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DO SOCIODEMOGRAPHIC FACTORS IMPACT IN THE USE OF CASH IN RETAIL TRANSACTIONS? AN ANALYSIS IN THE CITY OF SÃO PAULO[#]

FATORES SOCIODEMOGRÁFICOS IMPACTAM NO USO DE DINHEIRO EM TRANSAÇÕES DE VAREJO? UMA ANÁLISE NA CIDADE DE SÃO PAULO

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Abstract

This paper presents the result of a study that assessed the use of cash in retail transactions in the city of São Paulo and the influence of individuals´ sociodemographic condition and transaction value on the likelihood of paying with banknotes. Respondents were selected by quota sampling process based on their sociodemographic profiles. The analyses were carried out using Pearson´s chi-squared test, as well as estimates from probit models. The results indicated that 56% of the respondents´ last purchases were settled in cash, and that both the transaction value and the buyer´s sociodemographic condition influence the likelihood of using banknotes.
Keywords: Consumer. Personal finance. Payment instrument. Consumer payment choice. Retail payment.

Resumo

Este artigo apresenta o resultado de estudo que avaliou o uso do dinheiro em transações de varejo na cidade de São Paulo e a influência da condição sociodemográfica e do valor da transação dos indivíduos na probabilidade de pagamento com notas. Os respondentes foram selecionados em processo de amostragem com base em seus perfis sociodemográficos. As análises aplicaram o teste qui-quadrado de Pearson e estimativas com modelos probit. Os resultados indicaram que 56% das compras dos respondentes foram liquidadas à vista e que tanto o valor da transação quanto a condição sociodemográfica influenciam a probabilidade de uso de cédulas.
Palavras-chave: Consumidor. Finanças pessoais. Instrumento de pagamento. Escolha de pagamento do consumidor. Pagamento de varejo.

[#] The views expressed in the paper are those of the author and do not necessarily reflect those of any institution.

Introduction

The presence of paper banknotes in our cultures has been questioned for at least half a century (Reisted, 1967). Predictions and expectations of cashless societies with the obsolescence of cheques and the appearance of purely electronic systems are not uncommon and have become assiduous since the appearance of the credit card in the 1950s (e.g., Bergsten, 1967; Caskey & Sellon, 1994; Szmigin & Foxall, 1999). Since then, plastic cards have conquered a significant market share in retail transactions in different nations (Capgemini & BNP Paribas, 2017), reaching important percentages both in developed (Esselink & Hernández, 2017) and developing countries (Committee on Payments and Market Infrastructures [CPMI], 2015). More recently, new forms of electronic transactions are being launched, with monetary authorities around the world talking seriously about central bank digital currencies (Auer, Cornelli, & Frost, 2020).

Although recent history shows the advance of alternative payment instruments, it does not seem difficult to admit that coins and banknotes are still the most used payment instrument in retail transactions in many countries (Krüger & Seitz, 2014; Rogoff, 2016; Wang & Wolman, 2016; Wheatley, 2017). Alfonso, Tombini, and Zampolli (2020) exalted the use of cash in Latin America, with preference over cashless payments occurring even among banked users. As a novelty, the authors described the instant payment instruments Pix and CoDi, in Brazil and Mexico, that threat to reduce cash usage considerably. Pix and CoDi were created by governments, thus "they feature an option that allows individuals to send and receive payments at no cost. Furthermore, merchants´ cost to receive payments is lowered to zero in CoDi and significantly reduced in Pix" (Alfonso, Tombini, & Zampolli, 2020, p.78). However, major changes in the cash dominance are yet to be seen.

Some studies released by the Central Bank of Brazil (BCB) have confirmed the dominant position of cash in Brazil, in addition to presenting a positive correlation between the value of the transaction and the frequency of the use of banknotes (BCB, 2013, 2018). In another Brazilian study, Fávero, Belfiore and Fouto (2006) found that individuals from less privileged sociodemographic category use more cash in their transactions than privileged ones. Generally, the Brazilian data confirms its alignment with results around the world.

Doubts may arise with the possibility of a relationship between an individual´s sociodemographic condition and the transaction´s value to make our perception of the use of cash short-sighted. It can be the case when the transaction value is the driving force towards the use of cash, rather than the agent´s income or sociodemographic condition. Although this scepticism seems dissipated because the consumption baskets of different individuals or countries potentially have a higher average value for the wealthier, there is a gap in the literature urging to be filled with combined considerations of both the sociodemographic condition of buyers and the value of transactions as determinants to use cash in retail transactions.

In this context, this study sought to evaluate, as a first objective, the participation of coins and banknotes as payment instruments in transactions declared by residents of São Paulo. As the first step in the analysis, I tested the similarity in the distribution of the instruments used by sociodemographic categories. Then, I evaluated the significance of the sociodemographic conditions and the value of the transaction over the probability of using coins and banknotes, as a second objective.

The data were collected applying a questionnaire with 188 residents of São Paulo, in 2018, inquiring about the payment instrument used in their last purchases, the value of the transaction, and other information for control. The segmentation of respondents into sociodemographic clusters was supported by an exploratory factor analysis.

The results revealed that 56% of the interviewees´ last transactions were paid with coins or banknotes, suggesting the prevalence of this instrument at the time. Furthermore, the study´s results corroborated

the influence of individuals´ sociodemographic condition on the likelihood of using paper money on a retail purchase, controlling for the transaction value. In other words, it supports the idea that people from a less privileged sociodemographic category tend to use relatively more coins and banknotes than the most privileged ones, regardless of the transaction value.

The paper was divided into six sections, including this brief introduction. The second section describes the study approaches to assess the use of cash. The third section explicitly presents the two hypotheses to be tested. The fourth describes the methodological aspects applied in the study, and the fifth presents its results. The sixth and final section is dedicated to the concluding remarks.

Literature Review

The literature that evaluates cash usage´s driving forces points out that both the specifics of the transactions and the characteristics of the agents can impact the likelihood a retail transaction is paid with coins or banknotes. Cash is more common in low-value transactions (Humphrey, Pulley, & Vesala, 1996; Klee, 2008; Wang & Wolman, 2016) and in some types of commerce (Hayashi & Klee, 2003); and some authors suggest a negative impact of buyers´ incomes on the use of coins and banknotes (e.g., Carow & Staten, 1999).

Interestingly, some of the factors driving the use of cash in retail transactions can be directly associated to merchants´ propensity to accept other payment instruments. At major urban cities, plastic cards are the leading alternatives. In online shopping, they have increased significantly in the last years, with a further push during the COVID-19 pandemic for several products. However, driven by the use of cash, this paper remains focused on only physical payment transactions, such as those taken place at brick-and-mortar shops or street vendors.

Credit and debit cards are amongst payment instruments that were most widespread in urban populations at the end of the 20th century. The advancement of their embedded technology from magnetic stripes to contactless quality with the incorporation of smart chips with radio frequency identification (RFID) explain the phenomenon (CPMI, 2015).

The propensity for merchants to accept card payments can be driven by the possibility of discriminating non-card instruments with discounts or surcharges, and the rates and fees of point-of-sale terminals and cash advances. Against card acceptance, the possibility of tax evasion or the use of cash for illicit activities due to their low traceability should increase the demand for banknotes. Humphrey (2004) and Rogoff (2014 and 2016) cited these advantages of cash to advocate for restrictions on the issuance of high-value notes by governments, in a gradual process of eliminating paper money.

Plastic cards can have some other benefits over paper money and other payment instruments (Guedes, Curi, Arashiro, Ribeiro, & Mazetto, 2011). Practicality is an apparent advantage. There is evidence that the use of credit cards increases the probability of consumption (Braga, Isabella & Mazzon, 2013) and increases the average purchase ticket (Prelec & Simester, 2001; Soman, 2001), serving as an alternative to loans term (Demirgüç-Kunt & Klapper, 2012). Merely recording transactions makes cards convenient for small businesses without organized bookkeeping. In violent urban centres, the attributes of safety and practicality can be relevant and generate benefits for both cardholders and merchants. Cards are also associated with financial inclusion by their use in the promotion and distribution of social benefits (Demirgüç-Kunt & Klapper, 2012). On the other hand, advantages related to the use of cards in day-to-day transactions do not come free of charge. Many cardholders do not avoid paying annual fee to issuers.

Another aspect related to the use of cash is the impact of support infrastructure, such as ATMs. There is abundant evidence that banknote use increases with the number of ATMs in an economy, while the balances in banknotes held at home or wallets are reduced (Boeschtoen & Fase, 1992; and Humphrey,

Pulley, & Vesala, 1996). From the banks´ point of view, economy of scale is relevant in the ATM supply, although it does not necessarily have an effect on profitability (Humphrey, 2004).

As the benefits of ATMs to economies and service providers are related to scale, it is usual to find joint operations in different countries, in order to dilute unit costs and not to compete in cash distribution services. TecBan is a Brazilian company owned by the main banking institutions in the country and provider of Banco24Horas ATMs throughout the country that fits this idea. Along the same line, Snellman and Virén (2006) advocated that the concentration of ATM networks in associations or a smaller number of companies generate incentives to reduce the number of terminals, negatively influencing the demand for cash. Although ATMs facilitate payments thus stimulating the economy, it also spurs cash use by incentivising withdrawing.

Regardless of recognized imperfections and difficulties in analysing the use of different payment instruments (Krüger & Seitz, 2012), many authors conclude that electronic devices generate lower social costs than physical instruments such as cash (Hancock & Humphrey, 1997; Humphrey, Willesson, Lindblom, & Bergendahl, 2003; Valverde, Humphrey, & Del Paso, 2004; Krüger & Seitz, 2012). In comparison to some other payment alternatives, banknotes have already been associated with smaller average purchasing values (Hirschman, 1979; Feinberg, 1986) and lower willingness to spend (Prelec & Simester, 2001), mainly but not exclusively, because cash does not serve as an option for credit, like cheques or cards (Demirgüç-Kunt & Klapper, 2012). As a concern exacerbated by the recent COVID-19 pandemic, and previously studied by some authors, paper banknotes can be an important vector in the transmission of viruses (Thomas et al. 2008; Auer, Cornelli, & Frost, 2020). So, why banknotes are massively used in many countries? Similarly, is the overuse of banknotes in the country a symptom of some dysfunction in the payment instruments market?

It seems clear that any dysfunction in the payment instrument market could or should be explained not only in the instruments per se, but also in other elements of a national economy. In Brazil, for example, where the economy shows a high level of informality (e.g., Schneider, 2004), the large share of conventional instruments such as paper banknotes does not seem to be an anomaly. Nevertheless, the share of cash used in retail transactions should be contemplated for further inferences.

Assessing the use of banknotes in an economy requires segregating the focus onto supply and demand. On the supply side, the production of banknotes and coins are quantified and accessible. Despite the advantage of data availability, this focus restricts the assessment of the effective use of banknotes in a society to its production. On the demand side, research is sparser though more granular and largely supported by data from families and individuals. The paper follows with comments on the two approaches.

Studies from the supply side perspective

From a supply perspective, the studies that investigate cash as a payment instrument focus on banknote production and circulation, largely benefiting from the fact that the data is known to the monetary authorities. The concept of monetary base is usually employed in this approach, excluding the cash held by banking institutions. Nevertheless, the data associated with the money supply that highlight patterns for the amount of cash in circulation or kept by households, also present some well-known deficiencies.

One notable gap in the supply approach is the level of data aggregation. Considering the ratio between the paper money held by the public and the gross domestic product of a country, as in Rogoff (2016), it is possible to estimate the levels of participation of banknotes in different nations, which vary, in most cases, between 3% and 20%. Although the data are comparable across nations, information on how much of that share is used in retail transactions is not provided.

Furthermore, the presence of a strong currency, such as the dollar, euro or Swiss franc, which holdings by foreigners make statistics more challenging, seems to influence the number of banknotes in circulation.

In the US, it is estimated that 40% to 70% of the dollars issued and held by the public are outside the country (Porter & Judson, 1996).

Additionally, Rogoff (2016) argued that a nation´s inflation influences the use of cash in an economy, endorsed by the evidence that countries with a history of high inflation such as Argentina, Nigeria and Brazil show low values of local currency per capita in their economies. In such cases, the loss of the reserve value of the notes makes the population turn to other alternative assets.

For the reasons above mentioned, evaluations focused on the supply side do not provide a conclusive view on the use of banknotes in economies, despite its importance. Therefore, more attention is attributed to the demand side approach.

Studies from the demand perspective

From a demand perspective, well-known studies that evaluate the possession or use of paper money focus on the characteristics of users or transactions. They can be divided into two major methodological groups. The first includes sample surveys of individuals or families in which respondents are explicitly asked about the transactions they carried out and the payment instruments used to settle them. In Brazil, the Family Budget Survey (POF) of the Brazilian Institute of Geography and Statistics (IBGE) is an example of this approach, allowing the differentiation between the share of credit cards and other instruments. However, POF does not distinguish instruments such as banknotes, cheques and debit cards in different categories, segregating only credit cards from all other payment instruments grouped under the name "cash purchase".

Other surveys in Brazil evaluate the possession and use of banknotes and coins, with the BCB sponsoring some of them (BCB 2013, 2018). The most recent ones endorsed the relevance of money in the Brazilian economy. One evidence of the importance of banknotes was given by the statistics showing that 37% of the wages in the country were paid in cash in 2018 (BCB, 2018).

In the US, both the Diary of Consumer Payment Choice (DCPC) and the Survey of Consumer Payment Choice (SCPC) allow inferences about the number of payments made with banknotes and coins, in addition to the Survey of Consumer Finances (SCF). The first two are organised by the Federal Reserve of Boston and the last one by the Fed Board. The DCPC has proved itself to be an improvement over the SCPC in two aspects (Greene, O´Brian, & Schuh, 2017). First, instead of using the respondent´s memory to remember past transactions, as the SCPC does, the DCPC asks respondents to keep notes on current expenses each day. Additionally, instead of tracking only the quantities of transactions carried out with each payment instrument, the DCPC keeps a record of the values of these transactions, in a similar manner to the Brazilian IBGE´s POF. Despite the DCPC´s richness of details, methodological changes that have occurred between editions make comparative assessments difficult over time. With an increased comprehensive focus on household consumption, the SCF – held every three years – is also adopted in studies about payment instruments.

The second approach or methodological line commonly employed to evaluate the use of banknotes and coins retains data from transactions, collected directly from the establishments´ cash registers, as in Klee (2008) and Wang and Wolman (2016). In addition to the advantage of extracting factual payment instrument used, data from retailers provide additional statistics such as the settlement speed associated with each instrument, at the cash desk, generating useful information for better understanding of people´s use of banknotes.

Studies that apply one of the two approaches show, in general, that cash is associated with both the particularities of transactions and the characteristics or sociodemographic factors of individuals. Regarding the characteristics of transactions, the use of banknotes is more common in low-value purchases (Humphrey et al. 1996; Bounie & François, 2006; Klee, 2008; BCB, 2013; Wang & Wolman, 2016), being the instrument most used in some type of businesses, such as restaurants and gas stations

(Hayashi & Klee, 2003). Moreover, paper money provides the shortest time for settlement between competing instruments (Caskey & Sellon, 1994; Klee, 2008).

Under a socioeconomic focus, some published results have endorsed that individuals of lower wealth or lower sociodemographic strata tend to use more cash proportional to their spending levels than rich individuals or those from higher sociodemographic strata (Kennickell & Kwast, 1997; Carow & Staten, 1999). Such a conclusion on the level of wealth or income, however, does not yet seem to be definitive. With data from the 1998 edition of SCF, Stavins (2001) found that net wealth negatively affects the likelihood of using electronic instruments. Finally, with a plausible explanation based on the security issue, it has already been pointed out that women tend to use proportionally less banknotes than men (Bounie & François, 2006).

The hypothesis that sociodemographic factors are associated with the payment instrument choice was tested in Brazil by Fávero et al. (2006), who rejected the null hypothesis of indifference between groups of consumers with three sociodemographic profiles at the level of significance of 10%. In other words, according to the authors less privileged sociodemographic groups tend to use banknotes in their transactions to a greater extent than more privileged sociodemographic groups. However, the results were not conclusive in this respect as it was not possible to reject the same hypothesis at the 5% level of significance. Additionally, as the authors only contemplated low, medium-low and medium income groups and did not control the values of the transactions, this research sought to complement the knowledge on the topic, asking the respondents about the instruments used in their latest acquisition and the value of their purchase, in order to allow statistical control of the average values of transactions by the buyer´s social subgroup.

Research Hypothesis

Based on the previous discussion, the first hypothesis of this study can be expressed as:

- H1: The frequency distribution of payment instruments used in the last transactions of individuals in São Paulo is similar between different sociodemographic categories.

Some evidence pointed out earlier (e.g., Carow & Staten, 1999; Fávero, Belfiore, & Fouto, 2006) suggested that people from less privileged categories use cash proportionally more than people from more privileged categories, understood here by the constructed sociodemographic groups. Therefore, I expect the rejection of hypothesis H1.

As the use of more paper money by individuals of a lower sociodemographic stratum can occur due to transactions of lower average values and not due to their sociodemographic condition per se, the second hypothesis to be tested is:

- H2: There is no influence of the individual´s sociodemographic category on the probability of using paper bills when controlled by the value of the transactions.

For the tests, I do not expect the rejection of the variable´s parameter representative of the sociodemographic category. Intuitively, the projected results are in line with the idea that people from less privileged areas, denoted in this paper as "poor", use banknotes differently from people in more privileged areas, regardless of the transactions´ price. Therefore, parameters from both transaction value and sociodemographic category parameters are expected to be different from null, rejecting H2.

Description of the research and methodology

To achieve the proposed objectives, a sample survey was conducted with residents of the city of São Paulo. For each individual, I asked the payment instrument used in the last transaction along with its

value. The age, education level and gender of each individual at the time of the interview were also captured. The questionnaire was applied in person in high-traffic areas between February 15th and March 2nd, 2018, in different locations of São Paulo. For the data collection, ten districts were selected, two for each of the five subgroups.

The process of selecting respondents was a quota sampling with the sample structured as an equivalent proportion of the population for five established subgroups, which does not allow precise inferences about the population because it is non-probabilistic, but it admits testing whether people from the lower social strata tend to use notes more than people from the higher social strata, controlling for the values of transactions.

In the sampling process, a factor analysis was applied to stratify the target population, i.e., residents of the 96 administrative districts that make up the city of São Paulo. An indicator was constructed from the normalised values of the six variables presented below, with sources indicated in parentheses:

- Income – Average value of the nominal monthly income of people aged 10 and over (IBGE, 2011)
- Age – Average age of the resident population (IBGE, 2011)
- Education – Average years of study of the resident population (IBGE, 2011)
- Residents – Number of people residing in 2004 (IBGE, 2011)
- Growth – Growth rate of resident population between 1991 and 2004 (Fundação Seade, 2019)
- Mortality – Mortality rate due to homicide in 2011 (Secretaria Municipal da Saúde da Prefeitura de São Paulo [SMS-PSP], 2019)

The exploratory factor analysis (EFA) allows identifying dimensions of common variability in a set of phenomena and generating observable factors. Thus, I sought to summarise the six sociodemographic characteristics presented in a smaller number of factors, possibly a single one, with the support of an EFA. Despite the criticisms related to the subjectivity implicit in the decisions necessary to conduct a factor analysis (Henson & Roberts, 2006), the choices made were preferably over usual alternatives in studies alike.

The analysis of the correlation matrix between the variables was performed by applying the factor extractions by the principal component analysis, according to the Kaiser criterion, i.e., retaining the factors with eigenvalues greater than 1 and performing the rotation orthogonal to the matrix using the Varimax method. The adequacy of the data regarding the degree of partial correlation was assessed with the Kaiser-Meyer-Olkin test (KMO), requiring 0.7 as a minimum limit to consider the data adequate. The hypothesis of inadequacy of the constructed model was evaluated with the Bartlett test.

The data suggested the formation of a single explanatory factor of 92.5% of the observed variance, with a KMO of 0.78 and no single variable showing an indicator below 0.71. Bartlett´s test rejected the null hypothesis of variables not correlated with a p-value of 0.001. The weights of each variable in the single built factor are shown in Table 1.

Table 1 – Weights of variables in the factor indicator (rotated matrix)

Variable	Weight
Income	0.8753
Age	0.9444
Education	0.9642
Residents	-0.5451
Growth	-0.7290
Mortality	-0.6175

Source: Elaborated by the author.

When applying the weights to the original variables, the factor indicator (FI) varied between -1.56 and 2.21 for the 96 administrative districts of the city. Based on the FI for each administrative district, the classification proposed by Fávero et al. (2006) and applied in this study is presented in Table 2. Although those authors used only the first three categories in their study, all the five groups were considered here. The average data for all variables and the FI by district are presented in the Appendix I.

Table 2 – Sociodemographic classification based on the factor indicator

Profile (group)	Classification	Factor indicator (FI)
I	Low	FI < -1.01
II	Medium-low	-1.00 < FI < -0.51
III	Medium	-0.50 < FI < -0.01
IV	Medium-high	0.01 < FI < 0.99
V	High	FI > 1.00

Source: Based on Fávero et al. (2006).

For the purpose of calculating the required sample size, the question about the payment method can be seen as dichotomous, considering whether the interviewee used banknotes or not in his or her last purchase. As the proportion of the response in the population was not known, the sample size was calculated considering an ad hoc proportion of 50%, with a confidence level of 90% and sampling error of 6%. The unusual value for the sampling error was established because of the available resources. Thus, for a population of 10,679,760 people, the required sample was 188 individuals, distributed among the groups as described in Table 3. Due to the fact that the application of the questionnaires extrapolated the number of individuals for some subgroups in the collection process, i.e., 304 individuals were interviewed, the surplus was removed randomly among respondents in each subgroup, keeping the desired proportion among them

Table 3 – Characteristics of groups and sample size

Profile (group)	Income*	Age*	Educ*	Residents	Growth*	Mort*	Factor*	Sample
I	950.89	28.47	6.22	3,017,367	4.17	14.79	-1.28	53
II	1,213.94	30.30	7.21	2,612,379	1.14	11.42	-0.73	46
III	1,663.18	32.29	8.27	1,877,106	0.15	9.76	-0.24	33
IV	2,290.92	34.73	9.65	1,885,020	-1.13	9.93	0.38	33
V	4,811.00	37.31	13.09	1,287,888	-1.54	7.20	1.52	23

Sources: Growth: (Fundação Seade 2019); Mort: (SMS-PSP 2019); Other variables: (IBGE 2011). *Notes*: Educ = Education; Mort = Mortality; *mean values.

For the assessment of hypothesis H1 on the frequency distribution of the instruments among the subgroups, a contingency table was constructed with subgroups and payment alternatives, applying Pearson´s chi-squared test (χ^2).

For hypothesis H2, an econometric evaluation was used with the sectional data collected, applying probit models, in which the conditional probability of payment in cash, given the sociodemographic classification, can be seen as:

$$P(cash = 1 \mid poor) = G(\gamma_0 + \gamma_1 poor + \varepsilon) \quad (1)$$

where the cash payment option is represented by the *cash* binary variable, which values 1 when the last transaction made by the respondent was paid with cash and 0 when another instrument was used, i.e., credit card, debit card, cheque, prepaid card, store card or voucher; *poor* is a dummy variable that indicates whether an individual resides in districts belonging to sociodemographic subgroup I or II, as classified in Table 2 by the denomination "low" or "medium-low", respectively; and ε is a stochastic term. In the probit model, G represents the normal cumulative distribution function.

One of the challenges of the model presented in equation 1 is the absence of other relevant variables to explain the use of banknotes, such as the value of the transaction (Humphrey, Pulley, & Vesala, 1996; Bounie & François, 2006; Klee, 2008; Wang & Wolman, 2016). Furthermore, it has been pointed out that women use less cash than men (Bounie & François, 2006). The lack of these variables would imply a non-consistent parameter γ_1. Therefore, they must be included in the estimates.

Additionally, due to the fact that the questionnaire applied (in the Appendix II) captured the years of education and the respondents´ age, such information were also considered in the equation to be estimated:

$$P(cash = 1 \mid \mathbf{X}) = G(\gamma_0 + \gamma_1 poor + \gamma_2 value + \gamma_3 gender + \gamma_4 educ + \gamma_5 age + \varepsilon) \qquad (2)$$

where **X** represents the set of explanatory variables; *cash*, *poor* and ε are as before; *value* is the value of the transaction declared by the respondent, in reais (R$); *gender* is a binary variable equal to 1 if the respondent is a man and 0 if she is a woman; *age* is the number of complete years of the respondent; and *educ* is the respondent´s level of education measured by the number of years in school. Descriptive statistics for the collected data are presented in Table 4.

Table 4 – Descriptive statistics of variables

Variable	Measure	# Obs	Mean	Std. Dev.	Min	Max
cash	binary	188	0.5638	0.4972	0	1
value	monetary value (R$)	188	118.57	297.79	0.25	2,400
poor	binary	188	0.5265	0.5006	0	1
sex	binary	188	0.4680	0.5003	0	1
age	discrete (years)	188	37.31	13.99	18	78
educ	discrete (years)	188	11.33	3.76	0	19

Source: Elaborated by the author.

The correlations between the variables for the constructed sample are shown in Table 5. As a point of attention, the presence of binary variables requires the application of specific correlation statistics for some pairs. In particular, bisserial and tetrachoric correlations were used. As a highlight, the *cash* variable has significant and not negligible correlations with *value*, *poor* and *educ*.

Table 5 – Correlations between study variables

	cash	*value*	*poor*	*gender*	*age*	*educ*
cash	1					
value	[-0.1300]*	1				
poor	(0.2403)*	[0.0759]	1			
gender	(0.1371)	[0.0969]	(0.0399)	1		
age	[-0.0551]	{0.1092}	[-0.0368]	[-0.0280]	1	
educ	[-0.2728]*	{-0.0322}	[-0.3314]*	[-0.0487]	{-0.3021}*	1

Source: Elaborated by the author. *Notes*: Values between braces represent Pearson statistics; values between brackets are bisserial correlation coefficients; and values between parentheses are tetrachoric correlation statistics. The asterisk * indicates significance at the 0.10 level.

It should be observed that education influences the variable *poor* because the average years of study was used in the construction of sociodemographic classifications. Thus, to mitigate collinearity between *educ* and *poor*, I considered the variable *educ* as an instrument in a two-stage setup. In this configuration, the equations to be estimated can be represented as:

$$\text{[first stage]} \qquad P(poor = 1 \mid \mathbf{X_1}) = G(\beta_0 + \beta_1 educ + \beta_2 age + \varepsilon_1) \qquad (3)$$

$$\text{[second stage]} \qquad P(cash = 1 \mid \mathbf{X_2}) = G(\gamma_0 + \gamma_1 poor + \gamma_2 value + \gamma_3 gender + \varepsilon_2) \qquad (4)$$

where all variables are as before; $\mathbf{X_1}$ contains educ and age, $\mathbf{X_2}$ contains *poor*, *value* and *gender*, and ε_1 and ε_2 are stochastic terms. For the two-stage setup, two difficulties occurred. The first arose as both endogenous variables, i.e., *cash* and *poor*, are binary. Such a case is configured in the so-called forbidden regression, which discourages the use of a two-stage least squares estimator (2SLS) for non-linear models resulting in inconsistent standard errors. In these conditions, the procedure of maximum joint likelihood was followed, as described in Baum (2006).

The second difficulty referred to the fact that the instrument chosen, i.e., *educ*, does not qualify properly as a valid one. Although the significant correlation between *educ* and *poor* does not suggest a null parameter β_1 in the first stage (equation 3), eventual *educ* covariance with errors in the second stage (ε_2 in equation 4) may show the instrument´s weakness. Intuitively, the educational level can contain information about the way an individual settles his or her retail transactions in addition to determine the sociodemographic group he belongs. For this problem, it was preferred to exacerbate this criticism to the questionnaire´s design and to maintain the proposed estimates.

Results

The results of the interviews revealed that money was the instrument most frequently used in the respondents´ declared purchases, employed in 56% of the transactions (106 times out of 188); followed by the debit card, with about a quarter of participation in total (46 times out of 188).

The contingency tables for the evaluation of the first hypothesis (H1) are shown in Tables 6 and 7, for groups I to V and the poor variable, respectively. The division by the six payment instruments considered does not show rejection to the null hypothesis of equality in the distributions by the five groupings, according to Pearson´s chi-squared test (χ^2), pointing to a result contrary to that of Carow and Staten (1999), who suggested a negative impact of buyers´ incomes on the use of banknotes.

Table 6 – Frequencies of the instruments by sociodemographic groups

	Group					*Poor*	
Instrument	I	II	III	IV	V	1	0
Coin or Banknote	34	30	16	16	12	64	44
Debit card	11	6	9	13	7	17	29
Credit card	5	7	7	2	4	12	13
Cheque	0	0	0	1	0	0	1
Store card	1	0	0	1	0	1	1
Voucher	2	3	1	0	0	5	1
p-values of Pearson´s χ^2	(0.301)					(0.074)	

Source: Elaborated by the author

However, considering the grouping provided by the poor variable, the hypothesis of equal distributions is rejected at the 0.10 level ($\chi^2_{(4)} = 4.541$), in favour of the intuition that the instruments used by individuals in the less privileged geographical areas of the city (i.e., *poor* = 1) are distinct from those used by others.

The dichotomous specification of payment in cash (*cash* = 1) or with another instrument (*cash* = 0) showed similar results rejecting the null hypothesis of equality in the distributions between the two groups, in line with the idea that individuals from the less privileged geographical area of the capital use proportionately as much paper money as residents of other sociodemographic background, at the 0.05 level ($\chi^2_{(1)} = 4.434$).

Table 7 – Frequencies of the use of payment instruments by sociodemographic groups

	Group					*Poor*	
Instrument	I	II	III	IV	V	1	0
cash = 1 (coin or banknote)	34	30	16	16	12	64	44
cash = 0 (other)	19	16	17	17	11	35	45
p-value Pearson`s χ^2	(0.338)					(0.035)	

Source: Elaborated by the author

Overall, the results for the grouping category poor rejected the first hypothesis (H1) of the study, suggesting that people from a better sociodemographic background uses cash less frequently than unprivileged ones.

The analysis of the second hypothesis (H2) was constructed in a way that allows to control both transaction characteristics and individual sociodemographic background. The estimations were performed with a gradual addition of dependent variables on the model of equation 1 (versions 1A, 1B and 1C), until reaching the model of equation 2. Finally, the estimates were performed with the poor variable as instrument in a two-stage setting (equation 4). The main results of the different models are in Table 8.

Table 8 – Main results of the estimates

Model (equation):	(1)	(1A)	(1B)	(1C)	(2)	(4)
poor	0.475**	0.499***	0.490***	0.479**	0.232	1.267***
	(0.186)	(0.187)	(0.188)	(0.189)	(0.210)	(0.272)
value		-0.000603*	-0.000677**	-0.000653**	-0.000738**	-0.000624**
		(0.000318)	(0.000324)	(0.000327)	(0.000354)	(0.000308)
sex			0.384**	0.378**	0.400**	0.310*
			(0.190)	(0.191)	(0.193)	(0.187)
age				-0.00508	-0.0108	
				(0.00678)	(0.00722)	
educ					-0.0920***	
					(0.0334)	
constant	-0.0987	-0.0362	-0.198	-0.00312	1.402**	-0.600***
	(0.133)	(0.137)	(0.160)	(0.306)	(0.594)	(0.190)
Observations	188	188	188	188	188	188
Pseudo R^2	0.0255	0.0407	0.0566	0.0588	0.0895	-
χ^2 (ρ = 0)	-	-	-	-	-	-0.737
p-value	-	-	-	-	-	0.0079

Source: Elaborated by the author. *Notes*: Standard errors of estimators in parentheses; *** p <0.01, ** p <0.05, * p <0.1. Endogenous: Prob(*cash* =1)

The results exhibit that the transaction value has a negative impact on the probability of paying with cash at a significance level of 5% or better in all models. For the estimation of equation 2, the introduction of the *educ* variable reduces the significance of the *poor* variable´s parameter, failing to refute the null hypothesis at 10%. A caveat that must be made is that the discrete variable *educ* has a different amplitude from the dummy variable *poor*, partially explaining the loss of significance of *poor* when *educ* was introduced.

The two-stage estimation proved to be adequate, showing significant parameters for the first stage (not shown), and finding that *educ* presented high correlation with the variable *poor*, and low correlation with the errors of equation 4´s estimation. As an endorsement to the two-stage model, the parameter ρ that measures the correlation of ε_1 and ε_2 errors in equations 3 and 4 were significantly different from zero (χ^2 = -1.13, df = 1, p = 0.006), suggesting that the two equations are associated and should be estimated

together. The general F-test presents the assessment that all parameters are null and was rejected at the 0.01 level (χ^2 = 87.89, df = 6, p = 0.000). Overall, the treatment of the poor variable`s potential endogeneity by the application of a two-stage model was adequate.

The equation`s 4 results showed significant parameters at the 0.1 level for both value and poor, indicating that not only the value of the transaction influences the likelihood of using money but also the sociodemographic condition of consumers. Thus, the results are in line with the intuition that less privilege people tend to pay more with cash, but at certain value of the good or service traded the payment mode may shift to a cashless alternative, given that the transaction value influences the probability of using cash as well.

Final considerations

Despite the disadvantages of coins and banknotes over other payment instruments, international evidence suggests that they continue to dominate retail transactions in many countries (Krüger & Seitz, 2014; Rogoff, 2016; Wang & Wolman, 2016; Wheatley, 2017; BCB, 2018). The results of the present study, which focused on residents of the city of São Paulo, were in line with this general view and indicated that 56% of the respondents' last transactions were settled with cash. Debit and credit cards were the second and third choices, respectively, being used by half of the privileged respondents (i.e., *poor* = 0) and by a third of the unprivileged ones (i.e., *poor* = 1). Although plastic cards have conquered a position among the most important payment choices, the results of this study show that they still lagged behind coins and banknotes in 2018.

Considering the fact that previous studies focusing on payment options in retail transactions are scarce and a yet smaller number considered coins or banknotes, this study pursued new evidence regarding the use of cash in Brazil, aiming to only physical payment transactions such as those that took place at brick-and-mortar shops or street vendors. The exclusion of online acquisitions was purposeful and should not be viewed as a limitation. On the contrary, it helps to shed light on the most important payment choice in the city of São Paulo.

Even though the paper employed a small sample in its evaluations, it contemplated the effects of transactions' values and buyers' characteristics, and the results suggested that the probability of using banknotes in a retail transaction is influenced by both. The results substantiated the argument that regardless of the price of a good or service being bought, the sociodemographic stratum of a person influences the likelihood of paying in cash. Nevertheless, the results also suggested that some goods and services, due to their prices, are more inclined to be paid in cash, even by rich individuals. Tipping valet drivers, waiters and other service providers, together with buying from street vendors and purchasing small stationery items, candies and cigarettes, is considered among the low-value candidates.

The results can be interesting for several stakeholders in retail transactions. Focusing on cashless payments, Szmigin and Foxall (1999) claimed that a better understanding of the differences among the consumers is important for more effective segmentation; the study provides lessons to retailers, marketing professionals and researchers. Furthermore, the non-cash payment instrument suppliers, such as acquirers, card issuers or other players with innovative payment technologies, can benefit from the data and results disclosed. Some inferences can be made using the knowledge that almost 40% of the Brazilians did not own a smartphone at the time this study was taken; according to the Pew Research Center (2019), these were mostly women and old citizens. For example, it would not make much sense to provide a smartphone app-only access to pay for goods or services that are focused on the bottom of the sociodemographic pyramid.

Several new payment instruments that challenge coins and banknotes have been launched around the world. Pix is an example. Created by the Brazilian government, it provides instant money transfer via smartphones. Although privileged residents may adhere to Pix for at least some of their transactions – whether currently paid with cash or an alternative instrument such as plastic cards or cheques – less-privileged persons may encounter a device barrier. Despite the fact that this statement is a mere conjecture, the Pew's research clearly sends a signal that differentiates the city of São Paulo from other major urban cities in developed countries, where smartphone penetration is more than 99% in some cases. Thus, the confirmation that less-privileged residents of São Paulo use more cash than more privileged ones raises a flag towards the exclusion of those who do not own smartphones in the payment-competitive landscape.

Like any empirical study, this also comes with criticism. When the respondents' years of study (i.e., variable *educ*) was adopted as an instrument for the sociodemographic category, I assumed a low covariance between *educ* and the probability to pay with banknotes after taking out the effects of sociodemographic category (*poor*), the value of the transaction (*value*) and the gender of buyers (*gender*). However, the assumed low covariance is not necessarily true although sample statistics presented small values. In addition, the study did not contemplate the supply side of the transaction, such as merchants' characteristics or characteristics of the goods or services purchased, which can provide valuable information too. Finally, the data collection period lasted less than a month. Thus, the data may be influenced by the flow of wages, which are usually paid on a monthly basis in the city. As another consequence of the same deficiency, the work did not show the growing and apparently consensual trend in the use of electronic instruments (Dodgson, Gann, Wladawsky-Berger, Sultan, & Goerge, 2015).

Lastly, after completing the study, the theme was stimulated by the COVID-19 crisis. The data collection was carried out before the pandemic, but a simplified methodology can be put to the test and prompt a similar and comparable assessment afterwards. Do the residents of São Paulo continue to use as much paper money after the pandemic? Did the difference in the use of money between distinct sociodemographic classes change after the pandemic? These questions remain open to be answered in another study.

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Appendix

Table I – Characteristics of the administrative districts of São Paulo

Group	District	Inc*	Age*	Educ*	Residents	Growth	Mort*	Factor
I	Anhanguera	1020	27.93	6.63	52735	11.81	18.43	-1.56
	Parelheiros	888	27.67	5.67	121422	6.22	13.76	-1.53
	Grajaú	910	28.00	5.89	385578	5.47	13.33	-1.48
	Iguatemi	912	28.07	5.70	117314	5.35	14.43	-1.45
	Marsilac	772	29.29	4.81	9165	3.35	17.54	-1.44
	Jardim Ângela	888	27.47	5.80	266682	3.17	12.33	-1.42
	Cidade Tiradentes	868	27.52	6.76	229606	6.94	17.55	-1.42
	Lajeado	861	28.10	5.76	171901	3.32	18.11	-1.40
	São Rafael	951	28.36	6.18	136104	3.27	17.47	-1.27
	Perus	1008	28.73	6.47	78978	4.22	19.24	-1.22
	Jardim Helena	898	28.76	6.16	144220	1.56	17.83	-1.18
	Itaim Paulista	914	28.73	6.33	227137	2.60	11.73	-1.16
	Pedreira	1032	28.81	6.52	141149	3.91	12.15	-1.14
	Brasilândia	983	28.91	6.49	259596	1.99	15.37	-1.12
	Capão Redondo	1035	28.88	6.62	253752	2.14	12.36	-1.07
	Guaianases	1025	28.83	6.44	103049	1.86	10.32	-1.05
	Vila Jacuí	1063	29.38	6.63	154786	3.35	12.05	-1.04
	Jaraguá	1088	29.10	7.01	164193	4.48	12.14	-1.04
II	Vila Curuçá	997	29.39	6.51	151994	1.59	9.11	-0.97
	Jardim São Luís	1110	29.48	7.05	247692	1.52	11.37	-0.89
	Sapopemba	1023	30.53	6.60	286857	0.86	10.72	-0.86
	Campo Limpo	1324	29.59	7.32	199806	1.78	10.11	-0.80
	Cidade Ademar	1227	30.08	7.07	244692	0.48	12.22	-0.78
	Parque do Carmo	1338	30.01	7.01	66345	1.52	10.61	-0.78
	Itaquera	1191	30.31	7.27	207598	1.34	15.02	-0.77
	Cachoeirinha	1277	30.16	7.23	153009	1.54	11.27	-0.75
	Tremembé	1352	30.64	7.63	175152	2.65	13.12	-0.69
	Ermelino Matarazzo	1197	30.54	7.31	109195	1.06	12.41	-0.68
	Raposo Tavares	1460	29.90	7.52	92809	0.90	11.29	-0.67
	Cidade Dutra	1269	30.62	7.47	196416	1.20	12.29	-0.66
	Cidade Líder	1271	30.55	7.47	121860	1.77	8.08	-0.64
	José Bonifácio	1069	30.34	7.62	107020	0.27	13.38	-0.63
	São Mateus	1178	30.99	7.15	156060	0.29	8.84	-0.62
	São Miguel	1140	31.61	7.18	95874	-0.52	12.84	-0.55
III	Vila Andrade	3632	28.76	9.04	85295	5.52	8.28	-0.49
	Cangaíba	1265	31.73	7.83	143158	1.72	9.29	-0.47
	Jaçanã	1318	31.68	7.86	92377	0.51	11.49	-0.42
	Vila Maria	1438	31.88	7.53	110411	-0.78	10.91	-0.41
	Sacomã	1579	31.91	8.17	231128	0.72	8.66	-0.34
	Artur Alvim	1244	32.82	7.84	109251	-0.60	12.15	-0.29
	Ponte Rasa	1365	32.94	7.94	96877	-0.42	16.13	-0.29
	Vila Medeiros	1266	33.31	7.65	135158	-1.08	12.99	-0.27
	Pirituba	1667	32.68	8.34	163014	0.55	11.04	-0.22
	São Domingos	1653	32.45	8.53	85913	1.57	9.4	-0.22
	Aricanduva	1381	33.46	7.81	94359	-0.15	6.71	-0.19
	Rio Pequeno	2296	31.92	8.78	113336	0.78	5.62	-0.12
	Sé	1401	31.16	8.93	18307	-2.97	10.22	-0.09
	Limão	1593	33.15	8.49	79065	-1.00	11.85	-0.08
	Freguesia do Ó	1627	33.76	8.57	142841	-0.48	14.18	-0.06
	São Lucas	1492	33.95	8.05	134646	-0.90	3.34	-0.04
	Jaguaré	2057	31.40	9.17	41970	-0.40	3.61	-0.02
IV	Vila Matilde	1643	34.13	8.56	101302	-0.54	11.16	0.02
	Jabaquara	2055	32.77	9.20	214074	0.02	8.04	0.02

Group	District	Inc*	Age*	Educ*	Residents	Growth	Mort*	Factor
	Brás	1521	31.71	9.47	22986	-2.84	13.03	0.05
	Jaguará	1643	34.98	7.95	24432	-1.49	3.21	0.10
	Pari	1606	33.56	8.88	13264	-3.55	15.43	0.13
	Vila Formosa	2137	35.14	8.53	92749	-0.39	9.65	0.15
	Bom Retiro	1643	32.47	9.60	24172	-3.02	11.01	0.18
	Casa Verde	1875	34.31	9.09	79578	-1.44	12.59	0.18
	Penha	1679	35.01	8.86	121967	-0.64	8.28	0.19
	Vila Prudente	1954	35.03	8.71	97961	-1.15	5.32	0.23
	Vila Sônia	2953	32.74	10.21	87810	0.46	13.23	0.25
	Mandaqui	2102	34.03	9.84	103049	-0.04	8.21	0.30
	Vila Guilherme	1935	34.94	9.08	46675	-2.09	8.98	0.31
	Carrão	2020	35.94	9.04	75047	-1.13	10.75	0.35
	Ipiranga	2470	35.20	9.56	98146	-0.23	8.08	0.39
	Cursino	2390	35.12	9.81	98899	-0.82	9.98	0.43
	Belém	2107	34.80	9.87	36820	-2.25	12.56	0.45
	Água Rasa	2227	36.81	9.19	82668	-1.04	7.04	0.50
	Campo Grande	2935	33.85	11.07	93296	1.02	10.08	0.52
	Tucuruvi	2005	36.37	9.89	95183	-1.21	11.22	0.55
	Socorro	2873	35.71	9.95	37650	-1.02	11.06	0.57
	Vila Leopoldina	4795	34.19	10.83	26887	0.05	14.83	0.65
	República	2081	35.10	10.95	44779	-1.92	13.93	0.66
	Cambuci	2669	35.28	10.52	26472	-2.53	1.75	0.77
	Mooca	2932	36.97	11.09	60437	-1.31	10.28	0.93
	Tatuapé	3314	36.94	11.22	78717	-0.27	8.47	0.95
	Liberdade	3129	35.67	12.24	57789	-2.08	16.02	1.03
	Santana	3160	37.28	11.79	120050	-1.02	8.55	1.10
	Butantã	3185	36.57	12.17	50737	-1.00	8.52	1.12
	Santa Cecília	3164	36.53	12.31	66881	-1.87	12.28	1.15
	Barra Funda	3928	36.51	12.01	12106	-2.08	12.77	1.16
	Bela Vista	3460	35.94	12.62	60367	-1.30	8.56	1.18
	Lapa	3689	38.23	11.61	57053	-1.57	6.94	1.25
	Morumbi	6960	34.15	12.67	32875	-1.48	3.88	1.32
	Saúde	3810	37.43	12.85	115806	-0.65	4.26	1.39
V	Campo Belo	5133	37.24	13.13	63162	-1.58	13.3	1.49
	Santo Amaro	4834	37.43	13.16	56336	-2.20	5.85	1.59
	Perdizes	4780	37.44	13.61	100733	-0.57	3.4	1.62
	Vila Mariana	5339	38.15	13.95	120064	-0.75	5.38	1.78
	Consolação	5165	38.26	13.73	51046	-2.00	6.44	1.79
	Alto de Pinheiros	6169	38.54	13.41	42509	-1.27	5.56	1.81
	Itaim Bibi	6005	38.02	13.89	74630	-2.74	5.09	1.90
	Pinheiros	5467	38.49	13.95	58623	-2.21	4.41	1.90
	Moema	7385	38.02	14.80	68988	-0.85	3.27	2.11
	Jardim Paulista	6647	38.91	14.85	78133	-2.09	2.23	2.21

Sources: Growth: Fundação Seade (2019); Mort: SMS-PSP (2019); Other variables: IBGE (2011). *Notes*: Educ = Education; Mort = Mortality. *mean values.

Table II – Questionnaire and related variables

Item	*Question*	Description/Options	Variable
instrument	Which instrument did you use to pay for your last retail purchase?	*A: Coin or banknote* *B: Debit card* *C: Credit card* *D: Check* *E: Prepaid card* *F: Store card* *G: Voucher* *H: Other*	*cash* = 1 if instrument = A; *cash* = 0 otherwise.
value	How much did you pay for your last retail purchase?	*Value in reais (R$)*	*value*
residence	What district do you live?	*Districts from Table I*	*poor* = 1 if residence is from subgroup I or II*; poor = 0* otherwise.
gender	What is your gender?	*1: male* *2: female*	*gender* = 1 if male; *gender* = 0 if female.
age	How old are you?	*Number of years*	*age*
educ	How many years of school/college/university did you do?	*Number of years*	*educ*

Source: Elaborated by the author.