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Interest rate risk of central banks in Central and Eastern European countries and its impact on profitability and credibility in a turbulent socio-economic environment

Piotr Karaś*, Krzysztof Kil#

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Abstract

Interest rate risk management at central banks is subordinated to the achievement of macroeconomic monetary policy objectives. However, interest rate risk can materialise and result first in a deterioration of profitability and then in a loss of credibility for the central bank.

The primary objective of this research article is to evaluate the diversification of interest rate risk levels among central banks in selected Central and Eastern European (CEE) countries and the repercussions of these risk levels on the financial performance and credibility of these institutions. The analysis covers financial data from 2018 to 2023, a period of significant socio-economic upheavals, including the COVID-19 pandemic and the war in Ukraine. The influence of unconventional monetary policy instruments on market risk levels is also examined.

Panel data analysis using linear regression dynamic models confirms that the scale of interest rate risk significantly affects central bank profitability in selected CEE countries. Moreover, profitability levels have a significant impact on institutional credibility.

Keywords: central bank, Central and Eastern Europe, interest rate risk, profitability, credibility

JEL: E52, E58

* Krakow University of Economics; e-mail: karasp@uek.krakow.pl; ORCID: 0000-0002-2360-0848.
# Krakow University of Economics; e-mail: kilk@uek.krakow.pl; ORCID: 0000-0002-2575-7806.

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1. Introduction

It is widely acknowledged that from the mid-1980s until the onset of the financial crisis in 2007, the world's major economies entered a period commonly referred to as the Great Moderation (Hakkio 2013). This era was marked, among other things, by the implementation of monetary policy guided by the framework known as the Taylor Rule paradigm, with the primary instrument being the management of short-term interest rates by central banks (Taylor 1993, pp. 195–214). During this period, the significance of effective communication and transparency in the actions of monetary authorities grew considerably, as it was believed that such an approach enhanced the credibility of central banks (Blinder 1999). It was underscored that the credibility of monetary authorities was intrinsically linked to anchoring inflation expectations, which played a pivotal role in shaping inflationary dynamics within the economy (Fischer 1984, p. 26). Notably, during the Great Moderation, discussions surrounding monetary policy largely overlooked considerations of financial stability, as noted by Bernanke (2013).

It can be argued that with the collapse of Lehman Brothers, the era of the Great Moderation came to a conclusion, ushering in a period characterized by significant upheavals in both the macroeconomic landscape and the operations of central banks. From the perspective of major central banks, the post-2007 years can be tentatively categorized into the following phases:

1. The period of the financial crisis and its containment (since August 2007) – marked by a drastic easing of monetary policy and the introduction of unconventional policy instruments.

2. The period of attempting to normalise monetary policy (since the turn of 2015–2016) – involving strategies to normalise balance sheets and gradually raise interest rates.

3. The period of the COVID-19 pandemic outbreak (early 2020) – characterized by monetary policy easing and another round of unconventional liquidity provision instruments.

4. The post-pandemic inflation surge, coinciding with the eruption of the Russia-Ukraine conflict (first half of 2022) – marked by a gradual tightening of monetary policy.

The outbreak of the financial crisis prompted monetary authorities to recognize that financial instability could precipitate disruptions in the real economy. Consequently, after 2007, major central banks reassessed their objectives and took measures to restore and sustain financial stability. This shift in focus toward financial stability as a fundamental responsibility of central banks also rationalised the introduction of unconventional policy instruments. Post-crisis interest rate policies encompassed strategies of maintaining low but positive interest rates, policies of zero interest rates, and policies of negative interest rates (Pyka, Nocoń 2019, p. 95). Noteworthy among these extraordinary central bank actions were quantitative easing programmes, which can be seen as a modern, expanded implementation of the lender of last resort function for the entire economy.[1]

In Central and Eastern European (CEE) countries, the dynamics of inflationary processes and crisis phenomena diverged from those in the world's largest economies, leading to distinct decisions in terms of the timing and scale of monetary policy interventions. Nevertheless, central banks in this region employed a similar array of instruments as their major counterparts. While the central banks in this region did not need to enact extraordinary measures in response to the 2007 crisis, the outbreak of the COVID-19 pandemic prompted some of them to initiate programmes for the purchase of state

[1] As part of the traditionally understood function of the lender of last resort, the central bank is tasked with providing liquidity to banks in the form of loans during crises. Nowadays, it is suggested that in crisis situations, the central bank does not have to limit its actions solely to the banking sector and can use instruments other than loans to provide liquidity.

Treasury and government-guaranteed securities.[2] Furthermore, due to their geographical location and raw material import structures, certain countries in the region experienced heightened inflationary pressures post-COVID, exacerbated by price increases resulting from Russia's invasion of Ukraine. Consequently, central banks in the region grappled with double-digit inflation rates not witnessed in decades (peak inflation in selected countries was as follows: Slovakia 15.4%, Czech Republic 18%, Poland 18.4%, Bulgaria 18.7%, Estonia 24.8%, Hungary 25.7%).

In the literature, there is a debate on the role of credibility in the activities of the central bank on one hand, and its financial strength and the risks to which its activities are exposed on the other (Bini Smaghi 2011). Among the authors dealing with this issue, there is a consensus on the existence of a relationship between monetary policy and the credibility of the central bank (Cepeda, Taboada, Villamizar-Villegas 2023, p. 1). Others point to the relationship between macroeconomic stability and the credibility of the central bank (Park 2023, p. 145).

The thesis that there is a link between the credibility of the central bank and its monetary policy and its financial strength is more controversial.[3] Opponents of this relationship point to central banks that show losses but still enjoy credibility (Petruš 2010). Furthermore, it is argued that central banks can cover current losses with future profits (Filipová 2024). Belhocine, Bhatia and Frie project the net income of the Eurosystem and its "top-five" national central banks for the period from 2022 to 2031. Although these banks will incur losses, this will not affect the credibility of the Eurosystem. The ECB's credibility will depend on its ability to achieve its objective of price stability and will not be contingent on its financial strength. In the case of the ECB (2023, p. 8), losses must remain orthogonal (i.e. independent) from monetary policy decision-making. Other authors present milder views. Lee and Yoon (2016, p. 141) show that in the case of South Korea, the losses generated by its central bank did not affect its monetary policy. However, they caution that this may be because the loss of equity has not yet reached a critical level and do not rule out that such a situation may occur in the future, leaving the question open as to whether it will then affect the shape of monetary policy. Ize (2006, pp. 8–10) analyses 87 central banks, dividing them into two groups according to the criterion of pre-transfer profits. He classifies 60 central banks as strong and 27 as weak. In countries with weak central banks, inflation tends to be higher compared to countries with strong central banks. However, his analysis should be treated with caution, as it covers data for only one year. Perera, Ralston and Wickramanayake (2013, p. 409) reach similar conclusions, showing that greater financial strength of the central bank can translate into lower inflation levels. This applies more to developing countries than to developed countries. Stella (1997, p. 8) posits that a central bank does not need capital in the formal sense, i.e. funds provided by the state to establish the bank and retained earnings, but central banks with negative net worth usually operate inefficiently. Hall and Reis (2015, p. 1) argue that if the dividend policy for the government is structured so that these payments do not exceed the net income of the central bank, then the bank will always be solvent, and the threats to its stability "are real in theory, but remote in practice today". Rule (2015, p. 25), on the other hand, argues that from a theoretical point of view, losses and a potential negative equity position should not affect the central bank's ability to achieve its statutory goals, but there is potentially a limit to the losses a central bank can incur before it threatens its reputation and independence. Tombe and Chen (2023, pp. 12–13), estimating the losses

[2] Poland, Romania, Croatia, and Hungary belonged to this group of countries (Fitzgeorge-Parker 2020).

[3] Tanaka presents an overview of research directions on the relationship between central bank capital and credibility (Tanaka 2021).

of the Bank of Canada, argue that these losses, although not undermining its ability to fulfil its mandate, may pose a challenge in terms of reputation and communication. Cosier (2023, p. 10) speaks in a similar tone, recommending strengthening the capital structure of the Bank of Canada to improve its resilience, financial independence, and accountability. Broeders and Wessels (2022, p. 12; 2023, p. 304) argue that in the medium term, capital adequacy is crucial for the credibility and independence of the monetary authority. Nordström and Vredin (2022, p. 3) review the literature on why monetary policy is not constrained by the central bank's financial results or capital, why central bank independence may require a certain level of equity, and why monetary policy could be affected by the financial position of the central bank. The gathered arguments lead them to posit that in the short term, neither financial results nor equity constrain the scope of monetary policy. However, a central bank struggling with a lack of profits and equity may need recapitalization from public funds, which could negatively impact its independence and the credibility of its monetary policy.

In theoretical considerations, Tanaka (2013, pp. 2–17) constructs a model proving that for maintaining the credibility of the central bank, what is important is not the capital itself, but the financial strength, which he equates with the fact that the central bank does not generate persistent losses. Pinter and Pourroy (2023, p. 16) point out that the relationship between the level of capital, losses, and monetary policy decisions may also depend on the monetary regime adopted by the central bank. Negative equity or concerns about insolvency may force the central bank to abandon the exchange rate control strategy earlier than it would if it were solely guided by pure inflation developments. It seems that such a situation occurred in Switzerland in 2015.

The European Central Bank has long maintained that EU central banks must be financially independent. This means, among other things, that in the long term, their equity should be at least at the level of statutory capital, and these banks should avoid long-term losses exceeding this capital level. As the ECB (2010, pp. 22–23; 2022, p. 26) argues, otherwise, central banks may have difficulty performing their tasks, and it could negatively impact the credibility of the Eurosystem's monetary policy.

The financial weakness of a central bank can precipitate adverse repercussions for the central bank itself, the financial system, and the broader economy. A vulnerable central bank may lose credibility in executing its core functions, including monetary policy, exchange rate management, acting as a government agent, or sustaining a smoothly functioning domestic payment system. These adverse consequences can be especially pronounced during financial crises (Stella 2002, p. 3). This occurs because the central bank's losses would need to be covered either through internal or external sources. In the former scenario, financing would necessitate current and future money creation (seigniorage), which may require an alteration in the goals and principles of monetary and exchange rate policy. More specifically, the central bank may need to reduce interest rates to stimulate demand for the money it creates, as expounded in portfolio theory (Markowitz 1952). This could potentially undermine confidence in the stability of interest rates and exchange rates, affecting the valuation of financial instruments (including risk premiums) and disrupting their supply and demand dynamics. In the latter case, external recapitalisation, i.e. public injection of capital, would carry the risk of political pressure on the central bank and further erosion of its credibility. These factors could ultimately influence shifts in inflation expectations and expectations regarding future exchange rate developments, thereby affecting decisions made by economic agents. Consequently, it appears imperative that the central bank maintains a capital base sufficient to cover present and future operational expenses and potential losses arising from the fulfilment of its mandate (Ernhagen, Vesterlund, Viotti 2002, p. 7).

To summarize the presented review of positions, the debate on the relationship between the financial strength of the central bank and the effectiveness of its monetary policy can be summed up as follows: on the one hand, financial strength does not guarantee effective monetary policy, nor does financial weakness mean that the central bank will lose credibility or conduct monetary policy inefficiently (Schwarz et al. 2015, p. 9). On the other hand, there is insufficient evidence to suggest that the financial position of the central bank has no impact on its credibility or the monetary policy it conducts.

With this in mind, and taking into account the evolving macroeconomic environment, changes in monetary policy and the actions of central banks in recent years, a link between the risk of rising interest rates arising from sudden inflationary events and the profitability and credibility of central banks cannot be ruled out. The existence of such a link may define the fundamental preconditions for the effective fulfilment of central banks' core functions.

This study's objective is to assess the variation in the level of interest rate risk among selected CEE central banks and its impact on the financial performance and credibility of the institutions under examination. The following research hypotheses are advanced: (a) the level of interest rate risk assumed by the central bank and the extent of its materialisation significantly influence the profitability of central banks in selected CEE countries, and (b) the level of profitability of central banks in selected CEE countries exerts a significant impact on their credibility. To test these research hypotheses, the study employs an extensive literature review, analysis of financial and statistical data, and econometric tools, including panel data regression (static models with fixed effects).

The article comprises eight chapters divided into two sections. The first section consists of three chapters that offer an overview of the existing body of knowledge on central bank credibility, profitability, and interest rate risk. The second section presents the findings of empirical research, including an evaluation of the level of interest rate risk, profitability, and credibility of selected central banks, as well as the significance of interest rate risk on the profitability of central banks and the influence of their profitability on credibility. This section also addresses the impact of changes in the utilisation of unconventional monetary policy instruments on market risk levels in the central banks of the analysed countries.

2. Central bank credibility

With the widespread acceptance of the rational expectations hypothesis and the interpretation of central bank operations within the framework of game theory, the credibility of central banks has emerged as a pivotal element considered in both theoretical studies and the practical operations of these institutions (Stella 2002, p. 21).

It is contended that a central bank deemed credible is better equipped to fulfil its core mandates. For instance, it can more effectively maintain low levels of inflation and, in the event of policy adjustments, such as the necessity to take measures to curb inflation, it can do so at a lower cost. A credible central bank is also better positioned to manage financial crises, acting as a lender of last resort when needed, and is more adept at safeguarding its independence from external influences (Blinder 1999, p. 7).

Credibility, in this context, may be defined as the central bank's commitment to adhering to well-articulated and transparent principles and policy objectives (Bordo, Siklos 2015, p. 1). The measurement

of credibility can be approached through two methods: the credibility creation approach and the credibility impact approach (Mackiewicz-Łyziak 2016, p. 126). In the former, variables believed to influence credibility are selected and examined, which can be categorized into: (a) real economy factors, such as economic growth, (b) financial factors, including financial crises and the central bank's financial robustness, and (c) institutional factors, encompassing inflation targets, central bank autonomy, and transparency (Bordo, Siklos 2017, p. 21).

The latter approach focuses on variables contingent upon central bank credibility. This can be subdivided into (a) indirect metrics, which assess changes in market parameters such as interest rates (particularly the yield curve) and exchange rates, as well as alterations in the volatility of financial instruments, and (b) direct metrics that emphasize the evaluation of credibility or trust in the central bank and investigations into inflation expectations. Direct metrics can further be categorized into those aiming to quantify the extent to which the private sector places confidence in the monetary authority's announcement of its inflation target when forming inflation expectations (Bomfim, Rudebusch 2000, p. 710). The second category comprises credibility indices, which scrutinize credibility gaps, i.e. the disparity between inflation expectations and the inflation target (Cecchetti, Krause 2002, p. 53; Levieuge, Lucotte, Ringuedé 2018, p. 495). In addition to measuring static gaps, the pace at which public opinion responds to changes in central bank policy can also be examined (Cukierman, Meltzer 1986, p. 1100).

Given the profound significance of credibility for central banks, a natural query arises: how can these institutions establish and uphold credibility? Credibility hinges on perception, rendering the consistency between a central bank's words and actions paramount. This primarily pertains to the central bank's commitment to maintaining inflation proximate to its target and responding appropriately in times of crisis (Blinder 2013, p. 165). It is not imperative for the central bank to consistently achieve success, but it should be perceived as responsible, transparent, and determined.

Hence, the initial step in cultivating credibility is to undertake actions and adopt a course of action that persuades external observers of the central bank's efficacy in realising its objectives. In this context, effective communication between the central bank and its environment assumes critical importance. Efforts aimed at enhancing the communication of the central bank's strategy and actions, targeting not only financial markets or experts but also the general public, can augment the central bank's credibility (Ehrmann, Georgarakos, Kenny 2023). However, there are substantial disparities in shaping credibility between these groups. For experts, transparency is a prerequisite, entailing the anticipation of greater access to information, including technical data. For the general public, transparency assumes a different connotation. The public assesses whether to believe that the central bank will achieve its objectives and whether its forecasts will materialise. This belief rests on the evaluation of the central bank's willingness and competence, rather than specific actions and their underlying rationale (Kril, Leiser, Spivak 2016, p. 90). Moreover, at the individual level, psychological and personal characteristics also influence perceptions of central bank transparency (van der Cruijsen, Eijffinger 2008, p. 3).

Secondly, institutional arrangements must safeguard the independence of the central bank, as it is a prerequisite for fulfilling its designated functions (ECB 2017). However, while independence is necessary, it is not sufficient, as even formally independent central banks can become entwined in informal networks that can detrimentally impact the credibility of monetary policy (Niedźwiedzińska 2022). Empirical research findings are inconclusive regarding the impact of independence on central bank credibility (Daunfeldt, Luna 2008; Posen 1998).

Nevertheless, one facet of central bank independence assumes critical importance for central bank credibility. The financial strength of the central bank, and thus its financial independence, stands as a determinant of central bank credibility. A central bank can gain credibility when the public can readily assess its financial stability (Stella 2002, p. 1). This implies that a robust and financially independent central bank is perceived as credible. Conversely, an extended period of losses incurred by the central bank can precipitate a credibility crisis, both economically and institutionally (Bindseil, Manzanares, Weller 2004, p. 2).

3. Central bank profitability as a determinant of its financial strength

In the extant literature, a universally accepted definition of a central bank's financial strength remains elusive. Nonetheless, a consensus exists that this strength hinges on two primary factors: the magnitude of its equity and the central bank's capacity to generate sustained profits (Pajdo 2017, p. 5). In this context, financial strength comprises two distinct facets: (a) financial robustness in terms of equity, wherein the central bank maintains a sufficient capital base, and (b) financial robustness concerning the balance sheet, where the configuration of assets and liabilities entails an acceptable level of risk and ensures stable profitability.

Regarding the maximum size of a central bank's capital, the criterion should be a comparison between the costs of servicing public debt and the return on equity of the central bank. If the central bank can achieve a higher return on its equity than the cost of servicing an equivalent amount of public debt, then maintaining such capital makes sense from the perspective of government revenue and public debt servicing. Otherwise, it seems plausible to consider reallocating a portion of the capital from the central bank toward reducing public debt (Ernhagen, Vesterlund, Viotti 2002, p. 15).

In addition to narrowly defined equity, central banks may also maintain financial buffers designed to shield capital from adverse repercussions resulting from fluctuations in market parameters (e.g. exchange rates, interest rates, commodity prices, creditworthiness) affecting the book value of the central bank's assets. These buffers encompass a general reserve fund, a risk provision, and revaluation accounts (Vergote et al. 2010, pp. 26–29). Formally, these buffers may wholly or partially fall under the classification of broadly defined equity (Narodowy Bank Polski 2023, pp. 204–205). The size and characteristics of such buffers are also contingent on the accounting principles adopted by a specific central bank (Schwarz et al. 2015, pp. 16–18).

The volume of a central bank's equity appears unproblematic when the central bank generates a profit. The composition of the central bank's balance sheet plays a pivotal role in shaping its profitability, stemming from activities conducted across various domains of its operations. Key factors influencing the central bank's balance sheet encompass:

– the size of the monetary base resulting from the central bank's role as an issuer of currency,

– the structure of assets, both foreign and domestic securities, resulting from monetary policy operations,

– the composition of assets arising from the central bank's role as a lender of last resort,

– the structure of foreign currency-denominated instruments stemming from reserve asset management and exchange rate control functions.

From this perspective, profit magnitude primarily depends on senior age income, net interest income, positive exchange rate differentials, and positive revaluation disparities in assets, particularly securities portfolios.[4]

The value of profit serves as an absolute measure of central bank profitability. Profitability can also be assessed and analysed through relative metrics, such as profitability ratios. The most critical indicator is the return on equity (ROE), which, in the case of central banks endowed with capital by the state, can be construed as the rate of return on investment and compared to the costs of public debt, presuming that providing capital to the central bank was funded through public debt issuance. As regards central banks, other metrics of profitability encompass: profit/GDP, return on assets (ROA), the ratio of net interest income to total profit, and the ratio of other costs to total profit (Novák, Vámos 2014, p. 503; Pajdo 2017, pp. 14–15). Relating profit to GDP allows for comparisons with the state's borrowing requirements relative to gross domestic product, illuminating the extent to which the state can reduce its public debt needs, as it can obtain a corresponding amount from the central bank in the form of a budget contribution. Assessing asset profitability for central banks warrants caution. The central bank's mandate diverges from that of commercial institutions; instead, it is oriented towards achieving socially significant objectives. As a result, shaping the central bank's balance sheet structure, particularly its assets, is governed by principles different from those applied in profit-oriented institutions. This is reflected in the fact that the central bank buys or sells asset components not only when their prices are optimal, but also when it serves the achievement of its statutory objectives. Given that interest income (from both domestic and foreign debt instruments) represents the primary source of central bank revenue, a metric highlighting the significance of this income source for the central bank is the ratio of net interest income to total profit. The ratio of other costs to total profit can be interpreted as a measure of the operational efficiency of central bank management, signifying the burden on profit attributable to costs like operating expenses and labour costs.

Due to the volume and nature of operations undertaken by central banks, both their revenues and costs, as well as the level and regularity of their earnings, are exposed to various risks. In recent years, the surge in interest rates has accentuated the significance of interest rate risk among these various risks.

4. Interest rate risk as a determinant of central bank financial strength

Central banks, akin to other financial institutions, encounter an array of risks. The principal risk categories for central banks encompass: (a) strategic risk, (b) financial risk, which can be further categorized into credit risk (comprising the risk of default and migration risk, also known as credit rating risk), market risk (encompassing exchange rate and commodity risk, as well as interest rate risk), and liquidity risk; (c) operational risk. One pivotal and distinct risk type for central banks is reputation risk, although it can be regarded as a meta-risk, signifying that it is not inherently linked to a specific central bank activity, but can arise as an aftermath of any of the aforementioned risks (Pyka, Nocoń 2018, p. 346; Vardy 2015, pp. 2–3).

[4] Profit is understood here as an economic category. Additionally, profit can be comprehended in formal terms, i.e. as an accounting category. These concepts are not mutually exclusive, but rather complementary. Hence, it is crucial to recognize the relationship between the adopted accounting solutions and profit, as well as the principles governing its distribution (Schwarz et al. 2015, pp. 13–16).

In recent years, inflation and interest rate hike cycles in many countries have elevated the significance of interest rate risk for central banks.

Central banks typically encounter interest rate risk in two contexts: as part of their routine operations in their mandated spheres of activity (comprising standard monetary policy operations concerning liquidity absorption and provision, alongside activities linked to reserve asset management), and in unconventional scenarios (in extraordinary monetary policy operations, as well as assuming risk from other entities, especially banks, during systemic crises, such as liquidity disruptions in the banking sector).[5]

As one of the primary tasks of a central bank is to conduct monetary policy, the choice of strategy and the instruments used as part of that strategy translates into the scale and types of risk that the central bank takes or to which it is exposed. However, there is no strategy that does not have as a side effect a lower or higher exposure of the central bank to interest rate risk.[6]

Despite numerous parallels between commercial banks and central banks, fundamental disparities exist concerning the motivations behind risk-taking and the ensuing risk exposure. The distinctiveness of central banks manifests in their capacity to directly influence short-term interest rates, inflation expectations, and exchange rates. Moreover, central banks prioritize safety and liquidity criteria over profitability when shaping their investment policies. The primary distinctions between central banks and commercial banks become evident in the motives and timing of decisions pertaining to changes in asset (or liability) structures. For instance, central banks may engage in the purchase or sale of foreign currencies not based on the potential profitability from exchange rate differentials, but rather guided by the necessity to fulfil monetary or exchange rate policy objectives. Similarly, the issuance of central bank securities or the purchase or sale of third-party securities is not primarily driven by commercial incentives but is guided by an evaluation of the present and future macroeconomic conditions and the stability of the financial system.

Sources of interest rate risk include the central bank's own interest rates, domestic market interest rates, and foreign interest rates. Exposure to domestic interest rate risk is closely linked to and a byproduct of conducting monetary policy. Exposure to foreign interest rates is related to managing official reserve assets. While the central bank has direct influence over its own interest rates, steering these rates is based on macroeconomic considerations rather than market risk management policy, which may conflict with the central bank's risk management strategy. The central bank influences domestic market interest rates through at least three channels: directly via transactions in the debt market (typically in the short-term interest rate segment, and in extraordinary situations, also long--term rates); indirectly by setting and achieving the operational target of monetary policy through the interest rate corridor for its overnight rate (where the lower bound of the corridor is the deposit rate and the upper bound is the central bank's lombard rate); and by shaping inflation expectations and, as explained by the expectations hypothesis, shaping future short-term interest rates. Here too, the primary motivation for the central bank's actions is fulfilling its mandate, not risk management.

[5] As part of broadly conceived extraordinary measures, central banks can also provide liquidity to institutions outside the banking sector, specifically to borrowers and investors in key credit markets (this was the nature of instruments introduced by the Federal Reserve, such as: commercial paper funding facility, asset-backed commercial paper money market mutual fund liquidity facility, money market investor funding facility, and the term asset-backed securities loan facility (Board of Governors of the Federal Reserve System, Credit and Liquidity Programs and the Balance Sheet: The Federal Reserve's Response to the Financial Crisis and Actions to Foster Maximum Employment and Price Stability, https://www.federalreserve.gov/monetarypolicy/bst_crisisresponse.htm).

[6] The interest rate control strategy is not to hold all, but only selected interest rates at a certain level.

A central bank holding official reserve assets will have foreign debt instruments in its portfolio. These securities are also subject to interest rate risk from the issuing currencies, but in this case, the domestic central bank (with exceptions for the world's most influential central banks) has no control over external monetary policy and market conditions abroad.

Interest rate risk can also be categorised into short-term interest rate risk, also known as income risk or carry risk, and long-term interest rate risk, also known as balance sheet risk or duration risk. The first type of risk arises from the term mismatch between assets and liabilities and the interest rate structure of these assets and liabilities (the share of fixed-rate versus variable-rate instruments). For central banks that have relatively more short-term variable-rate liabilities and relatively more long--term fixed-rate assets, an increase in short-term interest rates while long-term rates remain unchanged will reduce the central bank's interest margin. In this context, De Grauwe and Ji (2023) point out that quantitative easing programmes have led to an excess of bank reserves. Consequently, central banks incur interest expenses, and these costs may become unsustainable. As a solution, they propose a system of mandatory reserves, where only reserves exceeding the required minimum level would be interest-bearing.[7] The second type of risk manifests as the erosion of the central bank's portfolio of long-term debt instruments due to rising interest rates (Christensen, Lopez, Rudebusch 2015, p. 27).

The risk management process within a central bank necessitates consideration of the unique nature of its objectives and areas of activity. Nonetheless, given its status as a financial institution, the risk management methodologies and processes employed by commercial banks can and should serve as a foundational framework for evaluating risk within central banking (Liikanen 2017, p. 2).

To gauge interest rate risk, various measures encompassing sensitivity, volatility, and potential losses are frequently employed. The first group encompasses measures such as interest rate gap, duration, modified duration, convexity, and principal component analysis. The second group comprises metrics like variance and standard deviation. The third group incorporates quantitative tools such as Value at Risk and Expected Shortfall (Bessis 2015, pp. 43–188; Hull 2018, pp. 185–340; Iwanicz--Drozdowska 2015, pp. 174–177). Central banks, akin to other financial institutions, can employ these measures to assess the interest rate risk exposure within their asset and liability positions. Duration and modified duration are the most cited metrics. Beyond these fundamental measures, stress tests and scenario analyses can also be applied to evaluate interest rate risk (Anderson et al. 2022; Christensen, Lopez, Rudebusch 2015).

In summary, exposure to interest rate risk in a central bank is, in fact, a side effect of the adopted strategy and selection of instruments for monetary policy and reserve asset management. Specifically, this exposure is shaped by the size and structure of interest-bearing assets and liabilities, their sensitivity to changes in interest rates, and the mismatch between interest income and interest expense. In the academic literature, it is posited that interest rate risk can manifest itself in both environments characterized by extremely low interest rates and during periods of rising interest rates. In the former scenario, low interest rates may curtail the interest income derived from foreign and domestic asset portfolios, consequently diminishing the central bank's profits (Pajdo 2017, p. 15). Conversely, substantial portfolios of interest-bearing assets amassed during low interest rate periods are exposed to the risk of rising interest rates (Pyka, Nocoń 2018, p. 353; Rudebusch 2011, p. 1).

[7] It seems that this proposal contradicts the traditional argument that only reserves up to the required level should be interest-bearing because they are not the result of autonomous decisions by banks but rather administrative instruments of monetary policy, and as such, if they were non-interest-bearing, they would constitute a quasi-tax imposed on banks. According to this argument, reserves exceeding the minimum level should not be subject to interest.

5. Assessment of the interest rate risk, profitability, and credibility of selected central banks in Central and Eastern Europe

There is no consensus on which countries to count as Central and Eastern Europe (CEE). Various organisations and institutions employ different criteria to define countries falling into this category. For example, Raiffeisen Research applies the following categorisation for the region: Poland, Hungary, Czech Republic, and Slovakia, collectively referred to as Central European countries (CE); Romania, Bulgaria, Croatia, Serbia, Bosnia and Herzegovina, Albania, Kosovo, defined as South-Eastern European countries (SEE); and also includes Russia, Ukraine, and Belarus under the Eastern European countries (EE) category (Deuber 2020). In contrast, the Group of Banking Supervisors from Central and Eastern Europe (BSCEE Group 2021) encompasses 25 countries within the CEE term, including Albania, Armenia, Austria, Belarus, Bosnia and Herzegovina (Federation of Bosnia and Herzegovina, Republika Srpska), Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, North Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Turkey, and Ukraine. The OECD, on the other hand, designates the term Central and Eastern European Countries (CEECs) to a group of countries consisting of Albania, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, and the three Baltic states: Estonia, Latvia, and Lithuania.[8]

For the purposes of this study, a specific analysis has been conducted on the central banks of CEE countries that are members of the European Union but not part of the Eurosystem. Consequently, they possess greater autonomy concerning risk management, the establishment of financial strength (including the formulation of long-term profitability strategies), and the execution of monetary policy. Among the analysed central banks, four pursue an inflation targeting strategy: the Czech National Bank (CNB: Česká Národní Banka), Narodowy Bank Polski (NBP), the National Bank of Romania (BNR: Banca Naţională a României), and the National Bank of Hungary (MNB: Magyar Nemzeti Bank). Meanwhile, one central bank, the Bulgarian National Bank (BNB: Българска народна банка), employs an exchange rate targeting strategy. It is important to acknowledge that the central banks under analysis constitute a relatively diverse group, which is reflected, among other aspects, in their size, as measured by the total balance sheet value. The analysis period encompasses the years 2018–2023. The selection of this time frame enables a comparison of observed changes in the turbulent socio-economic environment of 2020–2023 with the period characterized by greater financial stability (2018–2019).

It should be noted that between 2020 and 2023, most of the central banks analysed recorded a significant increase in the value of their assets (Figure 1). The exception is the CNB, which experienced a decrease in the value of its balance sheet during the same period.

5.1. Interest rate risk in central banks

The central banks under scrutiny converge in defining interest rate risk. They link it primarily to the potential decrease in the market value of financial instruments due to adverse shifts in their yields (Narodowy Bank Polski 2023, p. 235). A comprehensive examination of central banks' annual reports

[8] Statistics Netherlands, CEE countries (CEECs), https://www.cbs.nl/en-gb/news/2018/31/international-road-haulage-over-4-percent-up-in-2017/cee-countries–ceecs–.

reveals that duration or modified duration (MD) is widely utilized to assess interest rate risk within these institutions.[9] Duration serves as a gauge for evaluating interest rate risk, providing a quantitative measure of the sensitivity of investment portfolios to alterations in the yields of financial instruments (Narodowy Bank Polski 2023, p. 65). It is acknowledged as a fundamental measure of absolute interest rate risk (Bulgarian National Bank 2023, p. 143). The central bank of Hungary highlights the use of duration, defined as the average remaining maturity of bonds, as a metric to assess the interest rate risk associated with its portfolio of debt instruments (Magyar Nemzeti Bank 2023, p. 91). Furthermore, central banks routinely monitor a measure known as convexity, although specific details regarding its levels are not disclosed (Bulgarian National Bank 2023, p. 143). Some central banks incorporate a maximum acceptable level of portfolio duration for reserve assets into their foreign reserve management strategies.[10]

Among the examined central banks, four institutions furnish precise information concerning the values of the duration of their financial instrument portfolios or the maximum allowable duration in line with their adopted asset management strategies, as presented in Table 1. Notably, Narodowy Bank Polski reported the highest average duration value among the analysed countries (however, in terms of annual duration, in 2023 the highest level was recorded in the Czech Republic). The duration value for the Polish central bank exceeded the sample by 67%. Central banks have employed diverse strategies concerning the acceptable level of interest rate risk. The Hungarian central bank has adopted and maintained a constant acceptable level of interest rate risk within its strategy. In contrast, Narodowy Bank Polski experienced a substantial increase in portfolio duration in 2021 (MD = 3.2), followed by a slight reduction in its value in 2022 and 2023. An analogous strategy to the Polish one for the level of interest rate risk was applied by the Czech central bank. The maximum duration level of this bank's reserve asset portfolio was observed in 2023. The National Bank of Romania observed a marginal increase in duration compared to previous years (0.35 years). In contrast, the Bulgarian National Bank succeeded in significantly reducing interest rate risk throughout the study period, with a reduction exceeding 80% (duration decreased from 0.88 years to 0.18 years).

The value of duration influences the magnitude of potential materialisation of market risk, as evidenced by the analysis of data concerning the central bank's sensitivity to rising interest rates. Data presented by NBP and the BNB indicate substantial disparities in this variable regarding its impact on equity. In the case of NBP, there was a substantial increase in sensitivity to rising interest rates over the study period. A 100 basis point increase would result in a decrease in equity of PLN 7.6 billion in 2019, PLN 14.9 billion in 2021 and PLN 14.7 billion in 2023, signifying an increase of nearly 100%. In contrast, the BNB exhibited a substantial reduction in sensitivity to interest rate risk. A 100 basis point increase in interest rates would have led to a loss of BGN 400.7 million in 2019, while in 2022, the loss would have been merely BGN 41.3 million, indicating a reduction of almost 90%.

[9] It quantifies the impact of a 1 basis point change in interest rates on the percentage change in the market value of an asset or liability (Bulgarian National Bank 2021, p. 153). The difference between duration and modified duration is that modified duration takes into account bond yields (1 + YTM) to assess the sensitivity of the bond price to changes in interest rates, while duration is a purely time-based measure of the average duration of cash flow returns.

[10] The central bank of Romania updates the optimal strategic risk parameters for the management of the official reserve assets portfolio every two years. As part of these updates for 2018–2019, it was assumed that the maximum average duration level for the entire portfolio of reserve assets cannot exceed one year and three months, and two additional limits were adopted: one year for the aggregate money market and liquidity tranches and two years and four months for the investment tranche. In the years 2020–2021, these limits were maintained, while in the years 2022–2023, these limits were raised to levels of respectively: one year and seven months, one year and five months, two years and six months (National Bank of Romania 2020, p. 345, 2022, p. 329, 2023, p. 320).

The direct consequences of the materialisation of interest rate risk can be illustrated by examining the activities of NBP in 2022. The loss of investment activities related to foreign exchange reserves (excluding realised and unrealised exchange rate differences) amounted to PLN 28.8 billion compared to PLN 1.7 billion in 2021. This was primarily driven by unrealised costs attributed to the fair value measurement of debt securities (-PLN 25.3 billion) and outcomes stemming from realised price disparities resulting from futures transactions and securities sales (-PLN 9.9 billion). The return rate on NBP's foreign reserves, excluding the impact of exchange rate changes, plummeted to -6.3% in 2022, while it stood at 2.3% in 2019 and 2020, and -1.3% in 2021 (Narodowy Bank Polski 2023, pp. 68–69). In 2023, NBP recorded a positive return on foreign exchange reserves of 4.7% (Narodowy Bank Polski 2024, p. 63).

Similar ramifications can be observed in the case of the National Bank of Romania, among others. As of 31 December 2022, the NBR reported provisions for unfavourable market valuation differences in the market valuation (unrealised losses from revaluation differences) of foreign currency securities amounting to MDL 3,333.407 million. This figure contrasts sharply with the loss of MDL 461.124 million recorded as of 31 December 2021 (National Bank of Romania 2023, p. 320). In the last year analysed, the loss on this account decreased to MDL 260.464 million (National Bank of Romania 2024, p. 295).

In the assessment of market risk, encompassing interest rate risk, several of the scrutinized central banks employ the Value at Risk (VaR) methodology. VaR represents the maximum potential loss within a predetermined time horizon (holding period), contingent on a defined probability level (confidence level or confidence interval). For instance, the Bulgarian National Bank calculates VaR with a 95% confidence level and a one-day holding period, considering the volatility observed in time series composed of 30 daily observations of total income, foreign exchange income, and interest income from assets (Bulgarian National Bank 2021, p. 153). Additionally, the BNB presents data on the correlation between foreign exchange risk and interest rate risk, as shown in Table 3. Conversely, the National Bank of Romania utilizes VaR for managing interest rate risk but refrains from disclosing the specific parameters used for VaR estimation or the values of this measure for individual years (National Bank of Romania 2020, p. 345; 2023, p. 320).

Drawing insights from the example of the Bulgarian National Bank, a significant increase in interest rate risk can be noted during periods of economic and social turbulence. The average daily value of VaR for interest rate risk in the years 2018–2019 was just under BGN 4.1 million, whereas in the years 2020–2022, it was BGN 7.3 million, signifying an average increase of nearly 80% during periods of socioeconomic shocks. Furthermore, alterations in the relationship between foreign exchange risk and interest rate risk are also discernible. There was a significant reduction in VaR for interest rate risk in 2023.

In the absence of published data on the VaR of the central banks of the other countries analysed, VaR values for the market risk of the National Bank of Albania, i.e. the central bank of a non-EU CEE country, are presented for comparison purposes. In this case, a significantly higher average VaR was also observed in 2020–2023 (ALL 7,332.75 million) compared to the preceding period (ALL 1,818.5 million).

Several of the CEE central banks analysed implemented additional limits on the interest rate risk associated with their portfolio of financial instruments during the period under study. An example is the National Bank of Romania, which established a relative interest rate risk limit for investment portfolios based on tracking error. Over the period spanning 2018–2023, the limit evolved as follows:

initially set at no more than 0.25% of annual relative return volatility in 2018, then reduced to 0.20% in 2019–2020, increased to 0.3% in 2021 and strongly curtailed to 0.1% in 2022, and eventually increased to 0.25% in 2023 (Bulgarian National Bank 2021, p. 44; 2022, p. 39; 2023, p. 40; 2024, p. 41).

5.2. Interest rate risk and unconventional monetary policy instruments

The observed changes in the extent of interest rate risk at the central banks analysed are partly related to the implementation by several of them of non-standard monetary policy instruments in the form of secondary market purchases of debt securities issued or guaranteed by the state Treasury (hereinafter government securities or Treasuries).[11] As indicated, for example, by Narodowy Bank Polski, these operations (commonly referred to as quantitative easing or QE) carried out in order to change the structure of liquidity in the banking sector in the long term, to provide liquidity in the secondary market for purchased Treasuries and to strengthen the monetary transmission mechanism (Narodowy Bank Polski 2023, p. 189).

The volume of these purchases varied, with NBP holding the largest portfolio of such instruments as a percentage of total assets between 2020 and 2023. The Czech National Bank and the Bulgarian National Bank did not engage in such operations (Table 5).

It is worth mentioning that fluctuations in the market value of securities acquired through unconventional measures resulting from shifts in yields do not have a direct reflection in the financial results of central banks. This is a consequence of accounting principles stipulating that foreign currency-denominated debt securities held until maturity, as well as domestic currency-denominated debt securities held for monetary policy purposes are valued at acquisition cost, excluding accrued coupons (clean price), taking into account accrued discounts and premiums, reduced by an impairment (Narodowy Bank Polski 2023, p. 144; National Bank of Romania 2022, p. 342).

It should also be noted, as exemplified by Narodowy Bank Polski, that simultaneously injecting liquidity into the market through structural operations and absorbing liquidity through the issuance of short-term bills generates significant risk concerning the alignment of the structure of active and passive interest rates. An analysis of NBP's financial data reveals that in 2020, government securities acquired by the central bank for monetary policy purposes yielded NBP revenue of just under PLN 1.58 billion. The cost of negative interest amounted to PLN 0.53 billion, resulting in a net income of PLN 1.05 billion, equivalent to a return rate of approximately 1% (Narodowy Bank Polski 2021, p. 214). Similarly, in 2021, net interest income from domestic instruments acquired for monetary policy purposes stood at PLN 1.99 billion, rising to PLN 2.19 billion in 2022 and PLN 2.15 billion in 2023. It is also worth noting that the weighted average cost of issuing NBP bills was 1.66% in December 2021 and increased to 6.75% in December 2022. In December 2023, the cost was 5.75%, increasing the total interest loss associated with the Polish central bank's monetary policy instruments from PLN 11.95 billion in 2022 to PLN 20.64 billion in 2023 (Narodowy Bank Polski 2022, p. 249; 2023, p. 251; 2024, p. 207). Consequently, the costs of absorbing excess liquidity incurred by the central bank were significantly higher than the income from liquidity-adding operations, which had a significant impact on its profitability. Furthermore, the weighted average maturity of government securities acquired in

[11] In Poland, for example, at the end of 2022, 55% of the value of assets purchased are debt securities issued by the state Treasury and 45% guaranteed by the state Treasury (Narodowy Bank Polski 2023, p. 189).

structural operations during 2020–2021 amounted to 6.81 years, which had a pronounced effect on the financial outcome in subsequent years.[12]

In the case of the National Bank of Hungary, a significant challenge can also be observed regarding its long-term engagement in instruments based on a fixed interest rate. Over 90% of the government securities purchased by the Hungarian central bank as part of QE operations in 2020 had maturities exceeding 10 years. In 2021, the value of government securities acquired by NBH increased from HUF 1,113,627 million to HUF 3,302,769 million, marking a remarkable increase of HUF 2,189,142 million. Nearly 95% of these securities had maturities exceeding five years. From 2022 to 2023, the value and maturity structure of these instruments haven't changed significantly (Magyar Nemzeti Bank 2021, p. 110; 2022, p. 110; 2024, p. 110).

When examining the development of net interest income among central banks in the context of interest rate risk and QE operations, it becomes evident that the most significant changes in 2022 and 2023 were observed in countries where the volume of purchased financial instruments issued or guaranteed by the state Treasury was the largest. As indicated in Table 6, this is particularly relevant for Poland and Hungary.

5.3. Central banks profitability

To evaluate the financial strength of the central banks analysed, their profitability served as a factor that influenced their long-term ability to perform basic functions. It should be noted that central banks under scrutiny show a notable heterogeneity in asset profitability levels and their alterations during the period 2018–2023. Interestingly, with the exception of the Bulgarian National Bank, all institutions reported a negative return on assets in 2022, where the most substantial declines were observed in the Czech Republic (Table 7). In the preceding year, the central banks of the Czech Republic, Hungary, and Bulgaria also registered negative ROAs. In 2023, negative ROA occurred in NBP and NBH.

To calculate the return on equity ratio, the broad definition of equity, as used by central banks, was adopted. The equity of central banks encompasses: statutory funds, reserve funds, reserves for covering exchange rate risk of the domestic currency against foreign currencies, positive revaluation differences, losses from previous years, and the current year's result available to the central bank (Česká národní banka 2023, p. 20; Narodowy Bank Polski 2023, p. 204).

As in ROA, the most significant decreases in ROE were observed in 2022 (Table 8). The National Bank of Romania maintained a positive ROE, although in 2022 it was more than 50% lower than in the years 2018–2021. Among the scrutinised central banks, the most substantial deterioration in ROE was observed in the case of the National Bank of Hungary and Narodowy Bank Polski in 2022, with a value of -76.22% and -31.24%, respectively. In 2023, three central banks had negative equity values (in two cases as a result of a significant current year loss). For this reason, it was not possible to determine ROE with an economically correct interpretation. In the case of the Bulgarian National Bank and the National Bank of Romania, a significant improvement in this measure of profitability is observed.

[12] Own calculations based on data available from the NBP, https://nbp.pl/en/statistic-and-financial-reporting/financial-markets/nbp-operations/.

5.4. Central banks' credibility

For the purposes of this section, central bank credibility is defined in terms of deviations of inflation expectations from the central banks' target rate of inflation. For the purposes of this study, credibility is measured employing the approach proposed by Cecchetti and Krause (2002, p. 53). According to this concept, the credibility index takes values in the range <0, 1>, with a value of 1 occurring when inflation expectations are below or equal to the central bank's inflation target and 0 when they are equal to or above 20%. When the level of inflation expectations is between the inflation target and 20%, the value of the index is standardised according to the equation 1.

$$IC = 1 - \frac{1}{0.2 - \pi^t}\left(E(\pi) - \pi^t\right) \quad \text{if} \quad \pi^t < E(\pi) < 20\% \tag{1}$$

where:

IC – index of credibility,

$E(\pi)$ – expected inflation rate (measured by the inflation forecasts published in the World Economic Outlook by the IMF; end-year forecasts are used),

π^t – target level of inflation (defined based on the monetary policy strategy of the analysed central banks; in the case of a range target, the middle of the range is taken).

The values of credibility index for the policy of individual central banks in CEE countries are presented in Table 9.

Based on the data in Table 9, it can be indicated that for all the central banks studied, a significant deterioration in their credibility is observed during the turbulent socio-economic environment. This applies in particular to the year 2022. The least deterioration in credibility was observed for the Bulgarian central bank. This bank had the highest level of credibility throughout the period under review. Extremely low levels of credibility in 2022 were observed in the Czech Republic and Hungary. In 2023, all banks have managed to partially restore their credibility.

6. The level of interest rate risk as a determinant of central bank profitability

The substantial differences in the profitability of central banks in CEE countries, observed over the period 2018 to 2023, provide a rationale for the search for factors influencing the magnitude of this phenomenon. To assess the significance of the impact of interest rate risk on the financial strength of central banks (perceived through the lens of their profitability), a panel study will be conducted. The analysis includes data from five central banks covering the years 2018–2023. The collected data have the characteristics of panel data, allowing for the observation of changes in two cross-sections simultaneously, i.e. across institutions (central banks) and over time. The primary advantage of this type of data is that its use in constructing and estimating econometric models facilitates hypothesis testing, increases degrees of freedom, reduces multicollinearity issues, and limits or eliminates bias in estimators (Dańska-Borsiak 2011, pp. 19–20). To perform the analysis, the dynamic panel model of the Generalized Method of Moment (commonly referred to as GMM), in the GMM-SYS version, was employed (Blundell, Bond 1998). GMM models are considered to be useful in financial

research, particularly in studies regarding banking (Andreß, Golsch, Schmidt-Catran 2013). One of the advantages of this method is the deviation from the standard assumption of strict exogeneity of regressors. Methods, which are based on GMM, are therefore particularly useful for models including endogenous or predetermined explanatory variables (Dańska-Borsiak 2011). Moreover, a small research sample (30 observations) also constitutes a factor, which conditions the use of the GMM-SYS model. The GMM-SYS estimator can produce more reliable and accurate results in similar cases (Baltagi 2005). Statistical inference within the scope of significance of the model parameters has been performed based on the 1-step estimate. The 2-step method could lead to erroneous conclusions, especially in the case of heteroscedasticity of the random component (Blundell, Bond 1998). For diagnostic purposes, the Sargan test was used for the 2-step method (Hansen test), as well as Arellano-Bond autocorrelation tests for first differences: AR (1) and AR (2). The final shape of the estimated dynamic regression models is given by equation 2.

$$CB.PROF_{\{i,t\}} = a_0 + a_1 \cdot CB.PROF_{\{i,t-1\}} + a_2 \cdot CB.FD_{\{i,t\}} + a_3 \cdot ENV_{\{i,t\}} + a_4 \cdot EXP.INRR_{\{i,t\}} + \varepsilon_{\{i,t\}} \quad (2)$$

where:

$CB.PROF$ – the measure of profitability (ROA) of the central bank,
$CB.FD_{\{i,t\}}$ – the vector of financial data variables of the central bank i in year t,
$ENV_{\{i,t\}}$ – the vector of control variables characterizing selected parameters of the socio-economic environment of the central bank i in year t,
$EXP.INRR_{\{i,t\}}$ – the vector of experimental variables that estimate the exposure of the central bank i to interest rate risk in year t,
$\varepsilon_{\{i,t\}}$ – the error term.

The profitability of central banks is measured using ROA, in accordance with the data presented in part 5.3. Due to the fairly widespread occurrence of negative equity in the central banks of the countries analysed during the period under review, the estimation using the ROE variable was abandoned (inability to determine it with a correct economic interpretation with a negative denominator). Explanatory variables were selected on the basis of a review of the literature and the inclusion of experimental variables. The characteristics of the explanatory variables are presented in Table 10. Unless otherwise indicated, the values of the variables are given in annual average terms. Descriptive statistics and the correlation matrix are included in Figure 2 and Table 14.

Based on the data collected and taking into account both the correlation matrix and the above assumptions, modelling was carried out, the results of which are shown in Table 11.

Based on the analysis conducted, the first research hypothesis was confirmed, indicating that interest rate risk is a significant determinant of central bank profitability in the CEE countries. It was shown that the level of assumed exposure to interest rate value risk, measured by the duration of the portfolio of official reserve assets, has a statistically significant negative impact (at the 5% significance level) on the level of ROA. Furthermore, the magnitude of the materialisation of interest rate risk in the area of foreign assets, expressed in basis points as the average y/y change in the yield on long-term government securities, was shown to have a significantly negative effect on the return on assets (at the 99% confidence level). The strength of the interaction between the level of interest rate risk and central bank yields increases in an environment of higher domestic interest rates.

The scale of central bank QE operations used, as reflected in the size of the portfolio of domestic fixed-interest rate debt instruments in banks' assets, also showed a negative statistically significant impact (1% significance level) on return on assets in the CEE central banks, indicating the significant implications of massive liquidity providing programmes launched during the COVID-19 pandemic on central banks' ability to build their profitability.

The analysis also confirmed a positive relationship between the size of central banks (measured by the natural logarithm of the value of their assets) and both their capital endowment and the profitability of their assets (with a confidence level of 99%). Asset yields are negatively affected by the reserve asset allocation strategy (share of euro reserve assets in relation to total reserve assets) and the level of interest rates (1% significance). On the basis of the analysis, the first research hypothesis has been confirmed, indicating that interest rate risk is a significant factor determining central bank profitability in the CEE countries. It has been shown that the level of accepted exposure to the risk of interest rate value, measured using the duration of the portfolio of official reserve asset instruments, has a statistically significant negative impact (at the 5% significance level) on the ROA level.

7. The impact of central banks' profitability on their credibility

An important concluding step in the analyses is to assess the impact of central banks' profitability on their credibility. Preliminary observation has shown significant variation in the credibility of individual central banks. Consequently, an attempt has been made to assess whether the financial strength of a central bank, as perceived through the prism of its profitability, is a significant determinant of its credibility. Complementary panel studies were conducted. The explanatory variable for credibility was defined as indicated in Section 6 above. Selected explanatory variables chosen based on the literature analyses presented in Section 3 were included in the model. The characteristics of the variables are presented in Table 12. Descriptive statistics and the correlation matrix are included in Figure 3 and Table 15.

Analogously to the model addressing profitability determinants, the dynamic model (GMM-SYS) was utilised. Its general notation takes the form given by equation 3.

$$CB.CRED_{\{i,t\}} = a_0 + a_1 \cdot CB.CRED_{\{i,t-1\}} + a_2 \cdot CB.HA_{\{i,t\}} + a_3 \cdot ENV_{\{i,t\}} + a_4 \cdot EXP.PROF_{\{i,t\}} + \varepsilon_{\{i,t\}} \quad (3)$$

where:

$CB.CRED_{\{i,t\}}$ – the measure of central bank credibility,

$CB.HA_{\{i,t\}}$ – the vector of control variables characterising the previous actions of the central bank in the monetary policy area during period t,

$ENV_{\{i,t\}}$ – the vector of control variables characterising selected parameters of the economic environment in which the central bank operates during period t,

$EXP.PROF_{\{i,t\}}$ – the variable characterising the central bank's profitability (ROA or PLM) during period t,

$\varepsilon_{\{i,t\}}$ – the error term.

Due to the existence of a strong correlation, the profitability variables were included in the model separately. The results of the estimation using the ROA variable are shown in Table 13, while those using the PLM variable are shown in Table 14.

Based on the analyses conducted, the hypothesis of the statistical significance of the impact of central bank profitability on the level of central bank credibility was confirmed. It was shown that as the profitability of a central bank's assets increases, its credibility improves. ROA was confirmed to affect the credibility gap at the 5% significance level. Based on the estimation, it was further shown that the central bank's credibility gap is strongly influenced by the experience of the central bank's historical struggle with inflation, understood as the central bank's ability to meet its inflation target in the previous year. This relationship is positive (the achievement of the inflation target in the previous year supports the current central bank's credibility) and is characterised by a high strength of influence. On average, higher levels of central bank credibility have also been shown in countries with a direct inflation targeting strategy and with lower levels of public debt (measured by the public debt-to-GDP ratio).

The results obtained from the estimation using the PLM variable as a profitability assessment tool (Table 14) reinforce the conclusions of the base model that includes ROA as a measure of profitability (Table 13). A negative statistically significant relationship (at the 10% significance level) was shown to exist between the PLM variable and the credibility level of the central banks, indicating a negative role of prolonged losses incurred by central banks in their ability to build credibility. In this context, it should be emphasised that an instrument that strengthens the central banks' credibility is their ability to limit losses in the medium term, so that these losses can be seen as an incidental phenomenon and not as a permanent loss of the central bank's ability to manage its assets efficiently. This is important because the absolute value of the coefficient for PLM is higher than for ROA.

8. Conclusions

The activities of central banks, despite their unique character and functions, are not without risks. An exemplary case of relatively minor significance in times of high macroeconomic stability is interest rate risk. The occurrence of shocks, related both to the consequences of the COVID-19 pandemic and supply-side factors associated with the Russian aggression against Ukraine, has led to abrupt changes in the determinants affecting the materialisation of interest rate risk. Despite the fact that most central banks maintain a relatively low appetite for interest rate risk (measured by the duration of the portfolio), the severity of the shock has resulted in substantial losses. Simultaneously, as demonstrated in the analyses, there has been a notable deterioration in the credibility of central banks.

The research results presented in this paper confirm the research hypothesis according to which the level of interest rate risk accepted by central banks and the scale of its materialisation are statistically significant but not exclusive determinants of the profitability of these entities in selected CEE countries. The second hypothesis, according to which the level of central banks' profitability in selected CEE countries interacts as one of the factors on their credibility, was also positively verified.

Regarding the process of managing interest rate risk in the central banks of CEE countries, it should be noted that while some of these institutions maintain concerns about future results, fearing that a further increase in profitability resulting from the downward movement in bond prices may negatively

impact their overall performance in the short term, the low duration of instruments in which foreign exchange reserves are invested means that the rising yields will have a positive medium-term effect on profits as maturing reserve components can be reinvested. The 2024 cycle of interest rate cuts that has taken place in most countries in the region will help to reduce interest rate risk, particularly for instruments of domestic issuers purchased under quantitative easing. The research findings allow for the formulation of a recommendation regarding the need for central banks to pay greater attention to the process of implementing interest rate risk management, especially during periods of rapid macroeconomic changes. The established relationship between central bank profitability and the credibility gap indicates that central banks should consider the stability of their financial results as part of their actions. The inability to maintain profitability by a central bank may be perceived as a factor that deepens mistrust in the implemented monetary policy strategy. In this context, central banks should view a lower exposure to interest rate risk as a stabilising tool to achieve financial results.

Simultaneously, certain limitations should be acknowledged in relation to the research conducted. On the one hand, these limitations stem from the relatively small research sample, encompassing selected CEE countries, and the ongoing macroeconomic uncertainty. On the other hand, constructing a balanced data panel on a larger sample of central banks is challenging due to the lack of standardisation regarding the publication of data related to the level of interest rate risk and the reluctance of central banks to provide data beyond what is published in their annual reports.

An important challenge and area for further research associated with the process of managing the interest rate risk of financial instrument portfolios is the implementation of ESG goals by central banks. This is exemplified, among others, by the National Bank of Hungary, which, since 2019, has included green bonds in its managed instruments. This issue is currently of significant importance for the central bank of the Czech Republic, as well. Earlier experiences indicate a relatively higher accepted duration of the portfolio for such instruments, which, in the case of an increased role in, among other things, reserve assets, will lead to dilemmas related to the possibility of limiting interest rate risk in central banks.

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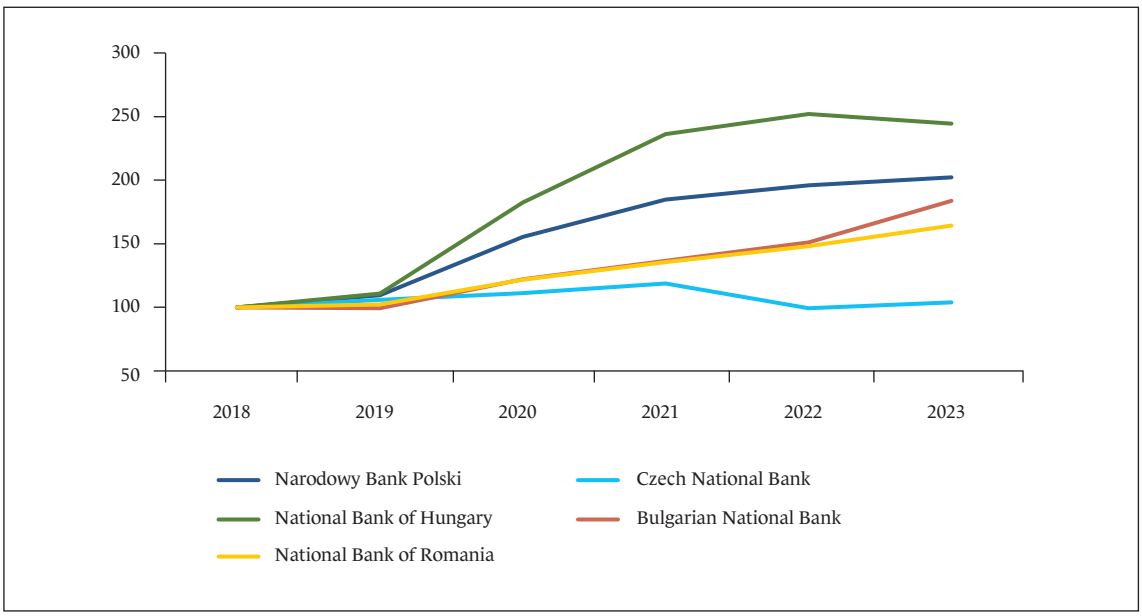
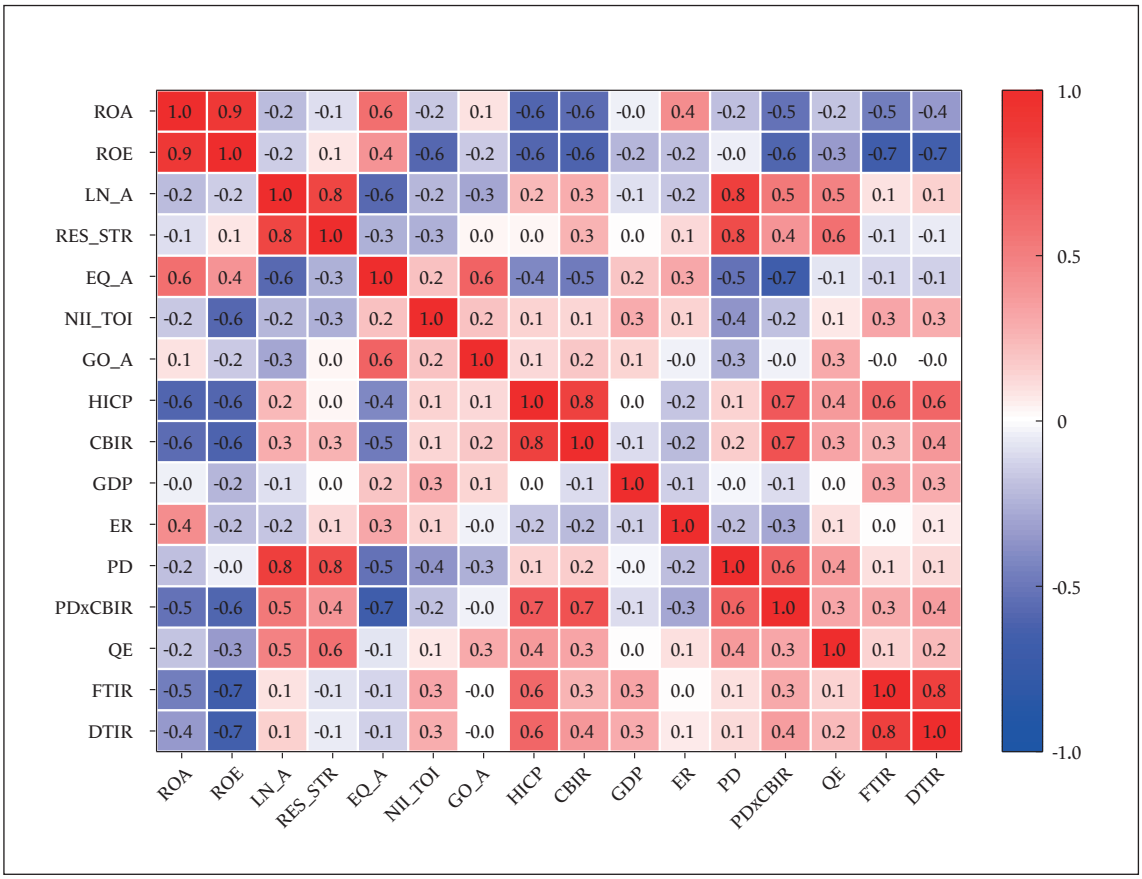
Appendix

Figure 1
Change in the total asset value of selected central banks in CEE countries in the years 2018–2023 (year 2018 = 100)



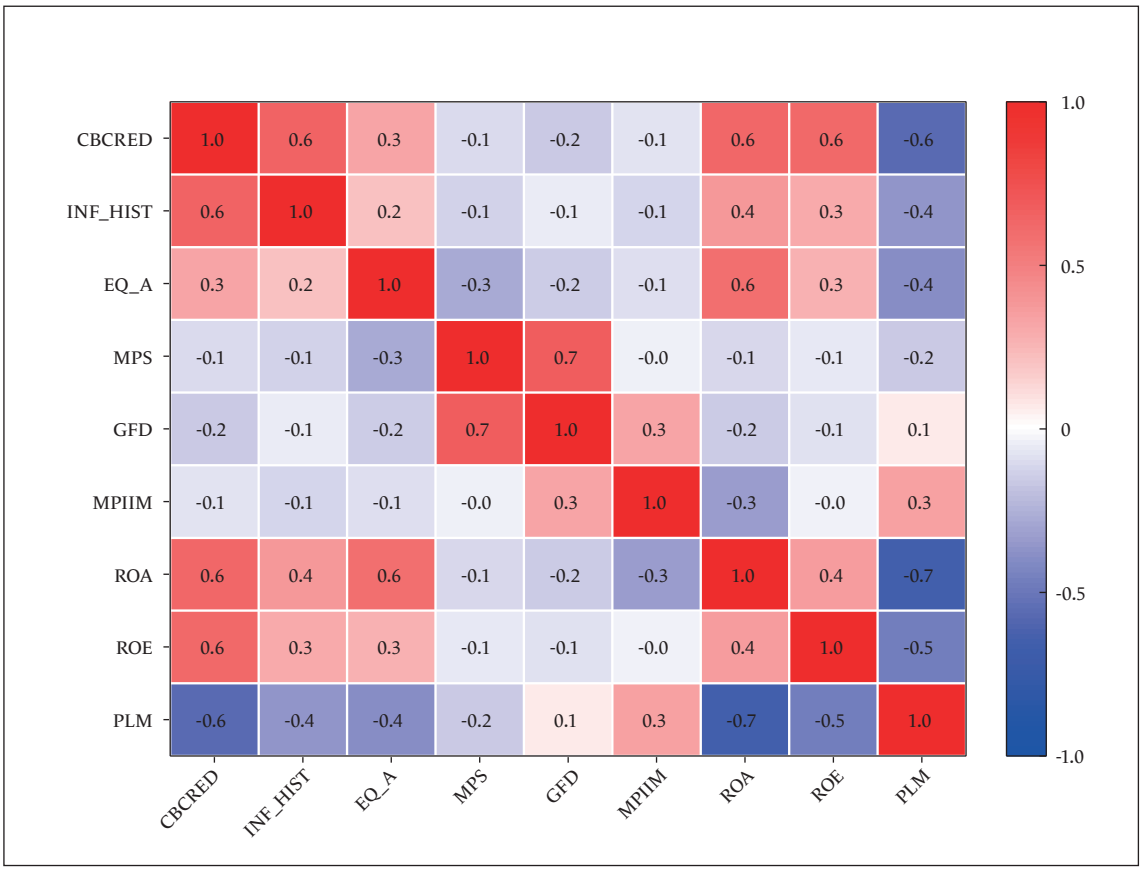
Source: authors' elaboration based on BankFocus database and financial reports of central banks.

Figure 2
Correlation matrix of variables used in the study of determinants of central bank profitability of selected CEE countries



Source: own compilation using the Gretl statistical software package.

Figure 3
Correlation matrix of variables used in the study of central bank credibility determinants of selected CEE countries



Source: own compilation using the Gretl statistical software package.

Table 1

Duration of the reserve asset portfolio of selected central banks in CEE countries from 2018 to 2023 (in years)

Central bank	2018	2019	2020	2021	2022	2023	2018–2023
Narodowy Bank Polski	2.13 (2.1)	2.12 (2.1)	2.11 (2.1)	3.23 (3.2)	3.09 (3.0)	3.21 (3.1)	2.65 (2.6)
Czech National Bank	1.93	2.05	2.15	2.26	2.76	3.44	2.43
National Bank of Hungary	1.0*	1.0*	1.0*	1.0*	1.0*	1.0*	1.00
Bulgarian National Bank	0.88	0.86	0.76	0.71	0.21	0.18	0.60
National Bank of Romania	1.25**	1.25**	1.25**	1.25**	1.58**	1.6**	1.36
Group total	1.32	1.30	1.28	1.55	1.47	1.89	1.47

Notes: for Poland, the value of MD published in NBP's annual reports is provided in parentheses. Duration estimates are based on the reserve asset structure and bond yields published by Bloomberg.

* The term "approximately 1 year" is used in the reports. NBH accepts higher durations for the MBS and green bond portfolio – 4–5 years in 2021; 5–6 years in 2022; 4.5–6.5 years in 2023.

** Upper limit specified in the reserve management strategy.

Source: authors' compilation based on central banks' annual reports.

Table 2

Central bank sensitivity to a 100 basis point increase in interest rates

Central bank	2018	2019	2020	2021	2022	2023	2018–2023
Narodowy Bank Polski (PLN billion)	n/a	-7.6	-9.1	-14.9	-14.1	-14.7	-12.1
Bulgarian National Bank (BGN million)	-352.9	-400.7	-291.8	-243.2	-41.3	-146.2	-246.0

Note: calculated on a modified duration basis, the cumulative decrease in unrealised revaluation gains or increase in unrealised revaluation losses if the yield curves increase uniformly by 100 basis points at the balance sheet date (Narodowy Bank Polski 2022, p. 142).

Source: authors' compilation based on central banks' annual reports.

Table 3
Average VaR values for interest rate and currency risk of the financial instruments portfolio of the Bulgarian National Bank (thousands of BGN) and the correlation ratio between them from 2018 to 2023

Category	2018	2019	2020	2021	2022	2023
VaR (interest rate risk)	3 930	4 214	8 483	6 866	6 496	947
VaR (currency risk)	17 391	24 083	58 094	39 892	49 775	44 142
Correlation coefficient (interest rate and currency)	0.16	0.46	0.14	0.32	0.19	0.16

Source: authors' compilation based on data from the BNB annual reports.

Table 4
VaR values for interest rate risk of the financial instruments portfolio of the National Bank of Albania from 2018 to 2023 (millions of ALL)

Category	2018	2019	2020	2021	2022	2023
VaR (interest rate risk)	1 459	2 178	1 868	2 680	10 592	14 191

Source: authors' compilation based on the Bank of Albania, *Annual Report*, various issues.

Table 5
Percentage share of government securities in the total assets of selected central banks in CEE countries from 2018 to 2023

Central bank	2018	2019	2020	2021	2022	2023
Narodowy Bank Polski	0	0	16.22	18.09	16.05	15.37
Czech National Bank	0	0	0	0	0	0
National Bank of Hungary	0	0	5.48	12.55	11.80	12.15
Bulgarian National Bank	0	0	0	0	0	0
National Bank of Romania	0	0	2.10	1.76	1.41	1.13

Source: authors' compilation based on BankFocus database and annual reports of central banks.

Table 6
Net interest income of selected central banks in CEE countries from 2018 to 2023 (million units of the national currency)

Central bank	2018	2019	2020	2021	2022	2023
Narodowy Bank Polski	2 558	3 294	3 142	2 252	-5 830	-1 646
Czech National Bank	-18 022	-37 387	-13 223	-18 467	-13 431	-129 882
National Bank of Hungary	27 101	49 447	40 661	-72 521	-1 062 304	-1 758 841
Bulgarian National Bank	194	185	167	90	112	1 346
National Bank of Romania	329	354	349	58	928	3 947

Source: authors' compilation based on BankFocus database and annual reports of central banks.

Table 7
Return on assets for selected central banks in CEE countries from 2018 to 2023 (in %)

Central bank	2018	2019	2020	2021	2022	2023	2018–2023
Narodowy Bank Polski	0.00	1.67	1.58	1.44	-1.99	-2.34	0.06
Czech National Bank	0.06	1.73	2.59	-1.01	-11.58	1.66	-1.09
National Bank of Hungary	0.47	2.17	1.56	-0.24	-1.48	-6.38	-0.65
Bulgarian National Bank	-0.12	0.96	0.52	-0.14	-0.02	2.25	0.57
National Bank of Romania	0.61	0.93	0.95	0.82	0.40	0.77	0.75
Group total	0.20	1.49	1.44	0.17	-2.93	-0.81	-0.07

Source: authors' compilation based on BankFocus database and annual reports of central banks.

Table 8

Return on equity for selected central banks in CEE countries from 2018 to 2023 (in %)

Central bank	2018	2019	2020	2021	2022	2023	2018–2023
Narodowy Bank Polski	0.00	28.16	20.74	17.74	-31.24	–	7.08
Czech National Bank	–	–	–	–	–	–	–
National Bank of Hungary	14.12	45.59	28.45	-5.97	-76.22	–	1.19
Bulgarian National Bank	-1.36	10.76	5.96	-1.85	-0.32	30.65	7.31
National Bank of Romania	6.58	8.10	7.86	6.84	3.32	7.31	6.67
Group total	3.87	18.52	12.60	3.35	-20.89	18.98	4.64

Note: for CNB (2018–2023), NBP and CBH (2023) an accurate calculation of ROE is not possible due to the negative value of equity.

Source: authors' compilation based on BankFocus database and annual reports of central banks.

Table 9

Credibility index of selected central banks in CEE countries from 2018 to 2023

Central bank	2018	2019	2020	2021	2022	2023	2018–2023
Narodowy Bank Polski	1.00	0.96	1.00	0.86	0.24	0.72	0.79
Czech National Bank	0.99	0.99	0.96	0.89	0.00	0.70	0.75
National Bank of Hungary	0.97	0.98	0.93	0.96	0.00	0.65	0.75
Bulgarian National Bank	0.94	0.97	1.00	0.93	0.41	0.85	0.85
National Bank of Romania	0.94	0.89	0.99	0.84	0.30	0.70	0.78
Group total	0.97	0.96	0.98	0.90	0.19	0.72	0.79

Source: own calculations based on the method of Cecchetti and Krause (2002, p. 53) using data extracted from the IMF World Economic Outlook.

Table 10
Characteristics of explanatory variables – panel study of determinants of central bank profitability

Variable	Description	Data source
	CB.FD	
LN_A	Size of the bank: estimated as the natural logarithm of the total balance sheet of the central bank (expressed in euros)	BankFocus database and banks' annual reports
RES_STR	Allocation policy of reserve assets: the proportion of reserve assets in euros in relation to total reserve assets	Calculated based on banks' annual reports
EQ_A	Capital endowment of the bank: total own equity to total assets	BankFocus database and banks' annual reports
NII_TOI	Diversification of income sources: share of net interest income in total operating income	BankFocus database and banks' annual reports
GO_A	Share of monetary gold in the assets of the central bank	BankFocus database and banks' annual reports
	ENV	
HICP	Inflation level: measured using HICP (Harmonized Index of Consumer Prices)	Eurostat
CBIR	Use of monetary policy instruments: central bank interest rate	Banks' websites
GDP	Economic development of the country where the central bank is headquartered: annual GDP growth rate	World Bank
ER	Realisation of exchange rate risk: annual change in the exchange rate of the currency that constitutes the largest part of the central bank's reserve assets	Own calculations based on ECB data
	EXP.INRR	
PD	Interest rate risk accepted by the bank: estimated using the duration of the portfolio of financial instruments of reserve assets	Banks' annual reports and own estimates
PDxCBIR	Interaction term PD and CBIR	Own calculations
QE	Involvement of the central bank in purchasing government securities on the secondary market as part of QE operations: measured as the value of acquired instruments relative to total assets	Own estimates based on banks' annual reports
FTIR	The magnitude of interest rate risk materialisation in the area of reserve assets: expressed in basis points, the average change in the year-on-year yield of long-term securities issued by foreign issuers (for the country where the central bank has the largest involvement in reserve assets) – weighted average for 2-year and 10-year government bonds	Own calculations based on Bloomberg data
DTIR	The magnitude of interest rate risk materialisation in the area of domestic assets obtained through QE: expressed in basis points, the average change in the year-on-year yield of long-term securities issued or guaranteed by the national Treasury – weighted average for weighted average for the total portfolio of government bonds	Own calculations based on Eurostat data

Source: own compilation.

Table 11
Results of panel study of determinants of ROA in central banks of selected CEE countries

Variable	Coefficient	Std. error	P-value	Statistical significance
ROA(-1)	-0.717	0.159	< 0.0001	***
const	-93.477	14.399	< 0.0001	***
LN_A	8.739	1.375	< 0.0001	***
RES_STR	-0.169	0.046	0.0002	***
EQ_A	0.705	0.118	< 0.0001	***
NII_TOI	-0.002	0.003	0.4543	
GO_A	-0.08	0.229	0.7262	
CBIR	-0.872	0.172	< 0.0001	***
GDP	-0.095	0.131	0.469	
ER	0.032	0.161	0.842	
PD	-1.138	0.502	0.0234	**
PDxCBIR	0.288	0.059	< 0.0001	***
QE	-0.177	0.032	< 0.0001	***
FTIR	-0.007	0.002	0.0011	***
Observations	30			
Central banks	5			
AR (1)	-1.604*			
AR (2)	1.383			
Hansen	19.556			
No. of instruments	20			

* significance at 10% level; ** significance at 5% level; *** significance at 1% level.
Time effects are included but not reported. System GMM (1 lag used as instrument).

Source: own compilation.

Table 12
Characteristics of explanatory variables – panel study of determinants of central bank credibility

Variable	Description	Data source
	CB.HA	
INF_HIST	History of fighting inflation, defined as the central bank's ability to achieve its inflation target in the previous year; binary variable: 1 – target achieved, 0 – target not achieved	Own analysis based on HICP inflation data (Eurostat) and central bank strategies (strategies available on central bank websites)
EQ_A	Central bank independence, assessed by the level of the central bank's equity	BankFocus database and banks' annual reports
MPS	Applied monetary policy strategy; binary variable: 1 for the direct inflation target strategy, 0 for other strategies	Analysis of central bank monetary policy strategies
	ENV	
GFD	Fiscal discipline of the government: measured by the ratio of public finance sector debt to GDP of the country	Eurostat
MPIIM	Effectiveness of the transmission of monetary policy impulses to the interbank market: measured by the absolute difference between the short-term interbank interest rate and the central bank's basic rate	Own calculations based on data available on central banks' websites and reference rate administrators
	EXP.PROF	
ROA	Central bank profitability, estimated using the return on assets	BankFocus database and banks' annual reports
PLM	Prolonged loss-making; binary variable: 1 – when the central bank incurs a loss for the second consecutive year, 0 – in other cases	Own analysis based on data from the BankFocus database and banks' annual reports

Source: own compilation.

Table 13
Results of the panel study of determinants of credibility of selected CEE central banks – profitability measured using the ROA variable

Variable	Coefficient	Std. error	P-value	Statistical significance
CB.CRED(-1)	-0.242	0.267	0.365	
Const	0.838	0.133	< 0.0001	***
INF_HIST	0.362	0.161	0.024	**
EQ_A	0.004	0.007	0.539	
MPS	0.167	0.058	0.004	***
GFD	-0.005	0.001	0.001	***
MPIIM	0.067	0.046	0.142	
ROA	0.043	0.017	0.011	**
Observations	30			
Central banks	5			
AR (1)	-1.831*			
AR (2)	-0.928			
Hansen	22.741			
No. of instruments	21			

* significance at 10% level; ** significance at 5% level; *** significance at 1% level.
Time effects are included but not reported. System GMM (1 lag used as instrument).

Source: own compilation.

Table 14
Results of the panel study of determinants of credibility of selected CEE central banks – profitability measured using the PLM variable

Variable	Coefficient	Std. error	P-value	Statistical significance
CB.CRED(-1)	-0.342	0.202	0.110	
Const	0.959	0.075	< 0.0001	***
INF_HIST	0.366	0.100	0.000	***
EQ_A	0.008	0.007	0.253	
MPS	0.079	0.056	0.157	
GFD	-0.003	0.001	< 0.0001	***
MPIIM	0.021	0.072	0.769	
PLM	-0.284	0.166	0.086	*
Observations	30			
Central banks	5			
AR (1)	-1.600*			
AR (2)	0.165			
Hansen	23.722			
No. of instruments	21			

* significance at 10% level; ** significance at 5% level; *** significance at 1% level.
Time effects are included but not reported. System GMM (1 lag used as instrument).

Source: own compilation.

Table 15
Descriptive statistics of the variables used in the examination of the determinants of central bank profitability of selected CEE countries

Variable	Mean	Median	Std. dev.	Minimum	Maximum
ROA	-0.07	0.57	2.78	-11.58	2.59
ROE	5.69	7.07	24.01	-76.22	45.59
LN_A	11.18	11.16	0.65	10.17	12.24
RES_STR	22.71	23.30	16.60	0.02	51.00
EQ_A	3.86	6.00	7.27	-14.87	13.14
NII_TOI	54.07	30.84	129.40	-217.80	457.90
GO_A	5.87	6.52	3.51	0.01	11.23
HICP	6.28	3.80	4.89	1.20	17.00
CBIR	2.71	1.43	3.11	0.00	12.63
GDP	2.61	3.70	3.63	-5.50	7.66
ER	0.99	0.32	3.57	-7.29	10.09
PD	1.58	1.25	0.91	0.18	3.44
PDxCBIR	4.72	2.03	6.58	0.00	24.01
QE	3.80	0.00	6.26	0.00	18.09
FTIR	37.20	-8.75	127.20	-122.50	306.5
DTIR	50.99	-10.63	148.70	-85.08	450.90

Source: own compilation using the Gretl statistical software package.

Table 16
Descriptive statistics of the variables used in the examination of the determinants of central bank credibility of selected CEE countries

Variable	Mean	Median	Std. dev.	Minimum	Maximum
CBCRED	0.79	0.93	0.30	0.00	1.00
INF_HIST	0.53	1.00	0.51	0.00	1.00
EQ_A	3.86	6.00	7.27	-14.90	13.10
MPS	0.80	1.00	0.41	0.00	1.00
GFD	45.70	46.20	17.40	20.00	79.30
MPIIM	0.36	0.15	0.57	0.00	2.97
ROA	-0.07	0.57	2.78	-11.60	2.59
ROE	4.64	5.96	21.70	-76.20	45.60
PLM	0.20	0.00	0.41	0.00	1.00

Source: own compilation using the Gretl statistical software package.

Ryzyko stopy procentowej banków centralnych krajów Europy Środkowo-Wschodniej a ich rentowność i wiarygodność w warunkach turbulentnego otoczenia społeczno-gospodarczego

Streszczenie

Między prowadzeniem polityki pieniężnej, wiarygodnością a pozycją kapitałową banku centralnego, jego rentownością i systemem kontroli ryzyka istnieje związek (Bini Smaghi 2011). Związek ten wynika m.in. z faktu, że źródłem jednego z rodzajów ryzyka, które występuje w działalności banku centralnego, jest zmienność stopy procentowej.

Mimo że, jak twierdzi Rudebusch (2011), ryzyko stopy procentowej w działalności banku centralnego powinno być kwestią drugorzędną, podporządkowaną makroekonomicznym celom polityki pieniężnej, to jednak może się ono zmaterializować i banki centralne mogą być narażone na jego negatywne konsekwencje. W szczególności może to oznaczać utratę wiarygodności i zwiększoną podatność banku centralnego na wpływy polityczne. To z kolei może ograniczać skuteczność polityki prowadzonej przez tę instytucję – centralną w systemie gospodarczym danego kraju.

Wystąpienie szoków związanych zarówno z konsekwencjami pandemii COVID-19, jak i z wojną w Ukrainie doprowadziło do gwałtownych zmian czynników oddziałujących na poziom materializacji ryzyka stóp procentowych. Pomimo że większość banków centralnych krajów Europy Środkowo-Wschodniej (EŚW) utrzymuje relatywnie niski apetyt na ryzyko stopy procentowej (mierzone przez *duration* portfela instrumentów), skala szoku okazała się tak duża, iż wiele z tych podmiotów wykazało straty. Co więcej, doszło także do istotnego pogorszenia się ich wiarygodności.

Celem artykułu jest ocena zróżnicowania poziomu ryzyka stopy procentowej banków centralnych w wybranych krajach EŚW oraz wpływu skali tego ryzyka na wynik finansowy i wiarygodność badanych instytucji.

Postawiono następujące hipotezy badawcze: (1) skala akceptowanego przez bank centralny poziomu ryzyka stopy procentowej oraz skala jego materializacji są istotnymi determinantami rentowności banków centralnych wybranych krajów EŚW oraz (2) poziom rentowności banków centralnych wybranych krajów EŚW ma istotny wpływ na ich wiarygodność. Na potrzeby weryfikacji hipotez wykorzystano pogłębiony przegląd literatury, analizę danych sprawozdawczych (bilansowych oraz pozabilansowych) i statystycznych, a także narzędzia ekonometryczne, tj. regresję danych panelowych (modele dynamiczne estymowane metodą GMM-SYS).

Do szczegółowych analiz wybrano banki centralne krajów EŚW będących członkami Unii Europejskiej, nienależące jednak do Eurosystemu, a w konsekwencji mające większą autonomię w zarządzaniu ryzykiem, budowaniu siły finansowej (w tym przez kształtowanie długookresowej rentowności) oraz realizacji polityki pieniężnej. Wśród analizowanych banków centralnych cztery realizują strategię celu inflacyjnego: Narodowy Bank Czech, Narodowy Bank Polski, Narodowy Bank Rumunii, Narodowy Bank Węgier, a jeden bank centralny stosuje strategię celu kursowego (Narodowy Bank Bułgarii). Analizowane banki centralne stanowią dość zróżnicowaną grupę, biorąc pod uwagę m.in. ich wielkość (mierzoną wartością sumy bilansowej).

Okres analiz obejmuje lata 2018–2023, aby możliwe było porównanie zmian obserwowanych w warunkach turbulentnego otoczenia społeczno-gospodarczego lat 2020–2023 z okresem większej stabilności finansowej (2018–2019).

Do najważniejszych czynników egzogenicznych, które wystąpiły w badanym okresie w krajach EŚW, należą szoki społeczne i ekonomiczne, związane m.in. z pandemią COVID-19 oraz konfliktem zbrojnym w Ukrainie. W analizie uwzględniono ponadto kwestię oddziaływania zmian w stosowaniu niestandardowych instrumentów polityki pieniężnej na poziom ryzyka rynkowego w bankach centralnych analizowanych krajów.

Biorąc pod uwagę charakterystykę pozyskanych danych (zmienne ciągłe i binarne w przekroju czasowo-przestrzennym), po uwzględnieniu wyników statystycznych testów poprawności estymacji przeprowadzono ocenę zależności między poziomem ryzyka stopy procentowej banków centralnych a ich rentownością i wiarygodnością, z wykorzystaniem regresji liniowej danych panelowych.

Pomimo stosunkowo niewielkiej próby badawczej krajów EŚW i utrzymującej się niepewności makroekonomicznej zaprezentowane wyniki badań potwierdziły hipotezę, że skala akceptowanego przez bank centralny poziomu ryzyka stopy procentowej oraz skala jego materializacji są istotnymi determinantami rentowności banków centralnych wybranych krajów EŚW. Pozytywnie zweryfikowano także drugą hipotezę – że poziom rentowności banków centralnych wybranych krajów EŚW ma istotny wpływ na ich wiarygodność.

Wnioski z badania sugerują, że banki centralne powinny zwracać większą uwagę na zarządzanie ryzykiem stopy procentowej w okresach gwałtownych zmian makroekonomicznych. Ustalony związek między rentownością banku centralnego a wiarygodnością podkreśla znaczenie stabilności wyników finansowych dla skuteczności prowadzenia polityki pieniężnej. Banki centralne powinny rozważyć zmniejszenie ekspozycji na ryzyko stopy procentowej, co służyłoby stabilizowaniu ich wyników finansowych oraz wspierałoby ich wiarygodność.

Ze względu na różnice w publikowaniu danych przez banki centralne wyzwaniem dla dalszych badań jest skonstruowanie zrównoważonego panelu danych obejmujących większą próbę badawczą. W artykule zidentyfikowano wyłaniający się obszar badawczy związany z wdrażaniem przez banki centralne celów środowiskowych, społecznych i korporacyjnych (ESG), czego przykładem jest włączenie zielonych obligacji do instrumentów, którymi zarządzają.

Słowa kluczowe: bank centralny, Europa Centralna i Wschodnia, ryzyko stopy procentowej, efektywność, wiarygodność