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RESEARCH ARTICLE

The Use of Cheques in the European Union: A Cross-Country Analysis

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Abstract The use of cheques has been declining in the European Union (EU), along increased integration in the payments field. This trend is not uniform across the EU, and some countries have implemented policies to discourage the use of cheques due to its considerable social costs and risks. This paper provides a cross-country analysis for the period 2000–2012 of the determinants of cheque usage, measured both as per capita number and share of payments. Special attention is given to the effects of the application of fees in a framework where unfunded cheques are considered as an autonomous type of crime in some EU countries. Our results suggest that the existence of fees influences negatively cheque usage, even when there are legal elements that increase its security.

Keywords European Union · Retail payments · Cheques · Panel data

JEL Classification F36 · G21 · E41 · E42

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1 Introduction

The evolution of the payments landscape is having a pivotal role in the process of monetary and financial integration in the European Union (EU). With the launch of the euro in 1999, there was a need to establish a payment system that allowed the implementation of a single monetary policy, eased the settlement of euro payments and reduced systemic risk – a key concern to central banks (Fratianni and Pattison 2001). The first generation Trans-European Automated Real-time Gross settlement Express Transfer (TARGET) system was established in that year. In 2008, the system was replaced by the second generation system TARGET2 – an infrastructure that played a relevant role in the recent crisis, as highlighted, for example, by Bordo (2014) and Dinger et al. (2014). The European financial integration process was further enhanced with increased harmonisation of retail payments and securities settlement. The Single Euro Payments Area (SEPA) project,[1] by establishing a single set of conditions, rights and obligations for euro payments regardless of the location, is contributing to take complete advantage of the Economic and Monetary Union (ECB 2013). The TARGET2-Securities (T2S) project, a single pan-European platform for securities settlement in central bank money which will be fully operational in 2017, will increase harmonisation on post-trade services, contributing to greater integration. Overall, these projects are providing the opportunity to reap the full benefits of financial and monetary integration, namely through economies of scale. This integration process is undoubtedly dynamic, and the Eurosystem vision for the year 2020 aims to further improve the payments landscape, namely through the consolidation of technical platforms (i.e., TARGET2 and TARGET2-Securities) and the development of a pan-European instant payments service, which will complement the European Commission's project to establish a Capital Markets Union in Europe (ECB 2016a).

Even though the consolidation efforts have been promoting an increase in the relevance of electronic payment instruments, there are still relevant differences in payment habits across EU countries. These differences can impact not only the social costs connected with payments, but also create entropy to the adoption of new (potentially more efficient and secure) solutions. The use of cheques is a relevant example: between 2000 and 2012 the annual per capita number of payments made with cheques in the EU reduced from around 24 to about 9. This corresponded to a decrease in the share[2] of cheque payments from 18 % to 5 % during that period. Yet, in a number of EU countries their use is still quite substantial. For example, in 2012 more than 15 cheques per capita were used in France, Cyprus, Malta and Ireland.[3]

Considering this and bearing also in mind that making payments with cheques involves non negligible social costs and risks, some countries in their analysis

[1] SEPA is a project that aims to harmonise retail payments in euro by enabling individuals, firms and public administrations to make and receive cashless payments throughout the Member States of the EU and Iceland, Liechtenstein, Monaco, Norway, Switzerland and San Marino using just one bank account located in any of these countries and a single set of payment instruments (credit transfers, direct debits and cards). For more information see, for example, Virtanen (2014).

[2] The share was computed considering the relative importance of the number of payments with cheques on the total number of payments made with cheques, credit transfers, direct debits and cards.

[3] According to the Bank for International Settlements, in 2014, the relative importance of cheques (in volume) was 37.5 % in the United States of America and 13.1 % in France.

regarding the possible evolution of retail payments might intend to reduce their use and promote the adoption of electronic payment instruments. In fact, Schmiedel et al. (2012) obtained evidence in a sample of EU countries that the average unit social cost of cheques is €3.55, which compares with €0.99 for cards. In addition, Kokkola (2010) refers that, among other risks, it is important to take into consideration the potential issues connected with the drawer's creditworthiness. As a result, in Malta an educational campaign to promote the use of cards and electronic payments was developed in 2012 and in Ireland rules to abolish the use of cheques by Government Departments, Local Authorities and State Agencies were established in 2014.

In order to define policies that effectively support a decline in the use of cheques, it is important to identify which are the determinants of cheques usage. The existing literature shed light on some of the elements that might influence the use of this payment instrument. On the one hand, a strand of empirical literature based on the analysis of individual survey data collected at the national level (Boeschoten 1998; Stavins 2001; Klee 2006; Borzekowski and Kiser 2008; and Koulayev et al. 2012) highlights the relevance of socio-demographic determinants in cheques usage. On the other hand, cross-country studies on retail payments, such as Humphrey et al. (1996) and Guariglia and Loke (2004), conclude that the economic environment and technological developments play a significant role in shaping payment habits. Our paper follows this last line of research, but also incorporates some potential socio-demographic determinants identified by the former strand of literature, as well as factors that reflect the existence of differences in the cost and security structure of cheque payments in the various countries.

Specifically, we propose the empirical examination of the impact on cheque payments of the existence of a fee associated with the use of cheques and the fact that unfunded cheques are considered as an autonomous crime (hereinafter referred to as legal variables), while controlling the effect of socio-demographic, economic, technological and institutional factors. We employ country level data from the European Central Bank Statistical Data Warehouse for the period between 2000 and 2012, as well as information on legal variables collected specifically for this research.

Cheque usage is analysed not only in terms of the traditional dependent variable of the per capita number of payment transactions, but also in terms of the share of the number of payments made with cheques, a measure of cheque usage that, as far as we known, was not considered before. In fact, while the former variable is obtained using the total population and this implies including persons that do not use any payment instruments (e.g., children) as well as persons that might not use all payment instruments (i.e., non-bancarised population), in our view the share or proportion of payments made with cheques (in volume), as an indicator of relative importance, eases cross-country comparisons of the intensity of cheques usage. This latter dependent variable has also the potential advantage of minimising the effects of variations in consumption (for example, due to situations of financial crisis, since it might affect in a similar way the use of other payment instruments).

The analysis of the two measures of cheque usage employs various estimation techniques: traditional linear-based fixed effects, random effects and

Hausman-Taylor estimators, as well as estimators based on Poisson and fractional regression models (FRM). The latter models, as far as we know, have never been considered in the literature of this area, but present the advantage of taking into consideration the nature of the dependent variables in analysis. In particular, the Poisson estimator incorporates the fact that the number of per capita payments made with cheques is a count variable and the fractional regression estimator accommodates the bounded nature (on the interval (0,1)) of the share of payments made with cheques.

We estimate a negative average partial effect of the existence of fees in the number of per capita and the share of payments made with cheques of around 28 and 0.13, respectively, and a positive effect related with the fact that unfunded cheques are considered as an autonomous crime of 10 and 0.03, respectively. The magnitude of these results is quite relevant because the mean of the number of per capita number and share of payments made with cheques in our sample is 8 and 0.08.

The remainder of this article is organized as follows. Section 2 defines the background and provides a summary of related literature. Section 3 describes the data used in the study and the methodology. Section 4 reports the empirical results. Finally, Section 5 draws the conclusions and provides policy orientations.

2 Framework

This section presents an outline of the use of cheques as a payment instrument in EU countries and highlights a number of measures already adopted to reduce payments with cheques. A summary of related literature is also provided.

2.1 Brief Overview of Cheques as a Payment Instrument

According to Kokkola (2010), a payment instrument is a tool or a set of procedures that allow the transfer of funds. Non-cash payment instruments, in particular, include those instruments that are not banknotes and coins. The most usual non-cash payment instruments in EU countries comprise cheques, payment cards, credit transfers and direct debits.[4]

Cheques are one of the oldest non-cash payment instruments. Their use in Europe began around the year 1400, and even though fraud situations occurred quite frequently, cheques were considered as a convenient mean of making payments (Quinn and Roberds 2008). The past years have seen remarkable changes in payment habits. Between 2000 and 2012 the annual number of per capita payments with cheques in the EU decreased 64 %, from around 24 to about 9 payments per capita (Table 1). The decreasing tendency in the use of cheques is also noticeable in the United States of America and in Canada, although in these countries the per capita number of payments made with cheques remained higher.

[4] For a detailed definition of each one of these non-cash payment instruments see Kokkola (2010).

Table 1 Evolution of cheques usage between 2000 and 2012

	2000	2012	Variation
Number of per capita payments with cheques			
European Union	23.7	8.5	-64 %
Euro Area	21.1	10.3	-51 %
United States of America	148.4	58.4	-61 %
Canada	54.0	21.6	-60 %
Switzerland	1.6	0.0	-100 %
Share of the number of payments with cheques			
European Union	18.4 %	4.6 %	-75 %
Euro Area	17.8 %	5.4 %	-70 %
United States of America	58.0 %	15.5 %	-73 %
Canada	28.1 %	7.5 %	-73 %
Switzerland	1.3 %	0.0 %	-100 %

Source: European Central Bank Statistical Data Warehouse for data on European Union and euro area and Bank for International Settlements for data on the United States of America, Canada and Switzerland

Focusing on the evolution of the per capita number of payments with cheques in the EU countries between 2000 and 2012, we conclude that the decreasing trend in the use of cheques is visible in all countries. Nonetheless, a noticeable heterogeneity still remains in the use of cheques. From the analysis of Fig. 1 we observe that, in 2012, more than 8 cheque payments per capita were made, on average, in France, Cyprus, Malta, Ireland, the United Kingdom and Portugal. The highest usage occurred in France, with around 43 cheque payments per capita in 2012. A clearer picture can be obtained if we add to the previous analysis information regarding the percentage share of payments made with cheques.

In the EU, the proportion of payments made with cheques (computed considering the relative importance of the total number of payments with cheques on the total

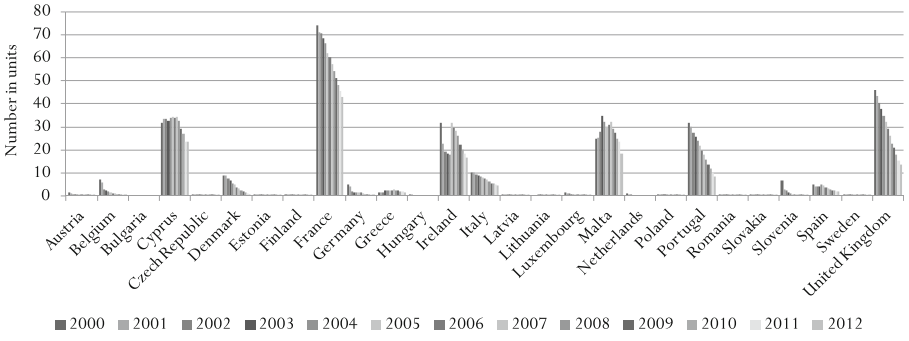

Fig. 1 Evolution of the per capita number of payments with cheques between 2000 and 2012 Source: European Central Bank Statistical Data Warehouse

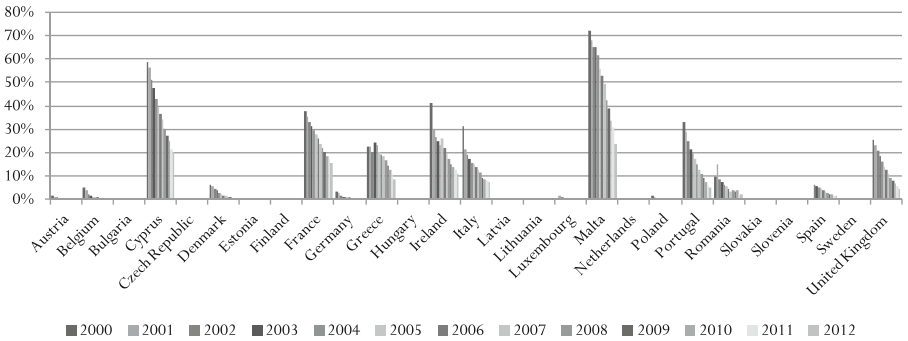

Fig. 2 Evolution of the share of the number of payments with cheques between 2000 and 2012 Source: European Central Bank Statistical Data Warehouse

number of payments made with cheques, credit transfers, direct debits and cards[5]) has decreased from 18.4 % to 4.6 % between 2000 and 2012 (Table 1). Regarding the relative importance of cheques in all the EU countries in 2012, we observe that in Malta, Cyprus, France and Ireland, the share of payments with cheques remained above 10 % (Fig. 2).

2.2 Outline of some of the Measures Adopted to Reduce the Use of Cheques

In order to reduce the use of cheques, different approaches have been followed by various authorities, such as Central Banks. At a cross-border level, in 2002, the guaranty of €200 provided with the Eurocheque[6] was removed. In addition, the European Commission decided to keep cheques outside the scope of community legislation as it considered that, since cheques are not as efficiently processed as other payment instruments, their use in a cross-border context should be avoided.

In 2001, Slovenia abolished the guidance of realisation of cheques (i.e., cheques can only be realised if there are funds on the account) and between 2001 and 2012 the number of per capita payments with cheques reduced around 98 %. In Malta, the Bankers Association, in collaboration with the Central Bank and the Association of Credit Management, implemented a campaign in 2012 to encourage the use of cards and online payments. In Ireland, cheques are no longer used by Government Departments, Local Authorities and State Agencies since the 19th of September 2014. In the United Kingdom, after an unsuccessful attempt to close the cheque clearing, it was decided, in 2011, to look for ways to improve the process. Other countries managed to reduce the use of cheques with the imposition of a fee on its use and increasing the marketing on other payment instruments provided free of charge, as occurred in Sweden, or through a raise in the processing charges and a reduction in the supply of free cheques, as happened in the Netherlands (APCA 2011).

[5] The analysis is focused on non-cash payment instruments.
[6] This type of cheque could be used in different countries.

2.3 Literature Review

The decreasing trend in the use of cheques has been reported and analysed in a number of studies. The vast majority of the studies in this field have generally focused on the analysis of consumers' use of payment instruments at national level, using data either collected through surveys and/or payment diaries to households or provided, for example, by grocery stores. Although this literature is mainly focused on the increasing use of electronic payment instruments, some studies still explore the use of cheques, but address mainly the impact of socio-demographic aspects, consumers' perceptions of payment attributes, characteristics of the transactions and financial incentives.

Boeschoten (1998); Stavins (2001); Klee (2006); Borzekowski and Kiser (2008) and Koulayev et al. (2012) are among the many authors that reported the effect of consumers' age, income and education in the use of payment instruments using data collected through surveys. More recent studies, for example of Koulayev et al. (2012), found evidence of a positive impact of age and a negative effect of income and education in the adoption and use of cheques. Schuh and Stavins (2010) and Schuh and Stavins (2013) complemented those analyses by incorporating in the explanatory factors consumers' perceptions of payment attributes (e.g., cost, speed, security, control, convenience and ease). Schuh and Stavins (2010) concluded that the use of cheques was negatively influenced by the perception of the cost and the inconvenience of cheques in comparison with alternative payment instruments. Schuh and Stavins (2013) also observed that consumers perceived cheques as being slow in terms of processing and less secure when compared with other payment instruments. The effect of transactions' characteristics in the choice of payment instruments was reported by Hayashi and Klee (2003), who found evidence of a negative impact of cashier absence and availability of self-service on consumers' probability of using cheques. Using data on payments made at grocery stores, Klee (2008) observed that the likelihood of using cheques reduced on Sundays and with smaller payments.

Humphrey et al. (2001) and Bolt et al. (2008) are among the small number of authors who were able to include information of the price of payment instruments in the analysis at country level (regarding Norway and the Netherlands). The authors concluded that the pricing of cheques could be an effective instrument in promoting the use of electronic payment instruments. Even though these studies provided empirical evidence of some of the reasons that explain the evolution in consumers' use of cheques, in particular in the United States of America (US), they have not presented detailed cross-country analyses. In fact, only few researchers studied the differences in the use of payment instruments between countries. Humphrey et al. (1996), although more focused on the shift to electronic payments, identified some of the factors that could explain the use of cheques. The authors used data on the number of transactions per person for the period between 1987 and 1993 from fourteen countries to estimate a model of payment instrument demand with Ordinary Least Squares (OLS). They found evidence of a negative impact of Point of Sale (POS) terminals availability and a statistically significant substitution effect with other payment instruments. While not providing empirical evidence, the authors emphasized that the differences in the use of payments instruments (including cheques) across countries exist due to historical reasons. In effect, theoretical studies stressed that, although cheques originate from the eastern Mediterranean, their use has been traditionally higher in the US than in Europe (in line with the data provided on Table 1) due to the reduced concentration in

the banking sector (Humphrey 2010) as well as owing to a nineteenth century banking legislation that discouraged the use of other payment instruments in the US (Quinn and Roberds 2008).

Guariglia and Loke (2004) extended Humphrey et al. (1996) analysis by estimating static equations using the within estimator and dynamic equations using the difference Generalized Method of Moments (GMM) and considering data on the per capita volume and value of payment transactions from fifteen countries for the period between 1990 and 1998. The authors obtained empirical evidence of a substitution effect between cards and cheques in the volume and value of transactions with cheques. Deungoue (2008) and Martikainen et al. (2015), while focusing their analysis on the convergence of payment behaviour in European countries (for the periods from 1990 to 2002 and 1995 to 2001, respectively), put forward some possible reasons for the differences in payments with cheques. In both cases, the results suggested that payments with cheques were not converging in the EU. Deungoue (2008) argued that this could be due to card competition and to the existence of different rules in the various EU countries (although this was not empirically tested).

The abovementioned studies shed light on some of the factors that explain the use of cheques. Nonetheless, legal factors associated with this payment instrument were not considered by those authors. As a result, the questions "what is the effect in the use of cheques in EU countries of the application of fees and the establishment of an autonomous type of crime for unfunded cheques, as well as what policy orientations can be derived from the empirical evidence?" remain to be answered. Therefore, we intend to contribute to the existing literature through the investigation, at the EU level, of the impact of the abovementioned legal factors, taking also into consideration the effect of socio-demographic, economic, technological and institutional factors, both in terms of the per capita number and share of payments made with cheques. As the use of cheques involves considerable social costs for EU countries that still rely on this payment instrument (see Schmiedel et al. 2012) and might as well be restraining countries from taking complete advantage of the financial and monetary integration in the EU (namely, through an increased use of more efficient electronic payment instruments), the proposed analysis is of particular relevance to policymakers, such as Central Banks, as it can unveil elements that could be taken into consideration when defining policies that may help discourage cheques usage.

3 Data and Methodology

In this section we present a brief description of both the variables used in the analysis and the methodology adopted in the econometric approach.

3.1 Data and Descriptive Statistics

The analysis was performed using data from the European Central Bank Statistical Data Warehouse regarding the per capita number and share of payments made with cheques in the EU countries. The data comprises all payment transactions initiated with cheques. According to the methodological notes of this database, it is considered as a cheque any written order from one party (the drawer) to another (the drawee, which is

usually a credit institution) requiring the drawee to pay a specified amount to the drawer or to a third party named by the drawer. Cheques are only counted on the payee's side when submitted for cheque clearing.

In terms of explanatory variables, and considering that this study intends to offer an examination of the impact in the use of cheques of legal factors not considered in the existing literature, two legal variables were included in the analysis: (i) the application of fees; and (ii) the establishment of an autonomous type of crime for unfunded cheques. In order to collect information on the existence of fees associated with the use of cheques we consulted the EU National Central Banks[7] and included in the model a time-invariant dummy variable (*fees*).[8] In addition, to verify if legal rules can impact the use of cheques, we also confirmed with National Central Banks if writing unfunded cheques was considered as an autonomous crime and included another time-invariant dummy variable (*crime*).

The choice of payment instruments can also be related with its users' characteristics. In general terms, cheques can be used by consumers and businesses (including from the public sector). In our model, we tried to capture the relevance of consumers' characteristics through socio-demographic factors typically only included in the analysis of survey data (e.g., in Boeschoten (1998); Stavins (2001) and Klee (2006)). In fact, investigations based on national payments data found that the education level of consumers has a negative impact in the use of cheques, while age might have a positive effect. Hence, in order to capture the effect of those characteristics at an aggregate level we included: (i) the share of population with upper secondary or tertiary education attainment (*edu*); and (ii) the median age of the population (*age*). We also attempted to reflect the business environment using two economic variables: the percentage change in the real Gross Domestic Product (*gdp*) and the private consumption as a percentage of GDP (*pcons*).

On the other hand, technological and institutional factors, usually incorporated in the existing literature on the analysis of cross-country differences in payment habits (e.g., in Humphrey et al. (1996) and Guariglia and Loke (2004)), were also added. We included as technological factors the number of Automated Teller Machines or ATM (*atm*) and POS terminals (*pos*) per thousand inhabitants. In fact, ATM facilitate cash withdraws and can also promote the use of cards for certain transactions. POS terminals, on the other hand, support payments with cards. These factors might assist the substitution of cheques at the point of sale. In addition, we also included institutional country characteristics: two dummy variables that reflect the fact that countries belong (or not) to the euro area (*euroarea*) and the impacts of the beginning of the recent financial crisis and of the SEPA project, in particular, the launch of the SEPA credit transfers scheme (*2008*). We also incorporated a variable denoting the number of offices or places of business that provide payment services (i.e., that execute payment

[7] In some cases we obtained the information on the website of the Central Banks and/or of commercial banks. In the collection of the information we requested data for the period under analysis. Since not all time information was provided by Central Banks, we considered it as time-invariant in the model.

[8] One of the elements that might affect the use of payment instruments is price. However, at cross-country level there is no information available on this factor. Humphrey et al. (1996) computed a proxy for the price of payment instruments used on their analysis that consisted on the amount of fees, but concluded that the influence was very modest. Our variable differs from the proxy proposed by Humphrey et al. (1996) since it captures the impact of the existence of fees, not the effect of their amount.

transactions on behalf of a natural or legal person) per thousand inhabitants (*offices*), as they can facilitate the handling of cheques by consumers and businesses. In order to account for possible substitutability effects, we included the number of per capita payments with cards (*cards*) and the number of cash withdrawals (*cash*) as a simple proxy for cash usage. Credit transfers and direct debits are generally used for payments of a different nature (e.g., rents) and, therefore, were not considered as direct substitutes of cheques at the point of sale. An interaction term between the variables *2008* and *fees* was also included in order to identify if the impact of the establishment of fees changed after the beginning of the recent financial crisis and of the SEPA project. Detailed information on the variables used in the empirical analysis can be found in Table 5 of the Appendix.

Table 2 presents the descriptive statistics for the dependent and independent variables used in the model. The mean number of per capita payments made with cheques between 2000 and 2012 was 8, while the mean share of cheque payments (in volume)

Table 2 Descriptive statistics of the independent variables for the 27 EU countries (period between 2000 and 2012)

Variable	Mean	Std. Dev.	Min.	Max.	No. Obs.
Dependent variables					
ncheques	8.01	14.70	0	74.00	349
propcheques	0.0830	0.14	0	0.72	334
Independent variables					
Legal factors (L_i)					
fees	0.85	0.36	0	1	351
crime	0.48	0.50	0	1	351
Socio-demographic factors (SD_{it})					
edu	0.67	0.14	0.21	0.87	351
age	38.91	2.25	32.4	45	351
Economic factors (E_{it})					
gdp	0.02	0.04	-0.16	0.12	350
pcons	0.77	0.08	0.47	0.93	351
Technological factors (T_{it})					
atm	0.65	0.33	0.03	1.66	350
pos	14.36	8.52	0.06	37.80	341
Institutional factors (I_{it})					
offices	0.57	0.29	0.09	1.84	338
euroarea	0.50	0.50	0	1	351
2008	0.38	0.49	0	1	351
cash	21.98	11.54	0.48	47.87	323
cards	53.72	51.44	0.04	230.10	345

The table reports the descriptive statistics of the dependent and independent variables in the period between 2000 and 2012 for the 27 EU countries. “Std. Dev.” stands for standard deviation, “Min.” for the smallest value of the observations, “Max.” for the highest value of the observations and “No. Obs.” for the number of observations

was 0.08 or 8 %. The variation between the minimums and maximums was quite substantial in both variables. In around 85 % of the sample there are fees associated with the use of cheques, while unfunded cheques are only considered as an autonomous crime in around 48 % of the sample. In what concerns to socio-demographic factors, we observe considerable differences in the education level between countries, while age characteristics are more similar. The economic and institutional factors reveal a diversity of situations, as we would expect.

3.2 Model Specification and Methodology

The empirical analysis of the effect on cheques usage of: (i) legal factors connected with the existence of a fee and the fact that unfunded cheques are considered as an autonomous type of crime in certain countries; and (ii) socio-demographic, economic, technological and institutional factors, was made by estimating a static model with the following functional form:

$$Y_{it} = G\left[\beta_0 + \beta_1 L_i + \beta_2 SD_{it} + \beta_3 E_{it} + \beta_4 T_{it} + \beta_5 I_{it} + \beta_6 (2008 \times \text{fees})_{it} + \varepsilon_{it}\right] \quad (1)$$

where Y_{it} is either the number of per capita payments made with cheques or the share of payments made with cheques (in volume), with i ($i = 1, \ldots N$) representing each country and t ($t=1, \ldots 13$) denoting the time period; L_i refers to two time-invariant dummies of legal factors (i.e., *fees* and *crime*); SD_{it} regards to socio-demographic factors (i.e., *edu* and *age*); E_{it} denotes economic factors (i.e., *gdp* and *pcons*); T_{it} regards to technological factors (i.e., *atm* and *pos*); I_{it} refers to institutional determinants (i.e., *offices*, *euroarea*, *2008*, *cash* and *cards*); $(2008 \times fees)_{it}$ is an interaction term, $\varepsilon_{it} = \alpha_i + u_{it}$, being α_i the country-specific effects and u_{it} the idiosyncratic error term. Finally, β_j, $j = 1, \ldots 6$, are vectors of parameters associated to each type of explanatory variables.[9] Whenever $G(.)$ is a nonlinear function, average partial effects (APE) are computed in order to measure the effect of unitary changes in these explanatory variables on the response variable.

The next two sections detail the econometric approach to model the two measures of cheque usage in analysis. The number of per capita payments with cheques, widely analysed by the literature, is modelled with linear models for panel data and a new approach based on count data regressions. Then, the new measure considered in this paper, the share of payments made with cheques, is described by FRM.

3.2.1 Models for the Number of Per Capita Payments with Cheques

In order to choose the most appropriate estimator for the examination of the effect of selected factors on the number of per capita payments made with cheques, we began by considering standard linear models, where model (1) is simply the linear index. In particular, we considered the fixed effects (or within) estimator and the random effects

[9] In order to capture changes in cheque usage due to other factors besides those included as explanatory variables or due to the simple passage of time, we also considered models including a linear time trend. However, because this variable was not significant and the coefficients of the other variables remained very similar, we decided to present more parsimonious models, which do not include the time trend.

estimator (Wooldridge 2002). In the former, the fixed effects α_i are eliminated by mean-differencing and, therefore, it is possible to obtain consistent estimates even with endogenous regressors, as long as the independent variables are only correlated with the time-invariant component of the error (i.e., α_i). However, because in the framework of this estimator it is not possible to estimate the coefficients of time-invariant variables such as those referring to the legal factors, our interest is focused on the random-effects estimator. This estimator allows the estimation of coefficients of time-invariant variables, but assumes that individual unobserved effects are random and not correlated with the explanatory variables.

A robust Hausman (1978) test was performed to validate the random effects estimator. As usual, under the null hypothesis the individual effects are random. In addition, a RESET test was applied to the random effects model to confirm the adequacy of the specification. To examine the robustness of the results we also validated the possibility that some of the explanatory variables (i.e., the technological variables *atm* and *pos*, as well as the institutional variables *cash* and *cards)* were correlated with the individual-level random effects, by using an alternative estimator based on instrumental variables proposed by Hausman and Taylor (1981) that includes elements from the fixed and random effects models. In this estimator, the time-variant variables are used not only to estimate their own coefficients but also as instruments in order to estimate the coefficients of time-invariant variables. To assess overidentifying restrictions in the model, we performed the Sargan-Hansen test (Cameron and Trivedi 2009). The null hypothesis of this test postulates that the instruments used in the model are valid.

Although linear models have been widely applied in the previous literature on the usage of payment instruments, they can have some shortcomings when using the type of data under investigation. In fact, the number of per capita payments made with cheques is a count variable with nonnegative integer values. According to Wooldridge (2002), linear models might not be the best solution, since they can generate negative predicted values. Therefore, a Poisson regression estimated by quasi-maximum likelihood (QML) was also tested.[10] In this framework, in (1), $G[.] = \exp[.]$. Three alternatives were considered: a fixed effects Poisson model, a random effects Poisson model where the random effects follow a gamma distribution, and a random effects Poisson model where the random effects follow a lognormal distribution. To validate the adequacy of the random effects models, RESET tests were performed. Finally, the linear random effects estimators were compared with the selected (lognormal) Poisson random effects estimator using the J test of Davidson and MacKinnon (1981) for non-nested regression models.[11]

3.2.2 Models for the Share of Payments with Cheques

Considering that the variable regarding the share of payments made with cheques is bounded between zero and one, linear models are not adequate according to Papke and Wooldridge (1996); Ramalho et al. (2011) and Ramalho and Ramalho (2016). A more

[10] Note that, according to Gourieroux et al. (1984), the Poisson estimator with robust standard errors is consistent, even under misspecification of the Poisson distribution, as long as the mean is correctly specified.
[11] Note that this is essentially a t test for the significance of the predicted outcome obtained under the model of the alternative hypothesis, which is included as an additional regressor in the model under the null hypothesis.

appropriate econometric approach, highlighted by Ramalho et al. (2011) and Papke and Wooldridge (1996), is the assumption of a functional form that imposes the needed constraints on the conditional mean of the dependent variable. We therefore used a FRM estimated by pooled QML with a robust version of the variance of the estimated parameters. The variable of interest Y_{it} is now defined on the interval (0,1) and G written as a logit $\left(G[.] = \frac{\exp[.]}{1+\exp[.]}\right)$, cloglog ($G[.] = 1 - \exp[.]$) and probit ($G[.] = \phi[.]$, with ϕ defined as a standard normal distribution) conditional mean functions. Although any cumulative distribution function could be used for G, we considered logit, probit and cloglog models. The former models are the most popular choices for FRM and the latter possess an alternative asymmetric functional form. To verify if the FRM were adequate, a RESET test of the specification of the fractional model was performed.

4 Empirical Results

This section provides the analysis of the results of the alternative estimators, presented in Table 3. The model selection strategy is presented and the effects of both the legal variables and the remaining covariates are discussed.

4.1 Model Selection

In terms of model selection for the analysis of the number of per capita payments made with cheques, in the linear specification the random effects model was not rejected by both the Hausman and the RESET tests. The results of this model, both in terms of coefficient magnitude and individual significance, are very similar to those of the fixed effects and the Hausman-Taylor estimators, which are also consistent in the presence of fixed effects. On the other hand, of the three Poisson-based nonlinear estimators considered, only the random effects Poisson model with a lognormal distribution was selected, with a RESET test presenting a *p*-value of 0.1482. When comparing the linear random effects with the selected Poisson random effects model using a non-nested hypothesis test we obtain a *p*-value of 0 and reject the correct specification of the linear random effects model. The opposite comparison leads to a *p*-value of 0.107, which yields the non rejection of the Poisson random effects with lognormal distribution model. For that reason, we will focus our analysis on the results obtained in this last model.[12] Notice the differences in variable significance relatively to the traditional linear model approach (Table 3 and Table 4) – in some cases the linear model increases the effect (for example, in variable 2008 the effect is approximately 16 times larger than that of the Poisson model) and in other cases it deflates (as it happens with *crime*, where the effect is about 2.8 times smaller than that of the selected Poisson model).

For the analysis of the share of the number of payments made with cheques we used three FRM. Since only the model with a probit conditional mean function was not rejected by the RESET test, we focus our analysis on its results. Note that, in comparison with the

[12] Note that there is evidence that the J test of Davidson and MacKinnon (1981) tends to over-reject the null hypothesis, namely when the model under the null presents a poor fit (Godfrey and Pesaran 1983). In this framework, the fact that our exponential model was not rejected is very encouraging and reinforces the choice of this model as the best description for the number of per capita payments with cheques.

Table 3 Estimation results for the period between 2000 and 2012 in 27 EU countries

Variables	Model of the number of per capita payments with cheques						Model of the share of payments with cheques (in volume)		
	Fixed effects	Random effects	Hausman-Taylor	Poisson (fixed effects)	Poisson (random effects with gamma distribution)	Poisson (random effects with lognormal distribution)	FRM (logit)	FRM (cloglog)	FRM (probit)
fees	-	-32.5580***	-33.1471***	-	-3.0578***	-4.4768***	-2.5971***	-2.3433***	-1.3017***
		(12.0884)	(12.5613)		(0.8835)	(0.7319)	(0.1783)	(0.1606)	(0.0793)
crime	-	3.6868	3.8804	-	0.8905	1.6765**	0.7249***	0.6566***	0.3756***
		(3.8371)	(4.8394)		(1.1082)	(0.8067)	(0.1518)	(0.1407)	(0.0693)
edu	-10.4664	-14.1013	-12.4294	1.5121	-0.5322	-0.2949	-4.0573***	-3.3963***	-2.2733***
	(10.6976)	(10.4751)	(13.1406)	(1.2167)	(0.7544)	(1.4652)	(0.2962)	(0.2702)	(0.1478)
age	0.0978	-0.1420	-0.0216	-0.2277**	-0.2972**	-0.2598**	-0.6299***	-0.5758***	-0.2964***
	(0.4669)	(0.4460)	(0.5959)	(0.0982)	(0.1298)	(0.1059)	(0.0521)	(0.0458)	(0.0277)
gdp	-8.6021**	-7.0659*	-7.8520	1.0351	0.7302	0.6312	-2.4337	-1.3085	-1.2322
	(4.1377)	(4.2083)	(4.9797)	(0.8745)	(1.0467)	(0.9083)	(2.7714)	(2.5472)	(1.2462)
pcons	-31.9871**	-27.8039**	-30.1482**	4.9484***	3.9143*	3.9646***	5.9998***	5.4869***	3.0304***
	(12.2546)	(11.0688)	(13.4158)	(1.5942)	(2.1316)	(1.3149)	(0.7976)	(0.7618)	(0.3601)
atm	-11.5692**	-10.6317**	-11.0735**	0.0569	0.1216	0.1994	0.2465	0.3911	-0.1699
	(4.5310)	(4.3357)	(4.9015)	(0.4265)	(0.5904)	(0.4534)	(0.4151)	(0.3742)	(0.2056)
pos	-0.0500	-0.0342	-0.0343	0.0080	0.0208	0.0181	0.0732***	0.0665***	0.0353***
	(0.1405)	(0.1218)	(0.1344)	(0.0107)	(0.0170)	(0.0121)	(0.0076)	(0.0072)	(0.0034)
offices	3.6257*	4.1059**	3.8469*	0.3747***	0.4630	0.4347**	0.2124	0.2013	0.2401
	(1.9891)	(2.0440)	(2.0689)	(0.1421)	(0.5530)	(0.1704)	(0.2789)	(0.2442)	(0.1536)
euroarea	1.8568	2.0722	1.9765	0.0596	0.1528	0.1694	0.9547***	0.9056***	0.4845***
	(1.2003)	(1.3284)	(1.3970)	(0.0932)	(0.3666)	(0.1415)	(0.1417)	(0.1191)	(0.0726)
2008	-7.2961**	-7.2756**	-7.2427**	-0.0612	-0.0530	-0.0721*	-0.4621**	-0.5363***	-0.1944*
	(2.8535)	(2.9442)	(3.4593)	(0.0411)	(0.0850)	(0.0429)	(0.2320)	(0.1958)	(0.1120)

Table 3 (continued)

Variables	Model of the number of per capita payments with cheques						Model of the share of payments with cheques (in volume)		
	Fixed effects	Random effects	Hausman-Taylor	Poisson (fixed effects)	Poisson (random effects with gamma distribution)	Poisson (random effects with lognormal distribution)	FRM (logit)	FRM (cloglog)	FRM (probit)
cash	-0.0572 (0.0830)	-0.0280 (0.0732)	-0.0510 (0.0828)	-0.0016 (0.0113)	0.0116 (0.0175)	0.0038 (0.0096)	-0.0019 (0.0112)	-0.0018 (0.0096)	0.0030 (0.0062)
cards	-0.0309 (0.0272)	-0.0257 (0.0247)	-0.0303 (0.0314)	-0.0055 (0.0036)	-0.0037 (0.0057)	-0.0041 (0.0036)	-0.0074*** (0.0025)	-0.0065*** (0.0024)	-0.0038*** (0.0011)
2008 x fees	8.9334** (3.1951)	8.9976*** (3.2580)	8.9619** (3.7245)	-0.2150** (0.0976)	-0.2073 (0.1816)	-0.2178** (0.1037)	-0.1943 (0.2669)	-0.1630 (0.2565)	-0.0454 (0.1169)
Hausman test *p*-value	-	0.9921	0.9370	-	-	-	-	-	-
RESET test *p*-value	-	0.4532	-	-	0.0296	0.1482	0.0000	0.0000	0.3660
Sargan-Hansen test *p*-value	-	-	0.5130	-	-	-	-	-	-
J-test *p*-value	-	0	-	-	-	0.107	-	-	-
No. Obs.	301	301	301	290	301	301	290	290	290

The table reports the fixed effects, random effects, Hausman-Taylor, Poisson fixed effects, Poisson random effects with gamma distribution, Poisson random effects with lognormal distribution and FRM with a logit, cloglog and probit distribution functions (with robust standard errors) estimation results for the dependent variables under analysis: number of per capita payments with cheques and share of payments with cheques (in volume). Standard errors are in parenthesis. Constant term coefficient not reported. Variables in value have been adjusted for inflation. Note that: * indicates significance at the 10 % level, ** at the 5 % level and *** at the 1 % level. "No. Obs." stands for the number of observations

Table 4 APE of selected models

Variables	Model of the number of per capita payments with cheques	Model of the share of payments with cheques (in volume)
	Poisson (random effects with lognormal distribution)	FRM (probit)
fees	-28.0150***	-0.1346***
crime	10.4913**	0.0388***
edu	-1.8454	-0.2350***
age	-1.6258**	-0.0306***
gdp	3.9500	-0.1274
pcons	24.8098***	0.3132***
atm	1.2480	-0.0176
pos	0.1133	0.0036***
offices	2.7206**	0.0248
euroarea	1.0604	0.0501***
2008	-0.4512*	-0.0201*
cash	0.0237	0.0003
cards	-0.0259	-0.0004***
2008 x fees	-1.3628**	-0.0047

The table reports the APE computed for the following models: Poisson random effects with lognormal distribution and FRM with a probit distribution function. Note that: * indicates significance at the 10 % level, ** at the 5 % level and *** at the 1 % level.

selected model for the number of payments, the model for the share presents much more individually significant variables (8 instead of 2 with a significance level of 1 %), which suggests that the set of covariates under analysis provides a better description of the share behaviour than that of the traditional number of payments.

4.2 The Effect of Legal Variables

Even though Humphrey et al. (1996) concluded that the impact of payment instrument prices was very modest,[13] according to our estimation results the existence of fees has a statistically significant negative impact on both the per capita number and share of payments made with cheques (Table 3). The estimated APE is −28.02 and −0.14 on each of the models (Table 4), which reflects a quite relevant impact since the mean of the number of per capita payments made with cheques in our sample is around 8 and the mean of the share is about 0.08. This influence was very clear in Sweden, where the decision to charge a fee per cheque in the beginning of the 1990s led to a sharp reduction in their use without any political convulsion, according to Nyberg (2008).

Our findings also suggest that the existence of an autonomous type of crime for unfunded cheques impacts positively the per capita number and share of payments made with cheques. The APE of the variable *crime* is 10.49 and 0.04, respectively. Overall, the existence of fees has a larger impact than legal penalties on the use of cheques. So, even when countries have

[13] The authors used a proxy for the prices of the various payment instruments due to unavailability of data for all countries included in the model.

legal provisions that increase protection and make cheques usage more attractive (in particular with larger amounts), the establishment of fees is effective in reducing cheques usage.

4.3 The Effect of Socio-Demographic, Economic, Technological and Institutional Factors

Regarding socio-demographic factors, age characteristics reveal a statistically significant negative impact on both the Poisson random effects with lognormal distribution model and the FRM with a probit conditional mean function. This might be surprising since, ceteris paribus, it is expectable that an older population uses more cheques as there might be a greater difficulty in the use of electronic payment instruments. However, nowadays cheques are typically used in large value payments, for example connected with the acquisition of home appliances, as well as the payment of children extra-curricular activities or tuition fees. In fact, a survey made in Ireland concluded that the use of cheques in 2014 was still dominated by smaller businesses and consumers. In both situations, around 50 % of cheques issued were payable to business (CBI 2014). This fact might justify the impact obtained, since normally those purchases are not made frequently by older persons. The variable connected with the education level of the population is only statistically significant in the share analysis. Higher levels of education are negatively related with the share of payments made with cheques. This result is in line with the conclusions of Koulayev et al. (2012) employing survey data on the use of payment instruments in the US. The observed impact can result from the fact that populations with average higher education levels replace more easily the use of cheques with electronic payment instruments.

In terms of the economic variables, the evolution of the variable *pcons* shows a statistically significant positive effect on the use of cheques, which is expectable as we consider this variable as an indicator of the business environment. Conversely, the effect of technological elements is not very clear. Only POS terminals have a statistically significant positive effect in the proportion of payments with cheques. This can be related with the fact that the number of POS terminals that already exist in several EU countries is very high and, for that reason, is not contributing to a greater substitution of cheque payments by cards. It can also result from the fact that the number of transactions considered in our analysis (namely in the computation of the share of payments with cheques) refers to both retail and large value transactions, while POS terminals are used, in most cases, in low value transactions. The substitution effect that is expectable in low value transactions with cheques can therefore not be visible if the number of large-value transactions is significant.

Finally, in what concerns to institutional factors, we observe that the variable that captures the impact of the beginning of the SEPA project and of the recent financial crisis has a statistically significant negative effect in both models. The impact of the SEPA project will probably increase in the future, when the focus is placed on the cards industry. In addition, the interaction between the variable *fees* and *2008* is statistically significant in the analysis of the per capita number of cheque payments. The interaction effect shows that, before 2008, the APE of the application of fees on the number of per capita payments made with cheques was around −28.02. After 2008, this effect increased to −29.38. This reflects that, following the launch of the implementation of the SEPA project and the start of the recent financial crisis, the impact of the adoption

of fees in the use of cheques was enhanced. In addition, the effect on the Poisson model of the number of offices that provide payment services is positive and statistically significant. As offices are used by consumers and businesses to deliver cheques for processing, a higher number of offices make it more convenient. The share of payments with cheques appears to be positively related with belonging to the euro area, whereas cards seem to play a role in substituting cheques. Contrary to the expected, cash did not reveal a statistically significant connection with the use of cheques.

The APE of some of these factors is quite significant when compared to legal determinants. This can reflect the fact that specific country characteristics might play a very important role in the use of cheques, therefore restricting the potential impact of the adoption of measures that influence the previously mentioned legal elements.

5 Concluding Remarks and Policy Implications

This paper investigated, from an empirical point of view, the effect on cheques usage at the EU level of the application of fees and the establishment of an autonomous type of crime for unfunded cheques, while controlling for the impact of socio-demographic, economic, technological and institutional factors. The original aspects of this article consist not only in the inclusion in the analysis of new and relevant factors collected specifically for this study, but also on the use of a novel dependent variable – the share of the number of payments made with cheques – that, due to its nature, can be a more reliable measure of comparison between countries, and on the employment of updated estimation techniques – more adequate to the characteristics of the data. The findings obtained are relevant as they provide new insights to policymakers, such as Central Banks, that intend to adopt measures to discourage cheques usage in countries where they are still frequently used. In fact, this payment instrument is associated with high social costs and few benefits to economic growth when compared, for example, with debit cards. Reducing its use might, therefore, ease the integration process in EU retail payments by promoting the substitution with more efficient and secure payment instruments and increase economic agents' trust, enhancing the benefits of financial and monetary union. As ECB (2015) highlights, since payments have a direct impact in the real economy, more efficient retail payments can contribute to achieve the aims of the single market.

Our key finding is that the existence of fees influences negatively cheques usage. This effect is quite relevant when compared to the mean of the per capita number and share of payments made with cheques and to the positive impact that results from the application of an autonomous crime regime to unfunded cheques. Hence, policymakers that intend to discourage the use of cheques can boost the implementation of measures that reduce the attractiveness of cheques by increasing their cost. In particular, they might intercede by supporting the establishment of fees by the banking community. They may also deter legal protection and discourage the implementation of protection laws on cheques, although this measure is relatively less relevant.

Our results also suggest that socio-demographic characteristics of consumers and the business environment can have an important role. Since the adoption of electronic

payment instruments will probably be quicker in countries where the population has higher education levels, policies and measures adopted should be appropriately differentiated and/or targeted at individuals with lower education levels. Improving financial literacy education on specific groups should generate increased awareness and confidence on electronic payment instruments and, as a result, expand their usage. It is also important to note that companies, compared to consumers, have more information on payment instruments and are more cost aware and efficiency seeking. Hence, the implementation of policies that bring more clarity on the costs and benefits (namely to merchants and governments) of the use of different payment instruments can be a good approach to reduce the use of cheques. This strategy could be more effective with a preceding survey that details information on the users and on the type of transactions where cheques are still the preferred payment instrument (for example, cheques might be the preferred payment instrument in large value transactions due to the time delay that occurs between its delivery and the clearing process). This could help identify alternative payment instruments or even new solutions (such as instant payments schemes that are being developed in a transnational context) that might be more adequate to each type of transaction. Indeed, as ECB (2016b) highlights, user expectations are evolving with increased dematerialization in the field of payments. Although full harmonisation is not the ultimate goal, one should bear in mind that the specificities of each country might have a transnational relevance in the context of the future developments in retail payments.

Finally, we also obtained evidence of the importance of the technological infrastructure and the institutional environment on smoothing the shift to more efficient payment instruments. In particular, policymakers should bear in mind that the technological infrastructure might play a role according to the implementation stage of the network in each country. Focusing the attention on enhancing the use of cards (in particular of debit cards) can be a good approach in discouraging cheques usage. These substitution effects might be reinforced in the future through projects at the EU level, such as the SEPA project. Implementing or increasing the prices associated with the services connected with cheques processing in bank branches or decreasing the number of offices might indirectly discourage cheques usage.

Notwithstanding the above, authorities should bear in mind that, even though social costs associated with the use of payment instruments provide the basis for policy intervention, the level of involvement should be carefully considered. If the existing framework of each country is not regarded, the adoption of the discussed measures can bring unintended distortions to the payments market (e.g., by increasing the use of cash, which has high costs to society). In addition, attention should be made to the fact that policy orientations provided by this study were derived using data for a specific time period (i.e., between 2000 and 2012). Finally, we also recall that the road to more efficient payment instruments is not done exclusively by reducing the use of cheques. Efforts should also be applied in providing secure and efficient electronic payment instruments.

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Appendix

Table 5 Description of the dependent and independent variables used in the empirical analysis

Variable	Description	Source
Dependent variables		
ncheques	Per capita number of payments made with cheques.	ECB SDW
propcheques	Share of the number of payments made with cheques computed considering the relative importance on the total number of payments made with cheques, credit transfers, direct debits and cards.	Authors' calculation based on data from the ECB SDW
Independent variables		
Legal factors ($\mathbf{L_i}$)		
fees	Dummy variable that equals 1 if fees are applicable on the use of cheques and 0 otherwise.	National Central Banks
crime	Dummy variable that equals 1 if unfunded cheques are considered as an autonomous crime and 0 otherwise.	National Central Banks
Socio-demographic factors ($\mathbf{SD_{it}}$)		
edu	Percentage of persons with upper secondary or tertiary education attainment.	Eurostat
age	Median age of population.	Eurostat
Economic factors ($\mathbf{E_{it}}$)		
gdp	Real change in the GDP.	Eurostat
pcons	Private consumption as a percentage of the GDP.	Eurostat
Technological factors ($\mathbf{T_{it}}$)		
atm	Number, per thousand inhabitants, of ATM (device that permits authorised cardholders, typically using machine-readable plastic cards, to withdraw cash from their accounts and/or access other services, such as balance enquiries, transfer of funds or acceptance of deposits) at the end of each year.	ECB SDW
pos	Number, per thousand inhabitants, of POS terminals (device allowing the use of payment cards at a physical point of sale) in the end of each year.	ECB SDW
Institutional factors ($\mathbf{I_{it}}$)		
offices	Number of places of business in the country per thousand inhabitants at the end of each year. Includes only those offices that provide payment services with cashless clearing and settlement.	ECB SDW
euroarea	Dummy variable that equals 1 when the country is from the euro area and 0 otherwise.	ECB SDW
2008	Dummy variable that equals 1 from 2008 onwards (i.e., after the beginning of the recent financial crisis and of the implementation of the SEPA project) and 0 otherwise.	ECB
cash	Number of cash withdrawals per capita.	ECB SDW
cards	Number of cards transactions per capita.	ECB SDW

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