal amount and the number of withdrawals relate to the primary location. Cash share is the ratio of the total number of cash transactions in a typical month at the POS to the total number of all purchases in a typical month at the POS. Survey weights used. T-tests of mean differences of innovators and non-innovators are displayed. Differences may stray from true values due to rounding and weighting. The Wilcoxon rank-sum test is displayed (z-values). Significance levels are denoted as *** $p<0.01$, ** $p<0.05$, * $p<0.1$. 


| Variable                | Innovator | Non-Innovator | t-Test | Ranksum-Test |
|-------------------------|-----------|---------------|--------|--------------|
| Usual Withdrawal        | 126.164   | 126.575       | -1.280 | 0.000***     |
| Nr. of Withdrawals      | 4.114     | 3.361         | 0.754***| 0.008***     |
| Cash in Wallet          | 59.209    | 68.512        | -9.611 | 0.000***     |
| Cash Share              | 0.329     | 0.357         | -0.026 | 0.000***     |

All variables are winsorized at the 99%-level except cash share. Cash management measures are reported in USD except the number of withdrawals and cash share. The usual cash withdrawal amount and the number of withdrawals relate to the primary location. Cash share is the ratio of the total number of cash transactions in a typical month at the POS to the total number of all purchases in a typical month at the POS. Survey weights used. T-tests of mean differences of innovators and non-innovators are displayed. Differences may stray from true values due to rounding and weighting. The Wilcoxon rank-sum test is displayed (z-values). Significance levels are denoted as *** p<0.01, ** p<0.05, * p<0.1.
lower cash amounts (−1.3 USD), have a lower average cash amount in wallet (−9.6 USD) and a lower average cash ratio in volume (−3%) than non-innovators. The Wilcoxon rank-sum test indicates that statistically the medians of contactless debit card innovators and non-innovators differ significantly.

To sum up, descriptive evidence shows that contactless payment may reduce both the volume and the value of cash transactions, whereas the latter primarily holds for contactless credit cards.

Five different types of contactless payment adopters can be defined based on the transition patterns of contactless payment in all five consecutive years in the entire 2009–2013 balanced panel:

1. Never-innovators (non-innovator; non-innovator);
2. Stayers (start-adopters and one-time switchers), who start without contactless payment, eventually adopt it within the five-year period and hold it to the end (non-innovator; innovator);
3. Leavers (stop-adopters and one-time switchers), who start with contactless payment and eventually dismiss it within the 5-year period (innovator; non-innovator);
4. Permanent innovators (innovator; innovator);
5. Multiple switchers (the rest), who switch between adoption and non-adoption of contactless payment one or several times within the 5-year period.

Table 7 provides adoption patterns of contactless payment for these five types of adopters in the years 2009–2013. It does so separately for contactless credit and debit cards. The matrix both displays the total share of each adoption type and all their possible combinations. This enables revealing the proportions of consumers who, for instance, simultaneously have contactless debit and credit cards.

Overall, penetration rates of contactless credit and debit cards are very similar. The presence of contactless payment is quite modest in the sample. Around 72 and 71% of respondents never adopted contactless credit or debit cards (non-innovator; non-innovator). Roughly 1% of consumers are permanent innovators of both payment cards, around 6% (credit) and 5% (debit) are stayers (non-innovator; innovator), roughly 6% (credit) and 4.5% (debit) are leavers (innovator; non-innovator), and approximately 15% (credit) and 19% (debit) are multiple switchers12.

Table 7 also provides information about multiple payment innovation adopters. Around 57% of respondents never adopted any contactless payment card in the entire period. 41.5% of consumers who adopted contactless credit cards at some point also adopted contactless debit cards within the years 2009–2013. 47.5% of one-time contactless debit card adopters had contactless credit cards at some point13. Furthermore, around 43% of all consumers in the sample had one of the two innovations at some stage, but only around 14% possessed both innovations at the same time14.

Stayers exhibited lower cash shares in volume in every year from 2009–2013 compared to never-innovators (see

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**Table 7** Adoption patterns of contactless payment in the entire sample

|                   | Contactless credit cards for t;T | Contactless debit cards for t;T |
|-------------------|----------------------------------|---------------------------------|
|                   | N-I; N-I                          | N-I; I                          |
| Non-innovator; non-innovator | 56.81                           | 3.03                           |
| Non-innovator; innovator     | 2.83                             | 0.94                           |
| Innovator; non-innovator    | 3.21                             | 0.22                           |
| Innovator; innovator        | 0.34                             | 0.24                           |
| Multiple switcher           | 7.71                             | 1.05                           |
| Total                       | 70.92                            | 5.26                           |

Numbers are in proportions and correspond to the 2009–2013 year balanced panel. Survey weights used. N-I and I denote non-innovators and innovators, respectively. Missings are coded according to the value of their previous year. \( t = 2009, 2010, 2011, 2012, 2013 \)

12 The relatively sizable number of multiple switchers could rely on the fact that US consumers possess on average 6.5 debit and credit cards issued by different banks.

13 The proportions are calculated using the sum of debit card innovators among credit card innovators (11.56%) in relation to the sum of credit card innovators (27.89%) and vice versa (13.79 vs. 29.02%).

14 Table 7 does not provide this information.
Fig. 2)\textsuperscript{15}. Cash shares also decreased over the years. This indicates that contactless payment adopters may have already used less cash before adopting contactless payment compared to never-adopters.

The dataset additionally provides rich information on demographic and financial characteristics. Table 12 (see Appendix) tabulates these statistics separately for contactless credit and debit card holders. It also includes the results of the mean comparison tests. The sample of contactless credit card adopters is statistically significantly more skewed towards higher income and education brackets (see Table 12). Credit card innovators are more frequently employed, widowed, between 55 and 64 years old, Asian, revolvers, and home owners. However, they are less likely to be single and black compared to non-innovators. These mean differences are all statistically significant.

As opposed to credit card innovators, statistically, the sample of contactless debit card adopters is significantly more skewed towards lower-income and lower-education brackets (see Appendix, Table 12). They are mostly younger, working, Black, Asian, Latino, or of another ethnicity, and are less likely to own a home and be retired compared to non-innovators.

To conclude, the descriptive statistics have offered some suggestive evidence that contactless payment is related to reduced cash usage in terms of value and volume. They have also revealed that assignment to the contactless feature is likely to be non-random.

\textsuperscript{15}The differences are not statistically significant. Similarly, cash measures in value overall tend to be smaller for stayers than for never-innovators.

\section{Methodology}

The panel dimension of the SCPC was used to estimate the relationship between contactless payment and cash demand. The standard panel data model with unobserved heterogeneity $\eta_i$ is

$$ M_{it} = \alpha I_{ijt} + \beta X_{it} + \gamma Y_{it} + \delta R_{it} + \epsilon_{it} + \eta_i, $$

where $M_{it}$ denotes the measurement of cash usage, $I_{ijt}$ takes the value of one if the individual is an innovator, i.e., a contactless payment adopter for payment method $j$, where $j$ relates to debit and credit cards, respectively. $X_{it}$ are the observed individual characteristics and a vector of proxies for transaction costs, as evidenced by Connolly and Stavins (2015). $Y_{it}$ is the household income to proxy for consumption expenditures\textsuperscript{16}, $R_{it}$ is the interest rate for primary checking accounts and the alternative cost of holding cash, and $\epsilon_{it}$ is the error term for all $i$. $\alpha$ is the parameter of interest, which measures the effect of contactless payment on cash usage.

The variable $I_{ijt}$ must be strictly exogenous to obtain an unbiased estimate of the parameter $\alpha$. However, the descriptive analysis has shown that adopting contactless payment is likely to be a non-random decision. Some unobserved variables may cause individuals to select into innovation $I_{ijt}$ and simultaneously use less cash (cf. Fung et al. (2014)). For instance, individuals with an affinity for new technologies may be more prone to hold less cash and be more likely to use contactless payment. Thus, the estimate may be biased and inconsistent (selection bias). Omitted variables related to payment automatism may also confound the estimation results (omitted

\textsuperscript{16}See Appendix for the variable definition.
variable bias). Payment behavior has been found to be largely habitual (van der Horst and Matthijssen 2013). Unobserved individual-specific fixed-effects \( i_t \) may thus correlate with the explanatory variable \( I_{ijt} \), which introduces a bias into the estimation\(^\text{17}\).

Furthermore, contactless payment and cash usage may suffer from reverse causality (cf. Fung et al. (2014)). Individuals who rely less on cash may adopt contactless payment to meet their personal preferences for frequent usage of payment cards, as this permits instantaneous payment. It is thus not evident if innovation drives cash demand or vice versa (simultaneity bias). The estimation includes perceived characteristics of cash relative to payment cards \( (\text{RCHAR}_i) \) in order to address this issue. However, appropriate instrumental variables would be more fruitful.

This study uses the within-group estimator (mean-difference model) to reduce concerns about unobserved individual fixed-effects by exploiting the panel dimension of the data to yield\(^\text{18}\)

\[
(M_{ijt} - \bar{M}_i) = \alpha (I_{ijt} - \bar{I}_i) + \beta (X_{ijt} - \bar{X}_i) + \gamma (Y_{ijt} - \bar{Y}_i) + \delta (R_{ijt} - \bar{R}_i) + (\epsilon_{ijt} - \bar{\epsilon}_i).
\]

The usual withdrawal amount, the cash kept in wallet, and the number of withdrawals in a typical month—winsorized at the 99% level—represent the variable \( M_{ijt} \) as the parameter for transactional cash demand. These variables analyze the effect on cash value (cf. Briglevics and Schuh (2013))\(^\text{19}\). \( M_{ijt} \) also serves as the variable for cash share in volume.

Equation 2 represents the baseline specification to be estimated. As an additional set of controls, I included the perceived characteristics \( k = \text{security}, \text{setup}, \text{acceptance}, \text{costs}, \text{records}, \text{and convenience of cash} (\text{RCHAR}_i) \) into the second specification\(^\text{20}\). This is because a significant amount of unobserved heterogeneity in cash usage can be captured by including individuals’ perceptions on payment methods characteristics (Jonker (2007); Kim et al. (2006); Ching and Hayashi (2010)). The third specification controls for individuals’ primary cash withdrawal method \( W_{ijt} \) as a proxy for the “shoe-leather” costs of withdrawing cash (cf. Briglevics and Schuh (2013))\(^\text{21}\).

I assume that consumers must have an interest-bearing bank account to be eligible for payment cards. Therefore, I use the subsample of checking account holders\(^\text{22}\). This has the advantage of eliminating the self-selection bias into payment cards since individuals are likely to open bank accounts to reduce transaction costs. Also, I limit the analysis to the subsample of never-innovators and stayers in order to distinctly appraise the effect of contactless payment on cash demand (see Table 7).

### 6 Estimation results

This section presents the estimation results of the model specification in Eq. 2 using fixed-effects (FE). Additionally, it reports the results of the cross-sectional analysis (OLS) using the dataset in 2013 (see Appendix). Tables 13, 15, 17, and 19 show the full set of OLS estimates for contactless credit cards. Tables 14, 16, 18, and 20 exhibit the full set of OLS estimates for contactless debit cards. Fixed-effects and OLS estimates are compared to comprehend the importance of controlling for unobserved heterogeneity.

Overall, the study reveals two major findings: first, individual-specific fixed-effects are present and contactless payment adopters positively selected. This is because FE estimates of contactless payment are mostly smaller than OLS estimates. The large differences in the goodness-of-fit \( (R^2) \) between the OLS and the FE models also indicate that cash usage differs more between individuals than over time (within). Second, contactless payment exerts no impact on individual cash payment behavior in the early stage of diffusion. Individuals with an affinity for payment cards are likely to replace traditional card payments in favor of contactless payments. In this way, the effect of contactless payment on cash usage is unaffected.

Below, I first discuss the effect of contactless credit cards on cash usage before analyzing the impact of contactless debit cards on cash demand.

\(^{17}\)Payment markets inherently include the two-sided market structure, where network effects are predominant. The value of contactless payment for a consumer depends on the number of others using this instrument. If the critical level of users is not exceeded, merchants would not invest in contactless payment terminals due to small economies of scale. Hence, the adoption and usage of contactless payment may face feedback effects.

\(^{18}\)If individual effects are random and uncorrelated with the variable \( I_{ijt} \), it leads to the random-effects model. However, employing the Hausman test on the balanced panel for all specifications rejects the null hypothesis of the random-effects model (test statistics are not provided). Therefore, the random-effects model does not provide consistent estimates compared to the fixed-effects model.

\(^{19}\)Money holdings \( M \) conceptually represent cash for transactional purposes in the classical model of cash demand. Individuals, however, do not only hold money for spending purposes but also for hoarding and precautionary reasons. Large cash holdings may also be motivated by anticipating large purchases and could be related not only to retail payments but also to in-person payments beyond POS payments. In this study, the measures of actual cash holdings may thus differ from balances consumers held for actual cash transactions. It is unfeasible to accurately measure cash demand without accurate transactional-level data. However, the reported amount of cash usually withdrawn, the cash kept in wallet, and the number of withdrawals are closely related to transactional cash balances (cf. Briglevics and Schuh (2013)).

\(^{20}\)See Appendix for variable definition.

\(^{21}\)Cash withdrawal methods include ATM (49%), bank teller (23%), check cashier (2%), cashback (13%), employer (4%), family (6%), and others (3%). The figures in brackets show the share of respondents using the specific withdrawal method. Innovators statistically significantly withdraw cash more frequently from ATMs and less often from check cashers than non-innovators.

\(^{22}\)Approximately 97% of individuals in the sample have a checking account.
6.1 Effects of contactless credit cards

I estimate three specifications using different controls for four types of cash measures. Table 8 presents the main results of the impact of contactless credit cards on cash usage. The results of the full set of covariates for each regression are reported in the Appendix

I find evidence that contactless credit cards have no statistically significant effect on cash expenses and cash share volumes in all specifications. The results are rather robust against the inclusion of additional controls. The estimated coefficients of contactless credit cards regarding the cash share volume and the number of withdrawals display the expected negative signs. However, the point estimates on the cash in wallet and usual cash withdrawn exhibit, against expectation, a positive sign in all regressions.

The estimates of the cross-sectional analysis show that statistically contactless credit cards significantly reduce cash share volume by approximately 5 to 6%, holding everything else constant. This is around half the size estimated by Fung et al. (2014) and comparable to Chen et al. (2017), who used cross-sectional and pooled data, respectively. Unobserved heterogeneity therefore drives the results using cross-sectional data.

6.2 Effects of contactless debit cards

Table 9 displays the main estimates of the regressions that analyze the impact of contactless debit cards on cash usage. The full set of estimates is provided in the Appendix.

Statistically, contactless debit cards significantly influence the number of withdrawals (see column [1]). The coefficient of the contactless feature has the predicted negative sign, but is sensitive to the inclusion of additional control variables. The estimated negative impact has a modest magnitude of −0.9, holding everything else constant. In other words, contactless debit cards induce individuals to make 0.9 fewer cash withdrawals per month. This is a sizeable reduction of 28% compared to the average number of withdrawals per month of 3.2. However, this effect becomes statistically irrelevant using additional control variables. It thus proves to be non-robust.

The impact of contactless debit cards on the remaining cash measure variables is statistically insignificant. Contrary to expectation, the estimated coefficients in column (3) show a positive relationship with cash share volume and cash in wallet. The point estimate in the usual cash withdrawal regression has the expected negative sign. In sum, contactless debit cards exert no impact on individual cash payment behavior.

In the cross-sectional estimation, contactless debit cards are associated with a statistically significant decline in cash share volume by approximately 4 to 6%, holding everything else constant. The results are rather insensitive to the inclusion of additional control variables and comparable to the effect of contactless credit cards. Conversely, contactless debit cards have no statistically significant effect on cash in value.

Overall, the findings demonstrate that consumers self-select into contactless payment. This leads to spurious results if unobserved heterogeneity is ignored (cf. Chen et al. (2017)).

7 Conclusion

This paper has investigated the impact of contactless payment on cash usage in the early stage of diffusion. Multiple layers of endogeneity are likely to be present in this setting, which requires an appropriate estimation strategy to obtain unbiased and consistent estimates. I have therefore employed the within estimator using a unique balanced panel dataset from 2009–2013 in the USA. This has allowed eliminating individual-specific fixed-effects.

I have found evidence that contactless credit and debit cards exert no statistically significant effect on cash usage in the early stage of diffusion after controlling for unobserved heterogeneity in cash usage. Consumers non-randomly choose contactless payment cards. Card-affined individuals replace conventional card payments with contactless card payments. The overall effect on cash usage therefore remains unaffected.

The results are in line with previous findings (cf. Chen et al. (2017)). It is important to control for unobserved heterogeneity in cash usage: The findings suggest a relationship between the adoption of contactless payment and decreasing cash usage if the endogenous choice of contactless payment is not accounted for. Omitted variables such as payment habitualization may also confound and bias the estimates. Therefore, the effect of contactless payment on cash demand is overestimated if unobserved heterogeneity is ignored.

Several caveats are worth mentioning. First, the dataset gives no insights into transactional purposes. Hence, the true values of cash purchases need to be proxied by the typical amount of cash per withdrawal, kept in wallet, and the frequency of withdrawals. These measures are not perfectly equivalent to the theoretical concept in the Baumol-Tobin framework. The difference between cash hoarding and cash usage for transactional purposes is likely to result in measurement errors. Incomplete information on the exact amount of

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23 The number of observations decreases in the estimations using control sets one and two because withdrawal methods and some perceived characteristics were not surveyed in 2009.

24 Fung et al. (2014) and Chen et al. (2017) estimated a negative effect of contactless credit cards on the cash share volume at roughly 13 and 8% using cross-sectional and pooled data, respectively.

25 The number of observations decreases in the estimations using control sets one and two because withdrawal methods and some perceived characteristics were not surveyed in 2009.
Table 8 Summary of FE regression results of contactless credit cards

| Variable          | Usual cash withdrawn            | Number of withdrawals          | Cash in wallet         | Cash share volume      |
|-------------------|---------------------------------|--------------------------------|------------------------|------------------------|
|                   | Baseline (1) Controls 1 (2) Controls 2 (3) | Baseline (1) Controls 1 (2) Controls 2 (3) | Baseline (1) Controls 1 (2) Controls 2 (3) | Baseline (1) Controls 1 (2) Controls 2 (3) |
| Contactless       | 6.766 6.855 8.906               | -0.325 -0.326 -0.295           | 8.371 6.850 6.067     | -0.011 -0.013 -0.013   |
| Credit cards      | (8.994) (11.044) (9.824)        | (0.355) (0.435) (0.446)        | (1.2976) (14.477) (14.318) | (0.027) (0.030) (0.030) |
| R²                | 0.012 0.016 0.088              | 0.006 0.009 0.031             | 0.009 0.014 0.024     | 0.013 0.033 0.035     |
| Observations      | 3592 2865 2865                 | 3602 2874 2873                | 3599 2874 2874        | 3556 2860 2858        |
| Individuals       | 853 845 845                    | 853 847 846                   | 851 844 844           | 852 846 845          |
| Demographics      | Yes Yes Yes                    | Yes Yes Yes                   | Yes Yes Yes           | Yes Yes Yes          |
| Relative characteristics | No Yes Yes | No Yes Yes | No Yes Yes | No Yes Yes |
| Withdrawal method | No No No                       | No No No                     | No No No              | No No Yes            |

Cluster robust standard errors are used and given in parentheses. Survey weights are used. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1. The full set of FE estimates are reported in the Appendix (see Tables 21, 23, 25 and 27).
checking account interest rates and household income may also lead to measurement errors. Measuring cash usage in terms of volume may also suffer from recall effects. Payment diaries reporting each transaction in detail, in conjunction with information on exact interest rates and income, would help to obtain more accurate results.

Second, the estimation results should be interpreted with caution since the diffusion of contactless payment cards and contactless-enabled terminals in the USA was still in its infancy in the years 2009–2013. It is likely that the effects are greater and also different if more cards are contactless and if consumers have readier access to more contactless-enabled terminals.

Third, appropriate instrumental variables were not available to properly control for possible reverse causality in the estimation. Individuals who rely less on cash may also adopt contactless payment to meet their personal preferences for frequent usage of payment cards. Plausible instrumental variables are necessary for future work: supply-side statistics come to mind (e.g., the number of contactless-enabled terminals differentiated by geographical region).

Fourth, the external validity of the results could be limited. This is because payment composition and payment infrastructure between the USA and Europe differ significantly due to their culturally and institutionally diverse evolution of payment systems. US Americans pay more by payment cards while Europeans rely heavily on cash as a payment means Bagnall et al. (2016). Therefore, specific payment patterns in the two payment areas may affect the magnitude of the estimated effects.

### Appendix

**Variable definition**

**Household income**

Annual household income, as a proxy for consumption, is surveyed as a categorical variable with 17 categories. Interest rates of checking accounts are also reported as categories in the SCPC. I computed the average of each category’s bounds to convert the categories into continuous variables. This makes interpreting the coefficients straightforward. Data for the median household income (over 200,000 USD) are drawn from the 2013 Survey of Consumer Finances as a proxy for the top income category (see SCF (2014)). I logarithmically transformed this variable for the estimation since test statistics conclude that the distribution of household income is skewed.

**Perceived characteristics**

The absolute ratings of the perceived characteristics of cash are transformed into relative ones—as in Schuh and Stavins (2013)—by using the following transformation:

\[
RCHAR_{ki}(j, h) = \log \left( \frac{CHAR_{kij}}{\sum_{h=1}^{H} CHAR_{kih}} \right),
\]

where \( k \) describes the six characteristics such as security, setup, acceptance, costs, records, and convenience, \( i \) indexes the consumer, \( j \) relates to cash, and \( h \) is credit and debit cards. The construction is applied to every consumer regardless of the adoption stage of the payment methods. The higher the value of the variable \( RCHAR_{ki} \), the more favorable cash is than debit and credit cards with respect to characteristic \( k \). This normalizes the perception of a particular attribute.

**Descriptives and regression tables**

| Variable | Usual cash withdrawn | Number of withdrawals | Cash in wallet | Cash share volume |
|----------|----------------------|-----------------------|----------------|------------------|
|          | Baseline 1 Controls 2 | Baseline 1 Controls 2 | Baseline 1 Controls 2 | Baseline 1 Controls 2 |
| Contactless debit cards | -2.250 (-7.691) | -2.966 (-7.751) | -5.062 (-7.725) | -0.904* (0.502) |
|          | (1) (2) (3) | (1) (2) (3) | (1) (2) (3) | (1) (2) (3) |
| \( R^2 \) | 0.012 | 0.011 | 0.067 | 0.008 |
| Individuals | 3874 | 3084 | 3084 | 3882 |
| Observations | 906 | 899 | 899 | 905 |
| Demographics | Yes | Yes | Yes | Yes |
| Relative characteristics | No | Yes | Yes | No |
| Withdrawal method | No | No | Yes | No |

Cluster-robust standard errors are used and given in parentheses. Survey weights are used. Significance levels are denoted as *** \( p < 0.01 \), ** \( p < 0.05 \), * \( p < 0.1 \). The full set of FE estimates are reported in the Appendix (see Tables 22, 24, 26, and 28).
| Variable          | Stayers |          |          | Attritors |          |          | t test | Mean diff. |
|-------------------|---------|----------|----------|-----------|----------|----------|--------|------------|
| Income (in 1000)  |         |          |          |           |          |          |        |            |
| < 25              | 0.185   | 0.389    | 1128     | 0.181     | 0.386    | 1039     | —      | 0.026      |
| 0.3 cm 25–49      | 0.358   | 0.480    | 1128     | 0.313     | 0.464    | 1039     | —      | 0.014      |
| 50–74             | 0.219   | 0.414    | 1128     | 0.251     | 0.434    | 1039     | 0.029  |            |
| 75–99             | 0.132   | 0.338    | 1128     | 0.116     | 0.321    | 1039     | —      | 0.025      |
| 100–124           | 0.037   | 0.188    | 1128     | 0.061     | 0.239    | 1039     | 0.026**|            |
| 125–199           | 0.049   | 0.216    | 1128     | 0.052     | 0.223    | 1039     | 0.009  |            |
| > 200             | 0.021   | 0.142    | 1128     | 0.025     | 0.158    | 1039     | 0.001  |            |
| Education         |         |          |          |           |          |          |        |            |
| < High school     | 0.046   | 0.209    | 1132     | 0.078     | 0.268    | 1041     | 0.023  |            |
| High school       | 0.432   | 0.496    | 1132     | 0.343     | 0.475    | 1041     | —      | 0.072**    |
| Some college      | 0.265   | 0.442    | 1132     | 0.292     | 0.455    | 1041     | 0.033  |            |
| College           | 0.168   | 0.374    | 1132     | 0.193     | 0.395    | 1041     | 0.015  |            |
| Post graduate     | 0.089   | 0.285    | 1132     | 0.093     | 0.291    | 1041     | 0.002  |            |
| Employment        |         |          |          |           |          |          |        |            |
| Working           | 0.789   | 0.408    | 1018     | 0.753     | 0.431    | 959      | —      | 0.036      |
| Retired           | 0.119   | 0.324    | 1018     | 0.168     | 0.374    | 959      | 0.050**|            |
| Unemployed        | 0.019   | 0.135    | 1018     | 0.005     | 0.074    | 959      | —      | 0.013*     |
| Other             | 0.062   | 0.242    | 1132     | 0.064     | 0.245    | 1041     | —      | 0.001      |
| Marital status    |         |          |          |           |          |          |        |            |
| Single            | 0.200   | 0.400    | 1132     | 0.195     | 0.396    | 1041     | 0.003  |            |
| Married           | 0.622   | 0.485    | 1132     | 0.641     | 0.480    | 1041     | 0.019  |            |
| Separated         | 0.134   | 0.340    | 1132     | 0.120     | 0.325    | 1041     | —      | 0.021      |
| Widowed           | 0.044   | 0.206    | 1132     | 0.044     | 0.206    | 1041     | —      | 0.001      |
| Age               |         |          |          |           |          |          |        |            |
| < 25              | 0.099   | 0.299    | 1132     | 0.157     | 0.364    | 1040     | 0.047  |            |
| 25–34             | 0.178   | 0.383    | 1132     | 0.188     | 0.391    | 1040     | 0.026  |            |
| 35–44             | 0.186   | 0.389    | 1132     | 0.177     | 0.382    | 1040     | —      | 0.013      |
| 45–54             | 0.239   | 0.427    | 1132     | 0.154     | 0.361    | 1040     | —      | 0.095***   |
| 55–64             | 0.135   | 0.342    | 1132     | 0.156     | 0.363    | 1040     | 0.015  |            |
| > 65              | 0.161   | 0.368    | 1132     | 0.167     | 0.373    | 1040     | 0.021  |            |
| Ethnicity         |         |          |          |           |          |          |        |            |
| White             | 0.733   | 0.443    | 1132     | 0.750     | 0.433    | 1041     | 0.035  |            |
| Black             | 0.139   | 0.346    | 1132     | 0.098     | 0.298    | 1041     | —      | 0.064**    |
| Asian             | 0.036   | 0.187    | 1132     | 0.030     | 0.171    | 1041     | —      | 0.0001     |
| Latino            | 0.133   | 0.34     | 1132     | 0.168     | 0.374    | 1041     | 0.037  |            |
| Other             | 0.092   | 0.289    | 1132     | 0.122     | 0.327    | 1041     | 0.031  |            |
| Others            |         |          |          |           |          |          |        |            |
| Male              | 0.485   | 0.500    | 1132     | 0.480     | 0.500    | 1041     | 0.004  |            |
| HH members        | 1.316   | 1.528    | 1132     | 1.331     | 1.584    | 1041     | 0.034  |            |
| Revolver          | 0.403   | 0.491    | 1122     | 0.403     | 0.491    | 1019     | —      | 0.015      |
| Home owner        | 0.671   | 0.470    | 1129     | 0.693     | 0.462    | 1018     | 0.058  |            |

*HH refers to household. Survey weights used. t tests of mean differences of stayers and attritors are displayed. Differences may stray from true values due to rounding and weighting. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1. Variables are displayed for 2009. Stayers participate five years in a row. Attritors participate in 2009 but not in all 5 years.*
### Table 11  First-year payment card and cash usage characteristics of stayers vs. attritors

| Variable                  | Stayers |          | Attritors |          | t test |          |
|---------------------------|---------|----------|-----------|----------|--------|----------|
|                           | Mean    | SD       | N         | Mean     | SD     | N        | Mean diff. |
| Contactless credit cards  | 0.103   | 0.303    | 1131      | 0.089    | 0.285  | 1027     | −0.015     |
| Contactless debit cards   | 0.099   | 0.298    | 1129      | 0.130    | 0.336  | 1029     | 0.034      |
| Credit cards              | 0.726   | 0.446    | 1131      | 0.717    | 0.451  | 1029     | −0.023     |
| Debit cards               | 0.757   | 0.429    | 1129      | 0.785    | 0.411  | 1028     | 0.029      |
| Credit card usage         | 0.567   | 0.496    | 1120      | 0.542    | 0.499  | 1019     | −0.036     |
| Debit card usage          | 0.641   | 0.480    | 1118      | 0.671    | 0.470  | 1019     | 0.033      |
| Usual withdrawal          | 122.368 | 161.119  | 1122      | 125.448  | 193.411| 1023     | 3.974      |
| Nr. of withdrawals        | 3.258   | 2.956    | 1123      | 3.757    | 3.710  | 1023     | 0.479*     |
| Cash in wallet            | 72.698  | 120.903  | 1116      | 64.834   | 104.088| 1016     | −8.315     |
| Cash share in volume      | 0.392   | 0.300    | 1074      | 0.36     | 0.301  | 968      | −0.027     |

Usage describes the fact that respondents make the corresponding type of payment at least once in a typical month. Survey weights used. t tests of mean differences of stayers and attritors are displayed. Differences may stray from true values due to rounding and weighting. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1. Variables are displayed for 2009. Stayers participate five years in a row. Attritors participate in 2009 but not in all 5 years.
### Table 12 Sample summary statistics

| Variable             | Entire sample | Credit cards | Debit cards |
|----------------------|---------------|--------------|-------------|
|                      | Mean | SD  | N | Mean | Mean | Mean diff. | Mean | Mean | Mean diff. |
| Income (in 1000)     |      |     |   |      |      |            |      |      |            |
| < 25                 | 0.202 | 0.402 | 5645 | 0.140 | 0.209 | −0.060*** | 0.302 | 0.189 | 0.115*** |
| 25–49                | 0.28  | 0.449 | 5645 | 0.253 | 0.283 | −0.029    | 0.285 | 0.280 | −0.004    |
| 50–74                | 0.199 | 0.4  | 5645 | 0.201 | 0.199 | 0.003     | 0.169 | 0.203 | −0.035    |
| 75–99                | 0.13  | 0.336 | 5645 | 0.133 | 0.129 | 0.001     | 0.097 | 0.134 | −0.038**  |
| 100–124              | 0.084 | 0.278 | 5645 | 0.090 | 0.084 | 0.004     | 0.058 | 0.088 | −0.027*   |
| 125–199              | 0.076 | 0.264 | 5645 | 0.111 | 0.072 | 0.037**   | 0.053 | 0.078 | −0.024*   |
| > 200                | 0.029 | 0.169 | 5645 | 0.072 | 0.025 | 0.044***  | 0.037 | 0.029 | −0.012    |
| Education            |      |     |   |      |      |            |      |      |            |
| < High school        | 0.042 | 0.2  | 5660 | 0.058 | 0.040 | 0.025     | 0.059 | 0.040 | 0.019     |
| High school          | 0.379 | 0.485 | 5660 | 0.250 | 0.393 | −0.132*** | 0.461 | 0.368 | 0.098**   |
| Some college         | 0.278 | 0.448 | 5660 | 0.277 | 0.278 | −0.010    | 0.274 | 0.279 | −0.015    |
| College              | 0.171 | 0.377 | 5660 | 0.198 | 0.168 | 0.022     | 0.145 | 0.174 | −0.026    |
| Post graduate        | 0.13  | 0.336 | 5660 | 0.216 | 0.121 | 0.095***  | 0.060 | 0.138 | −0.076**  |
| Employment           |      |     |   |      |      |            |      |      |            |
| Working              | 0.648 | 0.478 | 5546 | 0.709 | 0.641 | 0.070***  | 0.733 | 0.637 | 0.099***  |
| Retired              | 0.208 | 0.406 | 5546 | 0.196 | 0.209 | −0.015    | 0.126 | 0.218 | −0.088*** |
| Unemployed           | 0.062 | 0.242 | 5546 | 0.045 | 0.064 | −0.018    | 0.080 | 0.060 | 0.020     |
| Other                | 0.175 | 0.38  | 5660 | 0.140 | 0.178 | −0.041*** | 0.158 | 0.177 | −0.022    |
| Marital status       |      |     |   |      |      |            |      |      |            |
| Single               | 0.142 | 0.349 | 5660 | 0.110 | 0.145 | −0.030*   | 0.209 | 0.134 | 0.047     |
| Married              | 0.659 | 0.474 | 5660 | 0.674 | 0.657 | 0.010     | 0.610 | 0.664 | −0.027    |
| Separated            | 0.147 | 0.354 | 5660 | 0.145 | 0.148 | −0.005    | 0.166 | 0.145 | 0.016     |
| Widowed              | 0.052 | 0.222 | 5660 | 0.072 | 0.050 | 0.025*    | 0.015 | 0.056 | −0.036*** |
| Age                  |      |     |   |      |      |            |      |      |            |
| < 25                 | 0.045 | 0.206 | 5660 | 0.052 | 0.044 | 0.006     | 0.085 | 0.040 | 0.031     |
| 25–34                | 0.152 | 0.359 | 5660 | 0.119 | 0.155 | −0.031    | 0.245 | 0.139 | 0.095**   |
| 35–44                | 0.169 | 0.375 | 5660 | 0.228 | 0.163 | 0.066**   | 0.165 | 0.170 | −0.004    |
| 45–54                | 0.246 | 0.431 | 5660 | 0.242 | 0.246 | −0.010    | 0.271 | 0.243 | 0.041     |
| 55–64                | 0.182 | 0.386 | 5660 | 0.141 | 0.186 | −0.042**  | 0.114 | 0.190 | −0.071*** |
| > 65                 | 0.207 | 0.405 | 5660 | 0.219 | 0.206 | 0.012     | 0.120 | 0.218 | −0.092*** |
| Ethnicity            |      |     |   |      |      |            |      |      |            |
| White                | 0.765 | 0.424 | 5660 | 0.740 | 0.768 | −0.029    | 0.588 | 0.787 | −0.201*** |
| Black                | 0.142 | 0.349 | 5660 | 0.076 | 0.149 | −0.070*** | 0.198 | 0.133 | 0.065**   |
| Asian                | 0.031 | 0.174 | 5660 | 0.104 | 0.024 | 0.074***  | 0.058 | 0.028 | 0.038**   |
| Latino               | 0.093 | 0.29  | 5660 | 0.113 | 0.091 | 0.023     | 0.180 | 0.081 | 0.107***  |
| Other                | 0.062 | 0.241 | 5660 | 0.081 | 0.060 | 0.025     | 0.155 | 0.051 | 0.098**   |
| Others               |      |     |   |      |      |            |      |      |            |
| Male                 | 0.452 | 0.498 | 5660 | 0.434 | 0.454 | −0.026    | 0.507 | 0.445 | 0.050     |
| HH members           | 1.276 | 1.566 | 5660 | 0.975 | 1.307 | −0.353*** | 1.619 | 1.237 | 0.368**   |
| Revolver             | 0.419 | 0.493 | 5602 | 0.499 | 0.410 | 0.086***  | 0.339 | 0.429 | −0.078**  |
| Home owner           | 0.71  | 0.454 | 5607 | 0.752 | 0.706 | 0.055*    | 0.499 | 0.737 | −0.223*** |

N-I and I denote non-innovators and innovators, respectively. HH refers to household. The minimum numbers equal zero for every variable. Survey weights used. \( t \) tests of mean differences of innovators and non-innovators are displayed. Differences may stray from true values due to rounding and weighting. Significance levels are denoted as ***\( p < 0.01 \), **\( p < 0.05 \), *\( p < 0.1 \).
Table 13 OLS regression results of contactless credit on usual cash withdrawn

| Variable               | (1)            |             | (2)            |             | (3)            |             |
|-----------------------|----------------|-------------|----------------|-------------|----------------|-------------|
|                       | \( b \)        | se           | \( b \)        | se           | \( b \)        | se           |
| Contactless credit    | -5.301         | (14.613)     | -5.507         | (14.760)     | -10.587        | (15.396)     |
| log(income)           | 30.885***      | (6.308)      | 35.589***      | (6.301)      | 37.976***      | (6.451)      |
| Interest rate         | -6.433         | (11.463)     | -5.329         | (10.787)     | -1.799         | (9.505)      |
| Education             |                |             |                |             |                |             |
| High school           | -24.227        | (31.741)     | -23.819        | (33.539)     | -16.421        | (36.158)     |
| Some college          | -14.669        | (32.814)     | -13.565        | (34.835)     | -10.931        | (37.197)     |
| College               | -33.381        | (33.496)     | -28.655        | (35.686)     | -20.106        | (38.322)     |
| Post graduate         | -10.333        | (35.484)     | -6.421         | (37.492)     | 1.853          | (40.304)     |
| Employment            |                |             |                |             |                |             |
| Working               | -24.375*       | (13.123)     | -23.459*       | (13.400)     | -23.946**      | (12.172)     |
| Retired               | 3.797          | (24.020)     | 7.888          | (23.649)     | 9.055          | (23.476)     |
| Other                 | 31.713**       | (15.364)     | 35.325**       | (15.512)     | 33.888**       | (15.257)     |
| Marital status        |                |             |                |             |                |             |
| Single                | -35.151        | (34.478)     | -32.307        | (33.662)     | -33.348        | (30.590)     |
| Married               | -57.976*       | (32.407)     | -58.621*       | (31.320)     | -59.704**      | (29.269)     |
| Separated             | -27.190        | (34.106)     | -22.297        | (33.602)     | -16.506        | (30.831)     |
| Age                   |                |             |                |             |                |             |
| 25–34                 | 15.620         | (19.975)     | 22.015         | (20.370)     | 36.509**       | (18.243)     |
| 35–44                 | 11.993         | (22.396)     | 15.083         | (22.467)     | 34.465*        | (19.610)     |
| 45–54                 | 38.200*        | (22.869)     | 36.187         | (22.962)     | 39.305**       | (20.018)     |
| 55–64                 | 36.924         | (25.361)     | 31.116         | (25.617)     | 34.154         | (22.811)     |
| > 65                  | 44.779         | (31.808)     | 30.569         | (32.846)     | 31.962         | (30.458)     |
| Ethnicity             |                |             |                |             |                |             |
| White                 | -21.338        | (44.445)     | -22.980        | (45.108)     | -30.309        | (45.024)     |
| Black                 | 0.618          | (48.577)     | -5.700         | (48.927)     | -10.741        | (48.945)     |
| Latino                | 23.720         | (15.654)     | 18.551         | (14.956)     | 21.396         | (14.878)     |
| Other                 | -26.842        | (47.219)     | -28.048        | (48.138)     | -33.685        | (48.045)     |
| Other                 |                |             |                |             |                |             |
| Male                  | 25.931***      | (9.259)      | 27.375***      | (9.215)      | 22.688**       | (8.926)      |
| HH members            | 0.582          | (4.399)      | -0.194         | (4.387)      | 1.627          | (4.491)      |
| CC revolver           | -41.217***     | (9.535)      | -38.867***     | (9.681)      | -30.695***     | (9.370)      |
| Home owner            | 17.532         | (12.353)     | 16.992         | (12.130)     | 11.995         | (11.307)     |
| Rel. characteristics  |                |             |                |             |                |             |
| Security              | 19.570***      | (7.492)      | 14.066**       | (6.883)      |                |             |
| Setup                 | -18.465        | (11.395)     | -32.118***     | (11.052)     |                |             |
| Acceptance            | 22.753         | (16.290)     | 22.957         | (16.678)     |                |             |
| Costs                 | -1.936         | (13.064)     | -2.073         | (12.444)     |                |             |
| Records               | 13.911         | (8.519)      | 6.240          | (8.207)      |                |             |
| Convenience           | 37.702***      | (11.137)     | 33.056***      | (10.417)     |                |             |
| Withdrawal method     |                |             |                |             |                |             |
| Bank teller           | 83.374***      | (13.958)     |                |             |                |             |
| Check cashier         | 209.064***     | (60.061)     |                |             |                |             |
| Cashback              | -60.506***     | (7.440)      |                |             |                |             |
| Employer              | 103.620**      | (40.740)     |                |             |                |             |
| Family                | 8.894          | (28.750)     |                |             |                |             |
| Other                 | 98.102**       | (45.644)     |                |             |                |             |
| Constant              | -154.330*      | (88.997)     | -130.304       | (90.618)     | -206.721**     | (94.081)     |
| R²                    | 0.083          | 0.112        | 0.208          |             |                |             |
| Individuals           | 1464           | 1452         | 1452           |             |                |             |

*b* are the point estimates and se the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***\( p < 0.01 \), **\( p < 0.05 \), *\( p < 0.1 \).
Table 14: OLS regression results of contactless debit on usual cash withdrawn

| Variable                      | (1)     |             | (2)     |             | (3)     |             |
|-------------------------------|---------|-------------|---------|-------------|---------|-------------|
|                               | $b$     | $se$        | $b$     | $se$        | $b$     | $se$        |
| Contactless debit             | -0.289  | (15.510)    | 1.223   | (15.558)    | 9.603   | (14.638)    |
| log(income)                   | 30.668*** | (6.243)    | 35.371*** | (6.236)    | 37.663*** | (6.382)    |
| Interest rate                 | -6.450  | (11.468)    | -5.359  | (10.789)    | -1.879  | (9.476)     |
| Education                     |         |             |         |             |         |             |
| High school                   | -23.307 | (32.287)    | -22.802 | (34.366)    | -14.868 | (36.797)    |
| Some college                  | -13.768 | (33.322)    | -12.553 | (35.593)    | -9.257  | (37.827)    |
| College                       | -32.630 | (33.807)    | -27.787 | (36.219)    | -18.655 | (38.716)    |
| Post graduate                 | -9.745  | (35.788)    | -5.694  | (37.963)    | 3.112   | (40.608)    |
| Employment                    |         |             |         |             |         |             |
| Working                       | -24.510* | (13.185)   | -23.680* | (13.460)   | -24.508** | (12.242)   |
| Retired                       | 3.974   | (23.963)    | 8.098   | (23.549)    | 9.707   | (23.396)    |
| Other                         | 31.836** | (15.398)   | 35.356** | (15.511)   | 33.521** | (15.309)    |
| Marital status                |         |             |         |             |         |             |
| Single                        | -35.054 | (34.424)    | -32.225 | (33.655)    | -32.793 | (30.590)    |
| Married                       | -57.853* | (32.409)   | -58.531* | (31.351)   | -59.349*** | (29.342)   |
| Separated                     | -27.270 | (34.134)    | -22.438 | (33.636)    | -16.868 | (30.905)    |
| Age                           |         |             |         |             |         |             |
| 25–34                         | 15.708  | (19.864)    | 21.953  | (20.344)    | 36.273** | (18.138)    |
| 35–44                         | 12.183  | (22.272)    | 15.325  | (22.446)    | 35.682* | (19.596)    |
| 45–54                         | 38.522* | (22.684)    | 36.575  | (22.859)    | 40.826** | (19.913)    |
| 55–64                         | 37.198  | (25.172)    | 31.414  | (25.512)    | 35.368  | (22.644)    |
| >65                           | 44.811  | (31.841)    | 30.574  | (32.932)    | 32.553  | (30.558)    |
| Ethnicity                     |         |             |         |             |         |             |
| White                         | -20.823 | (44.223)    | -22.444 | (44.902)    | -28.547 | (44.897)    |
| Black                         | 1.536   | (47.930)    | -4.914  | (48.348)    | -9.532  | (48.363)    |
| Latino                        | 23.581  | (15.556)    | 18.363  | (14.851)    | 20.854  | (14.828)    |
| Other                         | -26.397 | (46.944)    | -27.731 | (47.925)    | -33.294 | (47.947)    |
| Other                         |         |             |         |             |         |             |
| Male                          | 25.788*** | (9.225)    | 27.224*** | (9.187)    | 22.361** | (8.901)     |
| HH members                    | 0.623   | (4.312)     | -0.164  | (4.309)     | -1.601  | (4.375)     |
| CC revolver                   | -41.239*** | (9.468)   | -38.696*** | (9.623)    | -30.571*** | (9.314)    |
| Home owner                    | 17.635  | (12.448)    | 17.170  | (12.158)    | 12.646  | (11.296)    |
| Rel. characteristics          |         |             |         |             |         |             |
| Security                      | 19.551*** | (7.470)    | 13.900** | (6.843)    |         |             |
| Setup                         | -18.688* | (11.126)   | -32.062*** | (10.874)  |         |             |
| Acceptance                    | 22.779  | (16.298)    | 22.936  | (16.708)    |         |             |
| Costs                         | -1.600  | (13.078)    | -1.383  | (12.515)    |         |             |
| Records                       | 13.805  | (8.518)     | 5.961   | (8.191)     |         |             |
| Convenience                   | 37.822*** | (11.228)   | 33.467*** | (10.451)   |         |             |
| Withdrawal method             |         |             |         |             |         |             |
| Bank teller                   |         |             |         |             |         |             |
| Check cashier                 | 83.496*** | (14.043)   |         |             |         |             |
| Cashback                      |         |             |         |             |         |             |
| Employer                      | 211.711*** | (59.847)   |         |             |         |             |
| Family                        | -59.936*** | (7.464)    |         |             |         |             |
| Other                         |         |             |         |             |         |             |
| Constant                      | -154.079* | (89.384)   | -130.316 | (90.949)    | -209.598** | (94.679)   |
| $R^2$                         | 0.083   | 0.112       | 0.208   |             |         |             |
| Individuals                   | 1464    | 1452        | 1452    |             |         |             |

$b$ are the point estimates and $se$ the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. **
Table 15 OLS regression results of contactless credit on number of withdrawals

| Variable                      | (1)      | (2)      | (3)      |
|-------------------------------|----------|----------|----------|
|                               | $b$      | $se$     | $b$      | $se$     | $b$      | $se$     |
| Contactless credit            | – 0.723  | (0.667)  | – 0.611  | (0.619)  | – 0.455  | (0.607)  |
| log(income)                   | – 0.816  | (0.543)  | – 0.880  | (0.547)  | – 0.804* | (0.456)  |
| Interest rate                 | – 0.216  | (0.345)  | – 0.210  | (0.358)  | – 0.132  | (0.360)  |
| Education                     |          |          |          |          |          |          |
| High school                   | – 4.241  | (3.365)  | – 1.537  | (1.920)  | – 1.858  | (1.803)  |
| Some college                  | – 5.073  | (3.278)  | – 2.369  | (1.795)  | – 2.621  | (1.742)  |
| College                       | – 4.302  | (3.217)  | – 1.714  | (1.846)  | – 1.946  | (1.754)  |
| Post graduate                 | – 4.301  | (3.332)  | – 1.636  | (1.965)  | – 1.938  | (1.811)  |
| Employment                    |          |          |          |          |          |          |
| Working                       | 1.685*   | (0.999)  | 0.957    | (0.691)  | 0.671    | (0.637)  |
| Retired                       | 0.782    | (1.170)  | – 0.390  | (0.587)  | – 0.386  | (0.603)  |
| Other                         | 0.341    | (1.032)  | – 0.550  | (0.606)  | – 0.591  | (0.597)  |
| Marital status                |          |          |          |          |          |          |
| Single                        | – 0.181  | (2.167)  | – 0.463  | (2.130)  | – 0.464  | (2.148)  |
| Married                       | – 1.721  | (1.933)  | – 2.179  | (1.859)  | – 2.166  | (1.873)  |
| Separated                     | – 2.621  | (2.038)  | – 2.909  | (2.016)  | – 2.781  | (2.041)  |
| Age                           |          |          |          |          |          |          |
| 25–34                         | – 1.942  | (2.781)  | – 2.190  | (2.776)  | – 1.676  | (2.410)  |
| 35–44                         | – 0.964  | (2.584)  | – 0.989  | (2.533)  | – 0.581  | (2.246)  |
| 45–54                         | – 0.614  | (2.681)  | – 1.013  | (2.552)  | – 0.614  | (2.277)  |
| 55–64                         | – 1.012  | (2.581)  | – 1.166  | (2.455)  | – 0.866  | (2.181)  |
| >65                           | – 0.767  | (2.692)  | – 1.088  | (2.424)  | – 0.561  | (2.153)  |
| Ethnicity                     |          |          |          |          |          |          |
| White                         | 0.788    | (1.041)  | 0.950    | (1.092)  | 0.587    | (0.952)  |
| Black                         | 4.407**  | (1.840)  | 3.045**  | (1.532)  | 2.715*   | (1.474)  |
| Latino                        | 0.314    | (0.633)  | 0.484    | (0.573)  | 0.409    | (0.587)  |
| Other                         | 5.129**  | (2.397)  | 5.319**  | (2.460)  | 4.874**  | (2.155)  |
| Other                         |          |          |          |          |          |          |
| Male                          | 0.985*   | (0.586)  | 0.728    | (0.509)  | 0.578    | (0.463)  |
| HH members                    | – 0.103  | (0.197)  | – 0.133  | (0.203)  | – 0.104  | (0.200)  |
| CC revolver                   | – 0.636  | (0.429)  | – 0.519  | (0.433)  | – 0.455  | (0.451)  |
| Home owner                    | – 1.527**| (0.773)  | – 1.125* | (0.628)  | – 0.962  | (0.670)  |
| Rel. characteristics          |          |          |          |          |          |          |
| Security                      | 0.131    | (0.287)  | 0.051    | (0.285)  |          |          |
| Setup                         | – 0.098  | (0.729)  | – 0.098  | (0.718)  |          |          |
| Acceptance                    | – 0.937  | (0.777)  | – 0.971  | (0.735)  |          |          |
| Costs                         | – 0.547  | (0.661)  | – 0.370  | (0.586)  |          |          |
| Records                       | – 0.029  | (0.423)  | – 0.109  | (0.406)  |          |          |
| Convenience                   | 0.456    | (0.702)  | 0.510    | (0.701)  |          |          |
| Withdrawal method             |          |          |          |          |          |          |
| Bank teller                   |          |          |          |          |          |          |
| Check casher                  |          |          |          |          |          |          |
| Cashback                      |          |          |          |          |          |          |
| Employer                      |          |          |          |          |          |          |
| Family                        |          |          |          |          |          |          |
| Other                         |          |          |          |          |          |          |
| Constant                      | 18.501***| (6.682)  | 17.340***| (6.624)  | 16.594***| (5.579)  |
| $R^2$                         | 0.092    | 0.086    | 0.111    |          |          |          |
| Individuals                   | 1464     | 1452     | 1452     |          |          |          |

$b$ are the point estimates and $se$ the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refers to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian and ATM. Significance levels are denoted as *** $p<0.01$, ** $p<0.05$, * $p<0.1$. 

[56x790]
Table 16 OLS regression results of contactless debit on number of withdrawals

| Variable                        | (1)       |          | (2)       |          | (3)       |          |
|---------------------------------|-----------|----------|-----------|----------|-----------|----------|
|                                 | \(b\)     | \(se\)   | \(b\)     | \(se\)   | \(b\)     | \(se\)   |
| Contactless debit               | 1.043     | (1.299)  | 0.028     | (0.899)  | 0.156     | (0.863)  |
| log(income)                     | -0.840    | (0.546)  | -0.905    | (0.553)  | -0.820**  | (0.457)  |
| Interest rate                   | -0.232    | (0.354)  | -0.212    | (0.359)  | -0.134    | (0.362)  |
| Education                       |           |          |           |          |           |          |
| High school                     | -4.155    | (3.334)  | -1.417    | (1.916)  | -1.775    | (1.778)  |
| Some college                    | -4.972    | (3.227)  | -2.250    | (1.775)  | -2.536    | (1.705)  |
| College                         | -4.213    | (3.171)  | -1.613    | (1.835)  | -1.873    | (1.726)  |
| Post graduate                   | -4.218    | (3.283)  | -1.551    | (1.963)  | -1.876    | (1.793)  |
| Employment                      |           |          |           |          |           |          |
| Working                         | 1.622*    | (0.961)  | 0.935     | (0.687)  | 0.653     | (0.630)  |
| Retired                         | 0.796     | (1.158)  | -0.368    | (0.589)  | -0.362    | (0.608)  |
| Other                           | 0.279     | (0.972)  | -0.540    | (0.606)  | -0.592    | (0.596)  |
| Marital status                  |           |          |           |          |           |          |
| Single                          | -0.137    | (2.173)  | -0.458    | (2.130)  | -0.450    | (2.147)  |
| Married                         | -1.700    | (1.933)  | -2.170    | (1.859)  | -2.154    | (1.873)  |
| Separated                       | -2.652    | (2.035)  | -2.923    | (2.017)  | -2.788    | (2.042)  |
| Age                             |           |          |           |          |           |          |
| 25–34                           | -2.019    | (2.755)  | -2.189    | (2.748)  | -1.672    | (2.391)  |
| 35–44                           | -0.903    | (2.610)  | -0.967    | (2.552)  | -0.546    | (2.265)  |
| 45–54                           | -0.518    | (2.720)  | -0.976    | (2.575)  | -0.568    | (2.299)  |
| 55–64                           | -0.943    | (2.608)  | -1.138    | (2.471)  | -0.827    | (2.195)  |
| > 65                            | -0.731    | (2.725)  | -1.092    | (2.448)  | -0.548    | (2.172)  |
| Ethnicity                       |           |          |           |          |           |          |
| White                           | 0.900     | (1.025)  | 1.006     | (1.084)  | 0.641     | (0.945)  |
| Black                           | 4.444**   | (1.815)  | 3.140**   | (1.553)  | 2.783*    | (1.495)  |
| Latino                          | 0.258     | (0.645)  | 0.466     | (0.580)  | 0.393     | (0.594)  |
| Other                           | 5.126**   | (2.426)  | 5.360**   | (2.488)  | 4.904**   | (2.173)  |
| Other                           |           |          |           |          |           |          |
| Male                            | 0.952     | (0.580)  | 0.712     | (0.509)  | 0.567     | (0.463)  |
| HH members                      | -0.103    | (0.196)  | -0.130    | (0.201)  | -0.102    | (0.197)  |
| CC revolver                     | -0.618    | (0.424)  | -0.523    | (0.437)  | -0.455    | (0.455)  |
| Home owner                      | -1.463**  | (0.742)  | -1.110*   | (0.629)  | -0.943    | (0.669)  |
| Rel. characteristics            |           |          |           |          |           |          |
| Security                        | 0.131     | (0.284)  | 0.048     | (0.281)  |           |          |
| Setup                           | -0.131    | (0.745)  | -0.112    | (0.731)  |           |          |
| Acceptance                      | -0.934    | (0.775)  | -0.972    | (0.730)  |           |          |
| Costs                           | -0.509    | (0.658)  | -0.340    | (0.586)  |           |          |
| Records                         | -0.040    | (0.423)  | -0.118    | (0.405)  |           |          |
| Convenience                     | 0.467     | (0.712)  | 0.521     | (0.710)  |           |          |
| Withdrawal method               |           |          |           |          |           |          |
| Bank teller                     | -0.397    | (0.521)  |           |          |           |          |
| Check cashier                   | 14.577    | (11.053) |           |          |           |          |
| Cashback                        | 0.005     | (0.762)  |           |          |           |          |
| Employer                        | 1.233     | (1.576)  |           |          |           |          |
| Family                          | -0.869    | (1.015)  |           |          |           |          |
| Other                           | 2.551     | (1.801)  |           |          |           |          |
| Constant                        | 18.355*** | (6.748)  | 17.354*** | (6.673)  | 16.527*** | (5.613)  |
| \(R^2\)                         | 0.093     | 0.085    | 0.110     |           |           |          |
| Individuals                     | 1464      | 1452     | 1452      |           |           |          |

\(b\) are the point estimates and \(se\) the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian and ATM. Significance levels are denoted as ***\(p<0.01\), **\(p<0.05\), *\(p<0.1\).
Table 17 OLS regression results of contactless credit on cash in wallet

| Variable                        | (1)       | (2)       | (3)       |
|---------------------------------|-----------|-----------|-----------|
|                                 | \(b\)     | se        | \(b\)     | se        | \(b\)     | se        |
| Contactless credit              | 3.606     | (9.568)   | 4.114     | (9.588)   | 3.644     | (9.590)   |
| log(income)                     | 22.446*** | (4.547)   | 22.969*** | (4.569)   | 23.999*** | (4.627)   |
| Interest rate                   | 0.189     | (4.865)   | −0.159    | (5.080)   | 1.013     | (5.229)   |
| Education                       |           |           |           |           |           |           |
| High school                     | 3.021     | (19.040)  | 5.792     | (19.713)  | 7.755     | (20.328)  |
| Some college                    | −1.895    | (19.759)  | 1.181     | (20.455)  | 2.198     | (21.104)  |
| College                         | 6.686     | (20.460)  | 10.365    | (21.135)  | 12.963    | (21.838)  |
| Post graduate                   | −0.388    | (21.309)  | 3.125     | (21.859)  | 5.460     | (22.622)  |
| Employment                      |           |           |           |           |           |           |
| Working                         | −0.812    | (7.003)   | −1.902    | (6.968)   | −2.606    | (6.863)   |
| Retired                         | 4.829     | (12.600)  | 7.901     | (12.779)  | 8.339     | (12.343)  |
| Other                           | 5.847     | (7.943)   | 6.809     | (7.767)   | 6.417     | (7.663)   |
| Marital status                  |           |           |           |           |           |           |
| Single                          | −23.529   | (16.831)  | −22.292   | (16.930)  | −22.157   | (16.365)  |
| Married                         | −37.789** | (15.762)  | −36.988** | (15.771)  | −36.980** | (15.222)  |
| Separated                       | −19.454   | (15.889)  | −16.866   | (15.985)  | −14.790   | (15.458)  |
| Age                             |           |           |           |           |           |           |
| 25–34                           | −8.511    | (12.364)  | −8.941    | (12.580)  | −2.698    | (11.661)  |
| 35–44                           | 0.027     | (13.513)  | −0.100    | (13.677)  | 7.076     | (12.889)  |
| 45–54                           | 10.213    | (13.987)  | 9.080     | (14.195)  | 11.900    | (13.194)  |
| 55–64                           | 25.764*   | (14.509)  | 23.771    | (14.812)  | 26.734*   | (13.945)  |
| > 65                            | 27.009    | (17.671)  | 21.299    | (17.972)  | 23.995    | (17.261)  |
| Ethnicity                       |           |           |           |           |           |           |
| White                           | −11.911   | (15.435)  | −11.541   | (15.553)  | −13.642   | (15.659)  |
| Black                           | −13.987   | (16.829)  | −13.339   | (16.991)  | −14.787   | (17.077)  |
| Latino                          | −2.992    | (7.632)   | −2.791    | (7.856)   | −2.092    | (7.895)   |
| Other                           | −4.479    | (17.283)  | −5.710    | (17.424)  | −7.681    | (17.707)  |
| Other                           |           |           |           |           |           |           |
| Male                            | 31.668*** | (4.811)   | 30.825*** | (4.872)   | 29.563*** | (4.812)   |
| HH members                      | 1.085     | (2.962)   | 0.912     | (2.918)   | 0.629     | (2.942)   |
| CC revolver                     | −15.320***| (5.121)   | −14.110***| (5.244)   | −12.023***| (5.169)   |
| Home owner                      | 17.379*** | (5.441)   | 15.936*** | (5.395)   | 15.149*** | (4.984)   |
| Rel. characteristics           |           |           |           |           |           |           |
| Security                        | −0.793    | (3.269)   | −2.355    | (3.236)   |           |           |
| Setup                           | −3.409    | (6.377)   | −7.041    | (6.319)   |           |           |
| Acceptance                      | 1.427     | (9.089)   | 0.830     | (9.227)   |           |           |
| Costs                           | −8.512    | (7.372)   | −7.981    | (7.201)   |           |           |
| Records                         | 0.457     | (4.830)   | −1.543    | (4.720)   |           |           |
| Convenience                     | 12.896*   | (6.699)   | 11.800*   | (6.435)   |           |           |
| Withdrawal method               |           |           |           |           |           |           |
| Bank teller                     |          |           |           |           | 20.917*** | (6.983)   |
| Check casher                    |          |           |           |           | 94.271**  | (40.477)  |
| Cashback                        |          |           |           |           | −13.049** | (6.096)   |
| Employer                        |          |           |           |           | 36.990**  | (15.603)  |
| Family                          |          |           |           |           | 4.733     | (10.735)  |
| Other                           |          |           |           |           | 28.496    | (19.593)  |
| Constant                        | −176.079***| (49.450)  | −177.989***| (50.897)  | −206.114***| (52.532)  |
| \(R^2\)                         | 0.153     | 0.155     | 0.182     |           |           |           |
| Individuals                     | 1465      | 1453      | 1453      |           |           |           |

\(b\) are the point estimates and se the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refers to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***\(p<0.01\), **\(p<0.05\), *\(p<0.1\).
Table 18: OLS regression results of contactless debit on cash in wallet

| Variable                          | (1)      |          | (2)      |          | (3)      |          |
|-----------------------------------|----------|----------|----------|----------|----------|----------|
|                                   | \(b\)    | \(se\)   | \(b\)    | \(se\)   | \(b\)    | \(se\)   |
| Contactless debit                 | -4.297   | (8.632)  | -2.101   | (8.698)  | 0.426    | (8.579)  |
| log(income)                       | 22.570***| (4.533)  | 23.138***| (4.532)  | 24.163***| (4.586)  |
| Interest rate                     | 0.261    | (4.868)  | -0.116   | (5.072)  | 1.036    | (5.223)  |
| Education                         |          |          |          |          |          |          |
| High school                       | 2.530    | (19.833) | 5.129    | (20.836) | 7.041    | (21.495) |
| Some college                      | -2.438   | (20.582) | 0.488    | (21.607) | 1.440    | (22.324) |
| College                           | 6.204    | (21.106) | 9.803    | (22.082) | 12.375   | (22.850) |
| Post graduate                     | -0.831   | (21.867) | 2.645    | (22.718) | 4.967    | (23.545) |
| Employment                        |          |          |          |          |          |          |
| Working                           | -0.532   | (7.003)  | -1.727   | (6.989)  | -2.544   | (6.873)  |
| Retired                           | 4.759    | (12.582) | 7.709    | (12.759) | 8.146    | (12.309) |
| Other                             | 6.109    | (8.026)  | 6.877    | (7.822)  | 6.326    | (7.713)  |
| Marital status                    |          |          |          |          |          |          |
| Single                            | -23.694  | (16.853) | -22.452  | (16.982) | -22.318  | (16.391) |
| Married                           | -37.883**| (15.795) | -37.085**| (15.815) | -37.094**| (15.245) |
| Separated                         | -19.301  | (15.917) | -16.765  | (16.034) | -14.785  | (15.485) |
| Age                               |          |          |          |          |          |          |
| 25–34                             | -8.175   | (12.195) | -8.666   | (12.419) | -2.950   | (11.503) |
| 35–44                             | -0.213   | (13.365) | -0.347   | (13.579) | 6.858    | (12.795) |
| 45–54                             | 9.806    | (13.872) | 8.696    | (14.121) | 11.577   | (13.133) |
| 55–64                             | 25.473*  | (14.316) | 23.488   | (14.655) | 26.461*  | (13.766) |
| > 65                              | 26.882   | (17.618) | 21.233   | (17.976) | 23.932   | (17.258) |
| Ethnicity                         |          |          |          |          |          |          |
| White                             | -12.432  | (15.334) | -11.990  | (15.489) | -14.012  | (15.560) |
| Black                             | -14.257  | (16.713) | -13.823  | (16.918) | -15.384  | (16.975) |
| Latino                            | -2.734   | (7.618)  | -2.590   | (7.836)  | -1.968   | (7.864)  |
| Other                             | -4.511   | (17.154) | -5.844   | (17.331) | -7.955   | (17.618) |
| Other                             |          |          |          |          |          |          |
| Male                              | 31.826***| (4.800)  | 30.983***| (4.856)  | 29.676***| (4.791)  |
| HH members                        | 1.076    | (2.949)  | 0.895    | (2.914)  | 0.601    | (2.933)  |
| CC revolver                       | -15.400***| (5.098) | -14.107***| (5.223) | -11.953***| (5.141) |
| Home owner                        | 17.090***| (5.481)  | 15.767***| (5.434)  | 15.089***| (5.014)  |
| Rel. characteristics              |          |          |          |          |          |          |
| Security                          | -0.734   | (3.257)  | -2.321   | (3.222)  |          |          |
| Setup                             | -3.304   | (6.158)  | -6.769   | (6.106)  |          |          |
| Acceptance                        | 1.383    | (9.081)  | 0.816    | (9.215)  |          |          |
| Costs                             | -8.711   | (7.340)  | -8.160   | (7.192)  |          |          |
| Records                           | 0.583    | (4.814)  | -1.448   | (4.716)  |          |          |
| Convenience                       | 12.647*  | (6.708)  | 11.532*  | (6.438)  |          |          |
| Withdrawal method                 |          |          |          |          |          |          |
| Bank teller                       | 20.921***|          |          |          |          |          |
| Check cashier                     | 93.853** |          |          |          |          |          |
| Cashback                          | -13.221**|          |          |          |          |          |
| Employer                          | 36.721** |          |          |          |          |          |
| Family                            | 4.369    |          |          |          |          |          |
| Other                             | 28.434   |          |          |          |          | (19.534) |
| Constant                          | -175.522***| (49.091)| -177.964***| (50.477) | -206.167***| (52.098) |
| \(R^2\)                           | 0.153    |          | 0.155    |          | 0.182    |          |
| Individuals                       | 1466     |          | 1454     |          |          |          |

\(b\) are the point estimates and \(se\) the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***\(p<0.01\), **\(p<0.05\), *\(p<0.1\).
### Table 19: OLS regression results of contactless credit on cash share volume

| Variable                      | (1)       | (2)       | (3)       |
|-------------------------------|-----------|-----------|-----------|
|                               | \(b\)     | \(se\)    | \(b\)     | \(se\)    | \(b\)     | \(se\)    |
| Contactless credit            | −0.053**  | (0.025)   | −0.052**  | (0.024)   | −0.059**  | (0.023)   |
| log(income)                   | −0.019    | (0.012)   | −0.009    | (0.012)   | −0.008    | (0.011)   |
| Interest rate                 | −0.041*** | (0.016)   | −0.032**  | (0.013)   | −0.029**  | (0.012)   |
| Education                     |           |           |           |           |           |           |
| High school                   | −0.026    | (0.073)   | −0.062    | (0.077)   | −0.047    | (0.071)   |
| Some college                  | −0.026    | (0.071)   | −0.062    | (0.075)   | −0.052    | (0.070)   |
| College                       | −0.049    | (0.071)   | −0.076    | (0.076)   | −0.063    | (0.070)   |
| Post graduate                 | −0.042    | (0.071)   | −0.080    | (0.076)   | −0.067    | (0.072)   |
| Employment                    |           |           |           |           |           |           |
| Working                       | −0.012    | (0.032)   | −0.004    | (0.031)   | −0.013    | (0.029)   |
| Retired                       | −0.059    | (0.038)   | −0.036    | (0.035)   | −0.047    | (0.034)   |
| Other                         | 0.013     | (0.030)   | 0.021     | (0.029)   | 0.017     | (0.028)   |
| Marital status                |           |           |           |           |           |           |
| Single                        | 0.097*    | (0.051)   | 0.091*    | (0.051)   | 0.092**   | (0.044)   |
| Married                       | 0.059     | (0.044)   | 0.055     | (0.044)   | 0.049     | (0.037)   |
| Separated                     | 0.037     | (0.047)   | 0.038     | (0.047)   | 0.040     | (0.040)   |
| Age                           |           |           |           |           |           |           |
| 25–34                         | 0.042     | (0.065)   | 0.063     | (0.065)   | 0.064     | (0.060)   |
| 35–44                         | 0.093     | (0.067)   | 0.099     | (0.067)   | 0.103*    | (0.061)   |
| 45–54                         | 0.118*    | (0.065)   | 0.126*    | (0.065)   | 0.123**   | (0.060)   |
| 55–64                         | 0.144**   | (0.066)   | 0.144**   | (0.066)   | 0.143**   | (0.061)   |
| > 65                          | 0.185***  | (0.072)   | 0.177**   | (0.070)   | 0.183**   | (0.065)   |
| Ethnicity                     |           |           |           |           |           |           |
| White                         | −0.022    | (0.066)   | −0.046    | (0.066)   | −0.064    | (0.064)   |
| Black                         | 0.017     | (0.075)   | −0.005    | (0.074)   | −0.021    | (0.073)   |
| Latino                        | 0.008     | (0.027)   | 0.004     | (0.027)   | 0.008     | (0.026)   |
| Other                         | 0.034     | (0.081)   | 0.014     | (0.078)   | −0.013    | (0.077)   |
| Other                         |           |           |           |           |           |           |
| Male                          | 0.066***  | (0.018)   | 0.064***  | (0.017)   | 0.056***  | (0.017)   |
| HH members                    | 0.002     | (0.007)   | 0.000     | (0.007)   | −0.001    | (0.007)   |
| CC revolver                   | −0.053*** | (0.016)   | −0.053*** | (0.015)   | −0.045*** | (0.015)   |
| Home owner                    | −0.058*** | (0.020)   | −0.057*** | (0.020)   | −0.059*** | (0.019)   |
| Rel. characteristics          |           |           |           |           |           |           |
| Security                      | −0.005    | (0.011)   | −0.008    | (0.010)   |           |           |
| Setup                         | 0.043*    | (0.022)   | 0.032     | (0.021)   |           |           |
| Acceptance                    | −0.066**  | (0.033)   | −0.064**  | (0.031)   |           |           |
| Costs                         | 0.066**   | (0.026)   | 0.061**   | (0.025)   |           |           |
| Records                       | 0.008     | (0.016)   | 0.004     | (0.015)   |           |           |
| Convenience                   | 0.118***  | (0.024)   | 0.116***  | (0.022)   |           |           |
| Withdrawal method             |           |           |           |           |           |           |
| Bank teller                   | 0.027     | (0.021)   |           |           |           |           |
| Check cashier                 | 0.126     | (0.170)   |           |           |           |           |
| Cashback                      | −0.086*** | (0.019)   |           |           |           |           |
| Employer                      | 0.209***  | (0.078)   |           |           |           |           |
| Family                        | −0.101*   | (0.060)   |           |           |           |           |
| Other                         | −0.088*   | (0.046)   |           |           |           |           |
| Constant                      | 0.442**   | (0.189)   | 0.499***  | (0.190)   | 0.497***  | (0.171)   |
| \(R^2\)                       | 0.083     |           | 0.134     |           | 0.173     |           |
| Individuals                   | 1475      |           | 1463      |           | 1463      |           |

*\(b\) are the point estimates and \(se\) the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***, \(p<0.01\), **, \(p<0.05\), *, \(p<0.1\).*
Table 20 OLS regression results of contactless debit on cash share volume

| Variable                        | (1) b  | se   | (2) b  | se   | (3) b  | se   |
|---------------------------------|--------|------|--------|------|--------|------|
| Contactless debit               | -0.062**| (0.026) | -0.047**| (0.025) | -0.043* | (0.024) |
| log(income)                     | -0.021* | (0.012) | -0.011  | (0.012) | -0.011  | (0.011) |
| Interest rate                   | -0.041**| (0.016) | -0.032**| (0.013) | -0.029**| (0.012) |
| Education                       |        |      |        |      |        |      |
| High school                     | -0.015  | (0.071) | -0.048  | (0.077) | -0.033  | (0.072) |
| Some college                    | -0.017  | (0.069) | -0.050  | (0.075) | -0.039  | (0.070) |
| College                         | -0.041  | (0.070) | -0.066  | (0.076) | -0.051  | (0.071) |
| Post graduate                   | -0.036  | (0.070) | -0.071  | (0.076) | -0.057  | (0.072) |
| Employment                      |        |      |        |      |        |      |
| Working                         | -0.011  | (0.032) | -0.005  | (0.030) | -0.015  | (0.029) |
| Retired                         | -0.057  | (0.037) | -0.035  | (0.035) | -0.045  | (0.034) |
| Other                           | 0.019   | (0.029) | 0.025   | (0.028) | 0.021   | (0.027) |
| Marital status                  |        |      |        |      |        |      |
| Single                          | 0.095*  | (0.051) | 0.087*  | (0.050) | 0.089** | (0.044) |
| Married                         | 0.060   | (0.043) | 0.054   | (0.044) | 0.049   | (0.037) |
| Separated                       | 0.037   | (0.047) | 0.037   | (0.047) | 0.039   | (0.040) |
| Age                             |        |      |        |      |        |      |
| 25–34                           | 0.047   | (0.064) | 0.065   | (0.065) | 0.066   | (0.060) |
| 35–44                           | 0.092   | (0.067) | 0.097   | (0.067) | 0.101   | (0.062) |
| 45–54                           | 0.117*  | (0.065) | 0.124*  | (0.065) | 0.123** | (0.061) |
| 55–64                           | 0.143** | (0.066) | 0.143** | (0.066) | 0.143** | (0.062) |
| > 65                            | 0.183** | (0.072) | 0.173** | (0.071) | 0.180***| (0.067) |
| Ethnicity                       |        |      |        |      |        |      |
| White                           | -0.020  | (0.066) | -0.043  | (0.066) | -0.060  | (0.065) |
| Black                           | 0.030   | (0.074) | 0.007   | (0.074) | -0.008  | (0.073) |
| Latino                          | 0.009   | (0.027) | 0.005   | (0.027) | 0.008   | (0.026) |
| Other                           | 0.042   | (0.080) | 0.020   | (0.078) | -0.006  | (0.077) |
| Other                           |        |      |        |      |        |      |
| Male                            | 0.066***| (0.018) | 0.064***| (0.017) | 0.056***| (0.017) |
| HH members                      | 0.003   | (0.007) | 0.001   | (0.007) | -0.001  | (0.007) |
| CC revolver                      | -0.054***| (0.016) | -0.054***| (0.015) | -0.046***| (0.015) |
| Home owner                      | -0.059***| (0.020) | -0.057***| (0.020) | -0.059***| (0.020) |
| Rel. characteristics            |        |      |        |      |        |      |
| Security                        | -0.003  | (0.011) | -0.006  | (0.010) | -0.006  | (0.010) |
| Setup                           | 0.038*  | (0.022) | 0.027   | (0.022) | -0.008  | (0.022) |
| Acceptance                      | -0.065**| (0.033) | -0.063**| (0.031) | -0.066**| (0.026) |
| Costs                           | 0.071***| (0.027) | 0.066***| (0.026) | 0.064***| (0.025) |
| Records                         | 0.008   | (0.016) | 0.004   | (0.015) | 0.006   | (0.015) |
| Convenience                     | 0.115***| (0.024) | 0.113***| (0.022) | 0.113***| (0.022) |
| Withdrawal method               |        |      |        |      |        |      |
| Bank teller                     | 0.024   |      | 0.024   |      | 0.024   |      |
| Check cashier                   | 0.129   |      | 0.129   |      | 0.129   |      |
| Cashback                        | -0.083***|      | -0.083***|      | -0.083***|      |
| Employer                        | 0.210***|      | 0.210***|      | 0.210***|      |
| Family                          | -0.097  |      | -0.097  |      | -0.097  |      |
| Other                           | -0.087* |      | -0.087* |      | -0.087* |      |
| Constant                        | 0.455** | (0.191) | 0.507***| (0.191) | 0.503***| (0.173) |
| $R^2$                           | 0.084   |      | 0.132   |      | 0.170   |      |
| Individuals                     | 1476    |      | 1464    |      | 1464    |      |

$b$ are the point estimates and $se$ the standard errors. Cluster-robust standard errors and survey weights are used. HH and CC refers to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***$p<0.01$, **$p<0.05$, *$p<0.1$.
Table 21 FE regression results of contactless credit on usual cash withdrawn

| Variable                      | (1)      | (2)      | (3)      |
|-------------------------------|----------|----------|----------|
|                               | b        | se       | b        | se       | b        | se       |
| Contactless credit            | 6.766    | (8.994)  | 6.855    | (11.044) | 8.906    | (9.824)  |
| log(income)                   | 14.122** | (5.529)  | 13.766** | (6.516)  | 13.252** | (6.046)  |
| Interest rate                 | -7.159   | (4.711)  | -6.441   | (6.039)  | -7.647   | (5.589)  |
| Education                     |          |          |          |          |          |          |
| High school                   | 43.406***| (14.167) | 122.086***| (14.509) | 85.841***| (15.074) |
| Some college                  | 32.472   | (34.641) | 89.550** | (38.303) | 54.721*  | (33.044) |
| College                       | 12.856   | (40.084) | 77.117*  | (44.403) | 48.044   | (37.261) |
| Post graduate                 | 108.020  | (96.184) | 158.726  | (114.876)| 129.450  | (103.538)|
| Employment                    |          |          |          |          |          |          |
| Working                       | 0.219    | (7.063)  | 1.280    | (8.799)  | -6.703   | (8.585)  |
| Retired                       | 16.541*  | (9.485)  | 2.175    | (15.467) | 2.803    | (12.956) |
| Other                         | 11.452   | (9.673)  | -5.433   | (11.630) | -2.332   | (9.974)  |
| Marital status                |          |          |          |          |          |          |
| Single                        | -13.859  | (26.602) | 23.607   | (20.204) | 19.462   | (16.548) |
| Married                       | -32.397  | (24.074) | -4.865   | (12.767) | -1.174   | (10.759) |
| Separated                     | -64.106**| (32.425) | -39.145  | (27.394) | -32.862  | (26.563) |
| Age                           |          |          |          |          |          |          |
| 25–34                         | -2.776   | (24.980) | -54.813  | (50.620) | -42.631  | (31.037) |
| 35–44                         | 7.863    | (31.520) | -43.413  | (56.847) | -30.950  | (38.648) |
| 45–54                         | 30.710   | (33.577) | -29.556  | (58.464) | -20.446  | (40.516) |
| 55–64                         | 22.564   | (36.222) | -54.677  | (60.666) | -43.059  | (43.378) |
| > 65                          | 22.965   | (38.734) | -63.749  | (63.070) | -54.154  | (46.441) |
| Other                         |          |          |          |          |          |          |
| HH members                    | 1.347    | (4.757)  | -0.497   | (5.104)  | -0.563   | (4.871)  |
| CC revolver                   | -8.449   | (5.819)  | -7.186   | (7.256)  | -4.161   | (6.674)  |
| Home owner                    | -0.779   | (10.929) | -6.971   | (13.889) | -6.730   | (13.816) |
| Rel. characteristics          |          |          |          |          |          |          |
| Security                      |          |          | -4.807   | (3.289)  | -4.943   | (3.177)  |
| Setup                         | 11.827** | (5.155)  | 6.380    | (5.042)  |
| Acceptance                    | 2.090    | (9.564)  | 2.860    | (8.746)  |
| Costs                         | -4.646   | (7.541)  | -6.628   | (7.101)  |
| Records                       | -6.953   | (5.380)  | -4.379   | (4.876)  |
| Convenience                   | -4.244   | (7.456)  | -3.704   | (7.332)  |
| Withdrawal method             |          |          |          |          |          |          |
| Bank teller                   |          |          |          |          |          |          |
| Check casher                  |          |          |          |          |          |          |
| Cashback                      |          |          |          |          |          |          |
| Employer                      |          |          |          |          |          |          |
| Family                        |          |          |          |          |          |          |
| Other                         |          |          |          |          |          |          |
| Constant                      | -68.904  | (73.526) | -84.921  | (93.207) | -74.108  | (80.500) |
| R²                            | 0.012    | 0.016    | 0.088    | 0.088    |
| Observations                  | 3592     | 2865     | 2865     |
| Individuals                   | 853      | 845      | 845      |

FE is the fixed-effects estimator obtained on the balanced panel. b are the point estimates and se the standard errors. Cluster-robust standard errors are used. HH and CC refers to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1
Table 22: FE regression results of contactless debit on usual cash withdrawn

| Variable                      | (1)            |            | (2)            |            | (3)            |            |
|-------------------------------|----------------|-----------|----------------|-----------|----------------|-----------|
|                               | b   | se   | b   | se   | b   | se   |
| Contactless debit             | -2.250 | (7.691) | -2.966 | (7.751) | -5.062 | (7.725) |
| log(income)                   | 13.180*** | (5.052) | 14.032** | (6.080) | 14.064** | (5.722) |
| Interest rate                 | -6.115 | (4.419) | -5.534 | (5.620) | -5.703 | (5.316) |
| Education                     |          |          |          |          |          |          |
| High school                   | 43.297*** | (16.342) | 110.610*** | (14.186) | 73.845*** | (15.433) |
| Some college                  | 79.346*** | (23.743) | 177.691*** | (57.411) | 89.593* | (47.979) |
| College                       | 50.543 | (31.071) | 153.333** | (60.971) | 71.590 | (51.456) |
| Post graduate                 | 134.919* | (81.733) | 239.194** | (120.869) | 154.730 | (109.015) |
| Employment                    |          |          |          |          |          |          |
| Working                       | -2.741 | (7.396) | -4.863 | (8.944) | -9.299 | (8.963) |
| Retired                       | 19.282* | (10.956) | 5.419 | (15.423) | 5.857 | (13.374) |
| Other                         | 8.306 | (8.753) | -6.275 | (11.157) | -5.310 | (9.909) |
| Marital status                |          |          |          |          |          |          |
| Single                        | -16.405 | (25.948) | 15.137 | (18.551) | 15.823 | (16.334) |
| Married                       | -35.387 | (23.518) | -9.051 | (12.606) | -3.195 | (10.892) |
| Separated                     | -58.642* | (30.508) | -30.496 | (23.113) | -21.275 | (22.700) |
| Age                           |          |          |          |          |          |          |
| 25–34                         | 27.552* | (15.736) | -2.481 | (9.766) | 0.370 | (12.142) |
| 35–44                         | 45.868* | (23.834) | 15.797 | (28.556) | 21.034 | (26.914) |
| 45–54                         | 65.007** | (26.469) | 26.038 | (31.001) | 26.697 | (29.051) |
| 55–64                         | 63.898** | (29.855) | 12.884 | (35.174) | 15.375 | (33.524) |
| > 65                          | 71.227** | (32.871) | 4.624 | (37.857) | 5.884 | (36.258) |
| Other                         |          |          |          |          |          |          |
| HH members                    | -0.524 | (4.680) | -0.951 | (4.890) | -0.696 | (4.738) |
| CC revolver                   | -7.442 | (5.676) | -3.239 | (6.892) | -1.042 | (6.369) |
| Home owner                    | -6.778 | (10.660) | -17.967 | (13.238) | -17.593 | (13.200) |
| Rel. characteristics          |          |          |          |          |          |          |
| Security                      | -5.028 | (3.208) | -4.280 | (3.126) |          |          |
| Setup                         | 10.431** | (4.616) | 7.110 | (4.588) |          |          |
| Acceptance                    | 3.481 | (8.858) | 4.735 | (8.138) |          |          |
| Costs                         | 1.605 | (7.332) | 0.797 | (6.999) |          |          |
| Records                       | -1.113 | (5.140) | -0.076 | (4.793) |          |          |
| Convenience                   | -4.070 | (6.906) | -4.625 | (6.730) |          |          |
| Withdrawal method             |          |          |          |          |          |          |
| Bank teller                   |          |          |          |          |          |          |
| Check cashier                 |          |          |          |          |          |          |
| Cashback                      |          |          |          |          |          |          |
| Employer                      |          |          |          |          |          |          |
| Family                        |          |          |          |          |          |          |
| Other                         |          |          |          |          |          |          |
| Constant                      | -118.698* | (67.890) | -187.422** | (92.827) | -134.658 | (83.228) |
| R²                            | 0.012 | 0.011 | 0.067 |          |          |          |
| Observations                  | 3874 | 3084 | 3084 |          |          |          |
| Individuals                   | 906 | 899 | 899 |          |          |          |

FE is the fixed-effects estimator obtained on the balanced panel. \( b \) are the point estimates and \( se \) the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as *** \( p < 0.01 \), ** \( p < 0.05 \), * \( p < 0.1 \).
### Table 23: FE regression results of contactless credit on number of withdrawals

| Variable                              | (1)            |        | (2)            |        | (3)            |        |
|---------------------------------------|----------------|--------|----------------|--------|----------------|--------|
| Contactless credit                    | -0.325 (0.355) |        | -0.326 (0.435) |        | -0.295 (0.446) |        |
| log(income)                           | 0.290* (0.152) |        | 0.193 (0.198)  |        | 0.236 (0.196)  |        |
| Interest rate                          | 0.203 (0.131)  |        | 0.282 (0.184)  |        | 0.237 (0.184)  |        |

**Education**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| High school   | 1.449*** (0.391) |        | 1.490*** (0.354) |        | 1.996*** (0.382) |        |
| Some college  | 1.229 (1.358)  |        | 1.101 (1.889)  |        | 1.803 (2.043)  |        |
| College       | 1.800 (1.601)  |        | 1.751 (2.139)  |        | 2.333 (2.274)  |        |
| Post graduate | 1.793 (1.497)  |        | 1.699 (2.123)  |        | 2.274 (2.254)  |        |

**Employment**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| Working       | -0.058 (0.292) |        | 0.199 (0.364) |        | 0.236 (0.354) |        |
| Retired       | -0.031 (0.415) |        | -0.040 (0.742) |        | 0.096 (0.742)  |        |
| Other         | -0.008 (0.315)  |        | 0.237 (0.474)  |        | 0.170 (0.469)  |        |

**Marital status**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| Single         | -0.645 (0.711)  |        | 0.060 (0.843)  |        | 0.035 (0.791)  |        |
| Married        | -0.838 (0.577)  |        | -0.772 (0.600) |        | -0.780 (0.571) |        |
| Separated      | -0.951 (0.782)  |        | -0.952 (0.831) |        | -0.907 (0.812) |        |

**Age**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| 25–34          | 0.826 (0.538)  |        | 0.618 (1.199)  |        | 0.551 (1.097)  |        |
| 35–44          | 1.439** (0.653) |        | 1.504 (1.261)  |        | 1.458 (1.149)  |        |
| 45–54          | 1.691** (0.752) |        | 1.615 (1.357)  |        | 1.558 (1.242)  |        |
| 55–64          | 1.688** (0.783) |        | 1.465 (1.394)  |        | 1.321 (1.280)  |        |
| > 65           | 1.290 (0.862)  |        | 0.999 (1.473)  |        | 0.736 (1.359)  |        |

**Other**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| HH members     | 0.007 (0.091)  |        | 0.090 (0.118)  |        | 0.063 (0.115)  |        |
| CC revolver    | 0.136 (0.231)  |        | -0.117 (0.262) |        | -0.151 (0.255) |        |
| Home owner     | 0.059 (0.418)  |        | 0.260 (0.507)  |        | 0.259 (0.498)  |        |

**Rel. characteristics**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| Security       | 0.022 (0.088)  |        | -0.005 (0.088) |        | -0.005 (0.088) |        |
| Setup          | -0.057 (0.220) |        | -0.076 (0.219) |        | -0.076 (0.219) |        |
| Acceptance     | -0.322 (0.266) |        | -0.294 (0.257) |        | -0.294 (0.257) |        |
| Costs          | 0.074 (0.187)  |        | 0.074 (0.186)  |        | 0.074 (0.186)  |        |
| Records        | 0.033 (0.138)  |        | -0.010 (0.134) |        | -0.010 (0.134) |        |
| Convenience    | -0.034 (0.163) |        | -0.024 (0.162) |        | -0.024 (0.162) |        |

**Withdrawal method**

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| Bank teller    |          | -0.657*** (0.223) |        | -0.657*** (0.223) |        | -0.657*** (0.223) |        |
| Check cashier  |          | -1.107 (0.828)  |        | -1.107 (0.828)  |        | -1.107 (0.828)  |        |
| Cashback       |          | 0.353 (0.299)   |        | 0.353 (0.299)   |        | 0.353 (0.299)   |        |
| Employer       |          | 1.245 (0.937)   |        | 1.245 (0.937)   |        | 1.245 (0.937)   |        |
| Family         |          | 0.391 (0.459)   |        | 0.391 (0.459)   |        | 0.391 (0.459)   |        |
| Other          |          | 1.723*** (0.576) |        | 1.723*** (0.576) |        | 1.723*** (0.576) |        |

|                | Column 1 |        | Column 2 |        | Column 3 |        |
|----------------|----------|--------|----------|--------|----------|--------|
| Constant       | -2.080 (2.134) |        | -1.437 (2.954) |        | -2.437 (2.952) |        |
| $R^2$          | 0.006    |        | 0.009    |        | 0.031    |        |
| Observations   | 3602     |        | 2874     |        | 2873     |        |
| Individuals    | 853      |        | 847      |        | 846      |        |

FE is the fixed-effects estimator obtained on the balanced panel. $\hat{b}$ are the point estimates and $\hat{se}$ the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***$p<0.01$, **$p<0.05$, *$p<0.1$.
### Table 24: FE regression results of contactless debit on number of withdrawals

| Variable | (1) | | | (2) | | | (3) | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Contactless debit | b | se | b | se | b | se | b | se |
| log(income) | 0.186 | 0.131 | 0.151 | 0.186 | 0.179 | 0.185 |
| Interest rate | 0.180 | 0.119 | 0.195 | 0.164 | 0.171 | 0.165 |
| Education | | | | | | | | | |
| High school | 1.397*** | (0.281) | 1.366*** | (0.319) | 1.794*** | (0.345) |
| Some college | 1.176 | (1.763) | −5.620 | (5.910) | −5.640 | (6.675) |
| College | 2.032 | (1.993) | −4.699 | (6.010) | −4.814 | (6.763) |
| Post graduate | 2.141 | (1.893) | −4.665 | (6.004) | −4.771 | (6.758) |
| Employment | | | | | | | | | |
| Working | −0.171 | (0.258) | 0.112 | (0.322) | 0.096 | (0.310) |
| Retired | −0.442 | (0.322) | −0.378 | (0.316) | −0.231 | (0.605) |
| Other | −0.149 | (0.215) | −0.178 | (0.312) | −0.246 | (0.310) |
| Marital status | | | | | | | | | |
| Single | −0.182 | (0.864) | 0.729 | (1.050) | 0.685 | (1.027) |
| Married | −0.925 | (0.578) | −0.718 | (0.591) | −0.725 | (0.562) |
| Separated | −1.370 | (0.845) | −1.189 | (0.922) | −1.201 | (0.909) |
| Age | | | | | | | | | |
| 25–34 | 0.377 | (0.443) | −0.167 | (0.892) | −0.220 | (0.916) |
| 35–44 | 0.675 | (0.567) | 0.491 | (0.947) | 0.490 | (0.948) |
| 45–54 | 0.880 | (0.687) | 0.472 | (1.085) | 0.444 | (1.075) |
| 55–64 | 0.779 | (0.743) | 0.408 | (1.155) | 0.337 | (1.145) |
| > 65 | 0.612 | (0.841) | 0.215 | (1.268) | 0.033 | (1.255) |
| Other | | | | | | | | | |
| HH members | 0.074 | (0.093) | 0.125 | (0.116) | 0.108 | (0.113) |
| CC revolver | 0.127 | (0.199) | −0.033 | (0.249) | −0.054 | (0.244) |
| Home owner | −0.034 | (0.391) | 0.040 | (0.472) | 0.048 | (0.461) |
| Rel. characteristics | | | | | | | | | |
| Security | 0.054 | (0.084) | 0.027 | (0.083) | | | | | |
| Setup | −0.056 | (0.191) | −0.086 | (0.189) | | | | | |
| Acceptance | −0.168 | (0.224) | −0.140 | (0.212) | | | | | |
| Costs | 0.098 | (0.168) | 0.103 | (0.166) | | | | | |
| Records | 0.098 | (0.128) | 0.060 | (0.126) | | | | | |
| Convenience | 0.118 | (0.128) | 0.112 | (0.126) | | | | | |
| Withdrawal method | | | | | | | | | |
| Bank teller | −0.550** | (0.215) | | | | | | | |
| Check cashier | | −0.631 | (0.392) | | | | | | |
| Cashback | | | 0.276 | (0.302) | | | | | |
| Employer | | | 1.804* | (0.964) | | | | | |
| Family | | | 0.017 | (0.448) | | | | | |
| Other | | | 1.824*** | (0.566) | | | | | |
| Constant | −0.233 | (2.324) | 5.909 | (5.481) | 5.619 | (6.049) |
| $R^2$ | 0.008 | 0.015 | 0.041 | | | | | | |
| Observations | 3882 | 3090 | 3089 | | | | | | |
| Individuals | 906 | 900 | 899 | | | | | | 

FE is the fixed-effects estimator obtained on the balanced panel. b are the point estimates and se the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1.
Table 25: FE regression results of contactless credit on cash in wallet

| Variable | (1) | | (2) | | (3) |
|----------|-----|-----|-----|-----|-----|
|          | b   | se  | b   | se  | b   | se  |
| Contactless credit | 8.371 | (12.976) | 6.850 | (14.477) | 6.067 | (14.318) |
| log(income) | 12.786*** | (4.315) | 11.055*** | (4.237) | 10.827** | (4.272) |
| Interest rate | −4.682 | (4.328) | −7.248 | (5.624) | −6.786 | (5.622) |
| Education | | | | | | |
| High school | 22.749*** | (6.643) | 21.033** | (9.831) | 5.685 | (10.927) |
| Some college | 34.216 | (22.420) | 37.017 | (25.817) | 18.492 | (27.996) |
| College | 56.729** | (27.883) | 57.559* | (34.903) | 40.469 | (34.991) |
| Post graduate | 90.759** | (42.140) | 69.550 | (42.755) | 49.777 | (41.246) |
| Employment | | | | | | |
| Working | −5.712 | (7.804) | −3.206 | (8.858) | −3.256 | (8.653) |
| Retired | 5.639 | (9.589) | 33.880*** | (12.537) | 33.505*** | (12.363) |
| Other | 8.499 | (8.777) | 0.718 | (10.640) | 1.618 | (10.546) |
| Marital status | | | | | | |
| Single | 3.580 | (25.940) | 31.442 | (38.132) | 30.960 | (37.818) |
| Married | −2.111 | (24.427) | 10.350 | (36.163) | 11.797 | (35.912) |
| Separated | 0.832 | (24.022) | 6.940 | (35.086) | 7.005 | (34.823) |
| Age | | | | | | |
| 25–34 | −12.806 | (14.095) | −47.290* | (24.754) | −48.077* | (26.045) |
| 35–44 | −9.874 | (18.077) | −39.249 | (27.810) | −40.680 | (28.671) |
| 45–54 | −11.948 | (19.972) | −43.834 | (30.011) | −43.679 | (30.794) |
| 55–64 | −0.598 | (21.883) | −31.003 | (32.207) | −30.349 | (32.904) |
| > 65 | 2.505 | (23.721) | −27.453 | (33.924) | −25.689 | (34.512) |
| Other | | | | | | |
| HH members | 0.613 | (2.484) | −0.103 | (3.061) | 0.088 | (3.078) |
| CC revolver | −0.053 | (4.976) | −1.117 | (6.277) | −1.473 | (6.354) |
| Home owner | −2.163 | (8.108) | −6.272 | (10.283) | −6.916 | (10.301) |
| Rel. characteristics | | | | | | |
| Security | −2.873 | (2.274) | −2.415 | (2.262) | −2.415 | (2.262) |
| Setup | 2.135 | (4.750) | 2.088 | (4.763) | 2.088 | (4.763) |
| Acceptance | −0.195 | (5.424) | −0.452 | (5.493) | −0.452 | (5.493) |
| Costs | −1.493 | (5.273) | −1.690 | (5.286) | −1.690 | (5.286) |
| Records | 3.188 | (3.449) | 3.792 | (3.452) | 3.792 | (3.452) |
| Convenience | −1.924 | (4.760) | −1.777 | (4.800) | −1.777 | (4.800) |
| Withdrawal method | | | | | | |
| Bank teller | | | | | | |
| Check cashier | | | | | | |
| Cashback | | | | | | |
| Employer | | | | | | |
| Family | | | | | | |
| Other | | | | | | |
| Constant | −111.279** | (55.791) | −72.804 | (66.349) | −58.150 | (66.991) |
| R² | 0.009 | 0.014 | 0.024 | | | |
| Observations | 3599 | 2874 | 2874 | | | |
| Individuals | 851 | 844 | 844 | | | |

FE is the fixed-effects estimator obtained on the balanced panel. b are the point estimates and se the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1
Table 26  FE regression results of contactless debit on cash in wallet

| Variable                        | (1) |             | (2) |             | (3) |
|---------------------------------|-----|-------------|-----|-------------|-----|
|                                | b   | se          | b   | se          | b   | se  |
| Contactless debit              | 3.789 | (5.966)    | 4.256 | (7.965)    | 3.206 | (7.945) |
| log(income)                    | 14.059*** | (5.240)  | 13.057*** | (4.988)    | 13.154*** | (5.006) |
| Interest rate                  | −3.960 | (4.175)    | −7.424 | (5.338)    | −7.002 | (5.358) |
| Education                      |     |             |     |             |     |     |
| High school                    | 22.962*** | (5.741)  | 23.694**  | (9.272)    | 13.458 | (10.292) |
| Some college                   | 8.841  | (40.354)   | −42.988  | (49.328)   | −46.158 | (35.830) |
| College                        | 33.112  | (43.942)   | −25.073  | (52.826)   | −27.669 | (40.513) |
| Post graduate                  | 60.546  | (52.828)   | −16.242  | (58.945)   | −20.329 | (47.134) |
| Employment                      |     |             |     |             |     |     |
| Working                        | 2.339  | (7.593)    | 4.849  | (8.873)    | 5.420  | (8.717) |
| Retired                         | 6.492  | (8.506)    | 25.442** | (12.730)   | 24.980** | (12.509) |
| Other                           | 7.170  | (7.620)    | 4.548  | (9.582)    | 5.150  | (9.593) |
| Marital status                  |     |             |     |             |     |     |
| Single                          | −5.355 | (21.662)   | 3.977  | (32.038)   | 4.851  | (31.983) |
| Married                         | −17.728  | (20.232)  | −11.518  | (30.069)   | −9.448  | (29.966) |
| Separated                       | −25.935  | (24.999)   | −29.421  | (36.135)   | −26.059  | (35.745) |
| Age                             |     |             |     |             |     |     |
| 25–34                           | 5.047  | (13.856)   | −33.830  | (26.245)   | −31.345  | (26.809) |
| 35–44                           | 4.502  | (17.233)   | −32.614  | (29.194)   | −31.246  | (29.329) |
| 45–54                           | 2.512  | (19.327)   | −40.682  | (31.522)   | −37.907  | (31.710) |
| 55–64                           | 17.968  | (21.568)   | −24.783  | (33.801)   | −21.768  | (33.750) |
| >65                             | 25.009  | (23.794)   | −17.044  | (35.696)   | −13.001  | (35.650) |
| Other                           |     |             |     |             |     |     |
| HH members                      | −0.748  | (2.545)    | −0.673  | (3.064)    | −0.704  | (3.049) |
| CC revolver                     | −3.961  | (4.785)    | −1.643  | (5.826)    | −1.743  | (5.844) |
| Home owner                      | −1.334  | (7.684)    | −7.772  | (9.411)    | −8.442  | (9.467) |
| Rel. characteristics            |     |             |     |             |     |     |
| Security                        | −3.354  | (2.297)    | −3.030  | (2.304)    | −3.030  | (2.304) |
| Setup                           | 3.689  | (4.183)    | 3.683  | (4.189)    | 3.683  | (4.189) |
| Acceptance                      | −0.064  | (4.609)    | −0.270  | (4.640)    | −0.270  | (4.640) |
| Costs                           | −2.416  | (4.978)    | −2.466  | (4.982)    | −2.466  | (4.982) |
| Records                         | 1.844  | (3.087)    | 2.089  | (3.093)    | 2.089  | (3.093) |
| Convenience                     | −3.301  | (4.358)    | −3.054  | (4.361)    | −3.054  | (4.361) |
| Withdrawal method               |     |             |     |             |     |     |
| Bank teller                     | 14.425**  | (6.723)   | 14.425**  | (6.723)   |        |     |
| Check cashier                   | 4.667  | (13.153)   | 4.667  | (13.153)   | 4.667  | (13.153) |
| Cashback                        | −3.940  | (5.414)    | −3.940  | (5.414)    | −3.940  | (5.414) |
| Employer                        | −17.593  | (14.111)  | −17.593  | (14.111)   | −17.593  | (14.111) |
| Family                          | 16.414  | (15.787)   | 16.414  | (15.787)   | 16.414  | (15.787) |
| Other                           | 5.485  | (9.757)    | 5.485  | (9.757)    | 5.485  | (9.757) |
| Constant                        | −108.235  | (67.233)  | −13.011  | (73.219)   | −17.689  | (67.989) |
| R²                              | 0.011  | 0.014      | 0.014  | 0.020      | 0.020  |     |
| Observations                    | 3882  | 3093       | 3093  | 3093       | 3093  |     |
| Individuals                     | 905  | 898        | 898  | 898        | 898  |     |

FE is the fixed-effects estimator obtained on the balanced panel. b are the point estimates and se the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1
Table 27 FE regression results of contactless credit on cash share volume

| Variable                  | (1)             |               | (2)             |               | (3)             |               |
|---------------------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|
|                           | b               | se            | b               | se            | b               | se            |
| Contactless credit        | −0.011          | (0.027)       | −0.013          | (0.030)       | −0.013          | (0.030)       |
| log(income)               | −0.007          | (0.013)       | 0.007           | (0.015)       | 0.006           | (0.015)       |
| Interest rate             | 0.013           | (0.010)       | 0.013           | (0.011)       | 0.013           | (0.011)       |
| Education                 |                 |               |                 |               |                 |               |
| High school               | 0.268***        | (0.069)       | 0.358***        | (0.030)       | 0.346***        | (0.033)       |
| Some college              | 0.308**         | (0.127)       | 0.536***        | (0.102)       | 0.522***        | (0.103)       |
| College                   | 0.160           | (0.140)       | 0.288**         | (0.119)       | 0.277**         | (0.119)       |
| Post graduate             | 0.155           | (0.166)       | 0.281**         | (0.137)       | 0.271**         | (0.135)       |
| Employment                |                 |               |                 |               |                 |               |
| Working                   | −0.011          | (0.016)       | −0.000          | (0.018)       | −0.002          | (0.019)       |
| Retired                   | −0.005          | (0.019)       | −0.026          | (0.027)       | −0.027          | (0.027)       |
| Other                     | −0.000          | (0.020)       | −0.036          | (0.025)       | −0.035          | (0.025)       |
| Marital status            |                 |               |                 |               |                 |               |
| Single                    | 0.040           | (0.060)       | 0.031           | (0.065)       | 0.033           | (0.064)       |
| Married                   | 0.008           | (0.046)       | 0.037           | (0.050)       | 0.039           | (0.050)       |
| Separated                 | 0.026           | (0.052)       | 0.067           | (0.054)       | 0.068           | (0.054)       |
| Age                       |                 |               |                 |               |                 |               |
| 25–34                     | −0.073          | (0.073)       | −0.296***       | (0.102)       | −0.298***       | (0.102)       |
| 35–44                     | −0.058          | (0.078)       | −0.287***       | (0.105)       | −0.289***       | (0.105)       |
| 45–54                     | −0.090          | (0.081)       | −0.320***       | (0.108)       | −0.323***       | (0.108)       |
| 55–64                     | −0.130          | (0.083)       | −0.364***       | (0.111)       | −0.365***       | (0.111)       |
| > 65                      | −0.099          | (0.087)       | −0.375***       | (0.114)       | −0.375***       | (0.114)       |
| Other                     |                 |               |                 |               |                 |               |
| HH members                | −0.004          | (0.007)       | 0.006           | (0.008)       | 0.006           | (0.008)       |
| CC revolver               | −0.006          | (0.013)       | −0.017          | (0.015)       | −0.016          | (0.015)       |
| Home owner                | −0.034          | (0.022)       | −0.032          | (0.028)       | −0.032          | (0.028)       |
| Rel. characteristics      |                 |               |                 |               |                 |               |
| Security                  | −0.008          | (0.006)       | −0.008          | (0.006)       | −0.008          | (0.006)       |
| Setup                     | 0.023*          | (0.013)       | 0.023*          | (0.013)       | 0.023*          | (0.013)       |
| Acceptance                | −0.009          | (0.016)       | −0.009          | (0.016)       | −0.009          | (0.016)       |
| Costs                     | 0.011           | (0.016)       | 0.011           | (0.016)       | 0.011           | (0.016)       |
| Records                   | 0.010           | (0.009)       | 0.011           | (0.009)       | 0.011           | (0.009)       |
| Convenience               | −0.003          | (0.013)       | −0.003          | (0.013)       | −0.003          | (0.013)       |
| Withdrawal method         |                 |               |                 |               |                 |               |
| Bank teller               |                 |               | 0.017           | (0.017)       | 0.017           | (0.017)       |
| Check cashier             |                 |               | 0.003           | (0.041)       | 0.003           | (0.041)       |
| Cashback                  |                 |               | −0.015          | (0.015)       | −0.015          | (0.015)       |
| Employer                  |                 |               | 0.002           | (0.039)       | 0.002           | (0.039)       |
| Family                    |                 |               | −0.009          | (0.032)       | −0.009          | (0.032)       |
| Other                     |                 |               | −0.004          | (0.027)       | −0.004          | (0.027)       |
| Constant                  | 0.304           | (0.192)       | 0.229           | (0.206)       | 0.251           | (0.207)       |
| $R^2$                     | 0.013           |               | 0.033           |               | 0.035           |               |
| Observations              | 3556            |               | 2860            |               | 2858            |               |
| Individuals               | 852             |               | 846             |               | 845             |               |

FE is the fixed-effects estimator obtained on the balanced panel. \( b \) are the point estimates and \( se \) the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***\( p < 0.01 \), **\( p < 0.05 \), *\( p < 0.1 \).
### Table 28: FE regression results of contactless debit on cash share volume

| Variable                          | (1)     | (2)     | (3)     |
|-----------------------------------|---------|---------|---------|
|                                   | b       | se      | b       | se      | b       | se      |
| Contactless debit                 | -0.003  | (0.033) | 0.003   | (0.038) | 0.004   | (0.038) |
| log(income)                       | 0.015   | (0.013) | 0.022   | (0.014) | 0.020   | (0.014) |
| Interest rate                     | 0.012   | (0.010) | 0.011   | (0.010) | 0.011   | (0.010) |
| Education                         |         |         |         |         |         |         |
| High school                       | 0.269***| (0.067) | 0.357***| (0.029) | 0.344***| (0.032) |
| Some college                      | 0.264*  | (0.158) | 0.488***| (0.087) | 0.454***| (0.097) |
| College                           | 0.090   | (0.169) | 0.226** | (0.109) | 0.195*  | (0.116) |
| Post graduate                     | 0.092   | (0.185) | 0.211*  | (0.125) | 0.181   | (0.129) |
| Employment                        |         |         |         |         |         |         |
| Working                           | -0.009  | (0.014) | 0.009   | (0.017) | 0.007   | (0.017) |
| Retired                           | -0.010  | (0.017) | -0.033  | (0.026) | -0.035  | (0.026) |
| Other                             | -0.016  | (0.018) | -0.032  | (0.023) | -0.031  | (0.023) |
| Marital status                    |         |         |         |         |         |         |
| Single                            | 0.013   | (0.067) | 0.028   | (0.072) | 0.027   | (0.071) |
| Married                           | 0.026   | (0.055) | 0.053   | (0.058) | 0.053   | (0.057) |
| Separated                         | 0.036   | (0.058) | 0.077   | (0.059) | 0.076   | (0.058) |
| Age                               |         |         |         |         |         |         |
| 25–34                             | -0.101  | (0.063) | -0.227* | (0.124) | -0.227* | (0.124) |
| 35–44                             | -0.093  | (0.067) | -0.222* | (0.126) | -0.223* | (0.126) |
| 45–54                             | -0.105  | (0.070) | -0.230* | (0.129) | -0.233* | (0.129) |
| 55–64                             | -0.133* | (0.073) | -0.260**| (0.131) | -0.261**| (0.131) |
| > 65                              | -0.101  | (0.076) | -0.253* | (0.133) | -0.254* | (0.133) |
| Other                             |         |         |         |         |         |         |
| HH members                        | 0.000   | (0.007) | 0.004   | (0.008) | 0.005   | (0.008) |
| CC revolver                       | -0.013  | (0.012) | -0.024* | (0.014) | -0.023  | (0.014) |
| Home owner                        | -0.040* | (0.021) | -0.032  | (0.026) | -0.031  | (0.025) |
| Rel. characteristics              |         |         |         |         |         |         |
| Security                          | -0.009  | (0.006) | -0.008  | (0.006) | -0.008  | (0.006) |
| Setup                             | 0.018   | (0.012) | 0.018   | (0.012) | 0.018   | (0.012) |
| Acceptance                        | -0.006  | (0.014) | -0.006  | (0.014) | -0.006  | (0.014) |
| Costs                             | 0.014   | (0.015) | 0.013   | (0.015) | 0.013   | (0.015) |
| Records                           | 0.003   | (0.009) | 0.003   | (0.009) | 0.003   | (0.009) |
| Convenience                       | 0.003   | (0.012) | 0.004   | (0.012) | 0.004   | (0.012) |
| Withdrawal Method                 |         |         |         |         |         |         |
| Bank teller                       | 0.020   | (0.016) |        |         |         |         |
| Check cashier                     | -0.017  | (0.043) |        |         |         |         |
| Cashback                          | -0.014  | (0.015) |        |         |         |         |
| Employer                          | 0.018   | (0.040) |        |         |         |         |
| Family                            | -0.015  | (0.028) |        |         |         |         |
| Other                             | -0.014  | (0.025) |        |         |         |         |
| Constant                          | 0.117   | (0.213) | 0.006   | (0.207) | 0.047   | (0.210) |
| $R^2$                             | 0.013   | 0.028   | 0.030   |         |         |         |
| Observations                      | 3832    | 3075    | 3074    |         |         |         |
| Individuals                       | 905     | 899     | 898     |         |         |         |

FE is the fixed-effects estimator obtained on the balanced panel. b are the point estimates and se the standard errors. Cluster-robust standard errors are used. HH and CC refer to household and credit card, respectively. Base category of categorical variables is lower than high school, unemployed, widowed, lower than 25 years, Asian, and ATM. Significance levels are denoted as ***p<0.01, **p<0.05, *p<0.1.
Abbreviations
ALP: American life panel; ATM: Automated teller machine; EMV: Europay international, MasterCard and VISA; EU: European union; FE: Fixed-effects; FED: Federal reserve system; GDP: Gross domestic product, LTP: Let’s talk payments; NFC: Near-field communication; OLS: Ordinary least squares; PIN: Personal identification number; POS: Point-of-sale; SCPC: Survey of consumer payment choice; SPA: Smart payment association; USA: United States; USD: United States dollar

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Availability of data and materials
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Competing interests
The author declares that he has no competing interests.

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