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Interest Rate Policy and the Assets and Financial Results of Central Banks in Selected European Union Member States

Abstract: In reaction to the 2008 global financial crisis, central banks made large-scale asset acquisitions using their reserves. This unusual monetary strategy has persisted throughout the pandemic, and in certain cases beyond 2022. By then, central bank balance sheets had grown by up to tenfold. Then, as interest rates climbed sharply, these enormous holdings began to suffer significant losses. These losses vary qualitatively depending on whether the central bank purchased domestic or international assets, resulting in transfers within or between countries.

The aim of the research undertaken in this article is to examine the impact of changes in the interest rates of selected central banks on the value of their assets in the period 2015-2023. The European Central Bank was selected for the study as the central bank of 20 euro area member states and the central banks of selected European Union countries still outside the euro area (Czech Republic, Denmark, Hungary, Poland, Sweden). The research used research methods based on literature studies in the field of finance and banking as well as statistical and econometric methods (Granger causality test and Vector Autoregression Model). The research used quarterly data from the Bank for International Settlements.

Keywords: central bank, assets, interest rate.

JEL Code: E58, E52, G12

1. Introduction

The concept of central bank losses is so alien to central bankers that their existence can be regarded as a lack of financial discipline, raising concerns about the financial system's stability. The important concern is whether central banks' financial losses will undermine their principal goal of keeping a stable pricing level in the economy. Intuitively, one could expect that central banks in poor financial condition would suffer a significant loss of legitimacy, independence, and public trust (Elgin & Öztunalı, 2024). In fact, a central bank struggling with losses and low equity may be obliged to forgo its inflation target in order to produce more income and profits. Alternatively, the central bank may get a capital injection from the government, but this option is unlikely to be pursued due to the negative impact on the central bank. Central banks cannot declare bankruptcy because there is no bankruptcy procedure for these public institutions. Furthermore, national governments own central banks, so taxpayers eventually support them. Bankruptcy also does not apply to central banks with private shareholders, such as the US Federal Reserve (which is entirely owned by private banks), Banca d'Italia, National Bank of Belgium, Bank of Greece, Swiss National Bank, Bank of Japan, and Central Bank of Turkey. Emprical studies show that central banks with private shareholders do not appear to differ from public central banks in terms of profitability or the share of profits paid to shareholders.

Central banks make monopolistic profits by printing money and bank reserves. Such earnings are created on a consistent basis, as creating fiat money is a highly profitable enterprise. Since central banks began using their balance sheets to mitigate the consequences of the global financial crisis, the Covid pandemic, and other events, they have taken financial positions, assuming enormous interest rate, credit, equity, and currency risks. As central banks' balance sheets expanded and interest rates fell to near zero beginning in 2008, long-term government and corporate bond yields (on the asset side) considerably outpaced interest rates on excess reserves (on the liability side), resulting in large profits for central banks. As a result, total transfers to governments have increased dramatically during this time period. Balance sheets expanded even faster in 2020, requiring central banks to invest in expensive government bonds with low or even negative yields, increasing the value of balance sheets that became more vulnerable to interest rate risk. In 2021, central banks began raising interest rates and shrinking their balance sheets in reaction to inflation, resulting in lower earnings and equity. Central banks began to pay greater interest rates on private bank deposits, possibly exceeding their seigniorage earnings, while incurring considerable capital losses on bond holdings on the asset side.

2. Central bank balance sheet

Most central banks' principal source of income is the profit gained by their monopoly on the issuance of tangible national currency. These earnings are derived from the difference between the face value of the note (or coin) and the cost of production (seniorage). Typically, the cost of producing a note is only a small proportion of its face value. Notes are the central bank's non-interest bearing obligations secured by interest-bearing assets. This spread creates an income stream that is always positive, until interest rates fall to zero or asset values fall. Currencies that act as an international reserve currency, such as the US dollar, can often obtain a privileged seigniorage income through international demand for their physical currency. Seigniorage income means that central banks are structurally profitable in normal times (Martinez-Resano, 2004).

Seigniorage income is not usually easily identifiable in central bank financial statements. Seigniorage is related to the amount of additional money printed. Since most central banks do not identify the specific assets that back the issuance of banknotes, this net income flow is not separately identifiable in their accounts. Any future introduction of central bank digital currencies (CBDC) by central banks could impact their seigniorage income, either through a decrease in revenue if banknote issuance were to decline significantly, or by offering a new source of income in the form of a seigniorage CBDC.

Some central banks require commercial banks to maintain a specific level of reserve requirements or other deposits with the central bank, which are often subject to a fee (Savluk & Breheda, 2024). Such restrictions have long been part of prudent liquidity management in the financial system. The requirement to pay a charge generates an interest-bearing liability, which is typically turned into higher-bearing central bank assets, resulting in a positive source of income. Interest paid on commercial bank accounts is often no more than the short-term interest rate. Loans to commercial banks, on the other hand, pay at least the short-term interest rate, with the possibility of an additional premium. Other assets, such as fixed-income securities, have longer maturities, allowing for higher yields if the yield curve slopes upward. At the same time, abrupt interest rate increases may undercut this yield. This is because increased interest payments are applied to all reserve accounts instantly, but higher yields on long-term bonds apply only to new purchases. As a result, the value of fixed-rate securities held in central bank assets declines.

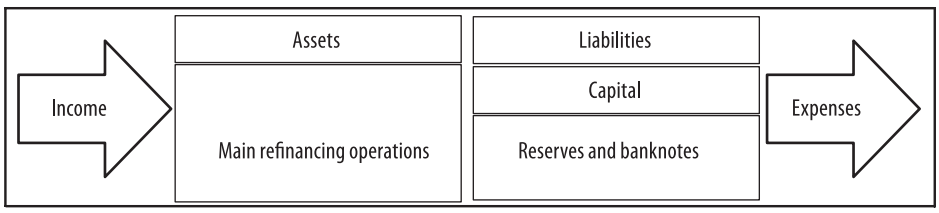
Central banks also maintain a portfolio of foreign exchange reserves on their balance sheets. In some circumstances, they may be hedged against currency risk, resulting in a net zero holding, whilst in others, there may be a significant open

currency position. In either instance, in the absence of central bank involvement in the foreign exchange market, such reserves can often be managed to generate positive net income by applying various risk premiums. However, this income is not assured and, if not hedged, is subject to significant exchange rate changes.

Central bank liabilities are commercial banks' banknotes and reserves, which combined make up central bank money. This is the best asset for settling transactions because it is the most liquid and risk-free asset in the market. Equity is the difference in value between a central bank's assets and liabilities. At first look, a central bank's balance sheet appears to have a capital position comparable to that of a firm. A central bank's stakeholder is typically the government, though some have private shareholders. The share capital and its own reserves serve the same purpose in a central bank as they do in a commercial bank: they operate as a buffer to absorb losses. Its own reserves are accumulated by retaining net income, much as corporations do. Outside of times of crisis, most central banks are highly profitable; nonetheless, they are typically obligated to pay dividends to shareholders, mostly their governments, limiting their long-term capacity to accumulate net assets. Share capital refers to the funds contributed by the central bank's shareholders when it was created, which are generally tiny and settled at face value. Therefore, the value of a central bank's own reserves changes with profits or losses, meaning that the overall capital position can become negative.

Figure 1 depicts, on the one hand, credit operations that create interest at the reference rate, and on the other, banknotes that generate no costs for the central bank and reserves that are far less valuable than banknotes. At the same time, the portion of the reserves matching to the minimum reserve needs is interest-bearing at the reference rate, while the excess is interest-bearing at the deposit rate, which is considered to be less than the reference rate.

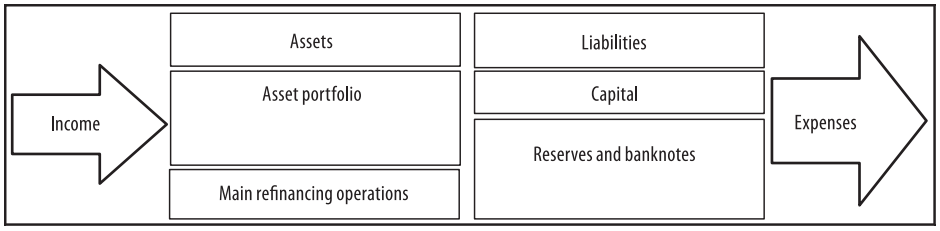
Figure 1: Assets and liabilities in the central bank's balance sheet during the period of standard monetary policy



Source: Own study

Figure 1 clearly conveys the idea that the central bank is structurally profitable in normal times, since the interest revenue from its assets exceeds the interest expense on its obligations. However, in times of crisis or risk of deflation, central banks may use non-standard measures (QEAP) to achieve their mandates, perhaps incurring losses (Figure 2).

Figure 2: Assets and liabilities in the central bank's balance sheet in the period after the implementation of quantitative easing policy



Source: Own study

In this case, an increase in interest rates immediately increases the central bank's costs because the interest paid increases from commercial banks' reserves deposited with the central bank. Because portfolio assets have extended maturities and only a portion is renewed at increasing interest rates, the rate of return on assets kept remains relatively constant. Thus, some of the monetary policy measures required by central banks to fulfill their mandates in changing conditions may eventually result in negative net interest revenue and losses for central banks due to structural changes in their balance sheets.

3. Literature review

As previously stated, central banks do not function for profit and hence cannot go insolvent. Instead of financial aims, they have political purposes, and the performance of their programs is best measured by their capacity to achieve and maintain price and financial stability, rather than profits. Central banks, unlike commercial banks, are not subject to capital regulations, hence they do not need to maintain a certain level of regulatory capital. The justification for this is that governments support their central banks, offering a guarantee to help retain public trust. Prudential rules have the potential to undercut this guarantee by requiring central banks to adhere to the same risk restrictions as private banks.

A central bank can nonetheless operate with a negative net worth in accounting terms since it has the ability to generate money and is not subject to the standard company solvency rules.

Central banks, as the sole issuers of their native currency, can always satisfy their obligations in that currency. The restrictions to money production are twofold. First, in all countries, printing money in excess of demand will eventually lead to inflation, which contradicts the central bank's goal of monetary stability. Second, the central bank may be legally limited in the amount of money it can issue. Foreign currencies are likewise subject to constraints. Central banks risk defaulting on their foreign currency obligations if they deplete their foreign exchange reserves and/or lose access to the international currency market. In such cases, a country is frequently forced to seek assistance from foreign central banks or take out a loan from an international agency such as the IMF, which comes with stipulations. Central banks, unlike commercial entities, rely on the strength of their shareholders, which always includes the Ministry of Finance. As a result, a central bank's credit rating is roughly equivalent to that of its national government.

Despite the prospect of a central bank operating with negative equity, there is a compelling justification for central banks having their own capital and reserves—or, at the very least, being better able to implement their policies with a strong capital foundation. Financial strength can help a central bank's independence and credibility, particularly by communicating to the market that it is prepared and able to act rapidly and without limitations in the event of a crisis. There is also the claim that central bankers who simultaneously serve as prudential regulators, regulating capital requirements for commercial banks, are better able to do so if their own institution is regarded to be financially sound. A financially independent central bank is generally considered to have sufficient resources to carry out its tasks without over-reliance on the government (Haldane, 2020).

In contrast, a financially reliant central bank may find its policy options constrained, if not dictated, by the finance ministry, and thus influenced by political factors. When a central bank lacks sufficient financial resources, market investors may believe it is losing political independence. A central bank's financial resources are more than just money; they also reflect the bank's legitimacy and independence (Haoudi & Touati, 2023).

Dalton and Dziobek (2005) believe that under normal conditions, a central bank should be able to operate economically at the basic level of seignorage income. Several central banks, however, suffered losses as a result of a variety of initiatives, including open market operations, the sterilization of foreign exchange in-

flows, domestic and foreign investments, loans and guarantees, and expenditures associated with financial sector reform.

According to Honohan (2019), central banks with negative equity are irrelevant; yet, economic logic requires a central bank to have positive equity. However, certain central banks have historically operated with negative equity (for example, the Central Bank of Israel, the Czech National Bank, and the Central Bank of Chile). According to Honohan, if central bank losses continue, net liabilities denominated in foreign currencies and domestic debt may immobilize a financially vulnerable central bank. Failure to address the issue of present losses or the resultant negative net worth will disrupt monetary management and may jeopardize the central bank's independence and credibility.

According to Bell, Chui, Gomes, Moser-Boehm and Pierres Tejada (2023), central bank losses are not indicative of monetary policy failure and do not limit the effectiveness of monetary and financial policy. Central banks' policy mandates include pricing and financial stability, not profit maximization. Their current losses, as well as previous benefits from quantitative easing, are the result of policy moves aimed to help them carry out their mandates. Furthermore, central banks are not subject to capital adequacy or bankruptcy procedures, and they can function successfully even with negative equity.

Furthermore, Franta, Holub & Saxaa (2022) give balance sheet estimates for the Czech Central Bank (CNB), implying that losses will eventually transform into profits and equity will revert to positive levels. In any case, central banks with negative equity as a result of previous losses should be able to return to profitability sooner or later, given reasonable assumptions.

According to Bunea, Karakitsos, Merriman and Studener (2016), while earnings are an important measure of commercial banks' operational effectiveness, they are not required for central banks. Because central banks are not profit-maximizing enterprises, their success should be evaluated primarily on their ability to perform their functions efficiently.

Galli and Neri (2023) believe that nearly all euro area central banks' profit and loss accounts have recently deteriorated. However, the authors add that if the losses are time-limited, even if they are considerable, they should not force central banks to seek government assistance, because central banks may operate efficiently even with negative capital for a period of time. Indeed, in some cases, it may be advantageous for central banks to disclose a loss. Several central banks have recently recorded losses, primarily as a result of the impact of unorthodox

monetary policy measures, such as asset purchases through quantitative easing (QE), which were implemented in response to various crises. During QE, central banks purchase significant amounts of government bonds and other assets to infuse money into the economy and promote economic activity, lowering long-term interest rates, encouraging borrowing and spending, and bolstering financial markets. As a result, when they buy these bonds and assets, the central bank's balance sheet expands, with the purchased assets on one side and an equal rise in the money supply on the liability side. However, central bank liabilities include interest-bearing reserves held by commercial banks, which means that when the money supply expands, so does the amount of interest they must pay on those reserves. So, if their assets, such as government bonds, have fixed interest rates, they may be unable to keep up with rising interest payments on reserves, resulting in losses for central banks. Nonetheless, it is best for central banks to absorb these losses because their purpose during this QE operation was to encourage economic activity, and these monies are being utilized to pursue larger financial stability goals, even if they may result in losses.

Morgan Stanley's chief economist argued that even if central banks experience losses, they do not lead to insolvency or loss of ability to conduct monetary policy since in such a circumstance, central banks stop transferring money to the Treasury and pile these losses as "deferred assets". Instead of decreasing its capital and reserves to cover the loss, the central bank will record it as a deferred asset on its balance sheet, representing the amount of the loss that must be recovered from future earnings and profits. This notion of delayed assets enables central banks to preserve financial stability and operational capacity even during times of loss, with no immediate negative impact on their ability to conduct monetary policy (Wigglesworth, 2022).

Indeed, in the vast majority of situations, governments are the sole shareholders of central banks, therefore earnings are typically passed on to the national treasury. If central banks disclose losses, in severe cases, governments may transfer funds to them in order to repair their financial situation. Such a circumstance may create worries about the independence of central banks' operations in response to political demands from governments. Furthermore, while several central banks claim that losses are irrelevant for evaluating their operational and political performance, recent research suggests that central banks are more likely to create profits while purposefully avoiding disclosing losses.

Goncharov, Ioannidou, and Schmalz (2023) did an empirical investigation to determine whether central banks avoid reporting losses and why. The analysis was carried out by focusing on a collection of observations in which profits were

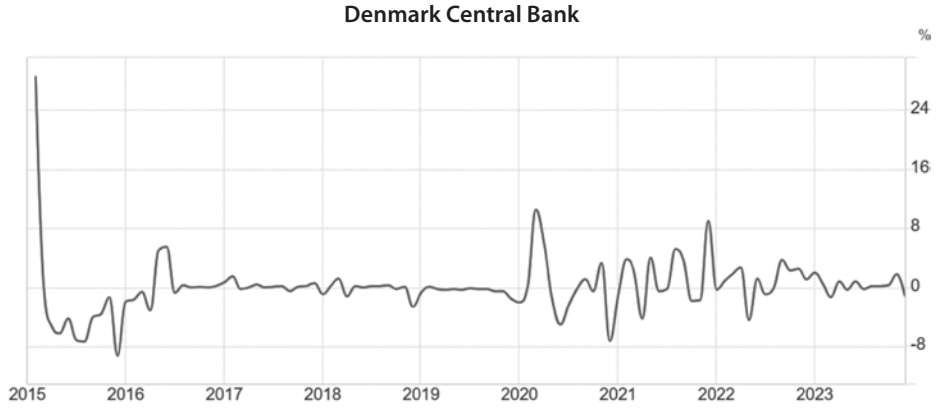
marginally above or below zero. The primary goal of this study is to determine whether there is a discontinuity in the distribution of central bank earnings when they are near zero, as such a discontinuity should indicate a preference for profits over losses. According to the authors, central banks are more likely to publish minor profits rather than small losses, implying that earnings are managed to avoid losses.

According to Ono and Pina (2023), central bank losses should have little impact on governments' budgetary balance sheets. However, even if the impact on government finances is minor, it will last a long period, as these losses will continue for several years.

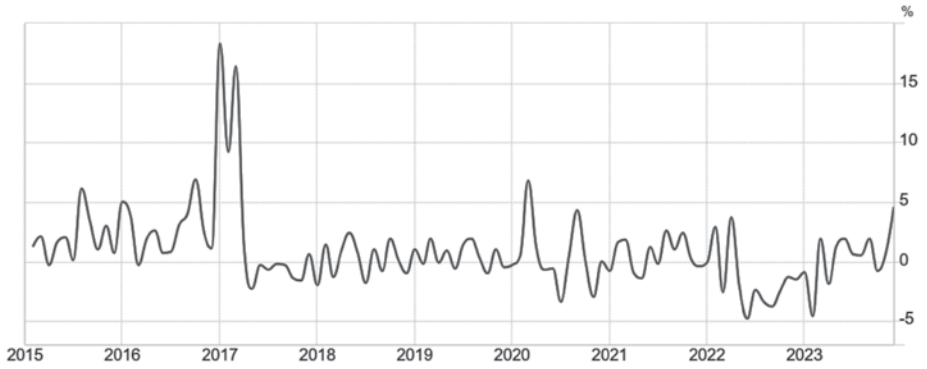
4. Data and empirical results

Analyzing the balance sheets of central banks of selected EU countries in the period 2015-2023, certain regularities can be observed. Namely, the balance sheets of central banks in countries with a lower level of development (Czech Republic, Hungary and Poland) were characterized by significant balance volatility, while in the case of central banks of more developed economies (Denmark, the euro area and Sweden) they were characterized by much greater stability. The relatively large volatility of the size of the central bank balance sheet in the EU countries with a relatively lower level of development is a consequence of the relatively greater susceptibility of these economies to various types of crisis phenomena, the effects of which central banks try to mitigate.

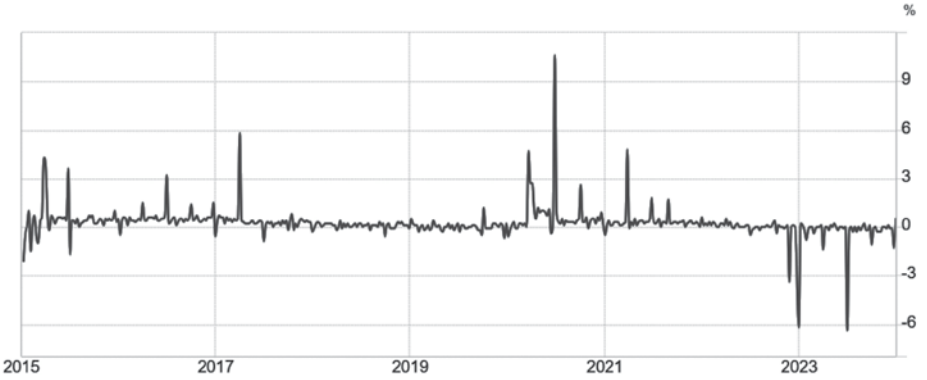
Figure 3: Central Bank Balance Sheet (percentage change from previous period)



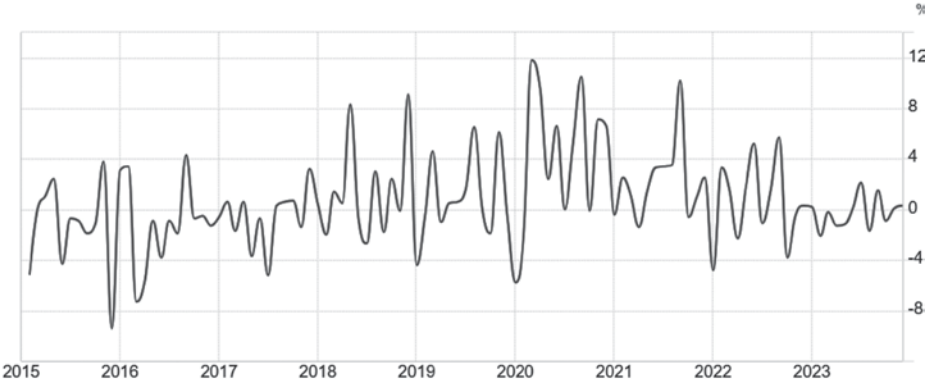
Czech Republic Central Bank

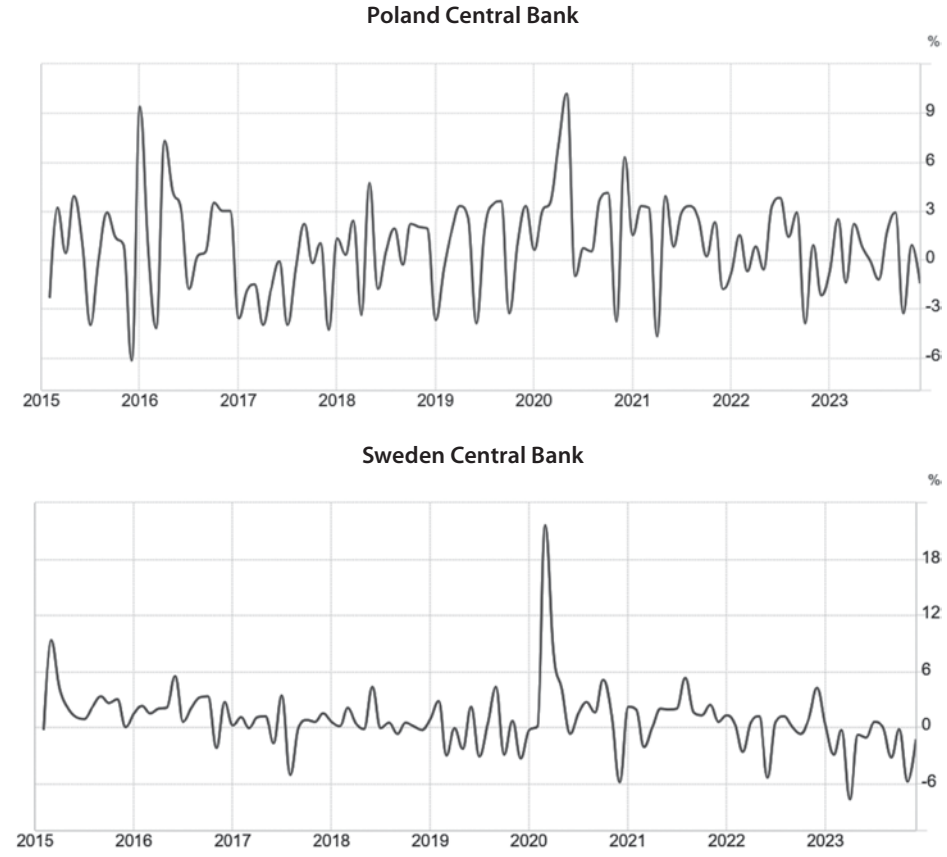


Euro Area Central Bank



Hungary Central Bank





Source: Tradingeconomics (2024)

According to the theoretical approach, changes in interest rates have a significant impact on the value of assets and the financial results of central banks. Increases in interest rates can lead to a decrease in the value of fixed-rate assets held and negatively affect the overall financial result of the central bank.

Hence, the motivation for the undertaken model research was an attempt at practical verification of the relationships between changes in the central bank interest rates and the value of assets held by the central bank in relation to GDP in selected EU countries, which appeared in the theoretical analyses. The relationships examined in this paper are presented using the following single-equation model:

$$aCountry(x) = \alpha + \beta \cdot irCountry(x) + \varepsilon \quad (1)$$

Where:

$aCountry(x)$ - value of central bank assets in relation to GDP in country x in %;

α - the free term of the equation;

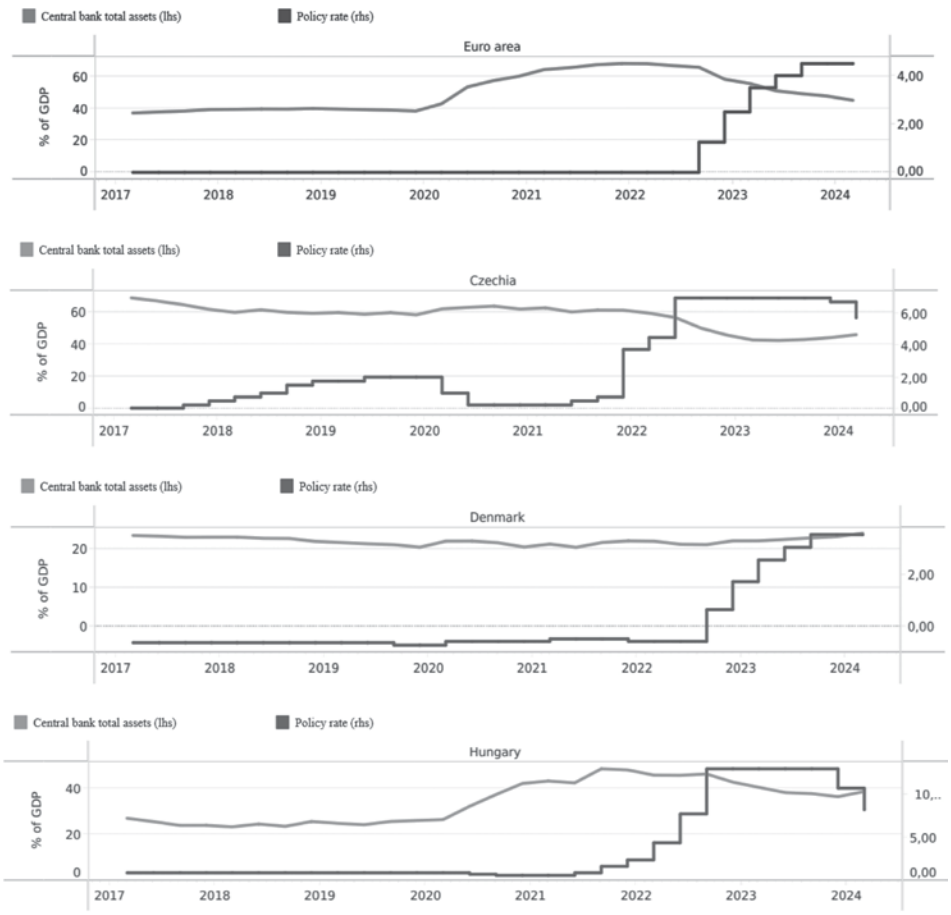
β - sensitivity coefficient;

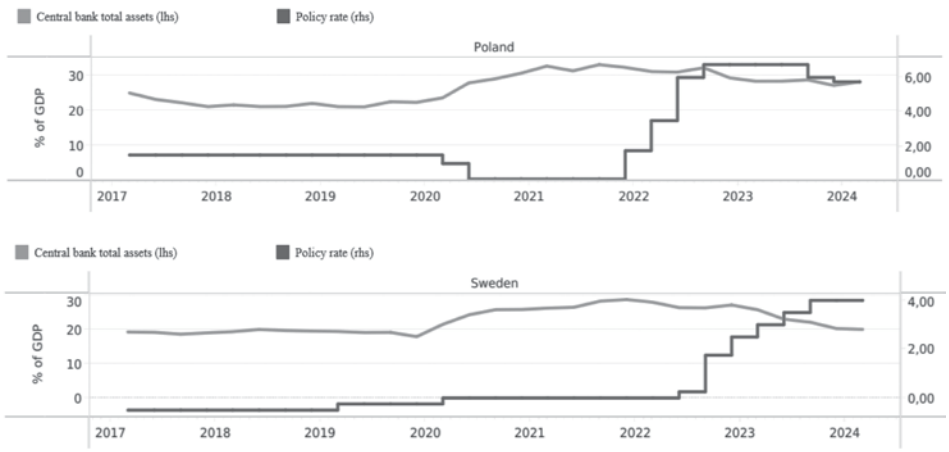
$irCountry(x)$ - reference rate of the central bank in country x in %;

ε - random component.

All statistical data used in the study came from database of the Bank for International Settlements. The analysis period covered the years 2015–2023, and the data were obtained on a quarterly basis.

Figure 4: Central bank interest rates and the value of central bank assets in relation to GDP (in %) in the period 2015-2023 in selected EU countries





Source: BIS (2024)

The data presented in Figure 4 indicate that in all of the countries studied, interest rates had been at quite low levels close to 0 until the beginning of 2022, and then there was a systematic and significant increase in interest rates in the subsequent years of the period studied. These changes were accompanied by corresponding changes in the value of central bank assets in relation to the GDP of individual countries. Namely, the value of central bank assets in relation to GDP systematically increased until 2022, after which there was a significant decrease in the value of these assets as central bank interest rates increased. The exception was Denmark, where the value of central bank assets in relation to GDP was at a relatively constant level throughout the period studied, and from 2022 onwards there was even a slight increase in the value of these assets in relation to GDP.

The calculated correlation coefficients between changes in interest rates and the value of assets to GDP were relatively low and positive in the countries studied, while in the case of the Czech Republic and Denmark the correlation coefficients were negative.

Table 1: Correlation coefficients of asset values and interest rates in selected EU countries

Items	Euro area	Czechia	Denmark	Hungary	Poland	Sweden
Correlation coefficient	0.19	-0.18	-0.07	0.49	0.31	0.28

Source: Own study

Statistics on assets in relation to GDP indicate significant differentiation in this respect between the EU member states examined. The greatest differentiation of

the value of assets to GDP was observed in the case of the central bank of the euro area, while the lowest in the case of the central bank of Denmark. The average value of central bank assets to GDP was the highest in the Czech Republic and the lowest in Sweden.

Table 2: Descriptive statistics assets to GDP

	ACZECHIA	ADENMARK	AEURO_A...	AHUNGARY	APOLAND	ASWEDEN
Mean	53.25304	23.31638	45.55678	33.88571	25.81370	21.24077
Median	59.48664	22.49209	39.93107	33.04973	24.89265	19.66196
Maximum	69.12538	39.50577	68.57519	48.44278	32.95489	28.69154
Minimum	30.69973	20.56323	22.63840	23.27963	20.95636	13.59422
Std. Dev.	11.14087	3.502149	14.11888	8.255151	4.067752	4.209639
Skewness	-0.602539	3.425476	0.245739	0.213038	0.308161	0.220195
Kurtosis	2.001689	15.11503	1.923884	1.634284	1.616957	1.972846
Jarque-Bera	3.775288	298.6354	2.157679	3.155364	3.534519	1.925524
Probability	0.151428	0.000000	0.339990	0.206453	0.170800	0.381837
Sum	1970.363	862.7060	1685.601	1253.771	955.1070	785.9084
Sum Sq. Dev.	4468.284	441.5416	7176.344	2453.311	595.6778	637.9582
Observations	37	37	37	37	37	37

Source: Own study

Similarly, in the case of reference rates of the central banks of the EU countries studied, there was a significant differentiation of these values. The greatest differentiation of central bank interest rates occurred in the case of Hungary, while the lowest in the case of the central bank of Denmark. The average level of the central bank interest rate was the highest in Hungary and the lowest in Denmark. It is worth adding that the average level of the central bank interest rate in Denmark was negative, which was unique among the EU countries studied.

Table 3: Descriptive statistics interest rates

	IRCZECHIA	IRDENMARK	IREURO_...	IRHUNGARY	IRPOLAND	IRSWEDEN
Mean	2.162162	-0.010811	0.674324	3.389189	2.360811	0.400000
Median	0.750000	-0.650000	0.000000	0.900000	1.500000	-0.250000
Maximum	7.000000	3.600000	4.500000	13.00000	6.750000	4.000000
Minimum	0.050000	-0.750000	0.000000	0.600000	0.100000	-0.500000
Std. Dev.	2.678630	1.407230	1.490694	4.466156	2.208133	1.456070
Skewness	1.012942	1.889886	1.909795	1.469050	1.122416	1.708022
Kurtosis	2.342794	4.841410	4.890590	3.407210	2.728636	4.284082
Jarque-Bera	6.993196	27.25276	28.00222	13.56396	7.882396	20.53226
Probability	0.030300	0.000001	0.000001	0.001134	0.019425	0.000035
Sum	80.00000	-0.400000	24.95000	125.4000	87.35000	14.80000
Sum Sq. Dev.	258.3020	71.29068	79.99811	718.0757	175.5307	76.32500
Observations	37	37	37	37	37	37

Source: Own study

In order to verify the research hypothesis regarding the occurrence of a significant impact of changes in the central bank reference rate on the value of assets held by the central bank, first, the Granger causality analysis was used to determine whether the explanatory variables are significant causes of the explained

variable of the model. The main assumption of the Granger causality analysis is the fact of causality, according to which, if the effect occurs in period t, then the cause appears in period t-k. Variable x is a Granger cause for variable y if the current value of variable y can be predicted with greater accuracy using past values of variable x than without them, with the remaining information remaining unchanged (Maddala, 2008).

Table 4: Granger causality test in the studied countries

Pairwise Granger Causality Tests
Date: 11/12/24 Time: 18:09
Sample: 2015Q1 2024Q1
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
IRCZECHIA does not Granger Cause ACZECHIA	35	2.46557	0.1020
ACZECHIA does not Granger Cause IRCZECHIA		0.54094	0.5878

Null Hypothesis:	Obs	F-Statistic	Prob.
IRDENMARK does not Granger Cause ADENMARK	35	1.82898	0.1780
ADENMARK does not Granger Cause IRDENMARK		1.18574	0.3194

Null Hypothesis:	Obs	F-Statistic	Prob.
IREURO AREA does not Granger Cause AEURO AREA	35	2.06877	0.1440
AEURO AREA does not Granger Cause IREURO AREA		3.15236	0.0572

Null Hypothesis:	Obs	F-Statistic	Prob.
IRHUNGARY does not Granger Cause AHUNGARY	35	0.69035	0.5092
AHUNGARY does not Granger Cause IRHUNGARY		4.37842	0.0215

Null Hypothesis:	Obs	F-Statistic	Prob.
IRPOLAND does not Granger Cause APOLAND	35	0.46923	0.6300
APOLAND does not Granger Cause IRPOLAND		3.13495	0.0580

Null Hypothesis:	Obs	F-Statistic	Prob.
IRSWEDEN does not Granger Cause ASWEDEN	35	0.96314	0.3932
ASWEDEN does not Granger Cause IRSWEDEN		7.28201	0.0026

Source: Own study

In all countries, there were no grounds to reject the null hypothesis due to the relatively high level of significance (Prob.> 0.05). Thus, in each case, in accordance with the results of the Granger causality test, the null hypothesis was accepted, according to which changes in interest rates were not the cause of changes in the

value of central bank assets in relation to GDP. This situation concerned all the EU countries examined.

The next stage of the analysis was the estimation of equation (1) using the Vector Autoregression Model. The main advantage of this estimation method is that in this case the studied phenomenon is analyzed using a set of equations which, in accordance with Sims (1980) postulate, simultaneously eliminate the problem of exogeneity of explanatory variables. The analysis assumed two periods y of lags between the explanatory variables and the explained variable (two quarters y). The choice of the order of lags was made in accordance with the results of the information criteria of the Akaike, Schwartz-Bayesian and Hannan-Quinn models. According to these criteria, the model with two lags had the greatest information capacity.

Table 5: Parameter estimates of the VAR model

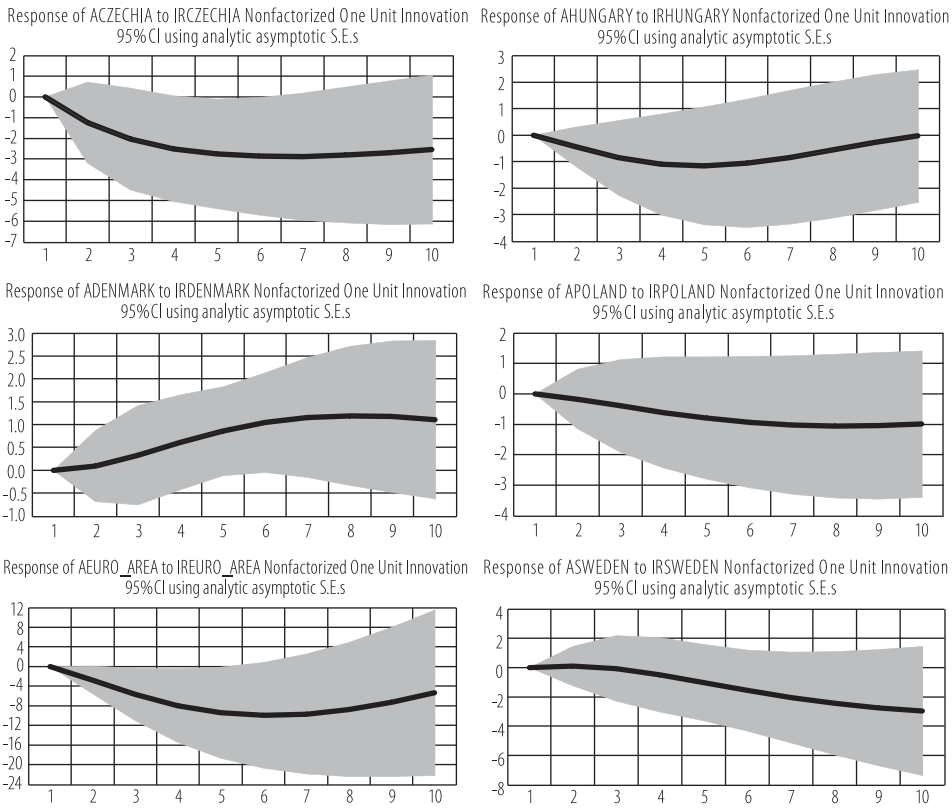
	ACZECHIA		ADENMARK		AEURO A...
ACZECHIA(-1)	0.925510	ADENMARK(-1)	0.732296	AEURO AREA(-1)	1.387395
	(0.17816)		(0.16173)		(0.16760)
	[5.19468]		[4.52803]		[8.27825]
ACZECHIA(-2)	-0.098911	ADENMARK(-2)	-0.160062	AEURO AREA(-2)	-0.415654
	(0.16542)		(0.10125)		(0.16941)
	[-0.59793]		[-1.58084]		[-2.45351]
IRCZECHIA(-1)	-1.248314	IRDENMARK(-1)	0.090733	IREURO_AREA(-1)	-2.775085
	(1.00272)		(0.39938)		(1.44490)
	[-1.24493]		[0.22719]		[-1.92061]
IRCZECHIA(-2)	0.704310	IRDENMARK(-2)	0.101598	IREURO AREA(-2)	2.642382
	(1.04354)		(0.45735)		(1.54351)
	[0.67492]		[0.22215]		[1.71193]
C	11.05524	C	9.606510	C	2.028659
	(3.88124)		(1.66080)		(1.33677)
	[2.84838]		[5.78427]		[1.51759]
R-squared	0.859281	R-squared	0.762657	R-squared	0.976526

	AHUNGARY		APOLAND		ASWEDEN
AHUNGARY(-1)	1.356458	APOLAND(-1)	0.963072	ASWEDEN(-1)	1.245050
	(0.17473)		(0.18950)		(0.17554)
	[7.76311]		[5.08215]		[7.09286]
AHUNGARY(-2)	-0.375965	APOLAND(-2)	-0.013926	ASWEDEN(-2)	-0.311234
	(0.18319)		(0.20337)		(0.17532)
	[-2.05232]		[-0.06848]		[-1.77521]
IRHUNGARY(-1)	-0.442207	IRPOLAND(-1)	-0.176499	IRSWEDEN(-1)	0.109896
	(0.37915)		(0.50015)		(0.68399)
	[-1.16632]		[-0.35290]		[0.16067]
IRHUNGARY(-2)	0.401607	IRPOLAND(-2)	0.039919	IRSWEDEN(-2)	-0.374917
	(0.37412)		(0.48794)		(0.76391)
	[1.07346]		[0.08181]		[-0.49079]
C	0.930494	C	1.772285	C	1.562701
	(1.88589)		(1.92782)		(1.04049)
	[0.49340]		[0.91932]		[1.50189]
R-squared	0.934119	R-squared	0.868751	R-squared	0.934683

Source: Own study

The next step of the analysis was to measure the impact of the central bank reference rate on the value of central bank assets in relation to GDP. This measurement was carried out using an impulse response function, which is a function of the response of the value of assets in relation to GDP to an impulse in the form of a unit change in the lagged central bank reference rate. According to the data presented in the figure below, a unit increase in the reference rate in the studied led to a gradual decline in the value of central bank assets in relation to GDP, and then to their stabilization after the seventh quarter from the moment of the shock change. The exception was Denmark, where an increase in the reference rate led to an increase in the value of assets in relation to GDP (figure 5).

Figure 5: Impulse response function of the value of central banks' assets in relation to GDP to an impulse in the form of a unit change in the reference rate

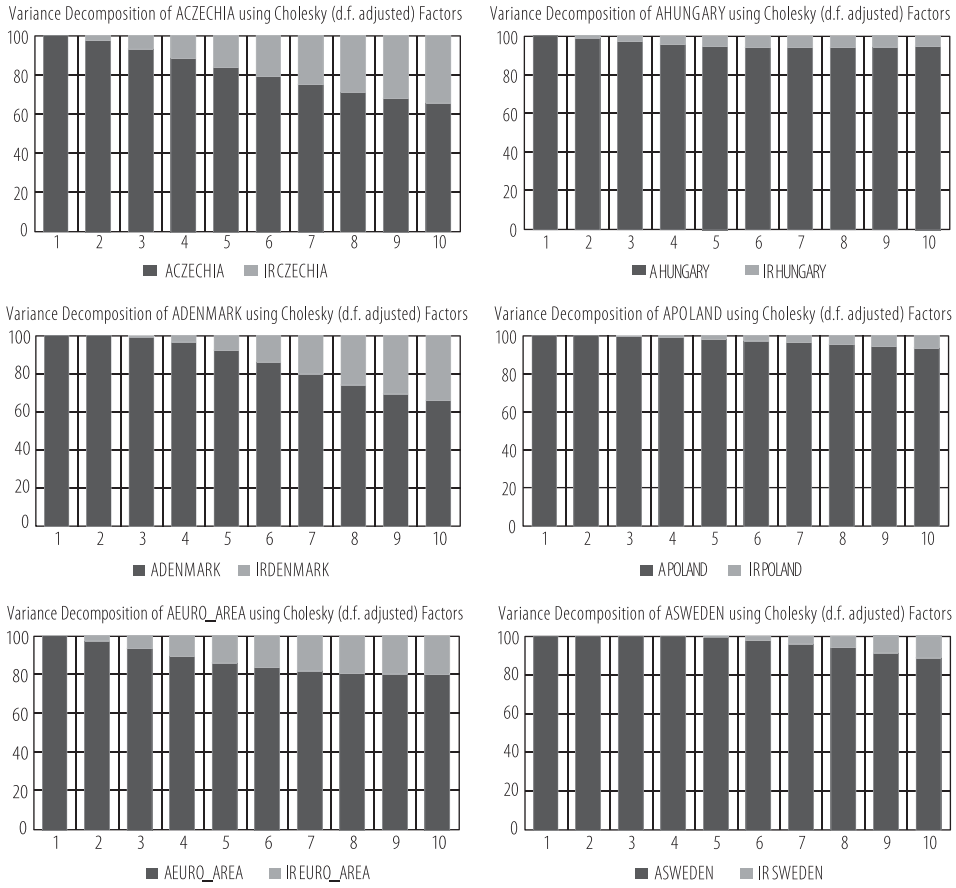


Source: Own study

At the same time, it should be emphasized that the greatest negative impact of the increase in the central bank reference rate on the value of the central bank's assets occurred in the euro area, while the lowest negative impact occurred in Poland and Hungary.

The last phase of the analysis was the decomposition of the variance of the residual component of the value of central bank assets in relation to GDP in order to assess the impact of changes in the central bank reference rate on the variability of the value of central bank assets in relation to GDP (Figure 6).

Figure 6: Variance decomposition of the central bank assets in relation to GDP



Source: Own study

According to the data presented in the figure above, changes in the central bank reference rate explained from 5% of the change in the value of assets in relation to GDP in Poland and Hungary to over 35% of the value of assets in relation to GDP in the Czech Republic and Denmark.

Concluding comments

The fundamental goal of most central banks is to keep prices stable. In order to carry out this duty, central banks engage in a variety of income- or loss-making operations, which are reported in central bank financial statements. The financial results at the end of the year should be viewed as a byproduct or side effect of the performance of their functions, rather than an objective in itself. This means that, unlike the private sector, a central bank is motivated by fulfilling its public responsibility of maintaining price stability through monetary policy rather than maximizing profits. Central banks, like other public institutions, must carefully manage their resources. They should also have enough resources to ensure their financial independence, which, along with a strong legislative framework, eliminates potential external pressures and a loss of confidence that could jeopardize their ability to execute its mandate and the smooth operation of the entire monetary system. However, there are rare cases where, despite smart resource management, central banks may incur losses as a result of monetary policy in order to ensure price stability. Central banks may be compelled to assume higher risks than usual at times, such as during economic crises. This was the situation for many central banks following the 2008 financial crisis and, more recently, the COVID-19 pandemic, when they were obliged to make unusual decisions to fulfill their mandates while avoiding catastrophic economic implications. Indeed, following the interest rate hikes in 2020-2022, some of these central banks have begun to report temporary losses or expect to incur losses in the near future. This is also the situation that the central banks of the EU Member States are involved.

The impacts of losses may change depending on the country's accounting laws, and their potential economic impact will be determined by whether or not the government budget compensates for these losses. It should be noted that a central bank's aim is not to maximize profits, but to maintain price stability. Because central banks are public entities, they are structurally profitable during "normal" times, and their assets are prudently and transparently managed. With this in mind, many central banks implement strong risk management rules and procedures to shield themselves from potential losses. However, the measures used to preserve price stability throughout multiple economic and financial crises in recent years have fundamentally altered the structure of their balance sheets, caus-

ing many of them to post losses and continue to do so in the coming years. The accumulated capital and regulations enable them to absorb some of these losses, and it is not uncommon for central banks to continue to execute their tasks and achieve their mandate despite negative equity. In any case, the losses reported by many central banks as a result of the strong and rapid rise in interest rates since 2020 are expected to be temporary and offset in the medium run. In short, the unprecedented losses will not preclude central banks from continuing to take the steps required to achieve price stability and fulfill their public mandate.

So, assuming that the government does not recapitalize the central bank, what will the long-term impact of a central bank loss be on the direction of capital flows and money creation? In this case, there is just a net transfer from the central bank to the various sectors of the economy, which does not occur when the central bank profits. Furthermore, if the central bank incurs a loss, money production increases, regardless of the composition of its assets. Nonetheless, in order to be completely independent in the discharge of its duties, the central bank must be confident that in the event of more severe losses, it will be supported by the fiscal authorities.

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