**Demand for currency in Poland in the years 1998-2021**

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Summary

1. **Motivation and research questions**

**In the late 1980s and early 1990s most central banks moved away from monetary targeting, adopting the level of the domestic interest rate and/or the level of the exchange rate as the operating target(s) of monetary policy.** As a result, central banks have abandoned attempts to precisely control the value of their balance-sheet liabilities, the most important of which are cash (or currency) in circulation, i.e. banknotes and coins with the public, and commercial bank reserves. However, given that these two types of liabilities are the ultimate means of settlement for all transactions in the economy, understanding their drivers is still vital to the functioning not only of central banks, but also of the financial system and the economy as a whole.

**There are several reasons why learning about the determinants of the demand for domestic currency is still an important and timely issue.** First, it is important for planning the process of issuing banknotes and coins by the central bank. Proper execution of this process in order to satisfy the demand for cash by economic agents is essential for maintaining confidence in money, especially in its physical form. Second, cash in circulation is one of the main variables taken into account when forecasting the banking sector's liquidity and preparing the central bank's financial plan. Knowing the determinants of cash demand is very important, as both excess and insufficient liquidity can have serious consequences for the functioning of the financial system. Knowledge of the determinants of currency demand is also important because of the ongoing debate about restricting or even abolishing cash. The issue of the future of physical cash has also become very topical in recent years in view of the development of the cryptocurrency market, as well as in the context of theoretical considerations regarding the possibility of introducing negative interest rates by central banks. There has also been a significant increase in research on central bank digital currencies, and in some countries pilot or actual implementation programmes have been launched. Given that currency in circulation is a major item on the central bank's balance sheet, a sharp decline in the demand for cash or its complete elimination could have serious implications for seigniorage income and thus also for the central bank independence and ability to conduct monetary policy.

**The debate over the future of cash and the factors affecting its circulation is motivated not only by theoretical considerations, but also, and perhaps most importantly, by empirical observations.** Despite the development and increasing use of alternative forms of payment, currency’s share of GDP has increased significantly over the past decade in many countries, especially in developed economies. Some studies indicate that the ratio of cash in circulation to GDP in these countries could be considered high even if seen over a 100-year horizon. Over the past several years, a marked increase in cash in circulation to GDP has also occurred in Poland, with particularly strong growth after 2013, and especially after the outbreak of the COVID-19 pandemic. Among the factors proposed to explain the phenomenon of persistently high or growing cash circulation, uncertainty is mentioned quite often in the economic literature.

**Taking into account the above premises, the dissertation attempts to determine the drivers of currency in circulation in Poland in 1998-2021.** The subject of the empirical study conducted in the dissertation is the aggregate demand for physical cash in circulation in Poland, i.e. legal tender banknotes and coins issued by the National Bank of Poland.

**The purpose of the study is to answer the following research questions:**

**Main research question:** What factors determined the demand for currency (banknotes and coins) in Poland between Q1 1998 and Q3 2021?

**Sub-questions:**

1. During the period under review, were income and the interest rate significant factors determining the demand for total cash in circulation, high-denomination banknotes, and coins? What was the elasticity of demand for these cash categories with respect to income and the interest rate?

2. Was uncertainty an important factor shaping the demand for total cash in circulation, high-denomination banknotes, and coins during the period under review?

3. What was the role of factors other than income, the interest rate and uncertainty in driving the demand for the above categories of currency during the period under study, assuming that these factors are not included in the cash demand equation directly, but modeled as an unobservable stochastic trend?

1. **The structure of the study and the research approach**

**The study was conducted in several stages and using various research approaches. The starting point (Chapter One) is a review of the theories and theoretical models of money demand with a particular focus on the determinants postulated by them.** Its purpose is to provide theoretical guidance on what variables should be included in the empirical money demand equation and what the expected direction and estimated strength of their impact should be.

**The second chapter reviews international empirical studies on the demand for cash published since the year 2000.** The purpose of conducting such a review was to obtain a reference point for the results of the study performed in the dissertation, especially given the fact that there are few items in the literature that comprehensively discuss the results of contemporary empirical studies on the demand for banknotes and coins. The review focuses primarily on the structure of estimated cash demand equations and the estimated impact of individual determinants. A systematization of the determinants of cash demand considered in the empirical literature is proposed, and additional, more detailed information on the obtained results is provided in the appendix.

**The third chapter describes the trends and conditions of cash circulation in Poland during the period covered by the empirical study.** In particular, data are presented on the value of cash circulation and its denomination structure, as well as the share of cash in payments and in the financial assets of Polish households. The infrastructural and institutional-regulatory conditions of cash circulation are also discussed. The analysis of trends and determinants of cash circulation carried out in this chapter formed the basis for evaluating and interpreting the results obtained in the following parts of the dissertation.

**The fourth chapter is an introduction to the empirical study that constitutes the main part of the dissertation.** **It contains a general characterization of the research approach, different from the one usually used in analyses of money demand.**

**The empirical analysis of cash demand in Poland assumes the following form of the demand function:**

$$\begin{array}{c}m=f\left(y,i,unc,NTP\right) \end{array}$$

In the above equation, m denotes one of three monetary aggregates in real terms: total cash in circulation, high-denomination (PLN 200 and PLN 500) banknotes or coins. The estimation of separate models for high-denomination banknotes and coins was intended to better capture the non-transaction- and transaction-related demand for cash, respectively. The scale variable (y), the opportunity cost of holding cash (i), and economic uncertainty (unc) were used as arguments for the demand function. The fourth argument, NTP, is an unobservable trend of cash demand. It is a variable intended to reflect unobservable or hard-to-measure factors not explicitly included in the model, which, in light of the theories presented in Chapter One, as well as the results of some of the empirical studies presented in Chapter Two of the work, may affect the demand for banknotes and coins. In particular, the NTP variable may capture the influence on cash demand of such factors as financial and technological innovations, consumer preferences and institutional factors (such as regulation or shadow economy activity).

**As a measure of economic uncertainty, the author's own economic uncertainty indices constructed from textual data were used**. The indices were created as a result of an automated search of the online archive of the Polish daily newspaper “Gazeta Wyborcza” for articles containing keywords on uncertainty and the economy, as well as selected subject areas: economic policy, fiscal policy, monetary policy, the stock market and the banking crisis. As a result of searching the archive, which contained about 4.5 million articles, 16 economic uncertainty indices were constructed, grouped into three topical groups, intended by design to reflect different types of economic uncertainty in Poland. Six of the developed indices were eventually used in model estimation.

**The empirical study conducted in this work used structural time series models (also known as unobservable component models), a particular type of state space models.** As a result, the unobservable trend of cash demand (the NTP variable) could be modeled as a stochastic trend. A stochastic trend was introduced into the cash demand equation for several reasons. Among the most important of these were: 1) the lack of statistical data that satisfactorily reflected the impact of such demand determinants as financial and technological innovations, institutional factors (e.g., shadow economy activity), or consumer preferences (especially at the aggregate level), and 2) the ability to account for the potentially non-linear and time-varying impact of the aforementioned factors on cash demand.

**The fifth chapter contains the results of the empirical study conducted (on data from Q1 1998 to Q3 2021 inclusive) in order to answer the research questions posed earlier.** It presents parameter estimates of the cash demand models and provides their interpretation.

1. **Key findings**

**As a result of the empirical study, the following answers to the research questions posed at the beginning of the dissertation were obtained:**

**Main research question: What factors determined the demand for currency (banknotes and coins) in Poland between Q1 1998 and Q3 2021?**

During the period under review, the demand for cash was determined primarily by such factors as GDP, the interest rate and banking-crisis-related uncertainty, which together accounted for about 65% of the change in total cash in circulation. Other (unobservable) factors not directly included in the demand equation and modeled using a stochastic trend that can most likely be associated with financial and technological innovation, institutional factors (e.g., the shadow economy) and consumer preferences were responsible for the remainder (35%) of the changes in cash circulation.

**Sub-questions:**

**1. During the period under review, were income and the interest rate significant factors determining the demand for total cash in circulation, high-denomination banknotes, and coins? What was the elasticity of demand for these cash categories with respect to income and the interest rate?**

During the period studied, the interest rate had a statistically significant impact on the demand for total cash in circulation, high-denomination bills and coins. Income, on the other hand, was a statistically significant driver of demand only for total cash in circulation and coins, while it proved to have no statistically significant effect on the demand for high-denomination banknotes.

The estimated long-run income elasticity of the demand for cash and coins was +0.95 and +0.93, respectively, i.e. close to “unity”, as implied by the quantity theory of money, and not significantly different from the values obtained in other studies. The estimated long-run interest rate elasticity of demand for cash was negative, in accordance with economic theory, being highest (in absolute terms) for high-denomination banknotes (-0.27) and lowest for coins ( 0.10), while for total cash in circulation it stood at -0.13. This estimate is consistent with the results of other empirical studies, also indicating higher interest elasticity of demand for higher denominations. The higher sensitivity to changes in the interest rate of the 200 zloty and 500 zloty banknotes may suggest that the demand for them was motivated more by their role as a financial asset and driven more by hoarding. In contrast, the relatively low elasticity to the interest rate of demand for coins indicates their mainly transactional role.

**2. Was uncertainty an important factor shaping the demand for total cash in circulation, high-denomination banknotes, and coins during the period under review?**

Of the six economic uncertainty indexes analyzed in the study, only the banking crisis-related uncertainty index had a statistically significant positive effect on cash demand, with the effect being significant only for total cash in circulation and high-denomination bills, but insignificant for coins.

During the period under review, a 100-point increase in the banking crisis-related uncertainty index, where an index value of 100 corresponds to the average level of uncertainty that existed in the period from Q1 1998 to Q4 2018, was accompanied, ceteris paribus, by an increase in the real circulation of total cash of about 1.3% in the same quarter and about 2.1% in the long term. In contrast, the real circulation of high-denomination banknotes rose in response to a 100-point increase in the index by about 1.6% in the same quarter and about 8.1% in the long term, ceteris paribus.

**3. What was the role of factors other than income, the interest rate and uncertainty in driving the demand for the above categories of currency during the period under study, assuming that these factors are not included in the cash demand equation directly, but modeled as an unobservable stochastic trend?**

The factors embodied in the unobservable stochastic trend, interpreted in the dissertation as financial and technological innovations, institutional factors and consumer preferences, played a significant role in driving cash demand in Poland. On average, they accounted for about 35% of the total change in total cash in circulation, 51% of the total change in the circulation of high-denomination banknotes and 33% of the circulation of coins between Q1 2001 and Q3 2021. At the same time, the role of these factors was not constant over time and fluctuated quite a lot. In particular, these factors clearly fueled the growth of circulation of high-denomination banknotes in 2014-2019. Among the hypotheses explaining this phenomenon one could include institutional changes in Poland that took place at the beginning of this period, such as the introduction of ‘forward guidance’ in Polish monetary policy, changes in the pension system which potentially shaped the savings preferences of Polish consumers, and a possible increase in the value of transactions in the shadow economy.

On the other hand, factors not directly included in the demand equation, hiding in an unobservable stochastic trend, had a slowing impact on the circulation of coins since around 2016. It seems that the downward path of the unobservable trend of coin demand during this period can be explained by intensive innovations in cashless payment instruments and the accompanying change in payment preferences of Polish consumers. Indeed, in the middle of the second decade of the 21st century, Poland saw accelerated growth in the number of non-cash transactions and devices accepting electronic payment instruments, especially contactless cards, as well as the development of mobile payments, accompanied by regulatory changes favorable to non-cash payments (reductions in the interchange fee). In addition, in 2020-2021, the downward-sloping shape of the the unobservable trend of coin demand can also be explained by a (voluntary) change in consumer preferences toward greater use of cashless payments due to the COVID-19 pandemic. At the same time, the COVID-19 pandemic had a weakening effect on coin demand through the pandemic-induced restrictions related to the isolation and quarantine of affected individuals and the activities of retail and service outlets, creating in effect a kind of coercive, physical, barrier to cash payments.