Álvez, Marcelo; Lluberas, Rodrigo; Ponce, Jorge

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Marcelo Álvez [*], ***Rodrigo Lluberas*** [**], ***Jorge Ponce*** [***]

[*] *Economic Research Department, Banco Central del Uruguay, Montevideo, Uruguay*

E-mail: maalvez@bcu.gub.uy

[**] *Economic Research Department, Banco Central del Uruguay, Montevideo, Uruguay*

E-mail (corresponding author): rlluberas@bcu.gub.uy

[***] *Economic Research Department, Banco Central del Uruguay, Montevideo, Uruguay*

E-mail: jponce@bcu.gub.uy

The Cost of Using Cash and Checks in Uruguay[1]

Abstract: The incorporation of new technologies to financial activities implies challenges and opportunities to financial authorities. They are reacting to the unavoidable trend towards digitalization of financial activities with the objective of preserving stable and efficient payment and financial systems. Uruguay, for instance, has promoted the use of electronic payment instruments and tested in the real economy a central bank digital currency called e-Peso. Digitalization of payment systems would reduce transaction costs by (partially) replacing less efficient means of payment, e.g. paper-cash and checks. In this paper we find that the cost of using cash in Uruguay is approximately 0.61% of GDP. Interestingly, 98.1% of this cost is borne by the private sector: banks and retailers 77.1% and households 21.0%. The cost of using checks is equivalent to 0.04% of GDP. Overall, replacing paper-cash and checks by other (electronic) means of payment would imply a transaction cost reduction for the private sector of the equivalent of up to 0.65% of GDP.

Keywords: payment system, cost of cash, cost of checks, electronic payments.

JEL Codes: D12; D23; D24.

[1] The opinions expressed in this publication are those of the authors and do not reflect the views of the Central Bank of Uruguay.

1. Introduction

There is an unavoidable technological trend worldwide. Technological developments are leading a rapid process of digitalization of most human activities. Financial markets are far the exception but one of the most impacted sectors. First, improvements in communications technologies, computing, data analysis, digital cryptography and new technologies, e.g. blockchain, help to reduce transaction costs. In turn, lower transaction costs reduce barriers to the entry of new competitors. Hence, it also helps to improve the competitive environment and to financially include new customers. Second, most of the changes towards digitalization are highly demanded by customers. Nowadays, immediateness, rapid access through mobile devices and better customer's experience, e.g. by reducing the time needed to operate in financial markets, are highly demanded by customers worldwide.

Digitalization is rapid and highly demanded[2]. These characteristics would determine that it does not stop in the foreseeable future. Instead, it would continue at an even higher speed. More importantly, the characteristics of the current digital trend together with the new developments would change dramatically the financial landscape. As Fabris (2018) states, there are new issues that defy governments in the field of monetary policy and financial stability. Financial authorities would face new challenges in order to fulfill their basic mandates in this new digital era.

For example, consider the case of Sweden. During the last decade, the Swedish banking system has developed a very efficient payment system. The success has been of such magnitude that most people are using it through their computers and mobile phones. The use of physical cash, on the other hand, has falling dramatically during the last years. Today, more and more retail stores are not accepting cash as a mean of payment in Sweden. And forecasts predict that people will completely stop using physical cash by 2025. In this scenario, how would the Central Bank of Sweden fulfill its mandate of providing an efficient and stable payment system? It will lack one of the key instruments to do so: cash. And, how would assure financial stability in case a banking crisis occur?

While digitalization challenges central banks, it may also be part of the solution. For example, the Central Bank of Sweden is studying the possibility of issuing a central bank digital currency, called e-Krona, in order to build an instrument

[2] For instance, Femić-Radosavović and Jovović (2017) show that new media affects the level of customer satisfaction.

that is accepted by the public and allows the central bank to fulfill its mandates. Along these lines, Garcia-Swartz, Hahn and Layne-Farrar (2006) present a cost-benefit analysis considering all parties involved in a transaction and state that the move towards a cashless society is, on the whole, beneficial.

Digitalization may also imply opportunities for financial authorities. In general, central banks receive the mandate of developing efficient and secure payment and financial systems. The reduction of transaction costs, the improved security and the advantages of data collection and analysis that is provided by the new digital technologies may be used to achieve these objectives. Their contribution would be more important in jurisdictions where the private sector does not take the leadership on technological innovation. In such a case, a proactive attitude towards financial development of markets and infrastructures would be necessary.

In Uruguay, one of the main objectives of the Financial Inclusion Law that was put in place in 2014 is to make the payment system more efficient. This is being achieved by promoting the use of electronic payment instruments and easing the access to the financial sector. There is an explicit policy to move towards the use of electronic payment instruments, e.g. debit and credit cards, instead of cash and checks.

Moreover, the Banco Central del Uruguay has been testing through a pilot experiment on the field a new central bank digital currency: the e-Peso. During the six months between November 2017 and April 2018 the Uruguayan Peso circulates under two formats: its classical paper-based bills and as e-Pesos in its digital form. The pilot plan was successful. It was used to test and evaluate many aspects of this novel technologies and central bank business models. Should the e-Peso be put into production, the declared intention of the authorities is that it should complement and not completely replace existing means of payments, including the paper-based bills. Part of the evaluation should consist on estimating the efficiency gains and cost reduction of (partially) substituting relatively costly means of payment.

In this paper we contribute to the literature by estimating the cost of using cash and checks in Uruguay. We collect data from several sources including Central Bank Annual Reports, Annual Survey of Economic Activity, Payment System Statistics, etc. and process it through methodologies that have been used in the previous international studies. The main costs we assess for the use of cash are related to producing notes and coins, transportation and security incurred by the banks and retailers, and the costs incurred by consumers in terms of fees

paid and other implicit costs such as liquidity cost, time cost and other costs associated with the risk of holding cash. To calculate the costs of using checks we consider the costs to the commercial banks and the costs to the consumers and firms.

We find that the cost of using cash in Uruguay is approximately 0.61% of GDP. This estimate is in line with previous studies for other economies. Interestingly, 98.1% of this cost is borne by the private sector: banks and retailers 77.1% and households 21.0%. The cost of importing and securing bill notes by the Central Banks is approximately 1.9% of the total private costs of cash. The cost of using checks is equivalent to 0.04% of GDP. Overall, replacing paper-cash and checks by other (electronic) means of payment would imply a transaction cost reduction for the private sector of the equivalent of up to 0.65% of GDP.

There are several considerations to be done. First, the previous estimation does not include the costs related to crime. We do not find reliable estimates for them in Uruguay. Nevertheless, we provide a short discussion of their order of magnitude in Section 4.4. Rogoff (2016) find that crime rates appear positively correlated with demand for paper currency and negatively correlated with credit and debit card penetration. Hence, the cost reduction by replacing paper bills would be even higher than our estimates if replacing paper cash and checks helps to reduce crime rates.

Second, the estimated figure represents the maximum cost that may be saved by stop using cash and checks. Third, partial substitution of cash and checks by electronic means of payment would imply a differently than proportional cost reduction. This would depend on the components of the cost equation that are mostly affected. Fourth, in order to compute the efficiency gain from replacing cash and checks for relatively more efficient means of payment on should consider the costs that are associated to the latter.

The paper is organized as follows. Section 2 presents a review of relevant literature. In Section 3 we present an overview of the recent changes in the payment system in Uruguay. Section 4 presents the results of estimating the private cost of using cash and checks in Uruguay. Section 5 shows that our results are in line with previous studies. Finally, Section 6 concludes.

2. Literature Review

Great effort has been made in the last fifteen years to measure the cost of dfferent payment instruments. In spite of this effort, there is still limited evidence to make consistent comparisons across countries. However, Hayashi and Keeton (2012) argue that it is possible to learn some lessons from other countries' costs studies, particularly in terms of how to measure and the type of information needed to estimate payment instruments cost. Then, they review the methodology and empirical results of previous cost studies for Australia, Belgium, Netherlands and Norway.

A common feature in previous work is the distinction between private and social costs. The former represent the costs faced by each agent for the use of a specific payment instrument. They include not only the agent's own costs but also any fees paid to other agents. Private costs are relevant, thus, for individual decisions. From the social point of view, the fees transferred from one agent to another do not increase the cost for the whole society. Hence, the social costs only include the agent own costs and are net of any fees paid to other agents. Finally, several studies consider the seigniorage paid to the central bank due to holding bills and coins among these transfers made by private agents (see for instance Bergman et al (2007), Brits and Winder (2005) and Stewart et al (2014)). As any fees paid from one agent to another, seigniorage is only a transfer to the central bank and does not represent a real use of resources for the society. Then, summing up private costs would overstate social costs as the fees paid by one agent will cover, at least in part, the resources spent in the transaction by the other party.

Another aspect considered in the previous literature is the distinction between fixed and variable costs. Fixed costs do not depend on the number or value of transactions while variable costs are those that increase with the number or value of transactions made. For instance, electronic payment transactions usually imply a large investment in technology and infrastructure but, once that is put in place, any additional transaction made has a very small cost. Then, electronic transactions have a high fixed cost but a low variable cost. On the other hand, printing and store bills, for instance, is expensive in terms of materials and labor and thus the variable cost for the use of cash could be high. This explains why cash is the cheapest payment instrument for small amount transactions, but it is not for larger ones (Bergman et al., 2007; Brits and Winder, 2005; Schwartz et al., 2007; Stewart et al., 2014).

Finally, Hayashi and Keeton (2012) stress the relevance of considering the cost per transaction or the cost per unit of value and its relationship with the idea of

constant versus increasing returns to scale. First, when studying social costs, it is important to take into account the volume use of the different payment instruments. It is not the same if a payment instrument, like cash for instance, is widely accepted and used in a large scale than a payment instrument that is only used in a small scale. The social cost of the former would be larger than the social cost of the latter just because it is used in a larger volume, i.e more transactions or value. In that sense, in order to compare the cost efficiency of different payment instruments, it is important to take the volume of transactions into account by analyzing the cost per transaction or the cost per unit of value (see also Brits and Winder (2005)). Second, the role of scale effects could be important in the measurement of the cost of payment instruments use. Comparing the cost per unit of value or the cost per transaction of different payment methods that are subject to constant returns to scale would give a good idea of their relative cost effciency. On the other hand, looking at unit costs, if payment instruments are subject to increasing returns to scale and thus the cost declines with use, this could be misleading in assessing cost effciency of alternative payment methods. For example in the four countries analyzed by Hayashi and Keeton (2012), Norway is the only one where the cost of using cash is higher than the cost of using debit cards, but also is the country with the lowest use of cash relative to debit cards. Comparisons across countries should take into account the volume use of the different payment instruments as a payment method could have a higher estimated cost in a particular country only because it is being used on a smaller scale (see also Stewart et al. (2014)).

There are differences across countries but, in general, payment instrument cost studies consider the cost at the point of sale (POS) and include among payment methods: cash, debit cards, credit cards, prepaid cards and, where used, also checks. A number of studies consider only the banking sector, the retail sector and the central bank as participants in the payment system while other also include the general public.

Brits and Winder (2005) estimate that overall social costs of POS transactions amount to 0.65% of GDP in the Netherlands in year 2002. They state that despite the increase in the number of electronic transactions, the bulk of POS payments is still made using cash: 85% of POS transactions are paid with cash. Besides cash, they include transactions using debit cards, e-purse and credit cards. Checks are not included as they were discontinued in the Netherlands for POS payments in 2002. They explicitly exclude consumers and consider the following agents in the payment system: the central bank, the banking sector and the retail sector. As expected, cash accounts for 73% of total social costs, followed by debit cards with 18%, credit cards with 6% and e-purse with just 3%. Half of social costs are borne

by the retail sector, while the banking sector accounts for 48% and the central bank for just 2% of the total.

The case of Belgium is studied by the National Bank of Belgium (2006). Similar to the Dutch study, they only consider the costs incurred by the central bank, the banking sector and the retail sector and exclude consumers, and the payment methods included are: cash, e-purse, debit cards and credit cards. They estimate total social costs to be 2,034 million euro or 0.74% of GDP in 2003. Similar to the Netherlands, most transactions at the POS are made using cash so the share of cash in total social costs is 78% followed by debit cards with 15%. Given the similarities of the payment systems in the two countries, the distribution of costs among participants in the payment system is also similar to the one found in the Netherlands: retailers borne 51% of total costs, the banking sector 47% and the issuing institutions just 2%.

Bergman et al. (2007) also ignore checks in their estimation of the social and private costs of using cash, debit and credit cards at the POS in Sweden in 2002. Contrary to the previous studies discussed, on top of the banking sector, the retail sector and the central bank, they also consider the costs incurred by consumers in the POS transactions. The combined social cost of paying with cash, debit card or credit card amounts to 0.4% of GDP in 2002. Cash payments represent 71% of the total number of transactions and 77% of total social costs, while the figures are 25% and 18% for debit cards. The results in terms of the distribution of costs across agents are not directly comparable to the studies for Belgium and the Netherlands because they also consider the general public, which accounts for a non-negligible proportion of the fees received by commercial banks.

Besides that and contrary to what happens in the other countries, banks charge retailers for the use of cards, which implies that, for instance, when taking into account fees paid by consumers and retailers to the banking sector for the use of cards, commercial banks obtain a net benefit of 1.4 billion SEK or 73% of the social costs of using cards. Then, the general public and, in particular, the retail sector account combined for most of the social costs for the use of cash and cards.

Also for Sweden, Guibourg and Segendorff (2007) estimate private costs in the banking sector for the production of payment services and compare them to the prices charged by banks for these services to consumers. They find considerable differences in costs between payment instruments. Paper-based instruments are more costly to produce than electronic payments. Among the latter, debit card payments are less costly than credit card payments and cash withdrawals. They

estimate that the provision of payment services yields profits for the banking sector. However, cash distribution to the public is financed through cross subsides from other payment services.

Schwartz et al. (2007) find that the annual cost incurred by financial institutions, merchants and individuals in Australia amounts to 0.95% of GDP in 2006. Cash transactions represent around three quarters of the total amount of operations and the cost of using cash accounts for half of total resources spent in transactions. Financial institutions borne 54% of total cost, followed by retailers with 30% and the general public with 16%. Interestingly, they gather data on the average time taken to process a cash transaction using alternative payment methods directly from merchants' time and motion analyses. They find that it takes around 20 to 25 seconds to process a cash transaction, lower than that for EFTPOS[3] at around 35 to 40 seconds, and credit and debit cards, around 45 to 50 seconds. Payments with checks take even longer than these methods; around 90 seconds.

Stewart et al. (2014) extend the analysis of the Australian case by incorporating new payment instruments. They estimate the costs borne by merchants, financial institutions and individuals in the use of different retail payment instruments to be equivalent to 0.54% of GDP in 2013. Only cash represents 0.19% of GDP and checks represent 0.02%. They do not include payment resource costs of consumers in the estimate of aggregate costs as they are considerably less reliable than cost for merchants and financial institutions. They consider contact-less card payments which are estimated to incur in resource costs that are between 10% to 20% lower than the comparable contact-based card transaction. They affirm that, at the average transaction size for each instrument, credit cards transactions are the most resource intensive, EFTPOS is the least and debit card is in-between them.

Of all methods considered in the study, direct debit is the one with the lowest cost, while check is the most expensive. They find that even when costs of providing rewards and the interest free-period are included, credit card remains less expensive than check. Consistent with Schwartz et al. (2007), they find that cash is the least costly instrument followed by debit cards, credit cards and checks.

In general, the overall impact of central banks operational activities on the social cost incurred on transactions is rather small, since the bulk of the costs are borne

[3] In Australia there is a payment instrument called EFTPOS which is similar to an e-purse or IDE in Uruguay, but it can not be used abroad or if the consumer is not present.

by the private sector, particularly by merchants and the banking sector. Our results for Uruguay are along this line. Also, the different studies have generally found that electronic payments are less costly per transaction than paper-based instruments. Then, direct debit is found to be the cheapest method and checks the most expensive one.

In order to compare the efficiency of different payments instruments, Hayashi and Keeton (2012) analyze not only their costs but also the benefits of each one. For example, the extent of acceptance, its convenience in terms of time and learning costs, or the characteristics of the new payments methods, which are absents in the traditional ones are aspects that could make an expensive method more efficient than a cheaper one.

In what follows we will describe the recent changes in the Uruguayan payment system as well as present our estimates of private costs for the use of cash and checks for the central bank, commercial banks, retailers and consumers in Uruguay in 2016.

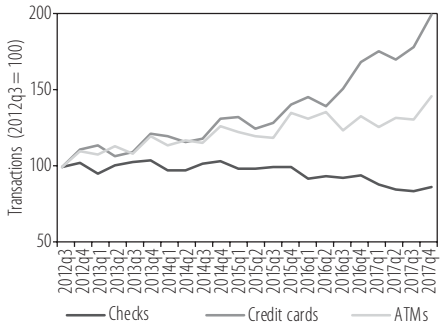
3. Recent changes in the payment system in Uruguay

After the approval and introduction of the Financial Inclusion Law there have been many changes in the use of payment instruments in Uruguay. In particular, there has been a decline in the use of checks and a dramatic increase in the use of electronic payment instruments such as debit, credit cards and electronic transfers.

There were 3.7 million checks issued in the third quarter of 2012, before the regulatory changes. The number of transactions using checks stayed relatively stable until the last quarter of 2015 when the number of checks issues started to decline. By the end of 2017, the number of checks issued quarterly declined by almost 600 thousands or 15% compared to the end of 2012. At the same time, the number of ATM withdrawals which is associated with the use of cash increased by 32% between the end of 2012 and the end of 2017 and the number of transactions using credit cards increased by 80% (see Graph 1).

There was a shift from paper-based methods to electronic payment instruments over the last 5 years. Graph 2 shows the evolution, between the second quarter of 2012 and the end of 2017, of the number of transactions using debit cards, electronic transfers and, as a proxy for cash, ATMs withdrawals. The number of transactions with debit cards increased more than 3000% and the number of electronic transfers increased more than 2000% during that period.

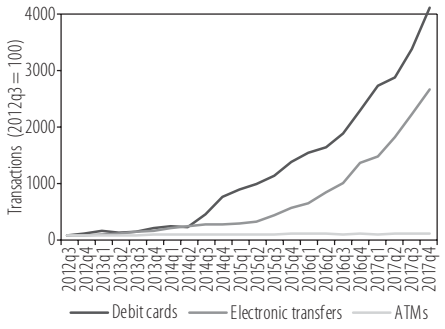
Graph 1: Number of transactions: checks, credit cards and ATM withdrawals



Source: Central Bank of Uruguay - Payment system statistics

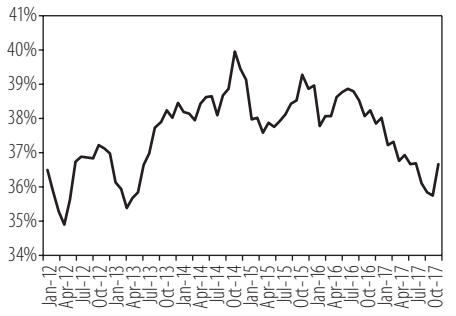
Still, the use of physical cash is widespread in the country. Graph 3 shows cash as a percentage of the M1 money aggregate (cash plus deposit money). Since the introduction of the Financial Inclusion Law this variable shows a negative trend: cash is losing importance in a broader definition of money that includes deposits. Nevertheless, the prevalence in the use of cash is still strong after almost four years of application of the Law.

Graph 2: Number of transactions: debit cards, electronic transfers and ATM withdrawals



Source: Central Bank of Uruguay - Payment system statistics

Graph 3: Cash in circulation to M1 (cash plus deposit money)



Source: Central Bank of Uruguay

4. Estimation of private costs

4.1. The market for cash and checks in Uruguay

We estimate the private cost of using cash and checks at the point of sale in Uruguay for the year 2016. We do not consider total costs to society but only private costs or, the costs that the agents incur when making transactions. As stated by Bergman et al. (2007), adding private costs for all the participants in the payment

system would over estimate social costs as there are transfers from one agent to another that should be netted when computing combined social costs.

The agents participating in both the cash and checks markets are the general public, retailers and banks. For cash, a central bank that issues notes is required while a central clearing agency is required for processing the checks. The Central Bank of Uruguay is in charge of issuing notes and coins that are distributed to commercial banks. The Central Bank of Uruguay manages the cash in circulation in order to contribute to the efficacy of the payment system, it also has to maintain the notes and coins in circulation in good condition and to minimize the risk of fraud and counterfeit notes and coins. For checks, there is a central clearing agency that is completely electronic (i.e there is no physical interchange of the checks between the banks) since 2015 and is managed by URUTEC.

4.2. Private costs of cash

The main costs we identify for the use of cash are[4]: cost of producing notes and coins, cost of transportation and security incurred by the banks and retailers and the costs incurred by consumers in terms of fees paid and other implicit costs such as liquidity cost, time cost and other costs associated with the risk of holding cash. Our estimations of the private costs of using cash for each economic agent are summarized in Table 1[5].

Table 1: Uruguay: Private costs of cash in 2016

	Private costs (million pesos)	Share of private costs (in %)	Percentage of GDP (in %)
Central Bank	189	1.9	0.01
Banks	1,264	13.1	0.08
Retailers	6,198	64.0	0.39
Housesolds	2,029	21.0	0.13
TOTAL	**9,680**	**100.0**	**0.61**

The Central Bank of Uruguay does not produce the notes and coins but import them from abroad. The information on notes and coins production costs was obtained from the Central Bank of Uruguay annual report. In order to avoid fluctuations over time we took the 3-year average between 2014 and 2016. Table 2

[4] See Bergman et al. (2007) for more details.

[5] See Appendix for more details on the data sources and calculations.

shows the the annual cost between 2008 and 2016 of having the coins and notes imported and stored in the Central Bank vault.

Table 2: Annual cost of producing notes and coins (million pesos)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Production costs	185	45	140	153	10	51	76	368	122

Source: Central Bank of Uruguay annual report

Then, according to the Bank's annual reports, buying notes and coins and transporting them to the safe vault in the Bank's main building cost, on average over the period 2014-2016[6], 189 million pesos annually, representing 0.08% of cash in circulation[7], or 0.01% of GDP in 2016.

The main cost of using cash for banks and retailers is that associated with transportation and security. We used the 2012 Annual Survey of Economic Activity (*Encuesta Anual de Actividad Económica 2012*) to obtain the annual income of security companies in Uruguay. The Annual Survey of Economic Activity collects balance sheet information from more than 5,000 firms in Uruguay for the year 2012. Using sample weights, we compute the total earnings of security companies for security and transport services to the general public. As our aim is to estimate the private cost of using cash for the year 2016, we adjusted the 2012 figures using the Consumer Price Index. Then, using this information, we estimate the transportation and security costs to banks and retailers to be just below 7,500 million pesos annually, which represents 3.3% of cash in circulation or 0.47% of GDP in 2016.

Unfortunately, we are not able to distinguish between banks and retailers costs from the Annual Survey of Economic Activity but we can infer from the commercial banks quarterly accounts how much are their transportation and security costs, which is a proxy for the banks' costs of using cash. From the 2016 statements, transportation and security costs for banks is 1,264 million pesos. If we assume that the rest of security companies` earnings for security and transport services is paid by retailers, then the latter incur in a total cost of 6,198 million pesos for using cash. Then, of the just below 7,500 million pesos cost that we esti-

[6] We take 3-year average in order to avoid the variation from year to year on the cost of importing notes and coins.

[7] Cash in circulation includes emission, current accounts, term accounts and savings accounts in the banking system.

mate banks and retailers incur for the use of cash, most of it (83.1%) are incurred by retailers, which represent 0.39% of GDP.

Finally, consumers incur in three types of costs when using cash: time cost for cash withdrawals, time cost at the cash register and opportunity cost of holding liquidity (See Baumol (1952)). To estimate total consumers' time costs of withdrawing cash and the time cost at the cash register we need information on the time it takes, a measure of the time cost for consumers and the number of transactions. For the former we use information from Klee (2008) and Bergman et al. (2007). Table 3 in Klee (2008) shows the time it takes to pay at the point of sale with cash, checks, credit and debit cards. On average, it takes 86.4 seconds to pay with cash, while the figure is 121.9 for checks, 101.5 for credit cards and 95.8 for debit cards. Bergman et al. (2007) use a survey from the Swedish Bank Association to obtain the time it takes to withdraw cash from ATMs. On average, they estimate this to be 50 seconds plus a minute queuing and walking to the cash machine. The time cost for consumers is obtained from the National Statistics Institute and assumed to be the average per capita earnings of urban households (23,114 pesos per month in 2016), which is estimated to be 165 pesos per hour in 2016, by assuming 35 hours per week of work. Finally, the number of cash withdrawals, which totals 173 million in 2016, is obtained from the Central Bank of Uruguay payment system statistics. We use the number of cash withdrawals, which represent a lower bound on the total number of cash transactions to proxy for the number of cash withdrawals.

First, consumers get cash mostly via the ATM system or in payment networks that have cash machines. In 2016, the total number of cash withdrawals was 172 million or 77 per year on average on the 2,255,250 debit cards available. After the Financial Inclusion Law each worker is entitled to 8 free cash withdrawals per month, so we will assume, to simplify, that Uruguayan consumers do not pay any fees but incur on time cost for the withdrawal of cash. Unfortunately we do not have data on the time spent on cash withdrawals so, following Bergman et al. (2007) and using information from a study by the Swedish Bank Association, we are going to assume that each cash withdrawal takes 50 seconds and the average time queuing and waiting is 60 seconds. According to the National Statistical Institute the average per capita monthly income was 23,114 Uruguayan pesos in 2016 which, assuming 35 hours of work per week, gives an hourly wage of 165 pesos. Then, the total time cost for cash withdrawals is 872 million pesos or 5 pesos per transaction.

Second, consumers incur a time cost at the cash register. Again, following Bergman et al. (2007) and using data from Klee (2008), we assume that it takes 86.4

seconds to make payments at the cash register. Given that we do not have data on the number of cash transactions we are going to use the number of cash withdrawals as a proxy and a lower bound. Then, given the hourly wage of 165 pesos, the cost of time incurred in each cash transaction at the register amounts to 4 pesos and the total time cost is 684 million pesos annually. Overall, the total cost of using cash to consumers is 1,557 million pesos or 0.10% of GDP in 2016.

To estimate the opportunity cost of holding liquidity, we need information on average cash holdings for transaction purposes and interest rates paid in current or savings accounts. To compute cash holdings for transaction purposes, we use data from the Uruguayan Households Financial Survey (*Encuesta Financiera de los Hogares Uruguayos*). In particular, we proxy households' liquidity holdings by cash holdings for regular weekly purchases. Then, average annual households' cash holdings for transactions amounts to 166,832 pesos which represents a total of 189,057 million pesos. Considering the interest opportunity cost to be 0.25%[8], the total opportunity cost of holding liquidity is 473 million pesos.

Then, total private costs of using cash amounts to more than 9,680 million pesos or 0.61% of GDP in 2016. Most of the cost, 77.1% of the total, is bearded by banks and retailers due to transport and security costs. Consumers' costs account for 21.0% of total private costs and the cost share for the Central Bank is just 1.9%. The distribution of total private costs among different agents is very similar to that found for Sweden[9]: banks and the retail sector bear the largest portion of the total cost of cash.

4.3. Private costs of checks

Checks are usually used for large purchases and mostly by firms. Indeed, in 2016 the average value of each check was USD 4,600 whilst, for instance, the average transaction with credit card was USD 44 and with debit card was USD 41. There were a total of almost 14 million checks emitted in Uruguay during year 2016 for a total value of USD 64.3 million.

To calculate the private costs of using checks we consider the costs to the commercial banks and the costs to the consumers or firms. Results are summarized in Table 3.

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[8] In general, savings accounts in domestic currency do not pay any interest rates, but there is a private bank in Uruguay that pays 0.25% on savings accounts. We take this as the interest rate foregone for holding cash.

[9] See Table 2 in Bergman et al. (2007).

For banks, the main costs are the printing costs and the clearing costs. From communications with a private bank, we estimate the cost of printing checks to be 7.5 pesos per check. On the other hand, from the commercial banks financial statements filed each month to the regulator we know that the total cost of clearing checks was 28.5 million pesos in 2016 or 2 pesos, on average, per check. Then, the private costs of checks for banks totals to 133 million pesos or 9.5 pesos per check.

The main costs of using checks for consumers are the cost of acquisition and the time cost at the point of sale. The average cost of acquisition is 30 pesos per check or a total of 420 million pesos in 2016. To calculate the time cost for consumers we need data on the time spent writing a check and the average earnings per capita. We obtain the former, as before, from Klee (2008), who estimates that it takes 121.9 seconds to pay with a check while the average earnings per capita is, as before, 165 pesos per hour. Then, the total time cost of using checks for consumers is 78 million pesos in 2016. The total consumers' private costs of using checks amounts, thus, to 498 million pesos or 35.6 pesos per check.

Taking together the private costs for commercial banks and consumers, the use of checks implies a private cost of 631 million pesos or 0.04% of GDP in 2016. Each check costs 45.1 pesos to consumers and banks.

Table 3: Private costs of using checks

		Private costs (million pesos)	Share of private costs (in %)	Percentage of GDP (in %)
Banks	Clearing	28	4.5	0.002
	Printing	104	16.6	0.007
Consumers	Acquisition	420	66.5	0.026
	Time cost	78	12.4	0.005
		631	100.0	0.040

4.4. Other costs of cash and checks

The private cost for banks, retailers and households of using paper cash would be even higher than the previous estimates if one considers the costs of cash-related crime. For example, one could add as a cost of using cash the value of the cash stolen, as well as the cost of homicides and injuries in cash related crime. Moreover, the costs incurred in prevention of cash related crime would be also considered as adding to the cost of using cash.

Rogoff (2016) argues that crime rates appear positively correlated with demand for paper currency. More precisely, Rogoff (1998) finds that illegal and criminal activities correlate positively with the circulation of large-denomination notes.

Aboal et al (2016) estimate the cost of crime in Uruguay. They find that the overall costs of crime amounts to 3.04% of GDP in 2010. This figure includes the costs incurred in anticipation of crime, as a consequence of it and in response to it. The data is not rich enough to distinguish which part of these costs is related to cash. Moreover, some of the costs in anticipation of crime are already consider in our estimations. Nevertheless, in order to have an order of magnitude, it is interesting to inform Aboal et al.'s (2016) figures for the value of stolen property: 0.60% of GDP for enterprises and 0.25% of GDP for households. Of course, these estimates include other items than cash. However, they provide an idea that the value of the cash stolen maybe is not small. Moreover, the cost of homicides and injures, many times related to robbery with violence on the street, is estimated at 0.30% of GDP[10].

5. Private cost of cash: comparison with other countries

Many studies have estimated the private costs of using cash; results for some of them are summarized in Table 4 together with our estimates for Uruguay. The private costs as a proportion of GDP ranges from 0.15% in Norway to 0.58% in Belgium and 0.61% in Uruguay; in-between are Sweden, Netherlands and Australia with costs ranging between 0.42% and 0.46% of GDP.

Private costs of using cash are related with payment instrument choice by consumers and merchants. In Uruguay, for instance, 50% of the households say that they pay their regular purchases exclusively with cash, while the figure is 61% for monthly purchases such as utilities, health insurance or schooling fees[11]. On the other hand, using a household survey for Norway, Gresvik and Haare (2009) find that cash payments represent just 15% of the total number of transactions and 7% of the total value of household payments. Households in Norway are more likely to use cards instead of cash for their payments; implying that the total private costs of card payments is 70% higher than that of cash.

[10] There could be other costs of cash management that we do not study in this paper. For instance, Luburić and Fabris (2017) study the effect of cash management on the quality of life.

[11] See Lluberas (2018) for more details.

Table 4: Private costs of cash in several countries

	Private costs as percentage of GDP (in %)	Source
Norway	0.15	Gresvik and Hare (2009)
Sweden	0.42	Bergman et al. (2007)
Netherlands	0.43	Brits and Winder (2005)
Australia	0.46	Schwartz et al. (2007)
Uruguay	0.61	Own calculations
Belgium	0.58	National Bank of Belgium (2006)

6. Conclusion

The incorporation of new technologies to financial activities implies challenges and opportunities to financial authorities. They are reacting to the unavoidable trend towards digitalization of financial activities with the objective of preserving stable and efficient payment and financial systems. Uruguay, for instance, has promoted the use of electronic payment instruments and tested in the real economy a central bank digital currency called e-Peso. Digitalization of payment systems would reduce transaction costs by (partially) replacing less efficient means of payment, e.g. paper-cash and checks.

In this paper we contribute by informing decision-makers about the current costs that are associated with the use of traditional means of payments. More precisely, we estimate the cost of using cash and checks in Uruguay. We collect data from several sources including Central Bank Annual Reports, Annual Survey of Economic Activity, Payment System Statistics, etc. and process it through methodologies that have been used in the previous international studies.

The main costs we consider and assess for the use of cash are related to producing notes and coins, transportation and security incurred by the banks and retailers, and the costs incurred by consumers in terms of fees paid and other implicit costs such as liquidity cost, time cost and other costs associated with the risk of holding cash. In turn, to calculate the costs of using checks we consider the costs to the commercial banks and the costs to the consumers and firms.

Our results show that the cost of using cash in Uruguay is approximately 0.61% of GDP. Interestingly, 98.1% of this cost is borne by the private sector: banks and retailers 77.1% and households 21.0%. The cost of using checks is equivalent to 0.04% of GDP. Overall, replacing paper-cash and checks by other (electronic) means of payment would imply a transaction cost reduction for the private sector

of the equivalent to up to 0.65% of GDP. This figure does not consider the cost related to paper-bills and checks crime because we do not get reliable information. Hence, the total cost for the private sector in Uruguay from managing cash and checks would be higher.

Finally, it is important to highlight that the estimated figure represents the maximum cost that may be saved by stop using cash and checks. Partial substitution of cash and checks by electronic means of payment would imply a differently than proportional cost reduction. This would depend on the components of the cost equation that are mostly affected. Moreover, in order to compute the effciency gain from replacing cash and checks for relatively more effcient means of payment one should consider the costs that are associated with the latter.

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Appendix

Table 5: Summary: Data sources

Variable	Source
Cost of transport and security	2012 Annual Survey of Economic Activity
Number of transactions	Payment system statistics
Cost of producing notes and coins	Central Bank of Uruguay annual report
Consumers' time cost	Klee (2008) and Bergman et al. (2007) Payment system statistics
Average earnings	Instituto Nacional de Estadisticas (INE)
Gross Domestic Product	National Accounts (Central Bank of Uruguay)
Average cash withdrawals per month (microdata)	2013 Households Financial Survey