# Factors Shaping Euro and Forint Cash Holding Ratios – The Rise of Cash Demand for Savings Purposes from the Turn of the Millennium*

*Anikó Bódi-Schubert – Ildikó Ritzlné Kazimir*

*This study reviews the factors shaping forint and euro cash demand for savings purposes by examining the cash holding ratio. Forint and euro cash holding ratios are both rising, which points to an increase in cash savings. According to the results, in the long run, the cash demand for savings purposes is determined by traditional variables such as wealth and yields, along with uncertainty, the price of financial services and the institutional environment. In the short run, the change in uncertainty and the evolution of short interest rates dominate. Crises and the sudden shifts in the institutional environment lead to a shock, with large growth in the cash holding ratio for both currencies.*

**Journal of Economic Literature (JEL) codes:** E12, E41, E58, E71

**Keywords:** cash demand, error correction model, uncertainty, cash holding ratio

## 1. Introduction

Cash plays a complex role in the economy: people purchase goods and services with it as a means of payment, which is referred to as the transactional demand for money. Economic actors hold some of their savings in cash, which is called the wealth-holding or precautionary motive (*Odorán – Sisak 2008*). This study focuses on the cash demand for savings purposes in the case of the forint and the common European currency, the euro. With the rise of digitalisation and electronic payments, a fall in cash demand has often been predicted in the past decades, but cash holdings have continued to grow in most countries of the world. This seemingly counterintuitive process has resulted in numerous studies, some of which are based on the micro-level analysis of consumer behaviour or take a macroeconomic approach to the subject (*Bagnall et al. 2016; Fujiki 2020; Rösl – Seitz 2022*). This trend remained intact, despite the large rise in electronic payments triggered by the lockdowns during the Covid-19 pandemic (*MNB 2022*). In Hungary, the value

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of cash transactions conducted through online cash registers dropped by 13.6 per cent between 2019 and 2020, while the volume of currency in circulation increased by 9.9 per cent. Therefore, consumption-based and income-based transactional demand for money[1] (*Fisher 1912*) does not explain the recent major expansion in cash demand.

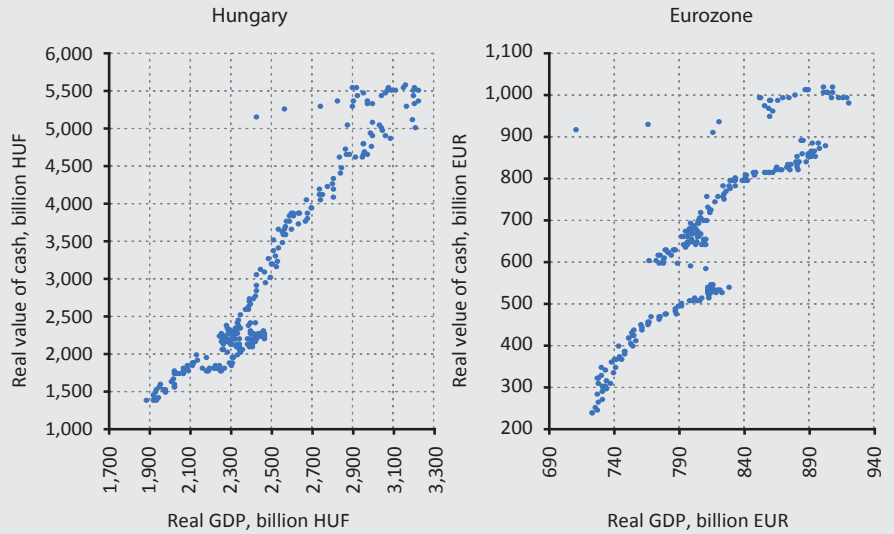
This study explores the motives for the cash demand for savings purposes, which is probably becoming increasingly important, although it cannot be observed directly. This issue is all the more significant because in order to formulated the appropriate policy measures for saving incentives or to influence the amount of cash in circulation, the factors shaping the cash demand for savings purposes should be established clearly.

Due to the highly sensitive nature of this topic, surveys do not yield reliable results with respect to the frequency and amount of cash savings. There are various methods for making an implicit determination of cash demand for savings purposes, such as examining the wear and tear of banknotes and the velocity of the denominations in circulation, or the comparison of electronic transactions and household consumption (*Végső 2020*). The method employed here is based on the approach used by *Dreger and Wolters* (*2009*). They argue that in an economy with stable payment preferences, there is only transactional demand for money, and one unit of income elasticity of cash demand, in other words the velocity of money, and its inverse, the cash holding ratio, are constant. But if the cash holding ratio is not constant, it implicitly expresses non-transactional demand for cash.

*Figure 1* illustrates the importance of cash demand in savings.

[1] It should be noted that Fisher does not simply mean cash but money in general, where the nominal demand for goods depends only on the amount of money in the economy.

**Figure 1**
**Development of the volume of cash and the real value of GDP in Hungary and the euro area, 2001–2022 and 2002–2022**



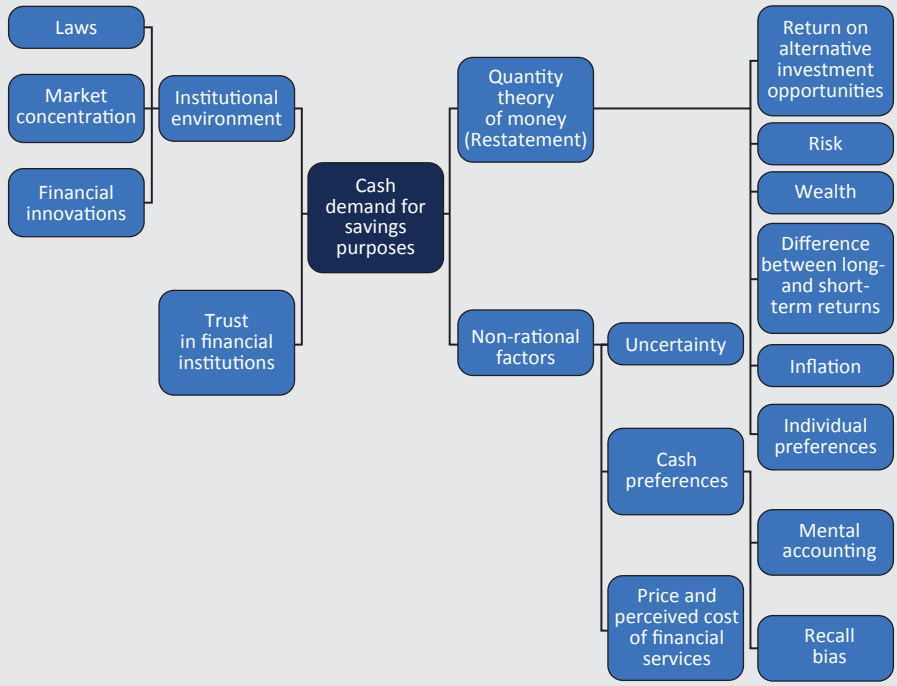

*Note: Monthly data, base year: 2010.*

*Source: Based on data from the Magyar Nemzeti Bank (central bank of Hungary, MNB), the European Central Bank (ECB) and the Hungarian Central Statistical Office (HCSO)*

*Figure 1* shows that the relationship between the real volume of cash and real income (real GDP) is far from stable, and that there are structural breaks in it, which underlines the importance of, and changes in, the cash demand for savings purposes. The structural breaks can be observed in Hungary between 2003 and 2004, in connection with the 2008 crisis and the recovery, along with the period after March 2020, whereas the euro area exhibits structural breaks due to the economic crisis of 2008–2009 and the 2020 Covid-19 crisis.

The evolution of the breaks and the different steepness of the sections in *Figure 1* are attributable to the factors affecting the cash demand for savings purposes, which are summarised in *Figure 2*, illustrating the conceptual model of the present study.

**Figure 2**
**Factors affecting the cash demand for savings purposes**




Cash holding preferences refer to the non-rational behaviour explaining savings held in cash, using a traditional economic approach. Households' financial decisions are often characterised by inconsistent and non-rational attitudes. These include mental accounting, where people set apart an amount of money for designated purposes. This is usually done in cash, because consumers find it easier to review and control their decisions in a material form, and overspending becomes more likely when opting for electronic payment methods (*Raghubir – Srivastava 2008*). The assessment of the different mental "accounts" also varies; it depends on the objective and the source as well (*Thaler 1985*). Another typical feature of non-rational consumer behaviour is when economic actors stick with unreasonable habits to justify an earlier decision. According to the recall bias, unusual, extraordinary events are perceived to be more frequent than they actually are. That is why earlier negative experiences and news related to the financial sector continue to have an effect for decades (*Hámori 2003*).

The evolution of the transaction costs of financial services can also lead to non-rational behaviour, if losses are felt more than the potential gains realised on an investment. In such a scenario, rising prices reduce the demand for other investment opportunities, due to loss aversion. An increase in the relative price of financial services may encourage households with relatively low savings to keep their accumulated assets in cash instead and thus avoid transaction costs. *Hicks* (*1935*) uses the cost of financial services in a broad sense, including both the actual and the alternative cost.

The above non-rational attitudes were also confirmed by a representative survey of the MNB conducted in 2022 among the Hungarian adult population. According to the results, 68 per cent of the population believed that many people held their savings in cash because they had had negative experiences with banks, and 60 per cent of respondents thought that cash was a good way of collecting money for a designated purpose. Furthermore, 65 per cent agreed that those with low savings did not benefit from keeping their money in a bank. *Belházyné Illés et al.* (*2018*) also underline that even among micro, small and medium-sized enterprises, using cash is a deep-seated attitude in certain situations.

In connection with cash holding preferences, it is also worth mentioning that Hungarian households' indebtedness increased significantly between 2004 and 2008. The 2008 FX loan crisis placed a huge burden on households, as even in late 2007 they spent 13 per cent of their disposable income on repayments and 40 per cent of debtors had low income in 2010. As a result of the negative experiences, households' loan demand fell after the crisis and so did their confidence in banks. This led to a greater use of cash among low-income earners, who financed their various livelihood crises from cash after the Great Recession (*Gosztonyi 2017*). This was confirmed in the survey results by *Horn and Kiss* (*2019*), who found that income, occupation and place of residence all have significant explanatory power for having a bank account and a bank card and thus also indirectly cash use. *Deák et al.* (*2021*) and *Végső et al.* (*2018*) showed that age, educational attainment and income are also key when it comes to choosing between methods of payment, and they also affect individuals' banking and bank card holding.

Uncertainty, first emphasised by *Keynes* (*1965*), is crucial in monetary theory. In an economic sense, uncertainty and risk are not synonymous, because in the latter case the probability of the outcomes is known. If economic processes were only influenced by risk, the future would be predetermined in the sense that all possible outcomes and the corresponding probabilities were known. But when it comes to uncertainty, the future is a set of unprecedented outcomes, because the potential outcomes and their probabilities are all unknown, and past trends do not give an indication of the future.

In uncertainty, decision-makers either avoid decision situations due to the lack of knowledge, or, giving in to their "animal spirit", they dive into an activity without second thoughts. The Keynesian uncertainty theory explains the type of behaviour when in the event of economic and social crises people want to acquire cash even at the expense of great losses, and the velocity of money declines (*Szepesi 2013*). In the absence of information, when making their decisions, people rely on the behaviour of the majority or the average, which leads to a conventional or common view of a situation (*Bélyácz 2013*). The spillover effect of a negative experience on other decision-makers is highlighted, among others, by *Kiss et al.* (*2018*) in connection with bank runs. In an uncertain situation with a lack of information, the urge to act is triggered by fear, anxiety and stress. The impulsiveness of action is also influenced by social media. This was seen during the waves of panic buying at the onset of the Covid-19 pandemic (*Omar et al. 2021*). The hoarding drive of households was a response to a sudden and unprecedented situation. But it did not involve just consumer goods alone, as cash demand also rose considerably. In connection with cash holding preferences, *Hicks* (*1935*) points out the time required to adjust to the new circumstances, which is partly due to the lack of information, and it should also be taken into consideration.

*Rösl and Seitz* (*2021*) also analysed the effect of uncertainty on cash demand, examining the evolution of the cash in circulation during Y2K, the Great Recession and the Covid-19 crisis. They found that the uncertainty caused by the crises they reviewed exerted a special shock on the demand for large denomination banknotes, and in such critical periods cash functions as a sort of public insurance service. This is because possessing and quickly accessing cash during the turbulent periods caused by a crisis helps mitigate the panic among the public, thereby facilitating stabilisation.

According to the new quantity theory of money, cash demand depends on wealth, personal preferences, the expected inflation rate and the yields of various alternative assets. Wealth includes assets in a broad sense, for example human capital, so there is low fungibility between the different types of wealth. Cash demand increases with wealth if the yield on other assets or the expected inflation drops. In the new quantity theory of money, the adjustment process of the wealth portfolio is the transmission mechanism between the amount of money and the price level (*Friedman 1986*). However, shifts in the prices of alternative assets may have a different effect on cash demand, because when asset prices rise significantly, household demand for cash increases because their wealth also expands. But higher asset prices could also dampen money demand (*Dreger – Wolters 2009*).

Finally, the role of institutions should also be highlighted as a factor influencing cash demand. In a broad sense, the institutional infrastructure includes the legal environment and the development of economic activities and financial services. The development of services is often related to technological progress, which may boost the profitability of financial services. Financial market innovations lead to a proliferation in cash alternatives and thus also an increased velocity of money. The evolution of institutions affects the equilibrium of financial markets and the effectiveness of economic policy, especially the achievement of inflation targets (*Minsky 1957*). *Miller* (*1991*) points out the effect exerted by financial innovations and deregulation processes on cash demand. *Bordo et al.* (*1997*) showed how the changes in financial institutions and also the structural changes in the economy affect the velocity of money. The effect of institutional changes on the velocity of money was also emphasised by *Kim* (*2014*). *Wasiaturrahma et al.* (*2019*) examined the volume of cash as a function of electronic means of payment (credit card, debit card) and the frequency of electronic payments, finding that the rise in the number of credit cards held by households has a negative effect on cash holdings, while an increase in the number of debit cards exerts a positive effect. *Laidler* (*1999*) demonstrated that institutional changes lead to an instability of the demand for money in the narrow sense.

The institutional environment is interpreted in a broader sense in this study. In particular, the correlations in society and the economy cannot be determined independently of space and time (*Csaba 2021*). In connection with the cash demand for savings purposes, three main factors in the development of the institutional system are highlighted. First, there is the way that financial markets are shaped directly by regulators. Recent policy measures have focused on expanding the use of electronic solutions. In Hungary these include the introduction of the instant payment system or the fact that from 1 January 2021 retailers using an OCR (online cash register) are required to offer at least one electronic payment solution. Another group of interventions, such as the introduction of the financial transaction levy and industry-specific taxes, along with free-of-charge withdrawal twice a month, regulate the market and optimise budget revenues. And the third, final group is the proliferation of financial innovations due to the relationship between institutions and technology. Such financial innovations include the rise of chip cards enabling tap-and-go payment and the appearance of FinTech firm services.

Another important factor related to institutions is seen in the evolution of the market structure. In the past decade, concentration in the market share of financial institutions has increased in Hungary, driven by acquisitions as well as the bankruptcies among regional credit institutions in 2014, when the operating licence of six institutions were withdrawn by the central bank due to insolvency.

Takarékbank became a legal successor to the regional credit institutions and FHB, which contributed to the growing concentration, along with the merger between MKB and Budapest Bank in March 2022.

The factors influencing cash demand also include activities in the non-observed economy (*Belházyné Illés – Leszkó 2017*). *Sisak* (*2011*) confirmed that the cash demand in the non-observed economy has a major impact on total cash demand, although this could not be quantified with his model.

The non-observed economy comprises numerous activities, a detailed and complete accounting of which, broken down by activity, is required in the national accounts, in accordance with ESA2010 (European System of National Accounts 2010). The appropriateness of the calculations is regularly verified by Eurostat on behalf of the European Court of Auditors. This means that Hungarian and euro area GDP data include the value added of non-observed activities. In Hungary, the non-observed economy accounted for 14.9 per cent of GDP in 2005, more than half, 57.7 per cent, of which, was due to tax evasion, and only 6.5 per cent of which was generated from illegal activities, for example drug trafficking and prostitution (*Murai – Ritzlné Kazimir 2011*).

The Hungarian government has introduced several measures since 2012 to combat tax evasion. To name but a few, the domestic recapitulative statement was introduced, just like the reverse charge of VAT, the obligatory use of online cash registers and the EKÁER system. The effectiveness of the measures is attested by the evolution of the VAT gap as measured on behalf of the European Commission and the estimation of VAT evasion using tax audit data, according to which VAT evasion peaked in 2011 at around 30 per cent relative to the total expected revenue, before dropping to 6.6 per cent by 2019 (*Ritzlné Kazimir – Máténé Bella 2020*; *EC 2021*). Thus, the decline in tax evasion could not have generated the massive rise in cash demand.

The present study ignored the cash demand-generating effect of the non-observed economy, mainly because the target variable was the cash holding ratio, and its calculation was not based on income from labour statistics but on GDP, precisely in order to take into account all primary income in the national economy, including income from the non-observed economy, when adjusting for the effect of the transactional demand for money.

The study examines the evolution of the cash demand for savings purposes and the factors affecting it in Hungary and the euro area. The paper follows the methodology of *Dreger and Wolters* (*2009*) and wishes to focus its examination and therefore looks at the cash demand for savings purposes and its main factors by calculating

the cash holding ratio and filtering out the transactional demand for money from cash demand and expanding the theoretical framework of the analysis.

## 2. Data

In collecting the data, a monthly database was compiled for Hungary and the euro area between 2000 and September 2022. However, some data were missing for this period, and the introduction of euro in the form of cash in January 2002 also limited the horizon of the analysis. The sources included data published on the websites of Eurostat, ECB, HCSO, MNB, and one time series was downloaded from the search data from Google Trends.

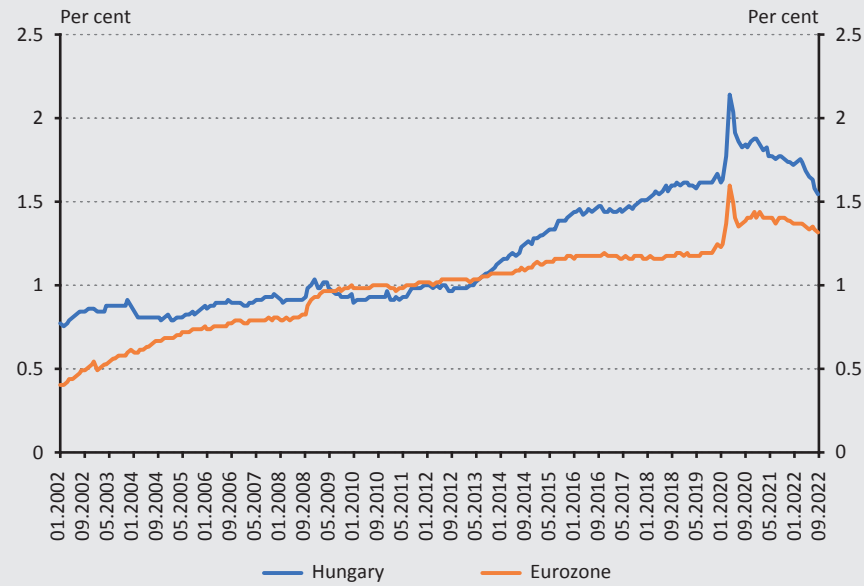
When selecting the indicators, the cash holding ratio was calculated from the seasonally and calendar-adjusted amount of cash in circulation[2] and – in the case of the Hungarian data – from seasonally adjusted time series of cash other than at monetary financial institutions[3] and in the course of this the proxy of real income was considered to be the chain-linked GDP (reference year 2010).[4] This was chosen because it contains entrepreneurial and capital income as well as the income generated in the non-observed economy. However, GDP is only available with a quarterly frequency, so it was broken down into a monthly time series with the Chow–Lin method, and the indicator series was the volume index of seasonally adjusted monthly industrial production compared to the average of 2015[5] (*Sax – Steiner 2013*).

When determining the nominal income time series, the consumer price index[6] was used instead of the GDP deflator, because the consumer value of real income was to be established. The GDP deflator is not suitable for this purpose, as the implicit price index of GDP is derived on the production side through a double deflation of the price index of goods and current expenditure, and on the output side as the aggregate result of the price indices of various final consumption items. For example, foreign trade price indices considerably influence the GDP deflator. Using the consumer price index instead of the GDP deflator is quite common; see, for example, *Sorensen – Yosha* (*2007*). The consumer price index was the basis for

[2] *Currency in circulation reported by MFIs, central government and POGIs in the euro area (stocks)*: https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=117.BSI.M.U2.Y.V.L10.X.1.U2.2300.Z01.E&periodSortOrder=ASC
[3] *Balance sheets of monetary financial institutions and monetary aggregates*: https://statisztika.mnb.hu/statistical-topics/balance-sheets-of-financial-institutions/monetary-and-other-balance-sheet-statistics/press-release---other-monetary-financial-institutions
[4] *GDP and main components (output, expenditure and income)*: https://ec.europa.eu/eurostat/databrowser/view/NAMQ_10_GDP__custom_7214506/default/table?lang=en
[5] *Industry – monthly data – index (2015 = 100) (NACE Rev. 2)*: https://ec.europa.eu/eurostat/databrowser/view/EI_ISIN_M__custom_4370627/default/table
[6] *HICP – monthly data (annual rate of change)*: https://ec.europa.eu/eurostat/databrowser/view/PRC_HICP_MANR__custom_4368815/default/table

calculating consumer price indices relative to the previous year's average ($HICP_t$), which was then used to calculate the nominal income time series with chain-linking (*Anwar – Szőkéné 2008*). The cash holding ratio was derived as the volume of cash relative to nominal income. The cash holding ratio in Hungary and the euro area is presented in *Figure 3*.

**Figure 3**
**Development of the cash holding ratio in Hungary and the euro area**



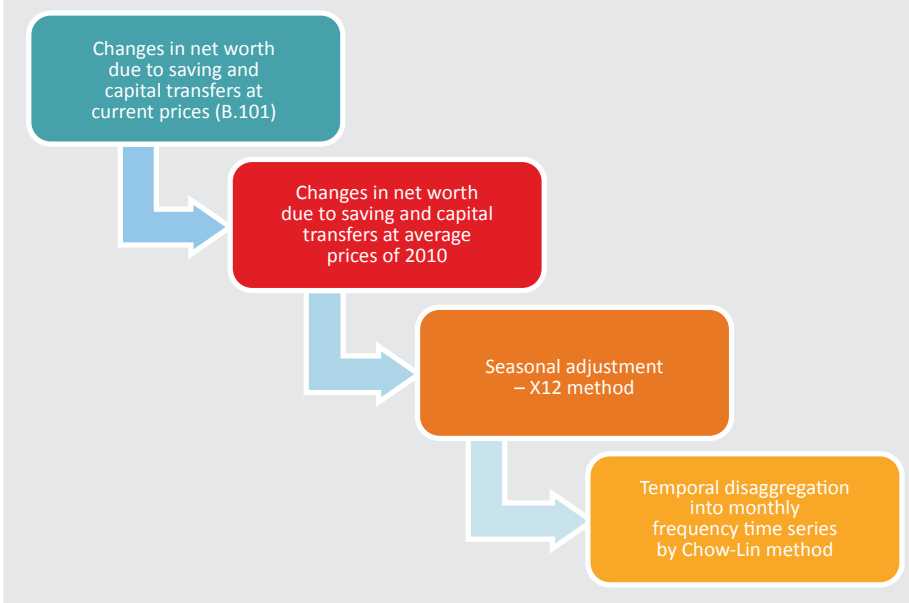

*Source: Calculated based on MNB, ECB and Eurostat data*

The Hungarian cash holding ratio was always higher than the euro area value, with the exception of the years of the 2008 economic crisis. The start of the crisis lifted both cash holding ratios under review in October 2008, and the onset of the first wave of the Covid-19 pandemic triggered a panic, with an unprecedented spike in both Hungary and the euro area.

The change in wealth was approximated with an indicator called the "changes in net worth due to saving and capital transfers" published for households and non-profit institutions serving households within the national accounts. However, this is only available at current prices and with a quarterly frequency.[7]

First, the current price time series was transformed into a 2010 average price by chain-linking. Choosing the appropriate price index posed dilemmas because the real change in wealth should ideally be calculated from the weighted price index of wealth items. Unfortunately, no such price index is available, and thus the consumer price index was chosen. After this, seasonal adjustment was performed with the X12 procedure. Finally, the quarterly time series was broken down into a monthly one. No monthly indicator time series is available for temporal disaggregation of the change in real wealth, and so the broken-down real GDP time series was used during the Chow–Lin MaxLog method. The calculation is shown in *Figure 4*.

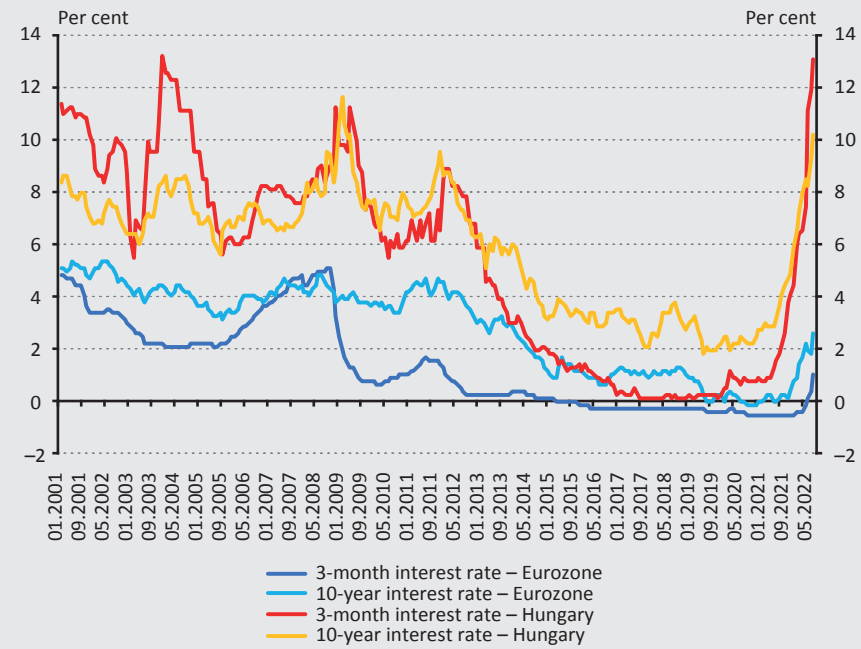
**Figure 4**
**Steps of calculating the monthly time series of net wealth**




[7] *Non-financial transactions – quarterly data*: https://ec.europa.eu/eurostat/databrowser/view/NASQ_10_NF_TR__custom_5605323/default/table
*The quarterly non-financial sector accounts of national economy*: https://statinfo.ksh.hu/Statinfo/themeSelector.jsp?&lang=en

With respect to yields, 3-month and 10-year benchmark rates were used for the Hungarian economy,[8] and the 3-month EURIBOR and 10-year interbank rate was used for the euro area.[9] The rates are presented in *Figure 5*.[10]

**Figure 5**
**Development of 3-month and 10-year interest rates**




*Source: Based on MNB and ECB data*

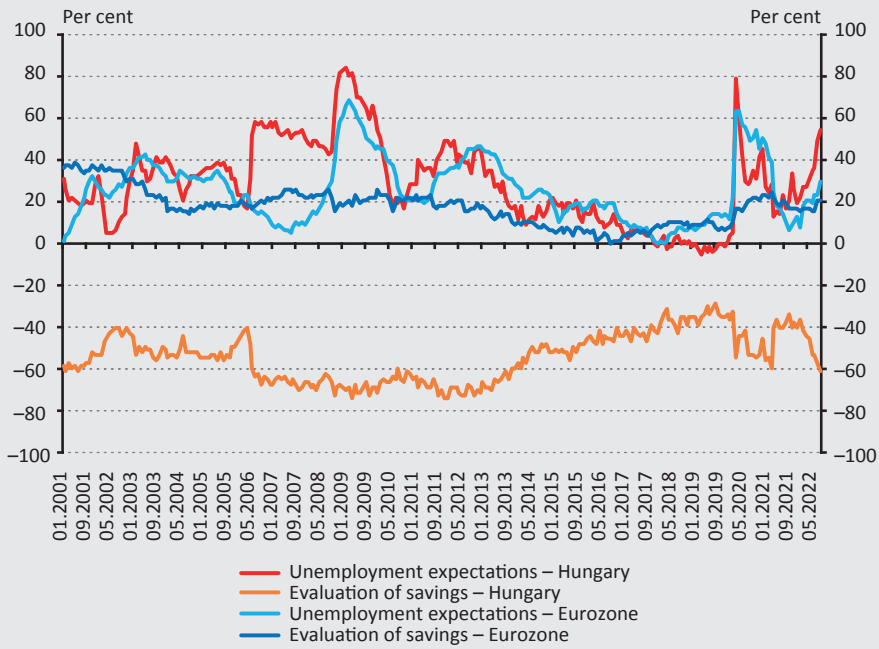
[8] *Benchmark yields on government debt securities*: https://statisztika.mnb.hu/timeseries/data-6559

[9] *Long-term interest rate for convergence purposes – 10-year maturity, denominated in euro – Euro area 19 (fixed composition) as of 1 January 2015*: https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=229.IRS.M.I8.L.L40.CI.0000.EUR.N.Z&periodSortOrder=ASC
*Euribor 3-month – Historical close, average of observations through period:* https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=143.FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA&periodSortOrder=ASC

[10] In connection with Hungarian interest rates, the peak at the end of 2003 deserves special mention, which was influenced by the FX liberalisation process that ended in 2001. This was the time when the forint became fully freely convertible, which, compounded by the deficit produced by the fiscal expansion in 2002, caused major problems. The government urged the devaluation of the forint, citing the deteriorating competitiveness of exporters. In the end, the Monetary Council approved the shift in the forint's exchange rate band on 4 June 2003. This decision surprised market participants, and it was followed by the depreciation of the forint, rising inflation and thus an increasing interest rate. The ensuing financial crisis called for fiscal consolidation. Among other measures, the scope of the subsidised housing loan programme was reduced at the end of the year. Together with the high interest rates, this measure made foreign currency loans attractive to households, which was one of the main reasons behind the falling income after the 2008 crisis. The next peak in interest rates was related to the Great Recession, followed by the second interest rate peak during the W-shaped recovery. Finally, Hungary experienced another change in the interest rate path after the start of the Covid-19 crisis, and the rise in interest rates that began then had come close to the 2003 peak by 2022 Q3.

Subjective uncertainty and the risk of investments was involved in the analysis on the basis of the Keynesian theory. These factors were measured with indices chosen from a range of items in the Economic Sentiment Indicator (ESI).[11] Uncertainty is reflected in the unemployment expectations for the subsequent 12 months,[12] while risk is mirrored by the perception of the current saving options.[13] *Figure 6* contains these indicators.

**Figure 6**
**Expectations of unemployment and assessment of savings, ESI indices**




*Source: Edited on the basis of Eurostat data*

There is much more variation in the perception of the saving situation in Hungary than in the euro area. Until 2014, savings were usually seen more favourably around elections. From 2013, related to the rise in household wealth, savings were steadily assessed in a more positive light. Slumps came during the Covid-19 crisis and during the war that started in February 2022, as well as the ensuing energy crisis. The

[11] The ESI is based on monthly business and household surveys conducted by the European Commission. The Hungarian data are surveyed by GKI Gazdaságkutató Zrt. The consumption survey is available at: https://ec.europa.eu/info/sites/default/files/questionnaires_hu_cons_hu.pdf, and data are available here: https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/business-and-consumer-surveys/download-business-and-consumer-survey-data/time-series_en

[12] Question 7 in the questionnaire asks: How do you expect unemployment to change over the next 12 months? (1. fall sharply, 2. fall slightly, 3. remain the same, 4. increase slightly, 5. increase sharply)

[13] Question 10 in the questionnaire asks: In the current economic situation, do you think that: (1. the situation is very unfavourable for saving, 2. fairly unfavourable for saving, 3. favourable for saving, 4. very favourable for saving)

perception of savings was more balanced in the euro area. The attitude towards saving opportunities was only dampened slightly after the 2008 crisis.

The index measuring the unemployment outlook, which reflects uncertainty, also varies more widely in the Hungarian data. In the first section of the time series, uncertainty fluctuates significantly in the election years until 2010. Other than this, the 2008 crisis and the downturn in 2011–2012 caused larger swings. After that, uncertainty steadily declined until the beginning of the Covid-19 crisis in 2020, when it almost reached the 2008 levels in March, before remaining permanently high. In the euro area, the uncertainty caused by the unemployment outlook did not cause such variation in the period under review, but the 2008 crisis, the 2012 downturn and the Covid-19 lockdowns raised uncertainty considerably.

The real effective exchange rate is equal to the purchasing power of the nominal effective exchange rate – i.e. the weighted nominal exchange rate of trading partners – relative usually to the average of a fixed year, and shows the opportunity cost of holding cash in the domestic currency. It is calculated by using the consumer price index or other price indices, for example the producer price index. In the euro area, the real effective exchange rate is an indicator of the euro demand for non-residents, while in the case of the forint it shows the domestic reserve demand of foreign currencies (*Fischer et al. 2004*). The incorporation of this indicator was necessitated by foreign demand and the FX demand replacing domestic currency holdings.[14]

Inflation cannot be included in the model, because the consumer price index has already been used to calculate the cash holding ratio. However, the standard deviation of the consumer price index is a good indicator of the fluctuations in inflation (*Fischer et al. 2004*). The indicator, in other words the variability of price levels, points to the instability of the inflationary environment, and as expected a rise in standard deviation reduces the cash holding ratio. Fischer et al. used the standard deviation of inflation data from the previous four years in their model.

The consumer price index of financial services was also included in the analysis.[15] The price of financial services determines the demand for fungible financial products (*Arango-Arango et al. 2018; Alvarez – Lippi 2017*), and its evolution serves as a non-rational motive for cash holding.[16] In Hungary, consumer prices of financial services

[14] *Forint nominal effective and real effective exchange rate indices*: https://statisztika.mnb.hu/timeseries/data-6526

[15] *HICP – monthly data (annual rate of change) – Financial services*: https://ec.europa.eu/eurostat/databrowser/view/PRC_HICP_MANR__custom_4368963/default/table

[16] According to the COICOP (Classification of Individual Consumption by Purpose) nomenclature for the goods and services purchased by households, the price index of financial services includes the following services: "Account servicing, bank cards, credit cards, loans, savings fees, money transfer, wire transfer fees and other savings bank fees, the management fee of private pension funds", along with "financial investment advice and tax advisory fee, and the transaction costs of brokers and real estate agencies, etc." (*HCSO 2019: p. 84*). This means that the price index also includes the cost of savings, lending and payments.

rose by 250 per cent between 1 January 2001 and September 2022, with average annual growth of 5.4 per cent between 2001 and 2021. In the same period, the average annual growth of consumer prices was 3.7 per cent. The rise in the price of financial services was strongly influenced by the introduction of the financial transaction levy on 1 January 2013, which was raised from 0.1 per cent to 0.3 per cent on 1 August 2013. As a result, the price of financial services increased by 36 per cent in one year. The price increase was realised not only in January and August, because some banks passed on the financial transaction levy in their fees in the months following the introduction and the hike. Furthermore, other financial items, such as account servicing and bank card fees also rose over the course of the year (*HCSO 2014*).

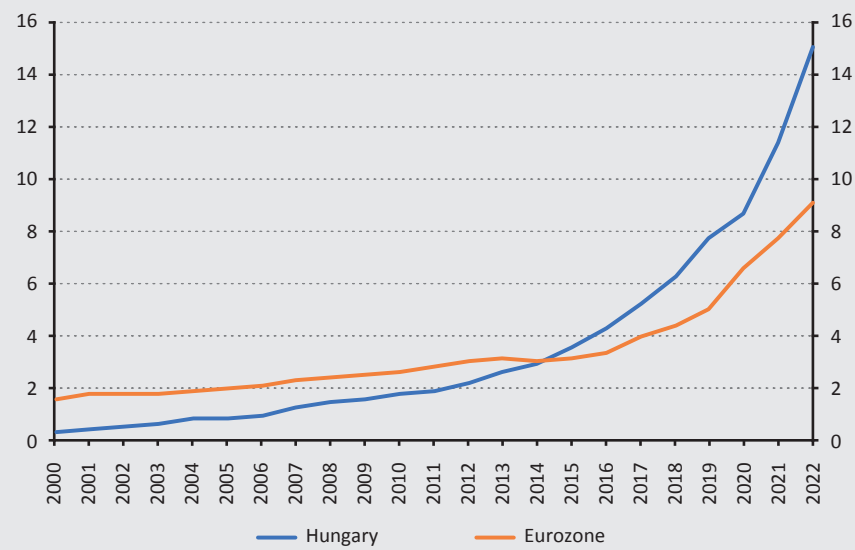
At the same time, the financial services price index in the euro area was 99 per cent of the January 2001 levels in September 2022. However, this does not mean that it remained flat throughout this period: it declined slightly until the onset of the financial crisis, then stagnated until early 2012, and fell by around 10 per cent in 2012. This may have been related to the supervisory and regulatory steps necessitated by the contraction in the balance sheet total in the EU's banking system, and to the Greek bailout package and the ECB's liquidity measures (*MNB 2012*). The price of financial services in the euro area remained more or less unchanged until 2018 and then started to rise somewhat from 2018.

A detailed analysis of institutional changes is beyond the scope of this paper, due to the complexity of how the three dimensions mentioned in the previous chapter, namely policy, regulation and market structure, evolved, and to the extent of the study's time horizon. However, since the paper focuses on the cash holding ratio, it is argued that the institutional changes are implicitly reflected in the changes of the payments infrastructure. It should be emphasised that the change in the infrastructure is influenced by the change in payment habits, which in this interpretation can also be regarded as a proxy for the transactional demand for money. The examination also involves the euro area, and accordingly variables describing the payments infrastructure were sought that were available for both areas. The collected dataset contains the following variables: number of terminals and transactions conducted through terminals (ATM and POS), over-the-counter cash withdrawals in bank branches, the number of POS transactions conducted with cards issued domestically, the number of domestically issued bank cards, and the number of wire transfers and bank branches.

The evolution of the institutional environment in Hungary and the euro area exhibits several similarities. The number of ATMs had already previously reached its maximum level in both cases, in 2017 in Hungary and in 2014 in the euro area. Since then, it has been on the decline: at the end of 2021 it stood at almost double the end-2000 figure in Hungary and it was 40 per cent higher than the end-2000 figure

in the euro area. The number of POS terminals rose in the period under review. By the end of 2021, it had increased by 740 per cent and 400 per cent compared to end-2000 in Hungary and the euro area, respectively. The turning points came earlier in Hungary in the number of transactions. As regards over-the-counter cash withdrawals, most transactions were conducted in 2002, before diminishing steadily after that. As the number of over-the-counter cash withdrawals contracted, ATMs were on the rise until 2011, but after that the number of transactions consistently decreased. At the same time, the number of POS transactions increased dynamically, up until the end of the period. This occurred later in the euro area, where over-the-counter cash withdrawals peaked in 2009, and ATM cash withdrawals did so in 2015. The dynamic institutional development in Hungary is also demonstrated by the fact that the share of wire transfers within all transactions was steadily declining from the start of the period, while in the euro area this indicator reached its highest point in 2009.

**Figure 7**
**POS card purchases per ATM cash withdrawal**




*Note: Number of ATM cash withdrawals with cards issued by resident PSPs – at terminals provided by resident PSPs – from euro area (changing composition): https://data.ecb.europa.eu/data/datasets/PSS/PSS.A.U2.F100.I10.I111.NT.X0.20.Z0Z.Z*
*Number of POS transactions with cards issued by resident PSPs - at terminals provided by resident PSPs – from euro area (changing composition): https://data.ecb.europa.eu/data/datasets/PSS/PSS.A.U2.F000.I10.I200.NT.X0.20.Z0Z.Z*
*Number of ATM cash withdrawals with cards issued by resident PSPs – at terminals provided by resident PSPs – from Hungary: https://data.ecb.europa.eu/data/datasets/PSS/PSS.A.HU.F100.I10.I111.NT.X0.20.Z0Z.Z*
*Number of POS transactions with cards issued by resident PSPs – at terminals provided by resident PSPs – from Hungary: https://data.ecb.europa.eu/data/datasets/PSS/PSS.A.HU.F000.I10.I200.NT.X0.20.Z0Z.Z*

*Source: Calculation based on ECB data*

*Figure 7* shows the number of POS transactions per ATM withdrawal. These two time series provide a good overview of the developments in Hungary and the euro area. In the Hungarian payment system, the ratio of POS transactions to ATM withdrawals was lower than in the euro area in the early 2000s, but the payments infrastructure has undergone a dynamic transformation since then. Since 2015, the number of POS transactions per ATM transaction has been consistently higher than in the euro area. This was influenced by the development of the infrastructure, affected by policy and regulatory measures, as well as by the market structure of financial institutions and payment habits.

It is quite difficult to capture institutional change with a single time series, and it can be derived as a latent variable produced as the aggregate impact of the above processes. The number of POS card purchases per ATM withdrawal is available with an annual frequency, which was broken down into monthly frequency with the Chow–Lin method, for which no indicator series was used.

Nevertheless, the overall transformation of the institutional environment is not fully captured by the above indicator. Therefore, an index of the searches for "Magyar Közlöny" (Hungarian Official Journal) was downloaded from Google Trends. The frequent transformation of the legal environment affecting several areas increases uncertainty and thus promotes the growth in cash holding. The primary source for tracking the changes in Hungarian laws is the Hungarian Official Journal. The frequency of the change in the legal environment and the importance of the new or amended laws can be approximated with Google Trends data for the corresponding search term. Of course, this index series does not directly measure the change in the complexity of the legal environment, it merely acts as a proxy. The Google Trends data series was cumulated, because this indicator is thought to offer a good approximation of the evolution of the legal environment's complexity. The benefits of using Google Trends data in econometric models was already pointed out by *Choi – Varian* (*2012*).

## 3. Methodology

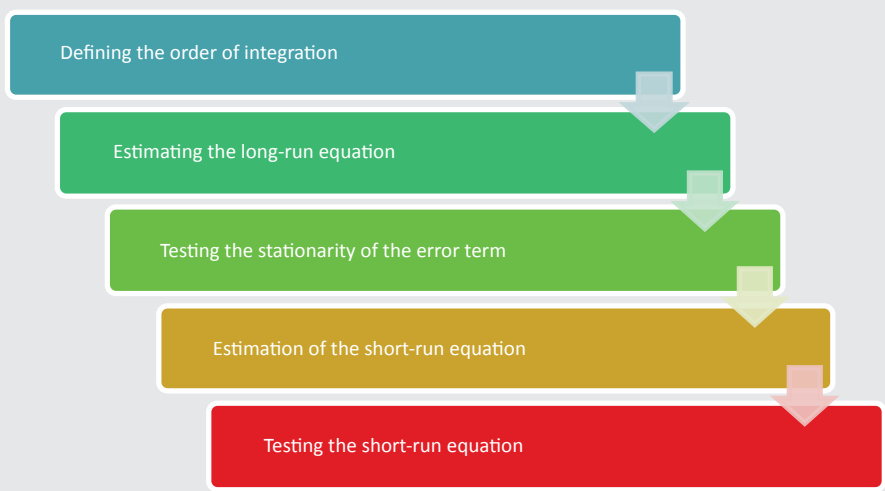
In the modelling, it was assumed that the long-run development of the cash holding ratio and the variables determining the cash demand for savings purposes is kept close to each other by an equilibrium mechanism. In the present case, it is the long-run equilibrium of the cash demand for savings purposes in the sense that the right side of the long-run correlations (see Equation (*1*) and (*2*)) can be considered the relative cash demand for savings purposes. The temporary adjustment of the deviations from the equilibrium occurs in the subsequent periods. These processes can be modelled with the error correction model, for which two equations need to be estimated. The first assumes the existence of time series that move close to

each other on an equilibrium path in the long run. The variables are then around the actual equilibrium path, and some market mechanism pushes the time series back towards the equilibrium path after the temporary deviations. An equation fitted on such processes models the long-run equilibrium, and the estimation error refers to the deviation from the equilibrium. This can also be seen as the speed of short-term adjustment, and it is used as an explanatory variable in the short-run equation written for the differences in the original variable. If the equilibrium concept is relevant, there are no major deviations from the equilibrium (*Engle – Granger 1987*).

In the long-run equation, the time series are not stationary, and the order of their integration is the same. A time series is considered stationary if the covariance between $y_t$ and $y_{t-s}$ only depends on $s$, and it is independent from $t$, and the correlation between the time series and its lagged version is independent from the beginning of the time series. This also means that the variance of error terms is constant, $\mathrm{Var}(u_t) = \mathrm{Var}(u_{t-s})$, if $s > 0$, the given time series has no trend, seasonality, and its autocorrelation structure remains constant over time. Stationary time series are considered to be integrated of order 0 and are denoted as I(0). If a time series can be made stationary through differentiation, it is called a series integrated of order one [I(1)]. The error correction model ensures the connection between the two horizons (*Miller 1991*).

The steps of fitting the model are presented in *Figure 8*.

**Figure 8**
**Steps of fitting the error correction model**




*Source: Based on Engle – Granger (1987)*

When quantifying the institutional changes, the general-to-specific method by *Hendry* (*1995*) was employed.

The following long-run equations were estimated for the Hungarian and euro area cash holding ratios:

$$\log(k_{EU,t}) = \gamma_{EU} + \beta_{EU,1}\log(nw_{EU,t}) + \beta_{EU,2}sr_{EU,t} + \beta_{EU,3}lr_{EU,t} + \beta_{EU,4}esiu_{EU,t} + \beta_{EU,5}\log(reer_{EU,t}) + \beta_{EU,6}inst_{EU,t} + \beta_{EU,7}D1 + \beta_{EU,8}D2 + ect_{EU,t} \quad (1)$$

$$k_{HU,t} = \gamma_{HU} + \beta_{HU,1}\log(nw_{HU,t}) + \beta_{HU,2}sr_{HU,t} + \beta_{HU,3}lr_{HU,t} + \beta_{HU,4}rir_{HU,t} + \beta_{HU,5}esiu_{HU,t} + \beta_{HU,6}\,reer_{HU,t} + \beta_{HU,7}inst_{HU,t} + \beta_{HU,8}\log(cpisd_{HU,t}) + \beta_{HU,9}cpik_{HU,t} + \beta_{HU,10}MK_{HU,t} + \beta_{HU,11}D2 + ect_{HU,t} \quad (2)$$

where *k* is the cash holding ratio, *nw* is the change in net wealth, *sr* is the 3-month interest rate, *lr* is the 10-year rate, *esiu* is unemployment, and *cpik* is the consumer price index of financial services. In the equations, *reer* denotes the real effective exchange rate, *inst* is the number of POS transactions per ATM transaction, *MK* refers to the cumulative Google Trends results for the search term "Magyar Közlöny" (Hungarian Official Journal), *cpisd* is the standard deviation of inflation in the 18 months preceding the relevant period, and *rir* shows the ratio of short- and long-term interest rates. Finally, *D1* is the dummy for the crisis between October 2008 and December 2011, while *D2* denotes the levelshift outlier due to the Covid-19 pandemic that began in April 2020. $ect_{EU,t}$ and $ect_{HU,t}$ are error terms in the long-run equation, representing the deviation from the equilibrium path, the lagged value of which is incorporated into short-run equations (3) and (4).

Short term correlations are presented in equations (*3*) and (*4*).

$$dlog(k_{EU,t}) = c_{EU} + \alpha_{EU,1}dlog(k_{EU,t-3}) + \alpha_{EU,2}dlog(nw_{EU,t}) + \alpha_{EU,3}d(sr_{EU,t-1}) + \alpha_{EU,4}d(esiu_{EU,t-1}) + \alpha_{EU,5}D3 + \alpha_{EU,6}D4 + \alpha_{EU,7}D5 + \alpha_{EU,8}D7 + \alpha_{EU,9}D8 + \alpha_{EU,10}D9 + \alpha_{EU,11}D10 + \alpha_{EU,12}D11 + \alpha_{EU,13}ect_{EU,t-1} \quad (3)$$

$$d(k_{HU,t}) = c_{HU} + \alpha_{HU,1}d(k_{HU,t-1}) + \alpha_{HU,2}d(sr_{HU,t-3}) + \alpha_{HU,3}d(esiu_{HU,t}) + \alpha_{HU,4}d(MK_{HU,t}) + \alpha_{HU,5}D6 + \alpha_{HU,6}D7 + \alpha_{HU,7}D8 + \alpha_{HU,8}D10 + \alpha_{HU,9}D11 + \alpha_{HU,10}D12 + \alpha_{HU,11}D13 + \alpha_{HU,12}D14 + \alpha_{HU,13}ect_{HU,t-1} \quad (4)$$

where the meaning of the variables is the same as in the long-run equation, and *α* shows the estimated values of the parameters. *Di*, *i* = 3,…,14 denote the additive outliers in the short-run model.

## 4. Results

Due to the availability of data, the error correction model was fitted on the period between January 2004 and September 2022 for the cash holding ratios of both currencies. The first step in the error correction methodology chosen here is the testing of the stationarity of the incorporated variables, using the ADF (augmented

Dickey–Fuller) test. The tests were performed with a constant and trendless specification, determining the order of integration of the variables included in the analysis. The null hypothesis of the ADF test is that the variable follows a unit root process. The test results are presented in *Table 3 of the Annex*, which shows that the variables involved in the analysis follow an I(1) process, with the exception of the Google Trends "Magyar Közlöny" search index, at a 1 per cent significance level.

The long-run equations were fitted on the original variables, before calculating their error terms and testing the stationarity of the error term. The parameters of the variables, the statistics describing the fit of the equations and the error term's ADF test results are shown in *Table 1*.

The parameters of the long-run equation largely were in line with our hypothesis. The rise in wealth reduces the cash holding ratio in the long run, and the long-term interest rate and the euro short-term rate have the same effect. Although judging from the parameters the relationship between the short-term interest rate and the forint cash holding ratio seems to be unidirectional, there is a negative correlation between the two variables. The positive parameter is due to the fact that on account of the multicollinearity arising from the ratio between the short- and long-term interest rates this parameter cannot be interpreted in itself.

In case of short- and long-term interest rate ratio variable was applied instead of difference, because the difference between short- and long-term rates foreshadows how short-term rates will evolve in the future. The models describing money demand usually use the difference between the interest rates as an explanatory variable, but here their ratio was chosen because we assume that the relationship between the difference and the cash holding ratio is not linear. The interest ratio variable has no expected sign. The correlation to cash holding is usually negative, because higher long-term interest rates suggest higher short-term rates in the future. But its sign can also be determined by the relative return on the series of future short-term interest rates as well as by inflation expectations (*Friedman 1977*). In Hungary, the variable is negatively correlated with the cash holding ratio.

Higher unemployment expectations point towards greater uncertainty and result in a larger cash holding ratio in the euro area. In Hungary, the long-run negative correlation is attributable to the relationship between the unemployment outlook and falling income. The ESI index signalling risks and measuring savings opportunities was not significant in any of the long-run models. As a result of real depreciation, the opportunity cost of forint and euro cash holding increases, which leads to lower cash holdings.

**Table 1**
**Parameters of the long-run equations**

| Variable name | Hungary | | | Euro area | | |
|---|---|---|---|---|---|---|
| | Variable | Parameter | t-statistics | Variable | Parameter | t-statistics |
| Cash holding ratio – dependent variable | k | | | log(k) | | |
| Constant | γ | 2.080 | 16.989*** | γ | 1.891 | 5.136*** |
| Change in net wealth | log(nw) | –5.200 | –4.461*** | log(nw) | –26.765 | –26.858*** |
| 3-month interest rate | sr | 0.076 | 11.471*** | sr | –0.007 | –3.5*** |
| 10-year interest rate | lr | –0.087 | –16.657*** | lr | –0.039 | –6.85*** |
| Ratio of 3-month to 10-year interest rates | rir | 0.002 | 6.682*** | | | |
| ESI – unemployment expectations | esiu | –0.546 | –14.119*** | esiu | 0.002 | 10.333*** |
| Real effective rate | reer | –56.462 | –7.393*** | log(reer) | –0.343 | –4.271*** |
| Number of POS transactions per ATM transaction | inst | 0.619 | 4.805*** | inst | 0.909 | 5.934*** |
| Consumer price index standard deviation | log(cpisd) | –0.043 | –4.046*** | | | |
| Financial services price index | cpik | 0.001 | 3.608*** | | | |
| Google trend – Magyar Közlöny | MK | 4.210E–05 | 1.825* | | | |
| Dummy (2008M10–2011M12) | | | | D1 | 0.082 | 9.117*** |
| Dummy (2020M4–) | D2 | 0.213 | 9.095*** | D2 | 0.113 | 6.844*** |
| Adjusted $R^2$ | 0.978 | | | 0.969 | | |
| Durbin–Watson-statistics | 0.444 | | | 0.624 | | |
| Number of observations | 223 | | | 223 | | |
| Error ADF test value | –6.317*** | | | –7.21*** | | |

*Note: ***, **, *: significant at 1, 5 and 10 per cent*

The institutional change parameter is positive for both currencies. In the past decades the transactional use of electronic money has become increasingly popular and commonly accepted as the institutional environment changes, and the transaction function of cash is gradually declining as the infrastructure matures. Paradoxically, this results in the rise of the cash holding ratio.

In the case of forint cash holding, the 18-month standard deviation was found to be significant, as a higher standard deviation reduces the cash holding ratio. With respect to the euro area, no horizon was found for which the standard deviation of inflation data had significant explanatory power for long-run cash holding.

Higher financial service prices entail a higher cash holding ratio, which confirms the assumption that with higher financial service prices investing savings is perceived as less logical, which is a non-rational motive for cash holding. No such correlation was found for the euro, which is assumed to be partly attributable to the heterogeneity of the euro area's banking system.

In the case of cash holding in Hungary, the cumulative time series of the search results for "Magyar Közlöny" is an indicator for the overall evolution of the legal environment, and the parameter has a positive sign.

Euro cash holding was significantly increased by the crisis between October 2008 and December 2011, so a levelshift outlier was incorporated into the long-run model for this period. The measures introduced on account of the Covid-19 pandemic in 2020 transformed the market environment to the extent that a levelshift outlier had to be incorporated into the model for this purpose as well.

The stationarity of the error term was tested for both equations, and it was found that both error terms were stationary in the case without a constant, which allows this data to be incorporated into the short-run model. The short-run equations are summarised in *Table 2*.

The short-run model was fitted on the difference of the cash holding ratio for Hungarian data, while in the case of the euro area cash holding ratio the log value was differentiated. The cointegration approach is appropriate for this analysis, because the error term of the long-run equation was stationary, and in the short-run equation the one-period lagged value was significant and negative, which means that short-term developments are converging towards the long-run equilibrium.

In fitting the short-run equations, the general approach was used, and the variables of the long-run equation and the appropriateness of its lagged time series were examined, taking into account the parameters of the fit of the model. This yielded equations of a much simpler structure than in the case of long-run time series, although several additive outliers cropped up in the short-run processes, especially towards the end of the time series.

**Table 2**
**Parameters of the short-run equations**

| Variable name | Hungary | | | Euro area | | |
|---|---|---|---|---|---|---|
| | Variable | Parameter | t-statistics | Variable | Parameter | t-statistics |
| Cash holding ratio – dependent variable | d(k) | | | dlog(k) | | |
| Constant | c | 0.011 | 5.483*** | c | 0.004 | 6.602*** |
| Cash holding ratio | $d(k_{t-1})$ | –0.142 | –3.755*** | $dlog(k_{t-3})$ | 0.098 | 2.328*** |
| Changes in net wealth | | | | dlog(nw) | 8.195 | 7.648*** |
| 3-month interest rate | $d(sr_{t-3})$ | –0.011 | –4.485*** | $d(sr_{t-1})$ | –0.003 | –3.377*** |
| ESI – unemployment expectations | d(esiu) | 0.001 | 4.453*** | $d(esiu_{t-1})$ | 0.001 | 2.842*** |
| Google trend – Magyar Közlöny | d(MK) | –0.001 | –4.761*** | | | |
| Dummy (2006M1) | | | | D3 | –0.018 | –2.35*** |
| Dummy (2008M1) | | | | D4 | –0.025 | –3.265*** |
| Dummy (2008M10) | | | | D5 | 0.054 | 6.919*** |
| Dummy (2010M1) | D6 | –0.048 | –3.066*** | | | |
| Dummy (2020M3) | D7 | 0.164 | 9.946*** | D7 | 0.069 | 8.044*** |
| Dummy (2020M4) | D8 | 0.353 | 14.211*** | D8 | 0.110 | 10.795*** |
| Dummy (2020M5) | | | | D9 | –0.061 | –5.034*** |
| Dummy (2020M6) | D10 | –0.096 | –5.425*** | D10 | –0.053 | –5.85*** |
| Dummy (2020M7) | D11 | –0.060 | –3.58*** | D11 | –0.037 | –3.532*** |
| Dummy (2020M8) | D12 | –0.054 | –3.441*** | | | |
| Dummy (2020M11) | D13 | 0.069 | 3.874*** | | | |
| Dummy (2022M8) | D14 | –0.071 | –4.462*** | | | |
| Error correction factor | $ect_{t-1}$ | –0.067 | –2.549** | $ect_{t-1}$ | –0.036 | –2.108* |
| Adjusted $R^2$ | 0.789 | | | 0.797 | | |
| Durbin–Watson-statistics | 1.989 | | | 1.738 | | |

*Note: ***, **, *: significant at 1, 5 and 10 per cent*

In the short term, the change in the Hungarian cash holding ratio is explained by the change in the cash holding ratio from the previous period. Thus, growth in the preceding month reduces the growth in cash holding in the current month. The rise in the short-term interest rate preceding the reference month by three months reduces the cash holding ratio of the reference month, and the negative parameter value is line with expectations. As unemployment expectations increase, the cash holding ratio grows, and the rise in the Google searches for "Magyar Közlöny" slightly decreases the latter in the short run.

The short-run cash holding ratio of the euro area is determined by the parameter's value three months prior to the reference period. It is influenced by the speed of change in wealth: an accelerating rise in wealth raises the euro cash holding ratio. An increase in the short-term interest rate in the preceding month reduces the cash holding ratio of the reference period, confirming the theory. Finally, rising unemployment expectations from one period earlier raise cash holding in the reference period.

In both equations, the rise in the short-term interest rate reduces the cash holding ratio, while uncertainty decreases it.

As regards the outliers, the outlier from January 2006 was probably caused by the continued euro area enlargement and publication of the ECB's guideline on regulating the cash supply.[17] The outliers from 2008 were due to the unfolding economic crisis for both currencies. The outlier from 2010 was partly due to the middle "peak" in the W-shaped recovery from 2008, as the 6.6 per cent GDP contraction in 2009 was followed by 1.1 per cent growth in 2010. On the other hand, the measures introduced in 2010, such as the nationalisation of private pension assets, the transformation of the tax regime, the cutting of red tape, and the introduction of special taxes in banking, telecommunication and the energy sector, resulted in a marked change in the regulatory environment.

The other group of outliers is explained by the Covid-19 lockdowns in 2020, the related measures, the easing of the lockdown and the subsequent waves. In March 2020, strict control measures had to be implemented in almost every European country, including Hungary. At the same time, laws were drafted to protect the threatened industries and those employed there and mitigate the impact of the downturn, and they came into effect during the same month or in April. As a result, the cash holding ratio increased substantially in March and April. The accumulated cash holdings decreased between May and August, when the lockdowns were partially eased.

In Hungary, the second wave that hit in November entailed another rise in the cash holding ratio. Finally, the last outlier came in August 2022, triggered by the partial

[17] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006O0009

phase-out of the cut in utility prices due to the energy crisis, which impacted not only households but also manufacturing sectors.

The fit statistics of short-run equations are presented in *Table 4 of the Annex*.

The autocorrelation arising from the error term of the short-run equations was analysed with an LM test. No autocorrelation can be demonstrated in the present models with a lag of two periods. The heteroscedasticity of the models was measured with the Breusch–Pagan–Godfrey test. According to the results, the error term does not exhibit conditional heteroscedasticity in either model. According to the Jarque-Bera test, the normal distribution of the error term is acceptable in both models. Finally, Ramsey's RESET test was also performed on both models. The results show that the structure of the model fitted on the euro area suggests a missing variable, although the test statistics do not indicate a missing variable in the Hungarian model.

## 5. Conclusions – Summary

This study sought to offer a complex approach to the cash demand for savings purposes. While the impact of traditional financial market correlations, such as the rational motives for cash holding, were found to be significant, the results show that several seemingly non-rational motives were verified for the cash demand for savings purposes, in both the euro area and Hungary. Among the latter factors, uncertainty plays a key role in the cash holding ratio. It exerts an impact in both the short and the long run, raising the cash holding ratio when it increases, but failing to have the same reducing effect when it declines. The conclusions are therefore consistent with the results by *Rösl and Seitz* (*2021*), who also confirmed that economic and social crises increase cash demand.

Since these factors, such as uncertainty, the rapid shifts in the institutional environment amidst the turbulent economic and social changes as well as the non-rational perception of the return on investments by economic actors, are expected to remain dominant, in the medium term the cash demand for savings purposes is not projected to decline substantially in Hungary or in the euro area.

It must also be emphasised that the Hungarian data confirm that rising financial service prices entail a higher cash holding ratio in the long run, probably because households believe that it is less rational to invest savings when financial service prices are higher. No such correlation was found for the euro, but it is worth noting that the consumer price of financial services increased by 250 per cent in Hungary, while it fell by 1 per cent in the euro area in the period under review.

The results show that the cash holding ratio can be used to demonstrate the impact of non-rational behaviour at the macro level regarding cash demand, and

the implications cannot be ignored when making economic policy decisions and developing incentives. As a result, in the context of the shocks in recent years and the subsequent adjustment processes, the impact mechanism of the variables in the traditional theories has become difficult to decipher.

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## Annex

**Table 3**
**Results of unit root tests**

| Variable name | Hungary | | Euro area | |
|---|---|---|---|---|
| | Test specification | t-value | Test specification | t-value |
| Cash holding ratio | N, 1 | –12.371*** | N, 1 | –12.590*** |
| Changes in net wealth | N, 1 | –3.381*** | N, 1 | –11.961*** |
| 3-month interest rate | N, 1 | –4.754*** | N, 1 | –6.208*** |
| 10-year interest rate | N, 1 | –7.251*** | N, 1 | –8.274*** |
| Ratio of 3-month to 10-year interest rate rates | N, 1 | –18.762*** | | |
| ESI – unemployment expectations | N, 1 | –16.522*** | N, 1 | –11.666*** |
| Real effective rate | N, 1 | –13.087*** | N, 1 | –12.783*** |
| Number of POS transactions per ATM transaction | N, 2 | –16.155*** | N, 2 | –16.155*** |
| Consumer price index standard deviation | N, 1 | –3.599*** | | |
| Financial services price index | N, 1 | –3.095*** | | |
| Google trend – Magyar Közlöny | N, 1 | –2.105** | | |

*Note: ***, **: significant at 1, 5 per cent*

**Table 4**
**Test statistics for short-run models**

| Test | Hungary | | Euro area | |
|---|---|---|---|---|
| | Test statistics | P-value | Test statistics | P-value |
| LM-test | 0.075 | 0.928 | 1.774 | 0.1723 |
| Breusch–Pagan–Godfrey | 0.665 | 0.796 | 1.003 | 0.449 |
| Jarque–Bera | 4.588 | 0.101 | 0.599 | 0.741 |
| Ramsey RESET test | 0.921 | 0.358 | 3.28 | 0.001 |