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The relationship between payment inclusion and the demand for cash

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Abstract

The aim of the article is to identify the existence of a relationship between payment inclusion and the demand for cash and the impact of the behavioural factor, which is the uncertainty associated with a natural disaster (pandemic) on various streams of demand for cash. The authors formulated the following research hypotheses H1: Macroeconomic determinants in the form of the cost of money (represented by the interest rate) significantly affect the transaction demand for cash despite the increase in non-cash transactions with the use of funds in bank accounts. H2: Uncertainty as a behavioural factor affects the size of the demand for money, although this impact is more significant in the case of a demand of a precautionary nature than of a transaction nature. H3: The level of financial inclusion measured by the dissemination of non-cash transactions has a significant and negative impact on the transaction demand for cash. In order to verify them, the authors built a linear regression model. The obtained results of the study allowed to confirm the impact of uncertainty on the demand for cash. However, the impact of payment inclusion on the demand for cash was not confirmed in the study.

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1. Introduction

In recent years the process of digitalization of economies has had many dimensions. It is especially visible in financial systems. One of its manifestations in the financial sector is the popularization of cashless payment methods and new payment instruments. In addition, the COVID-19 crisis contributed to the popularization of e-commerce and the acceleration of the transition from traditional cash to non-cash transactions. These phenomena can be interpreted in the context of an increase in the level of financial inclusion, especially its part called payment inclusion. However, the increase in the number and volume of non-cash transactions is not accompanied by a decrease in the value of cash in circulation. At the same time, we can observe high levels of growth demand for banknotes. Much research conducted so far indicates that the growth of banknotes in circulation is not due to transaction purposes, but to the use of banknotes as a means of storing value (Lalouette et al. 2021; Rösl, Seitz 2021). This is confirmed by the data showing a higher dynamic of demand for banknotes than the dynamics of gross domestic product (GDP) – according to the classical theory of money, the increase in demand for money is proportional to the growth of GDP. In the European Union (EU), for example, the ratio of banknotes in circulation to nominal GDP rose from 7.9% in 2008, to 10.5% in 2018, with the maximum difference in growth dynamics being in 2008 and 2009 (– 10 b.p.). In Poland, this ratio increased from 6.73% in Q1 2007 to 13.6% in Q3 2020.

The demand for banknotes and the nominal structure of this demand are important from the point of view of central banks and the entire economy. The amount of cash in circulation affects the elasticity of the demand for money in relation to interest rates, which affects the effectiveness of monetary policy. From this point of view, it would be inappropriate to completely displace cash from transaction circulation, as it would make the conduct of monetary policy more difficult. Moreover, some economists indicate that cash and the possibility of using it in the transactions carried out improves the level of social welfare and eliminates some kind of financial and social exclusion (Markose, Loke 2002).

The cash turnover generates real costs related to cash handling, which are divided into various entities (central bank, commercial banks, cash-processing entities etc.). By the European Central Bank (ECB), this cost is estimated at around 1% of GDP (Shmiedel et al. 2012). The costs of operating a cash-based payment system are estimated at 2–3% of GDP, and the transition to a cashless system reduces these costs by half (Rauf, Khan 2012). From this point of view, knowledge of the demand for specific denominations and the factors that determine them would optimize the cost of cash.

In addition, after the period of the pandemic crisis, central banks more and more often undertake research on digital money (CBDC), which would partially replace cash used for transaction purposes. Confirmation of the relationship between payment inclusion and the demand for transaction money would allow central banks to optimize their activities and work in this area.

Our research is grounded in the theory of money. In terms of the classical quantitative theory of money, the demand for money is purely transactional. A similar approach is presented by researchers from the neoclassical trend. A different approach is presented by the Keynesian theory of money, which indicates the existence of a multi-stream demand for money. According to the authors, such an approach is justified from the point of view of defining money through its basic functions. These are the function of the means of payment, which is reflected in transactional demand, and the function of the store of value, which corresponds to the demand for money as a store of value (Duwendag et al. 1996). In the study, the authors used such a multi-stream approach to the demand for money as the most appropriate for the real processes taking place in the modern payment system.

The inclusion of payment inclusion in the factors determining the demand for cash makes it possible to link the study with the trend of sustainable development economics. One of the pillars of the concept of sustainable development is social sustainability, which includes the concepts of "equality", "empowerment", "accessibility", "participation", "cultural identity" and "institutional stability". Financial inclusion, together with payment inclusion, which is its element, is an important element in improving the well-being and quality of life of society. The main goal of the authors of the article is to identify the relationship between payment inclusion and the demand for cash, which is also important from the point of view of implementing this concept of sustainable development (UN 2015).

The structure of the article is as follows. In part 2, based on the analysis of the literature, the state of knowledge about the factors determining the demand for cash was reviewed. Part 3 formulates the purpose of the research, research hypotheses, the methods used and the scope of the research. Part 4 contains the results of the study, preceded by a description of the methodology used and the characteristics of the research sample. Part 5 discusses the results obtained. The article ends with a summary containing an indication of limitations and further possible directions of research.

2. State of knowledge about the factors determining the demand for money

In the simplest way, the demand for cash can be defined as household desire and non-financial enterprises' state of cash resources (Duwendag et al. 1996). Another definition highlights the need for non-financial actors (households and enterprises) to maintain liquidity and cover the gap in time between inflows and outflows (Tobin 1956). In both presented approaches, the transaction motive of the reported demand for money is strongly emphasized. This approach grows out of the classical quantity theory of money (Brunnermeier, Sannikov 2016). But that is only one possible cash-holding motive. There are three main motives behind the reporting of the demand for money (Zamora-Perez 2021):

– transaction motive, i.e. the need for cash intended for the implementation of current payments; research shows that this is primarily a demand for low-denomination banknotes;

– a precautionary motive related to the storage of cash as a means of custody; this mainly applies to high-denomination banknotes;

– requirements reported by foreign entities, both for transaction and hoarded purposes. In many countries, the demand for banknotes is stimulated by the use of banknotes abroad, especially as vaults of value (Judson 2017); cross-border movement of banknotes is difficult to measure as there is no legal mechanism to track private transfers.

The ECB indicates that cash is held for transactions, for precautionary and for speculative purposes. Therefore, it can be concluded that there are two main ways of using cash – transactional and hoarded, carried out by both domestic and foreign entities (ECB 2003). Hoarded is generally understood to mean anything other than a transactional cash collection (Assenmacher, Seitz, Tenhofen 2019). This modern approach is derived from the Keynesian theory of money (Hewitson 1995).

The size of the demand for cash is monitored and corresponds to the volume of coins and banknotes in circulation. Most of the research to date has focused on aggregate demand for cash. It is much more difficult to separate the demand for cash into two streams: transactional and hoarded. The Deutsche Bundesbank estimates that less than 10% of banknotes in circulation are used for transaction purposes

(Deutsche Bundesbank 2016). For the Japanese economy, this figure is about 40% of the total amount of cash in circulation (Fujiki et al. 2017). To the best of our knowledge, there are no relevant surveys for Poland. An attempt to separate the demand for cash into transactional and precautionary demand should be based on an analysis of the demand for individual denominations of banknotes (excluding coins, because their importance in the volume of cash is marginal), assuming that low denominations are used in transactions. Such studies are rarely carried out.

The separation of two basic types of demand for cash divides the factors determining this demand also into two groups. The first one contains factors explaining the transactional demand, and the second one – the precautionary demand. Of course, it is impossible to strictly and unambiguously separate these determinants, but it should be noted that various factors strongly influence different types of demand. In the classical approach, the demand for cash depends on the interest rate, income level, and acquisition costs of cash (Baumol 1952; Tobin 1956). In the traditional approach, the level of the interest rate primarily affects the precautionary demand – in conditions of high interest rates, this demand is realized in the form of bank deposits, thus reducing the need for cash. In addition, it should be noted that in an environment of low interest rates (zero-floor), cash becomes more attractive as a means of payment and storage of wealth as the opportunity cost of holding it decreases (Liñares-Zegarra, Willesson 2021; Assenmacher, Seitz, Tenhofen 2017). This explains the increase in transactional demand for cash. At the same time, the increase in the number of non-cash transactions seems to weaken this tendency. Replacing cash with non-cash payment instruments decreases the importance of the opportunity cost as a factor determining the transactional demand for banknotes and coins. Thus, a decrease in the importance of the interest rate as the key determinant of the demand for money in the transaction function seems possible (Aminata, Sjarif 2020; Gupta, Kapoor, Yadav 2020). Therefore, the current state of research on the impact of the interest rate on the demand for money does not clearly indicate the nature of this relationship.

Many modern explanations exist for the cash requirement (Lalouette et al. 2021). They are partially related to the level of development of the financial system. The following belong to them:

– low level of trust in financial institutions and the inability to collect savings in reliable institutions,

– the stability of the financial system and the experience of past financial crises,

– availability and level of development of the payment system infrastructure and payment instruments enabling the execution of transactions with their use.

However, empirical studies show that demand for cash for everyday transactions is still popular despite the development of payment infrastructure and modern solutions in cashless payment systems (Świecka, Terefenko, Paprotny 2021). There is a modern consensus that the demand for cash for transaction purposes is determined based on:

– the scale of transactions related to the level of production in the entire economy; this applies in particular to the demand for low-denomination banknotes (ECB 2003);

– the cost of using cash or various payment instruments, opportunity costs of holdings currency (lost interest income);

– risk – measured with nominal or real interest; interest rates (both nominal and real) are a derivative of the central bank's inflation rate and monetary policy; the ECB indicated that in countries with high inflation and high interest rates, the average value of demand for banknotes so far is lower than in countries with low inflation and low interest rates (ECB 2003);

– additional demand for cash from abroad;

– taxes and regulations and especially taxation of labour and capital income and fiscal control of tax payments as a factor in the emergence of an informal economy that is based mainly on cash; it should be noted that in some countries, regulations are limiting the possibility of using cash in large--value transactions.

The use of cash for transaction purposes is one of the main determinants of the demand for banknotes (Alonso et al. 2018). Demand in this aspect is a derivative of the ease of access to cash (number and availability of automated teller machines – ATMs – and bank branches), applicable regulations (limiting the number of transactions made in cash), macroeconomic situation (unemployment rate, inflation rate), cultural factors (grey economy, corruption) and progress technological (access to the internet and mobile banking). Some of the determinants of using cash for transactional purposes are related to the habits and level of financial education and financial inclusion (Klapper, Singer 2014; Newman, Finn, van den Broeck 2014).

In the traditional approach, the use of cash for precautionary or speculative purposes (hoarded cash) is the result of perceived uncertainty (Miller, Orr 1966; Tobin 1958) and opportunity costs (ECB 2003). Uncertainty, unlike risk, is immeasurable, subjective and often psychological (Tversky, Kahneman 1992; Jedynak, Bąk 2020). The uncertainty, which is a behavioural factor, is related to the future economic situation (the level of interest rates and future costs of changes in the held portfolio of assets). Previous studies indicate the existence of such links (Bahmani-Oskooee, Kutan, Xi 2013; Atta--Mensah 2004). However, despite the importance and development of behavioural finance in explaining consumer behaviour, there is a lack of research on the impact of social uncertainty (an example is the pandemic and its effects) on the demand for cash, but may also be of a social nature (an example is a pandemic and its effects). The particular uncertainty related to the pandemic crisis has had an impact on the transaction demand for cash. The indicated factors may have a positive (production, private consumption, retail sale) or negative (opportunity cost) impact on the volume of demand.

The financial inclusion process has become essential in policymaking by financial regulators, especially after the financial crisis. Both the G20 group and the Basel Committee on Banking Supervision recognized financial inclusion as a fundamental policy element to achieve more excellent stability of the financial system, improve transparency and financial integration, and reduce macroeconomic fluctuations as well as social and political instability (World Bank 2018). Financial inclusion is an essential element of sustainable development.

According to the definition proposed by the World Bank, financial inclusion means that individuals and businesses have access to valuable and affordable financial products and services that meet their needs – transactions, payments, savings, credit and insurance – delivered responsibly and sustainably (World Bank 2018).

The multidimensionality of financial inclusion is already visible in the definition mentioned above, indicating the often-discussed problem of the availability and use of financial products or services. Conducted scientific debates present deliberations on the proper definition of the purpose of undertaken activities. Access is a much broader concept than its uses because allowing access to formal banking products does not mean that excluded people will be interested in them (BIS 2016).

The needs for financial services are most likely higher than it results from their current use. Moreover, these needs evolve, so an inclusive policy should constantly change and adapt, particularly to newly emerging technological innovations (BIS 2016).

The level of financial inclusion, measured as financial literacy, is related to the use of cash. It was noticed that respondents with lower results on the financial literacy test held higher amounts of cash,

particularly large-denomination banknotes, used ATMs more often to withdraw cash, and were more likely to pay in cash. The higher the level of financial inclusion, the more frequent the use of non-cash payment instruments and the lower the demand for cash (Henry, Huynh, Welte 2018). The relationship between financial inclusion and the demand for cash is used in Japan to redirect the flow of savings from cash and bank deposits to the capital market (Fujiki, Tomura 2020).

The impact of financial inclusion on the monetary aggregates M0 (taken as one of the measures of the demand for money) may vary depending on the country's economic development level. Financial inclusion has a positive and significant effect on the M0 aggregate in developed countries. Thus, the survey results indicate that the increase in economic activity of society is conducive to the increase in demand for reserve money. In developing countries, the relationship is negative and insignificant (Sidik, Achsani, Pasaribu 2018). For example, the negative impact of financial innovation, which can be equated with the level of financial inclusion, on reserve money was confirmed in the research conducted by Hafer and Kutan in relation to Philippines (Hafer, Kutan 2003).

Another essential element of financial inclusion is the areas that can be distinguished from this general concept. The World Bank identified four areas of financial inclusion due to the type of financial products or services, i.e. banking (payment), credit, savings, and insurance.

This study focuses on the payment aspect of financial inclusion, which hypothetically may have the most substantial impact on the demand for money. This type of foreclosure is one of the most frequently cited, as it includes access to a bank account, financial institutions, and services associated with a bank account (Czarnecka 2018).

Access to a bank account is seen as a basic need in most developed countries where cashless transactions predominate, so the consequence of exclusion in this area may be social exclusion. People who do not have a bank account or are passive holders have limited access to credit and savings products, which can increase poverty (EC 2008).

There are no official indicators for payment inclusion, similar to all areas of financial inclusion. It is assumed that fully banked people have access to a wide range of transaction banking, including accounts with electronic payment facilities and payment cards (EC 2008).

Technological progress has made it easier for individuals to access financial services, mainly through electronic retail payments. New non-cash payments, including mobile payments, internet payments, card payments and electronic billing, reduce costs and requirements, thus favouring financial inclusion (CEMLA 2016).

3. Purpose and scope of the study, hypotheses, adopted methods of analysis

The main goal of the authors of the article is to identify the relationship between payment inclusion and the demand for cash. Additional research goals concern:

1. Review of the literature in order to determine the current state of knowledge about the factors determining the demand for cash.

2. Identification of the impact of the cost of money on transaction demand for cash in the conditions of increasing payment inclusion (increase in the number of non-cash transactions).

3. Investigation into the impact of the behavioural factor of uncertainty related to a natural disaster (pandemic) on various streams of demand for cash.

The authors formulated the following research hypotheses:

H1: Macroeconomic determinants in the form of the cost of money (represented by the interest rate) significantly affect the transaction demand for cash despite the increase in non-cash transactions with the use of funds in bank accounts.

H2: Uncertainty as a behavioural factor affects the size of the demand for money, although this impact is more significant in the case of a demand of a precautionary nature than of a transaction nature.

H3: The level of financial inclusion measured by the dissemination of non-cash transactions has a significant and negative impact on the transaction demand for cash.

In the study, in the theoretical layer, a critical analysis of the literature was used. In the empirical part, the method of linear regression analysis was used. The Shapiro-Wilk test was used to test the normality of variable distribution. White's test was used to determine the presence of heteroscedasticity in the model. Model fit analysis was performed using the coefficient of determination R^2 and the coefficient of standard deviation of residuals.

The study was conducted using data on the Polish payment system published by NBP. The period covered by the analysis covers the years 2007–2020, which is sufficient to illustrate the trends in the researched area.

4. Research

4.1. Methodology

In modern literature, most research on the demand for cash focuses on constructing a model that describes the strength and direction of the impact of various factors influencing the demand for cash. At the same time, it should be noted that the demand for cash is analysed in separate denomination groups of banknotes – low, medium, and high denominations. This allows for the counteraction of the substitution effects related to the withdrawal and introduction into circulation of banknotes of various denominations (Assenmacher, Seitz, Tenhofen 2017). Moreover, it solves the proliferation of different types of cash demand (transactional and hoarded) satisfied by different denominations of banknotes. Low denomination banknotes are used more often for transactions, and high denomination notes are usually collected. Medium denomination banknotes (50 and 100 zloty banknotes in Poland) are used for transaction execution and are also collected, so they are analysed separately.

Models describing the determinants of cash demand are constructed by applying linear regression (Assenmacher, Seitz, Tenhofen 2017; Rösl et al. 2021). The independent variables that are used are macroeconomic variables. All studies take into account actual or nominal GDP. This variable explains the transaction demand for cash (according to the quantity theory of money, the demand is a derivative of GDP). However, there is also a substantive justification for the positive impact of GDP on the amount of hoarded banknotes. Another variable included in the models is the interest rate in the form of the risk-free rate as 10-year bonds or the bank deposit rate. It represents the opportunity cost of cash and usually explains both transactional and hoarded demand. Some models also take into account the nominal exchange rate. On the one hand, it represents the opportunity cost of holding a national currency, and on the other hand, it explains the foreign demand for domestic banknotes.

Our study used a different approach to building a regression model. Previous studies by other researchers have sporadically addressed the impact of other variables related to the level of financial inclusion, especially payment inclusion, on the level of demand for cash and especially on low denominations of banknotes. To account for this impact, we built a linear regression model, changing the independent variables and going beyond the traditional approach. Our research is also innovative in considering the behavioural factors in the form of uncertainty related to the epidemic.

4.2. Data

In our research, we used data on the size of banknotes in circulation, broken down into individual denominations. In Poland, there are six denominations of banknotes in circulation – 10 and 20 zloty (low denomination), 200 and 500 zloty (high denominations), and 50 and 100 zloty (intermediate denominations). Data on the size and structure of banknote circulation (equated with the total demand for cash) have been published since 2007.

Figures 1 and 2 present information about the level and structure of cash in circulation in Poland from 2007 to 2020.

Figure 1

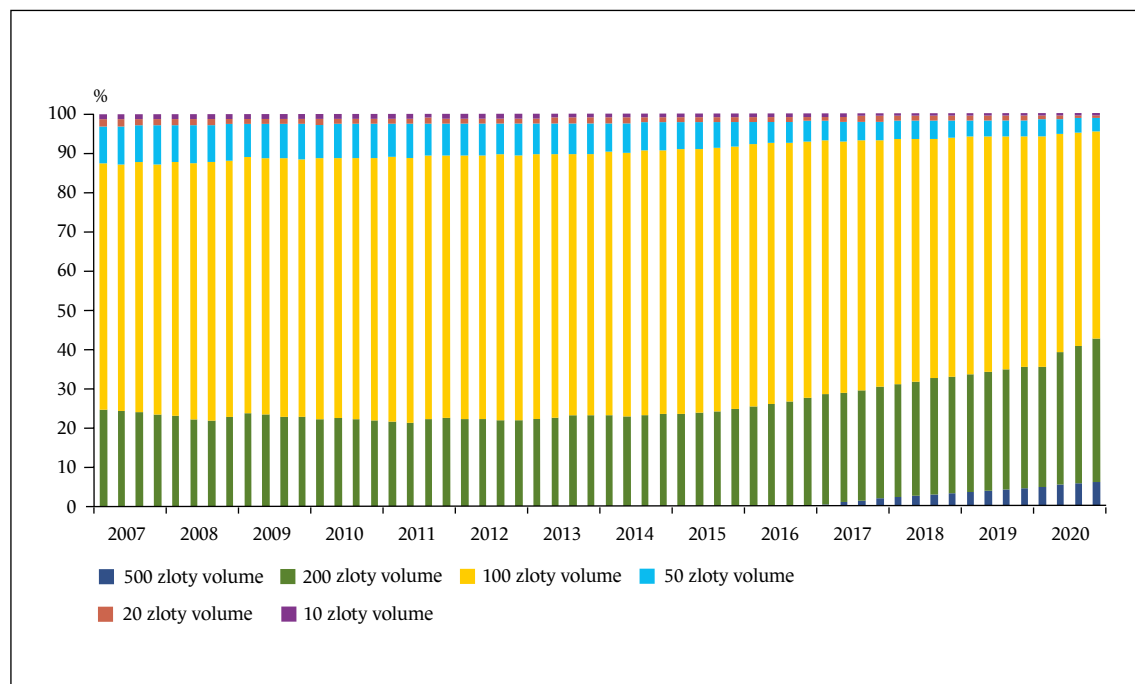Banknotes in circulation in Poland in the period QI 2007 – QIV 2020 – volume
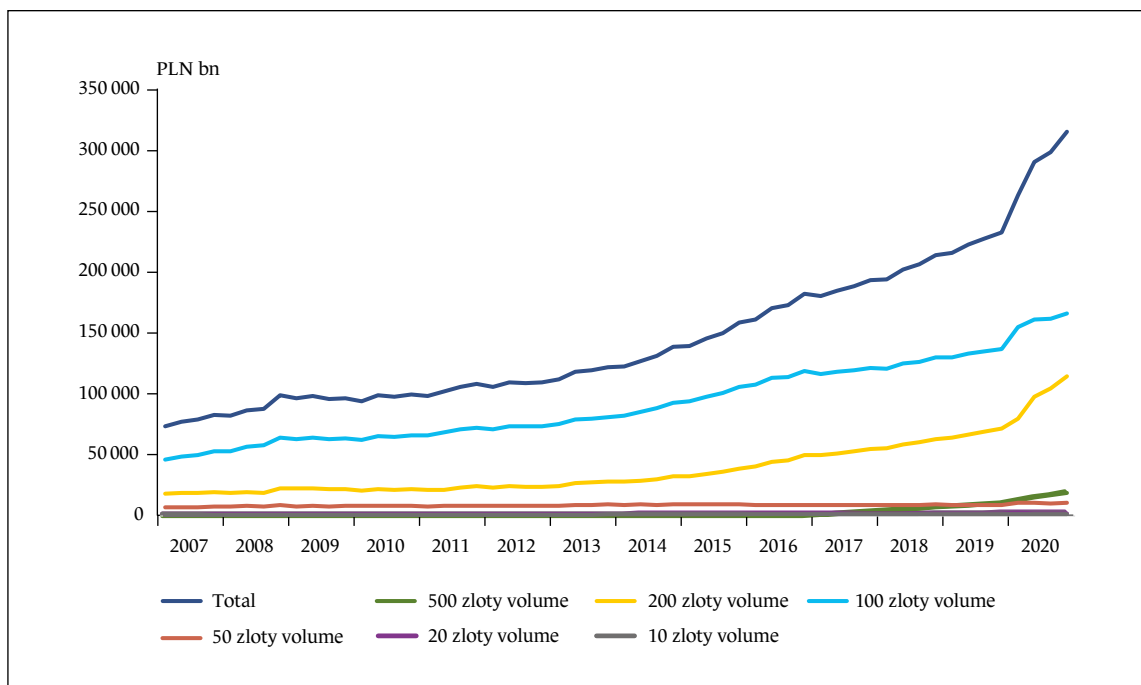
Source: https://www.nbp.pl/home.aspx?f=/statystyka/pieniezna_i_bankowa/m3.html.

Figure 2

Banknotes in circulation in Poland in the period QI 2007 – QIV 2020 – structure

Source: https://www.nbp.pl/home.aspx?f=/statystyka/pieniezna_i_bankowa/m3.html.

In the analysed period, the cash value in circulation was enhanced from about 74 to 316 billion zloty (from 19 to 68 billion euro). At the time, the value of 10, 20 and 50 zloty in circulation were stable, and that of 100, 200, and 500 zloty increased. If we analyse the structure of the banknotes in circulation, we can observe the increasing participation of 200 and 500 zloty (high denomination) and the stability of the 100 zloty. At the same time, the participation of low denomination banknotes decreased.

It is interesting to observe the cash to GDP ratio as calculated for different denominations of banknotes is presented (Figure 3). We find that the cash-to-GDP ratio had increased for high denomination banknotes and the 100 zloty banknote. However, this was stable for low denominations and the 50 zloty banknote (Figure 3).

Due to the above-mentioned multi-faceted nature of financial inclusion and the lack of an official measure of its level, indicators describing three areas were adopted. Data are drawn from official statistics from Narodowy Bank Polski. The share of cash withdrawals in ATM transactions combines cash and cashless circulation of money. This indicator illustrates the purpose of using payment cards during transactions at ATMs and the demand for cash.

Figure 3

Cash-to-GDP ratio in Poland in the period QI 2007 – QIV 2020 – banknotes by denomination
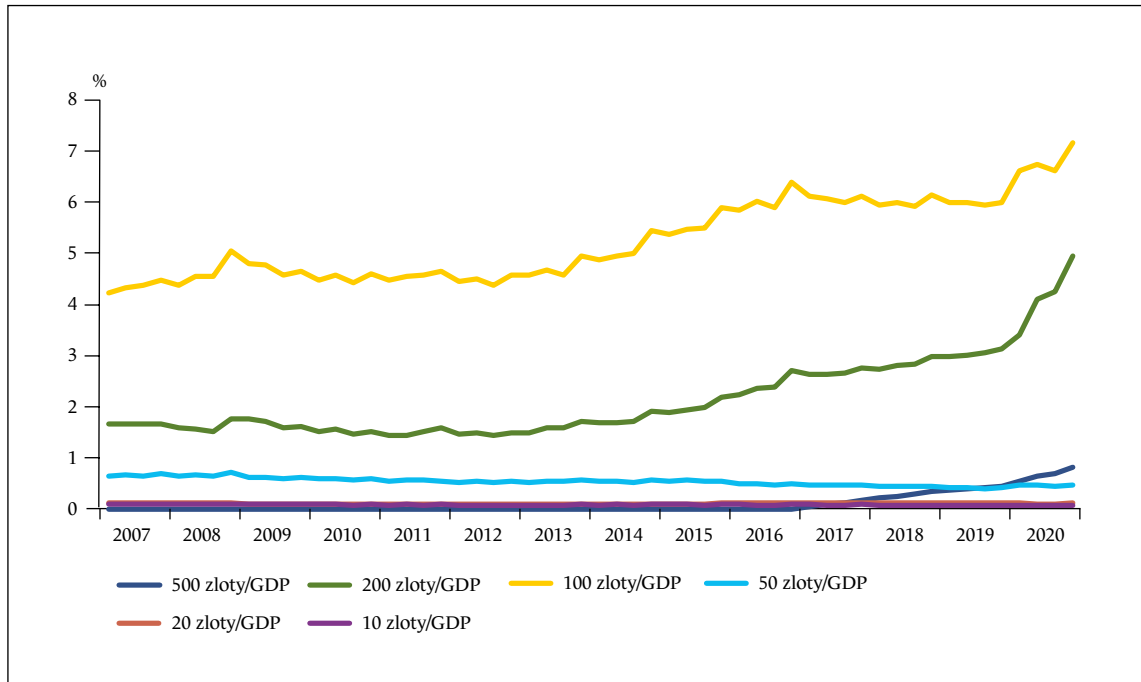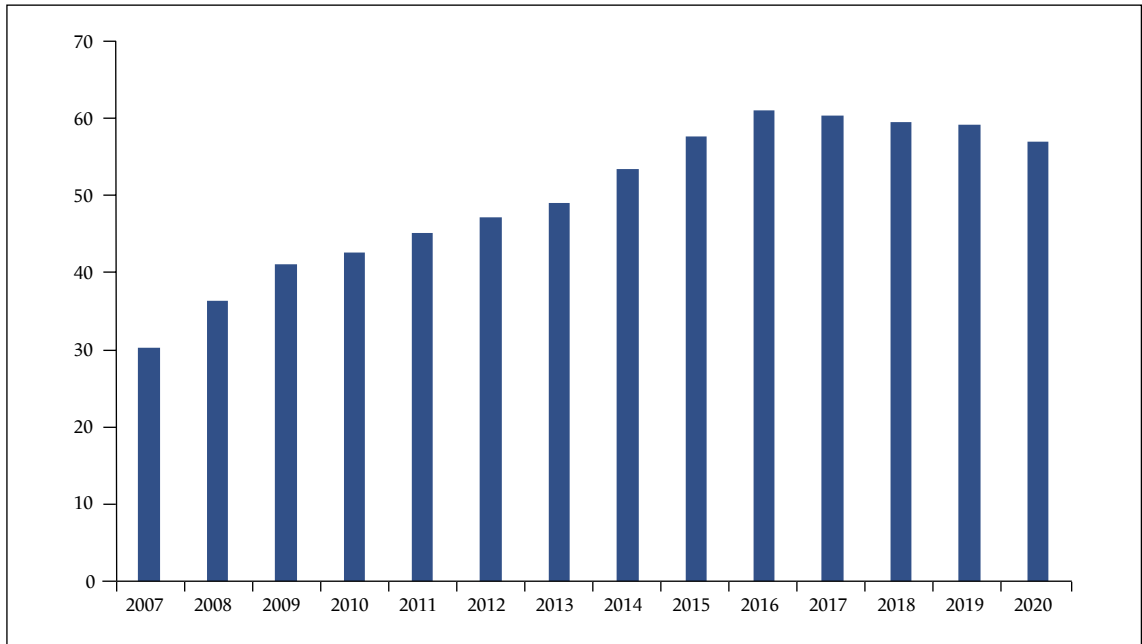

Source: authors' own calculations.

Concerning the International Monetary Fund, the greater the availability of ATMs (measured as ATM presence), the less effective the barriers to having a bank account and the more prevalent its use (IMF 2020). However, in the EU and Poland (Figure 4), a downward trend in the total number of ATMs has been observed since 2017. The reason is the increased popularity of electronic payments, which is the reason for the so-called consolidation in banking services. From the point of view of financial inclusion researchers, reducing the availability of ATMs may generate problems with the inclusion of people at risk of exclusion, who are an essential part of ATM users. These are people living in remote or rural areas which are not involved in new technologies and e-banking. ATMs provide them with the only possibility to use funds deposited in bank accounts (Lesjak 2019).

Unlike the decreasing number of ATMs, the number of POS (terminal point of sale) is growing, which indicates the increasing popularity of payment cards. Ease of transaction and the promotional activities of banks to encourage customers to link their bank accounts to this payment instrument can contribute to financial inclusion.

The share of card transactions in total retail sales is related to the use of payment cards, among others in POS, which are thus a substitute for cash, replacing it during the transaction. The reference of the number of card transactions to all transactions concluded as part of retail sales illustrates the progressive substitution of cash by payment cards. Operations in retail payment systems are an indicator of the development of e-commerce by considering payment systems.
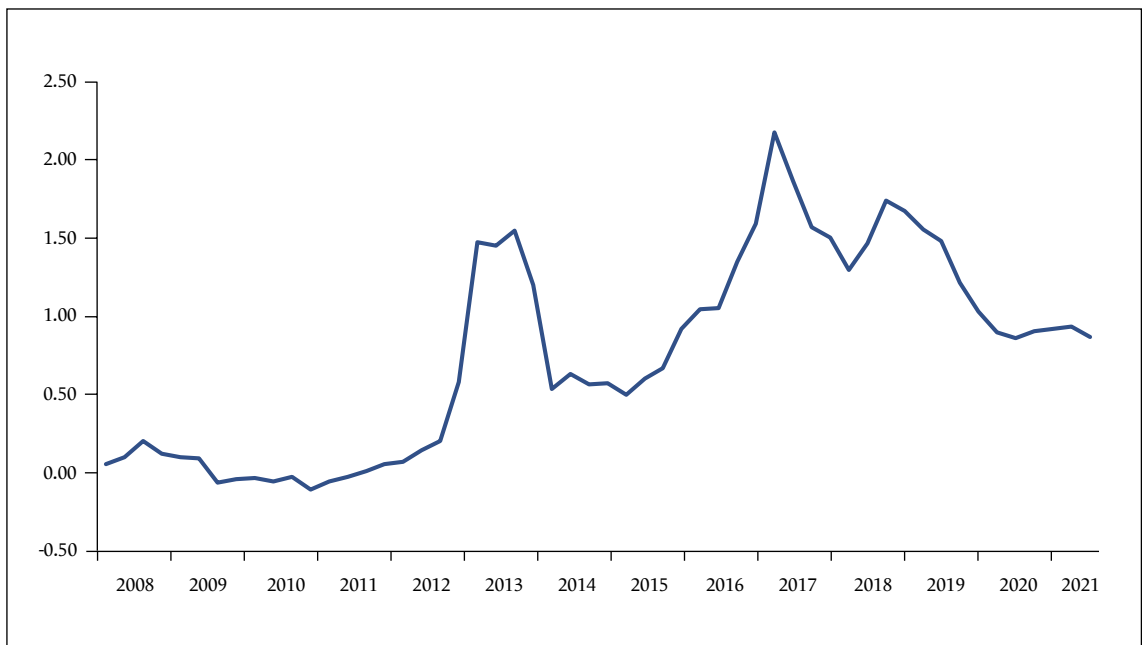
Figure 4

Number of ATMs per 100 000 adults in Poland in the period 2007–2020

Source: authors' own calculations.

Figure 5

Percentage change in the number of operations in retail payment systems (year-on-year)

Source: authors' own calculations.

In 2018, the most significant number of transactions were made using payment cards (62%). The most frequently used instrument was credit transfer (37%) (NBP 2019). The indicators adopted in this study describe the trends in the development of non-cash transactions in Poland and, at the same time, are adopted in the literature as measures of financial inclusion. Moreover, high ATM presence is associated with lower barriers to account ownership and higher use among account owners (van Oudheusden 2017).

Technological progress has substantially impacted the financial market infrastructure, including the development of retail payment systems. Data in Figure 5 presents the change in the number of operations to emphasize the pace of the development of the financial market. The noticeable increase in development dynamics was caused by the launch of instant payment systems in zloty, i.e. Express Elixir and the BlueCash payment system. Another increase is related to the launch of the Blik payment system as a new mobile payment scheme and system (NBP 2019).

4.3. Variables

In our research, we use the cash-to-GDP ratio as a dependent variable, which is calculated separately for each denomination of banknotes. The stock of cash-to-GDP dependent variable is very useful because (Amromin, Chakravorti 2009):
– there is a simple theoretical interpretation of this indicator as the inverse of money velocity,
– allows you to conduct panel research based on international comparisons.

The set of independent variables used by us is comprehensive. It includes variables of a macroeconomic nature embedded in the theory of money, variables describing the level of payment inclusion, and a behavioural variable related to the uncertainty resulting from the pandemic crisis.

The interest rate we understand as the interest rate on household bank deposits is a macroeconomic variable. We chose this type of interest rate because it is closely and directly related to the behaviour of households, and households report the demand for cash for transaction purposes. The interest rate will reflect the opportunity cost of using cash, or in other words, the cost of lost benefits in connection with the use of cash.

The level of payment inclusion is described in our study by three variables:
– share of card transactions in total retail sales,
– operations in retail payment systems,
– share of the number of cash withdrawals in total ATM transactions.

The inclusion of independent variables in the regression model in the form of variables describing the level of payment inclusion is an innovative approach and has not been used so far, to the best of the authors' knowledge. There is no consensus in the literature as to which indicator should be used to describe the level of payment inclusion in the most adequate way. The choice of variables made by the authors is innovative in this sense. In addition, variables describing the level of inclusion have not been used so far to explain different streams of demand for cash.

The share of card transactions in total retail sales reflects consumers' degree of use of payment cards. In order to smooth out significant seasonal deviations, a moving average was used, which shows the general development trend of this payment instrument. Total retail sales were adopted as the denominator, as using payment cards is the most common when making purchases.

A similar principle was adopted when determining the ratio to present the size of non-cash transactions in Poland, taking into account both the primary payment system, i.e. Elixir, and innovations in this area represented by Blik.

The percentage share of the number of cash withdrawals in total ATM transactions determines the use of ATMs for cash transactions with payment cards in Poland.

The pandemic crisis, whose impact is partly due to its behavioural effects, influences the demand for money depending on the denomination of the banknotes. In light of the research, the unique character of the pandemic crisis and the promotion of cashless transactions to reduce the transmission of the virus in society may result in a reduction in the demand for low denomination banknotes. On the other hand, a high level of uncertainty and distrust of banking institutions is conducive to the supply of high denominations, which would counteract possible problems with access to cash.

Table 1 shows the model's independent variables and the expected direction of their impact on the dependent variable (cash-to-GDP ratio).

Table 1

Independent variables

Variable	Definition	Direction of impact
Interest rate	Household bank deposit interest rate	−
Uncertainty	The occurrence of a crisis – variables	+/−
Share of card transactions in total retail sales	Percentage share of the value of payment card transactions in the total value of retail sales (as a moving average)	−
Operations in retail payment systems	The logarithm of the number of operations in retail cashless systems (Elixir, EuroElixir, Blue Cash, Blik)	−
Share of cash withdrawals in ATM transactions	Percentage share of number of cash withdrawals in total ATM transactions	+/−

Source: authors' own calculations.

4.4. Model

Before the regression analysis application, we used the Shapiro-Wilk test to check if variables follow a normal distribution. A Shapiro-Wilk test was performed and did not show evidence of non-normality. On this basis, we decided to use a parametric test. Detailed results of the Shapiro-Wilk test are presented in Table 2. Moreover, we had used White's test to determine the presence of heteroscedasticity in a regression model. The p-value is less than 0.05, so homoscedasticity is present.

Table 2

Results of Shapiro-Wilk test

Test	Denomination of banknotes			
	500 and 200 zloty/GDP	100 zloty/GDP	50 zloty/GDP	20 and 10 zloty/GDP
Shapiro-Wilk test	W = 0.98 p = 0.67	W = 0.99 p = 0.95	W = 0.97 p = 0.40	W = 0.98 p = 0.73

Source: authors' own calculations.

A regression analysis was applied to verify hypotheses H1 and H2:

H1: Macroeconomic determinants in the form of the cost of money (represented by the interest rate) significantly affect the transaction demand for cash despite the increase in non-cash transactions with the use of funds in bank accounts.

H2: Uncertainty as a behavioural factor affects the size of the demand for money, although this impact is more significant in the case of a demand of a precautionary nature than of a transaction nature.

The inclusion in the model of variables illustrating the impact of non-cash transactions on demand for money also allowed for the verification of subsequent hypothesis H3:

H3: The level of financial inclusion measured by the dissemination of non-cash transactions has a significant and negative impact on the transaction demand for cash.

The general formula of the regression model is the following:

$$DV = \beta_0 + \beta_1 IV + \varepsilon_i$$

where:

DV – dependent variable vector – reflecting factors influencing demand for banknotes,

IV – independent variables vector – reflecting demand for banknotes,

β – coefficient estimate for the independent variable,

ε_i – random variable.

Regression analyses were prepared for separate denominations. Four groups of banknotes were analysed:

– first – high denomination banknotes – 500 and 200 zloty,

– second – 100 zloty banknotes,

– third – 50 zloty banknotes,

– fourth – the low denomination banknotes of 20 and 10 zloty.

The division of denominations, which is used, takes into account the different purposes of each denomination. High denomination banknotes, i.e. 500 zloty and 200 zloty, are hoarded. On the other hand, low denominations, i.e. 10 zloty and 20 zloty, are used in transactions. Due to the ambiguous purpose of using 100 zloty and 50 zloty, they were analysed in separate models.

OLS regression results are presented in Table 3.

Table 3

OLS regression analysis results

Variables	Denomination of banknotes			
	500 and 200 zloty/GDP	100 zloty/GDP	50 zloty/GDP	20 and 10 zloty/GDP
Interest rate	-6.962*** (1.503)	-4.705* (1.806)	6.540** (1.775)	-5.167** (1.699)
Pandemic crisis	0.083*** (0.010)	-0.020 (0.012)	0.040** (0.011)	-0.044*** (0.011)
Share of card transactions in total retail sales	0.127*** (0.022)	-0.040 (0.027)	-0.152*** (0.026)	0,011 (0.025)
Operations in retail payment systems	-0.166 (0.515)	-1.127 (0.620)	-2.497*** (0.609)	0.721 (0.583)
Share of cash withdrawals in ATM transactions	-0.012 (0.096)	0.088 (0.115)	0.143 (0.113)	0.044 (0.108)
F statistic	1,319.923***	60.888***	62.379***	5.836**
R square	0.995	0.909	0.911	0.446

*$p < 0.1$; **$p < 0.01$; ***$p < 0.001$

Source: authors' own calculations.

To construct this regression model, we use one numeric independent variable (interest rate) and four variables that take into account the impact of crisis and payment inclusion – the pandemic crisis, share of card transactions in total retail sales, operations in retail payment systems and share of cash withdrawals in ATM transactions. The three last variables are the sample indicators of payment inclusion.

To assess goodness-of-fit in the regression models, we use the standard error of estimate (Se) and the coefficient of determination (R^2). The values of Se for the regression models do not exceed 0.014 units, which means that the demand volatility does not differ much from the obtained regression models based on the independent variables. The models based on all denominations except the 20 and 10 zloty banknotes are characterized by very high model fitting (R^2 at the levels of: 0.995, 0.909, 0.911), which indicates that the explanatory variables in the models significantly determine the size of the explained variable, which is demand volatility. The model, determined for the 20 and 10 zloty banknotes, is characterized by the lowest model fitting out of the four models obtained.

5. Findings and discussion

In our study, we obtained results that are only sometimes conclusive and differ for different banknote denominations (representing transactional or precautionary demand).

In our research, we found that the interest rate statistically impacts the consumption of all banknote denominations, i.e. precautionary and transactional demand. In the case of high-denomination banknotes, the interaction direction is negative, which is in line with the theory. In the case of transactional demand (for low-denomination banknotes), the impact was also negative, which needs to be clarified from theory – in this case, the impact of the interest rate on the size of the demand should not be significant. We would like to draw attention to the 50 zloty banknote. In this case, the direction of the impact of the interest rate is positive, which requires further research to explain the causes of this phenomenon. Other researchers obtained similar results. Amromin and Chakravorti (2009) notes that the change in the interest rate has little impact on the demand for low-denomination banknotes, while it has a substantial impact on high-denomination banknotes. Alvarez and Lippi (2007) find that the spread of financial innovation, including non-cash payment instruments, reduces the flexibility of the demand for cash relative to changes in the interest rate.

The impact of behavioural factors (uncertainty related to the pandemic crisis) on demand for cash is in line with our expectations. Increased uncertainty affects the increase in demand for high-denomination (not transaction) banknotes. On the other hand, in the case of low-denomination (transaction) banknotes, the demand is negatively correlated with the level of uncertainty. However, the impact force, in this case, is small. The explanation for this is the nature of the pandemic crisis, administratively introduced restrictions, and, consequently, the growing importance of non-cash transactions.

The presented research results allowed us to confirm the H1 and H2 hypotheses. Macroeconomic and behavioural factors significantly affect the demand for cash, and, thus, the transaction demand. The direction of the influence is in line with expectations and with previous research by other researchers.

A crucial element of our study was analysing the impact of payment inclusion on the level of transaction demand. This impact was differentiated depending on the inclusion measure used. We found that the share of card transactions in total retail sales has a statistically significant and positive effect on high-denomination notes that do not represent transaction demand. On the other hand, the impact on transaction demand (low-denomination banknotes) is not statistically significant. On the other hand, we observed a significant and negative impact of the discussed measure of payment inclusion on demand for banknotes with a face value of 50 zloty, which is in line with our expectations.

Earlier studies by other authors, contrary to the results obtained in our study concerning the lowest denomination banknotes, indicate a relationship between payment inclusion measured by the share of card transactions in retail sales and the transaction demand for banknotes. The research of Amromin and Chakravorti (2009) found that the increase in the use of payment and debit cards reduces only the transaction demand for cash, especially for banknotes of other denominations and coins. Stix's (2004) research focused on the use of cards and their impact on the demand for cash. In his opinion, the impact of the use of payment cards is significant and reduces the demand by nearly 1/3; in credit cards, this impact slightly exceeds 1/10. In Germany (von Kalckreuth, Schmidt, Stix 2009) credit cards had already had an impact on the demand for cash. Also in Italy, the use of debit cards significantly and negatively impacted the demand for cash (Li, Mercatanti 2015). Summarizing the results of the cited studies, the use of payment cards negatively correlates with the demand for low denomination banknotes, as they have a substitute function. Our study did not confirm this relationship concerning 20 and 10 zloty. However, a significant and negative effect was shown for 50 zloty.

Operations in retail payments systems is a measure that can be equated with using modern payment instruments and thus associated with the level of inclusions. In our study, this variable was statistically insignificant for all denominations except for 50 zloty, where the impact was negative. Our results correspond to previous research, indicating the need for more precise links between transaction demand and modern payment instruments. Trütsch (2020) pointed to the lack of a statistically significant impact of contactless payments on the use of cash. This is related to the behavioural aspect based on the client's personal preferences. Card users replace conventional card payments with contactless cards, so the impact on cash does not change. In addition, they indicated that contactless payments might be considered more competitive than conventional payment cards concerning cash transactions. Contactless payments are particularly used for low-value transactions, making them an attractive alternative to low cash payments. Similar conclusions are reported by Chen, Felt and Hunyh (2017) as it indicates the potential negative impact of contactless payments on cash use if the endogenous choice is not considered. These authors assess the impact of contactless payments on the demand for cash as overestimated, while unobserved heterogeneity is ignored. The authors perceive various technological innovations introducing new solutions in retail payments as phenomena with a negative impact on the demand for money, which has been visible recently and has led to a decrease in the use of cash (Stix 2003; Alvarez, Lippi 2009; Amromin, Chakravorti 2009). Total demand for cash has not fallen with the adaptation of modern payment instruments. Summarizing, it can be said that additionally, researchers pointed out that the increase in the use of non-cash payment instruments was associated with the limitation of the retail industry and the emergence of large merchants.

Our research confirms the ambiguous influence of ATMs on demand for cash. The relationship between each denomination group is insignificant, suggesting no influence of ATMs on the amount of cash in circulation. Other researchers dealing with this problem also pointed to ambiguous results. The demand for low-denomination banknotes is more susceptible to the popularity of debit cards. High denomination notes are used for non-transactional purposes, so the impact could be more visible. Thus, ATMs positively affect low denominations, while POS affects them negatively (Drehmann et al. 2002). According to Carbó-Valverde and Rodríguez-Fernández (2014), average ATM transactions have a positive and significant impact on the demand for cash. It was also noted that increasing the number of ATMs and POS terminals might lead to lower substitutability of cash for cards. The indicator reflecting the combined effect of ATMs and POS transactions appears to have a negative impact on the demand for cash. The dependence mentioned above may result from the different effects of debit cards when withdrawing cash from ATMs and at POS. The survey results suggest that the negative impact of POS transactions on the amount of cash in circulation may be offset by the positive impact of ATMs. Access to ATMs and its impact on transactional demand is ambiguous (Stix 2004). In the short term, their availability increases the demand for cash, but in the long term, it does the opposite. It can be concluded that this is related to the popularization of payment cards and the use of this instrument for cashless transactions (Rinaldi 2001; Snellman, Jukka, Humphrey 2001; Rauf 2012). The impact of the number of ATMs on cash in circulation is not clear.

On the one hand, reducing the number of ATMs may reduce the demand for cash, mainly if consumers can use other alternative payment instruments. On the other hand, the impact of ATMs on the use of cash may be insignificant, given the availability of alternative payment instruments (Snellman 2006). The impact of ATMs and payments at POS terminals was examined by Columba (2009), who showed that they had a negative effect on the amount of cash in circulation and a positive effect

on narrow money M1. In a developing country like Tanzania, Amromin and Chakravorti (2009) focused on the innovation of cashless payments such as mobile money transactions. It is an exciting direction, despite the need for clear evidence of a reduction in cash demand caused by making payments through mobile phone transactions. Mobile money transactions are gradually gaining popularity, which meant that in 2009 mobile payment was the most used method of payment after cash.

Our results do not confirm the H3 hypothesis. The impact of payment inclusion measured by various variables does not have a statistically significant impact on the transaction demand for the lowest denomination banknotes. On the other hand, we observed a statistically significant impact in the case of two out of three variables for the 50 zloty banknote, which can also be treated as representative of transaction demand. The direction of the observed impact is negative, which indicates the impact of the increase in the level of payment inclusion on the decrease in transaction demand for the 50 zloty banknote. According to the authors, the lack of impact of the level of payment inclusion on the demand for high-denomination banknotes, i.e. the demand for hoarding purposes, is theoretically justified. The demand for money as a means of storing value, which can be identified with the demand for high--denomination banknotes, is independent of the number of transactions and payment instruments used. Paradoxically, the independence of the demand for low-denomination banknotes from the level of payment inclusion may also be justified. Perhaps the 10 and 20 zloty banknotes are used in low--value transactions, carried out in commercial outlets (fairs, street trade, etc.), where non-cash payments cannot be made. Thus, this would explain the independence of the demand for these banknotes from the intensity and volume of non-cash transactions.

6. Conclusions

Because of the growing interest in financial inclusion, it is worth taking a closer look at its effects, as an impact on various areas of the economy. One of the examples of a slightly apparent dependence may be the discussed influence of financial inclusion on demand for cash. Institutions, such as the central bank, should assess decisions made by regulators to enable access to banking services and products for the excluded or at risk of exclusion as possible phenomena generating financial instability.

Factors influencing demand for cash described in the literature are partially reflected in our research results. The macroeconomic determinant in the form of the cost of money has the most substantial impact on each denomination of banknotes, and it is negative (except for 50 zloty, which is an exciting phenomenon). The results of the impact of the pandemic crisis are similar to the previous studies indicating the behavioural aspects determining the strength and direction of its impact on denominations of banknotes. The precautionary function of high-denomination banknotes results in a greater demand for them and is worth taking a closer look at times of uncertainty. The specific nature of the pandemic crisis resulted in lower demand for low-denomination banknotes, lowering the transaction demand for cash.

The indicators adopted in our study were aimed at approximating payment inclusion as accurately as possible and determining its impact on the demand for money. The significant results obtained for the indicators show the direction of the impact expected based on the literature. By recognizing 50 zloty as the denomination used in the transaction, we confirmed the significant impact of financial inclusion on demand for low-denomination cash. Such results were obtained in relation to the share

of card transactions in total retail sales and operations in retail payment systems, which indicate the negative impact of payment inclusion on money demand. The third area adopted to complete the description of the payment inclusion – share of cash withdrawals in ATM transactions – in our study does not affect the level of cash in circulation due to the ambiguous impact quoted in the literature.

Along with technological development, especially in non-cash payments, the interest in the impact of new solutions on the amount of money in circulation should increase due to some economic effects. As a rule, financial inclusion, most often seen today as providing access to electronic banking, should result in lower demand for cash. An exciting area of research will be to assess the impact of more innovative technologies, such as mobile phone transactions, which constitute an endogenous choice.

The authors are aware of the limitations of the study. The main reason is the limited number of explanatory variables describing the level of payment inclusion. This is related to the availability of data and possible approaches to the issue of inclusion itself. In future research, it would be advisable to include additional variables describing payment inclusion. In addition, the authors see the possibility of taking into account additional variables of a behavioural nature. Only the impact of uncertainty was considered in the study, while the authors are aware that other behaviours (mental accounting, aggregating financial flows, heuristics) can significantly affect the multi-stream demand for cash. In the discussion of the results, the authors pointed out the unusual behaviour of demand for the 50 zloty banknote. Further research should be conducted to consider additional factors that may explain this kind of anomaly.

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Związek między inkluzją płatniczą a popytem na gotówkę

Streszczenie

W ostatnich latach proces cyfryzacji gospodarek odbywa się na wielu płaszczyznach, co jest szczególnie widoczne w rozwoju systemów finansowych. Jednym z jego przejawów w sektorze finansowym jest popularyzacja bezgotówkowych metod płatności oraz nowych instrumentów płatniczych. Dodatkowo kryzys pandemiczny przyczynił się do popularyzacji e-commerce i przyspieszył przejście od tradycyjnych transakcji gotówkowych do bezgotówkowych. Zjawiska te można interpretować w kontekście wzrostu poziomu inkluzji finansowej, zwłaszcza jej obszaru zwanego inkluzją płatniczą. Równocześnie w gospodarce stale jest obserwowany wysoki popyt na banknoty. Wiele dotychczas przeprowadzonych badań wskazuje, że wzrost liczby banknotów w obiegu nie wynika z celów transakcyjnych, ale z wykorzystania banknotów jako środka przechowywania wartości.

Głównym celem artykułu jest identyfikacja związku między inkluzją płatniczą a popytem na gotówkę. Nasze badania opierają się na teorii pieniądza, szczególnie na keynesowskim wyjaśnieniu wielostrumieniowego popytu na pieniądz. Uwzględnienie inkluzji płatniczej wśród czynników wyjaśniających wielkość popytu na gotówkę sytuuje nasze badania w nurcie ekonomii zrównoważonego rozwoju i jest naszym innowacyjnym wkładem w rozwój nowoczesnych finansów.

W artykule zostały sformułowane następujące hipotezy badawcze:

H1: Uwarunkowania makroekonomiczne w postaci kosztu pieniądza (reprezentowanego przez stopę procentową) istotnie oddziałują na transakcyjny popyt na gotówkę, pomimo wzrostu liczby transakcji bezgotówkowych z wykorzystaniem środków pieniężnych zgromadzonych na rachunkach bankowych.

H2: Niepewność, jako czynnik behawioralny, wpływa na wielkość popytu na pieniądz, jednak wpływ ten jest silniejszy w przypadku popytu o charakterze przezornościowym niż transakcyjnym.

H3: Poziom inkluzji finansowej, mierzony upowszechnieniem obrotu bezgotówkowego, ma istotny oraz negatywny wpływ na transakcyjny popyt na gotówkę.

Ze względu na znaczenie gotówki w funkcjonowaniu gospodarki i banków centralnych nasze badania, wyjaśniające jeden z nierozpoznanych dotąd aspektów determinujących popyt na banknoty, mają istotny wymiar aplikacyjny.

Wcześniejsze badania sporadycznie odnosiły się do wpływu zmiennych związanych z poziomem włączenia finansowego, szczególnie włączenia płatniczego, na poziom popytu na gotówkę, zwłaszcza na niskie nominały banknotów. Aby uwzględnić ten wpływ, zbudowaliśmy model regresji liniowej, zmieniając zmienne niezależne i wychodząc poza tradycyjne podejście. Nasze badania są również nowatorskie w rozważaniu wpływu czynników behawioralnych (w postaci niepewności związanej z epidemią) na popyt na gotówkę.

Wpływ czynników opisanych w literaturze na popyt na gotówkę ma częściowe odzwierciedlenie w wynikach naszych badań. Czynnik makroekonomiczny w postaci kosztu pieniądza ma największy ujemny wpływ na popyt na każdy nominał banknotów (poza ciekawym zjawiskiem w odniesieniu do banknotu 50 zł). Otrzymane przez nas wyniki analizy wpływu kryzysu związanego z pandemią są podobne do wcześniejszych badań, wskazujących na behawioralne aspekty oddziałujące na popyt na

różne nominały banknotów. Potwierdziliśmy także, że przezornościowy popyt na banknoty o wysokich nominałach wzrasta w okresach niepewności. Specyfika kryzysu związanego z pandemią wpłynęła na spadek popytu na banknoty o niskich nominałach, co obniżyło popyt transakcyjny na gotówkę.

Przyjęte w badaniu miary poziomu inkluzji płatniczej pozwoliły na zbadanie jej wpływu na popyt na gotówkę. Istotne statystycznie wyniki potwierdzają kierunek oddziaływania inkluzji płatniczej na popyt na gotówkę, oczekiwany na podstawie wcześniejszych badań innych autorów. Uznając nominał 50 zł za transakcyjny, potwierdziliśmy istotny wpływ inkluzji na popyt na banknoty o niskich nominałach.

Wraz z postępem technologicznym, zwłaszcza w zakresie innowacyjnych rozwiązań w obrocie bezgotówkowym, zainteresowanie jego wpływem na obieg gotówki powinno rosnąć ze względu na efekty ekonomiczne. Inkluzja finansowa, a zwłaszcza płatnicza, postrzegana dziś najczęściej jako zapewnienie dostępu do bankowości elektronicznej, powinna zmniejszać popyt na gotówkę. Interesującym obszarem przyszłych badań będzie ocena wpływu innowacyjnych rozwiązań technologicznych w transakcjach płatniczych na popyt na banknoty o różnych nominałach.

Słowa kluczowe: popyt na gotówkę, zachowania płatnicze, inkluzja finansowa, inkluzja płatnicza, bank centralny