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The effectiveness of NBP's structural open market operations in 2020–2021: an input-output approach

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Abstract

The study evaluates the effectiveness of the Polish central bank's (Narodowy Bank Polski, NBP) structural open market operations in 2020–2021 as a quantitative easing (QE) instrument. QE was initiated in response to the Coronavirus (SARS-CoV-2) economic shock. The paper uses input-output methods based on an intersectoral Asset-Liability Matrix (ALM). ALM traces how monetary impulses originating in the central bank's balance sheet spread through financial links across institutional sectors. The outcomes suggest that in 2020 a significant portion of liquidity generated by asset acquisitions was absorbed into financial savings. It constrained the immediate stimulus to real activity under heightened uncertainty and pandemic restrictions. In 2021, as the economy reopened and demand increased, the net effect turned positive, consistent with a moderate revival of spending and investment, especially through the general government and non-financial corporate sectors. The findings indicate that NBP's QE programme was effective primarily as an instrument for stabilising financial markets and improving financing conditions. The macroeconomic stimulus was conditional on sectoral balance-sheet behaviour and on the degree to which liquidity leaked into precautionary saving rather than expenditure. The paper's conclusions should be interpreted as applying to the short-run transmission of liquidity in 2020–2021 rather than to the full medium-term costs and benefits of QE in Poland.

Keywords: quantitative easing, Narodowy Bank Polski (NBP), Asset-Liability Matrix, input-output analysis, intersectoral financial flows

JEL: E52, E58, E44, C67, G21

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1. Introduction

In response to the economic shock initiated by the COVID-19 pandemic in 2020, Narodowy Bank Polski (NBP) launched an asset-purchase programme. Structural open market operations (SOOR) was a form of quantitative easing (QE). In 2020–2021 NBP accepted 29 purchase operations, acquiring Treasury bonds and State Treasury-guaranteed debt securities on the secondary market. The aggregate nominal value was approximately PLN 144 billion: PLN 107.1 billion in 2020 and PLN 36.9 billion in 2021 (NBP 2021). The programme was started in March 2020, at the height of pandemic-related market stress, and originally focused on Treasury securities. From April 2020 the scope of purchases was extended to Treasury-guaranteed securities issued by Bank Gospodarstwa Krajowego (BGK) and Polski Fundusz Rozwoju (PFR). The programme aimed to strengthen financial-system liquidity and enhance the transmission of reduced policy interest rates during a period of economic uncertainty. It was the first asset-purchase programme of such scale in the history of NBP. The programme was similar to earlier measures adopted by major central banks, including the Bank of Japan, the Federal Reserve and the European Central Bank. NBP's programme aligned with the global trend of deploying unconventional monetary policy tools in response to economic crises.

Since the outset, however, the effectiveness of quantitative easing has been the subject of intense debate in both academic circles and central banking practice. Questions arise as to the extent to which asset purchases actually translate into an improvement in macroeconomic conditions – higher GDP growth, higher inflation, or a revival of credit activity – and to what extent they merely stabilize financial markets and reduce sovereign bond yields. The experience of large advanced economies suggests that QE operates primarily through several transmission channels: the liquidity channel, which improves conditions in stressed financial markets; the portfolio-rebalancing channel, which changes the composition of investors' portfolios (for example, by reducing the supply of long-term safe assets and encouraging investment in riskier instruments); and the policy-signalling channel (forward guidance), which communicates the intention to maintain accommodative monetary policy going forward. According to the latest report of the Bank for International Settlements (BIS 2023), during the pandemic crisis, the liquidity channel was initially most common – central bank asset purchases effectively mitigated disruptions in monetary transmission and calmed financial markets. In the later phase, as conditions stabilised, the portfolio-rebalancing effect became more important, while the signalling channel was relatively less significant (except in economies where policy rates were close to the effective lower bound, which increased the importance of communication). Many central banks – especially in emerging markets – terminated their asset-purchase programmes already one or two years after their launch and then, faced with a rapid economic rebound and rising inflation, moved on to monetary tightening. The short horizon of purchases helped to limit the risk of side effects such as excessive asset price increases or distortions in the functioning of the government bond market (BIS 2023).

Against this international background, the Polish asset-purchase programme represents an interesting case study. On the one hand, Poland, as an emerging-market economy, applied such an unconventional instrument for the first time, which raises questions about policy credibility and potentially different effects compared with advanced economies. On the other hand, the scale of Polish QE (relatively moderate in relation to GDP) and its short duration may imply limited macroeconomic effects. Indeed, recent cross-country studies (Stefański 2023) suggest that, in the group of countries that implemented QE for the first time (mostly emerging economies and smaller advanced

economies), the macroeconomic effects tend to be muted: although QE strongly boosts equity prices (by around 40% on average in the first year of the pandemic), its impact on bond yields is often weak or statistically insignificant, which translates into moderate and frequently insignificant increases in GDP growth (on the order of +0.4% on average) and no robust effect on inflation. Moreover, the effectiveness of QE appears to be higher in countries with more credible monetary and fiscal frameworks, which suggests that the instrument works best in advanced economies. Poland, with a well-established inflation-targeting regime and relatively sound public finances, could therefore be expected to derive some benefits from QE – the question, however, is how large these benefits were.

Traditional assessments of QE rely on macroeconomic models (e.g. DSGE models and counterfactual simulations without QE) and on event-study analyses that trace the reactions of financial markets to central bank announcements. For example, internal simulations by NBP using the NECMOD model indicate that the asset-purchase programme made the decline in GDP growth and inflation in Poland in 2020–2021 somewhat less pronounced (Hertel et al. 2022): NBP's QE reduced the fall in GDP growth by about 0.1 percentage point in 2020 and 0.5 percentage point in 2021, and limited the decline in inflation by 0.2 and 0.5 percentage points, respectively. The overall macroeconomic impact of Polish QE was comparable to the effect of three substantial interest-rate cuts implemented in the first half of 2020 (Hertel et al. 2022). This ex-ante perspective – based on the assumption of how the economy would have evolved without the programme – suggests a moderately positive impact of SOOR on the real economy. At the same time, critical voices have emerged: did the increase in financial liquidity actually translate into higher credit activity and investment, or did it rather fuel the accumulation of savings or increases in financial asset prices?

This article aims to answer these questions by applying an alternative analytical approach that analyses financial flows between institutional sectors of the economy. An input-output methodology, grounded in an intersectoral asset-liability matrix (ALM), was utilized. This framework depicts how monetary impulses generated by the central bank propagate across balance sheets within the financial system and how they influence saving and investment decisions in the real economy.

The objective of the article is to evaluate the effectiveness of NBP's structural open market operations in 2020–2021 using an input-output approach (asset-liability matrix). Effectiveness is defined as the ability of the asset-purchase programme to generate the preferred changes in financial flows in the economy by increasing investment (i.e. the financing of real asset purchases) to a greater extent than savings. The growth in investment and the growth in savings do not match. It arises from an asymmetry in the way fund supply and fund demand propagate through the financial system. Fund demand is ultimately financed by gross induced savings (GIS), whereas fund supply gives rise to gross induced investment (GII). The central bank at the same time changes its assets and liabilities, affecting both GII and GIS. The difference between them (net induced investment, NII) measures the effectiveness of monetary policy. A positive NII means that QE has the expansionary effects which are desirable in a recession. A negative NII (net induced saving, NIS) reflects a contractionary outcome and should be avoided during downturns (Tsujimura, Mizoshita 2003).

We analyse both direct effects (in sectors directly involved, such as the central bank, the banking sector and the general government) and indirect effects (induced flows in other sectors, e.g. non-financial corporations and households). The article contributes to the literature in two ways: first, by applying an innovative method of financial-flow analysis to the assessment of QE in an emerging-market economy; and second, by comparing the results obtained for Poland with international experience (United

States, Japan, euro area). The structure of the paper is as follows. After the introduction (Section 1), Section 2 presents a literature review on the effectiveness of QE and on the use of the input-output approach in the analysis of financial flows. Section 3 shortly depicts the research methods. Since the estimation procedures and the model's structure as a simulation tool are very complex, we refrain from providing a comprehensive technical description and instead refer the reader to the relevant literature. Section 4 reports empirical results for Poland, Section 5 discusses them in a broader theoretical and international context, and Section 6 summarizes the main conclusions.

2. Literature review

Quantitative easing has been the subject of numerous empirical studies. For the first time, it was introduced by the Bank of Japan at the beginning of the 21st century and later implemented on a larger scale after the 2008+ financial crisis by the Federal Reserve and other central banks. There is a broad consensus that QE effectively lowers long-term interest rates and eases financial conditions, especially in periods of stress. Already the first QE programmes in the United States and the United Kingdom were followed by substantial declines in government bond yields – on the order of several tens of basis points – and increases in the prices of other assets (equities, corporate bonds) via the portfolio-rebalancing channel. D'Amico et al. (2012), for example, estimate that the Federal Reserve's large-scale asset purchases in the first LSAP programme reduced the term premium on 10-year Treasury bonds by about 30–100 basis points, depending on the market segment. Weale and Wieladek (2016) find that asset purchases amounting to 1% of GDP raised the level of real GDP by around 0.18% in the United Kingdom and 0.04% in the United States and increased inflation by 0.3 percentage point in the UK and 0.04 percentage point in the US. The mechanisms behind these effects are the channels mentioned above: reductions in risk and liquidity premia due to improved market functioning, shifts of investors' portfolios towards riskier assets (which supports valuations and facilitates corporate financing), and, in economies with policy rates near zero, a strong signal that monetary policy will remain accommodative for an extended period.

Despite these favourable financial-market effects, the impact of QE on real activity and inflation is assessed in a more nuanced way. A strand of the academic literature suggests that the effects of QE on growth and inflation are relatively small and subject to considerable statistical uncertainty. Meta-analyses indicate that the average impact of asset-purchase programmes on the price level is on the order of a few tenths of a percentage point, while the effect on GDP ranges between roughly 0.1% and 0.5%, depending on the model and sample period, and is often not clearly statistically significant. Interestingly, a systematic difference has been documented between results published by central bank economists and those obtained by independent researchers. Fabo et al. (2021), in their study *Fifty Shades of QE*, show that publications authored by central bankers consistently report larger positive effects of QE on GDP and inflation than academic papers: the distribution of estimated effects in the former is shifted to the right relative to the latter. Moreover, central bank publications tend to use more positive language in their abstracts and report statistically significant beneficial effects of QE more frequently. Fabo et al. (2021) argue that this pattern may reflect a conflict of interest – when evaluating their own policies, central banks may (consciously or not) be inclined to confirm their effectiveness. At the same time, the authors do not rule out that central-bank researchers sometimes have access to better models or data, which could

also explain part of the difference. An interesting case in point is the Bundesbank, whose management has been sceptical about QE: studies co-authored by Bundesbank economists find smaller effects of QE than typical academic work, which may reflect a different institutional climate (Fabo et al. 2021).

The literature contains works in which quantitative easing is assessed less favourably. Especially in relation to medium-term inflationary risks and the possibility that central banks continued balance-sheet expansion for too long after market functioning had already stabilised. In the Japanese situation this perspective refers to work discussing the mixed macroeconomic effects of the Bank of Japan's 2001–2006 programme and the limited pass-through from financial-market stabilisation to sustained real activity (Ugai 2007; Honda, Tachibana 2011). The literature emphasises that the inflationary consequences of QE may differ from those of conventional monetary policy (Kowalewski, Shirai 2023). Our assessment concerns the short-run financial-flow effects of NBP's programme rather than a full medium-term welfare evaluation. These more critical perspectives make clear that the positive assessment advanced below applies primarily to the short-run analysed here. It does not preclude a less favourable medium-run interpretation once inflation, the policy mix, and post-2021 public-finance developments are taken into account (King 2021; Wieladek 2023; Michalski 2024).

Beyond the debate about the magnitude of the effects, the literature highlights the potential risks and side effects of QE. These include long-term implications for financial stability (excessive increases in asset prices, the formation of bubbles, greater risk-taking by investors), distributional and social issues (widening wealth inequality as a result of rising equity and real estate prices, which primarily benefit the wealthiest households), and risks to central bank independence (massive balance-sheet expansions may become subject to political pressure, especially when they generate accounting losses in an environment of rising interest rates – as has become an issue since 2022). Although these aspects lie beyond the scope of the present article, they clearly influence the overall assessment of QE's net contribution to economic welfare.

The study of financial flows between sectors begins with the integration of financial and real accounts within the System of National Accounts (SNA). Financial accounts record flows related to transactions in financial instruments, including the acquisition of financial assets and the incurrence of liabilities, as well as revaluations and other changes in volume. They also capture the stocks of financial instruments held by institutional sectors of the national economy and by the rest of the world. Each transaction has a counterpart transaction in the system, which may be a non-financial transaction (e.g. a transaction in products, a distributive transaction) or a financial one. The principle of quadruple entry accounting is also applicable to purely financial transactions. When Narodowy Bank Polski acquires a government-issued debt security, the stock of debt security increases by the same amount as the assets of the purchaser and the liabilities of the issuer. The same changes in currency and deposits of those two units are recorded. As a consequence of these transactions, the issuer may engage in non-financial transactions, such as purchases of tangible assets. Financial accounts present assets and liabilities as sector-by-instrument data. They show in which financial instruments institutional sectors locate their surplus of funds and in which financial instruments they incur liabilities.

Standard presentations of financial accounts (such as quarterly financial accounts published by central banks or Eurostat) display the assets and liabilities of individual sectors by financial instruments. However, since there is usually no data indicating who the creditor or debtor is with respect to a given instrument, financial accounts generally do not provide direct 'from-whom-to-whom' (W-to-W) information on financial flows.

Numerous researchers have emphasized the necessity of fully integrating financial balance sheets with flow accounts and constructing W-to-W flow matrices. Such integration enables the identification of who finances whom, in what amount, and through which financial instruments. These scholars have argued that the increasing complexity of the financial system and the global integration of markets require a more detailed understanding of intersectoral linkages. This was highlighted by the 2008 financial crisis, during which disturbances in one sector rapidly propagated to others. Reimund Mink was one of the pioneers of this approach. He developed the first experimental sectoral matrix for the euro area integrated with national accounts (McAdam et al. 2004). Similarly, Palumbo and Parker (2009) recommended integrating the system of financial and real accounts for the United States, aiming to facilitate the early detection of macroeconomic imbalances. In another significant contribution, Shrestha, Mink, and Fassler (2012) proposed the concept of unified W-to-W reports as a standard for financial statistics under the auspices of the International Monetary Fund. Unfortunately, publishing data in a W-to-W format is relatively rare. Financial accounts with counterparty information can be found, e.g. in the Eurostat database or Financial Accounts of the United States. Empirical analyses based on this format (also called payer-payee matrices) often employ estimation methods to convert national accounts data (e.g. Klein 2003; Okuma 2012; Tsujimura, Mizoshita 2003). Most of the studies based on W-to-W data primarily focus on the functioning of financial systems, frequently in the context of recent financial crises, policy impact assessments, sectoral interlinkages, and international integration. In contrast, the connections between financial savings and tangible investments are explored far less frequently. Nevertheless, several studies have addressed the quantitative easing issue. For instance, Tsujimura and Mizoshita (2003) presented a procedure for compiling the ALM from flow-of-funds (FoF) accounts in balance sheet format and used an input-output model based on the ALM to examine the Bank of Japan's quantitative easing policy. Their analysis showed, among other things, that the effects of monetary policy can be traced through changes in the balance sheets of financial sectors. However, this approach faced criticism from some central bankers, who argued that it overlooked the real effects on production and employment. In response to these comments, Tsujimura and Tsujimura (2018) developed an extended method for tracing fund flows, integrating real and financial transactions to provide a more comprehensive view of the transmission mechanism and the effects of the US QE programme. In general, the results of their analyses indicate that the effectiveness of QE largely depends on the structure of financial linkages within the economy and the behaviour of individual sectors. If the additional liquidity is quickly absorbed by sectors inclined to spend or invest, the stimulative effect will be more substantial. Conversely, if the extra funds are retained within the financial sector or saved by households, the impact on the real economy may be weaker.

The literature yields several important insights: (1) QE has proven effective in stabilizing financial markets and lowering sovereign bond yields, but its impact on the real economy is moderate and contested; (2) when assessing the effects of QE, it is useful to complement macroeconomic models with an analysis of financial flows that takes into account the structure of the financial system and sectoral behaviour; and (3) an input-output approach based on the asset-liability matrix makes it possible to trace both direct and indirect flows associated with monetary policy, thereby providing a valuable complement to traditional methods. In the next section, we present the research methodology, which operationalizes the approach described above for the case of Poland in 2020–2021.

3. Methodology

The empirical analysis is based on data officially published in the Eurostat database, as well as various supplementary publications, including financial reports from Narodowy Bank Polski. In particular, the following sources were utilized:

1. Financial accounts: counterpart information – quarterly data (nasq_10_f_cp), which provide intersectoral flows related to deposits (F22 + F29), debt securities (F31, F32), loans (F41, F42), and listed shares (F511).

2. Financial balance sheets – quarterly data (nasq_10_f_bs), which present financial assets and liabilities in a cross-classified format by financial instruments (grouped into 21 categories) and institutional sectors (S11 – non-financial corporations, S12 – financial corporations, S13 – general government, S14 – households, S15 – non-profit institutions serving households, S2 – rest of the world) and subsectors of financial corporations sector (S121 – central bank, S121_S122_S123 – monetary financial institutions, S124 – non-MMF investment funds, S125 – other financial intermediaries, except insurance corporations and pension funds, S126 – financial auxiliaries, S127 – captive financial institutions and money lenders, S128 – insurance corporations, S129 – pension funds).

Due to the lack of data in the W-to-W format for certain instruments (F12 – special drawing rights, F512 – unlisted shares, F519 – other equity, F52 – investment fund shares/units, F6 – insurance, pensions and standardised guarantees, F7 – financial derivatives and employee stock options, F8 – other accounts receivable/payable) it was necessary to apply estimation methods (see the Appendix for details). The sector-by-sector square matrix of intersectoral flows is constructed from a set of balance sheets of financial assets (**E**) and liabilities (**R**). The intuition behind this approach is as follows: given information on the total assets and liabilities of individual sectors by financial instruments (i.e., **E** and **R** matrices, both of dimensions n sectors × m instruments), it is possible to estimate the matrix of intersectoral flows (**Y**, a square matrix of dimension $n \times n$) by assuming that the counterparty structure for a given instrument reflects the distribution of assets/liabilities across sectors. In other words, if, for example, the household sector (S14) holds 44% of all investment fund shares in the system, then 44% of the investment fund shares registered in the system as the liabilities of non-MMF investment funds subsector (S124) can be attributed to the S124–S14 relationship. Such assumptions, based on proportionality or related methods (e.g., maximum entropy approaches – see e.g. KNF (2011)), allow for the construction of from-whom-to-whom matrices for individual financial instruments. By aggregating these matrices, a consolidated table of financial flows between sectors – ALM – is obtained.

In the classical input-output model, the exogenous variable is final demand, located in the second quadrant of the IO table. Analogously, a financial input-output table based on the asset-oriented system, which places financial asset surpluses over liabilities in the second quadrant, corresponds to a model where money supply acts as the exogenous variable. Its transposition, i.e. the table based on the liability-oriented system, corresponds to a model where money demand is the exogenous variable. Using both models in parallel enables the identification of the net effect of quantitative easing, which, on the one hand, involves an increase in the money supply, and on the other, a rise in the demand for money. Identification of these effects requires treating the central bank (CB) as an exogenous sector within the model. The methodological details of evaluating quantitative easing using the financial input-output model (Tsujimura, Mizoshita 2004) are described in the Appendix.

In this model, the additional financial impulse is treated analogously to an increase in final demand in the classical IO model. Financial multipliers in the liability-oriented model show how much the assets and liabilities of individual sectors will increase, for example, in response to a unit increase in the central bank's net liabilities.

The economic interpretation is as follows: if, for instance, the central bank increases its liabilities (i.e. issues reserve money) by a certain amount through bond purchases, this directly raises the assets of the banking and government sectors (as commercial banks sell bonds and receive funds, and the government benefits from lower financing costs). Indirectly, these funds may circulate further, e.g. reaching households as deposits, then partially flowing to firms as loans, and so on. The multipliers capture the cumulative effect of all these rounds of financial flows. Naturally, this impulse should also be analysed in the asset-oriented model, as an increase in the money supply resulting from the central bank's bond purchases.

The simultaneous application of an asset-oriented model (1) and a liability-oriented model (2), with the central bank treated as an exogenous sector, enables the derivation of a net efficiency measure of a QE programme from the perspective of stimulating the real economy. In model (1), the increase in investment induced by the central bank's expansion of its financial assets is determined endogenously. Conversely, in model (2), the increase in savings resulting from the growth of liabilities in the exogenous sector is also endogenously determined. The difference between the induced increase in investment and savings constitutes the net effect, which indicates whether quantitative easing contributed to economic stimulation (a positive net effect) or not. In other words, a positive net effect implies that a greater share of newly created funds was spent (e.g. through an increase in public debt financing expenditures or a rise in corporate lending) rather than saved, suggesting a boost in economic activity. A negative net effect, on the other hand, indicates that a significant share of the funds was absorbed into financial savings, which may reflect a weaker transmission to the real economy.

Certain limitations of the financial input-output model should be acknowledged. First, it assumes the constancy of financial flow structure coefficients, which may not hold true, especially during crisis periods when liquidity preferences tend to rise sharply. Additionally, the model operates in nominal terms and does not account for price responses (inflation) to an increase in money supply. Finally, the model captures static outcomes at a given point in time, rather than dynamic trajectories, which may be crucial for understanding long-term effects.

4. Results

NBP's QE programme, implemented through structural open market operations in 2020–2021, consisted of purchases of various debt instruments on the secondary market. Government bonds were the dominant component: NBP bought Treasury securities with a nominal value of around PLN 112 billion (including Treasury bonds and securities guaranteed by the State Treasury). The remaining part of the portfolio comprised State-guaranteed debt securities issued, among others, by PFR and BGK to finance financial-shield schemes for enterprises and the COVID-19 Counteracting Fund. Purchases began in March 2020 – at the peak of market turmoil – and were conducted intensively until mid-2020, after which they continued on a smaller scale in 2021. The average auction frequency was 1–2 operations per month in 2020 (19 operations in total) and fell to several operations in 2021 (10 in total).

The immediate effect of NBP's actions was a marked improvement in conditions on the domestic government bond market. Yields on 10-year government bonds, which had temporarily spiked above 3% in March 2020, fell to around 1.5% by the end of the second quarter of 2020 after the announcement and launch of the purchase programme. By acting as a major buyer on the market, NBP improved market liquidity – bid-ask spreads narrowed and trading volumes recovered relative to the crisis trough at the start of the pandemic, a pattern consistent with international evidence that QE operates strongly through the liquidity channel during crises. NBP's actions also had an important signalling dimension: announcing its readiness to purchase assets signalled the central bank's determination to maintain an accommodative stance. As various empirical studies for Poland and Hungary indicate, announcements by NBP (and, analogously, by Magyar Nemzeti Bank) contributed to lowering sovereign yields during the pandemic. It can therefore be concluded that the operational objective of the programme – stabilizing financial markets and ensuring low funding costs for public debt – was achieved.

From the perspective of the central bank's balance sheet, the QE programme increased liabilities in the form of commercial banks' reserves (the NBP financed purchases by creating reserve money) and in the stock of currency in circulation. On the asset side, NBP built up a substantial portfolio of Treasury and government-guaranteed bonds. By the end of 2021, NBP's total assets had risen to around PLN 377 billion, from roughly PLN 300 billion before the pandemic – a growth driven mainly by asset purchases (with the remaining difference reflecting exchange-rate changes in foreign reserves and other items). In other words, as a result of the QE programme, NBP became the holder of about 20% of domestic public debt (according to Ministry of Finance estimates).

Turning to the input-output analysis, the key experiment is to simulate the impact of an additional monetary impulse on intersectoral flows. In the liability-oriented model, this impulse enters as an increase in NBP's liabilities associated with the issuance of reserve money; in the asset-oriented model, it appears as an increase in NBP's assets resulting from bond purchases. Financial input-output multipliers make it possible to determine how the amount corresponding to the value of the open market operations (PLN 107.1 billion in 2020 and PLN 36.9 billion in 2021) is distributed, after multiple rounds of transactions in different financial instruments, across institutional sectors.

The results indicate that the largest direct beneficiaries of the liquidity injection were the banking sector and the government sector, which is natural given the design of the operations. Commercial banks (S122) sold a significant share of their bond holdings to NBP, which led to an increase in their assets in the form of cash and reserves. Government institutions (S13) benefited indirectly through lower debt-servicing costs: although they did not receive cash directly from NBP, the decline in yields reduced the cost of financing, which is reflected in the model as lower borrowing needs. The rest of the world sector (S2) and investment funds (S124) also experienced some increase in assets, which can be interpreted as the effect of bond sales by foreign investors and domestic funds to NBP (although, in practice, the participation of non-residents in NBP's operations was limited by the rules of the programme, the model allocates part of the impulse to them as well).

The most interesting patterns, however, emerge for the indirect effects captured by the multipliers. The analysis shows that induced financial flows largely reached the sector of non-financial corporations (S11). In the model, sector S11 records a substantial increase in both assets and liabilities, which means that firms incurred additional obligations (e.g. new loans, bond issuance, trade credit) while simultaneously accumulating financial assets. This apparent paradox – a simultaneous rise in assets and liabilities – reflects the fact that enterprises may have taken advantage of easier access to financing

(for example, cheaper credit thanks to low interest rates and abundant liquidity in the banking system), while at the same time placing part of the funds back into financial instruments (e.g. deposits) rather than spending them immediately. In net terms, the corporate sector appears to be one of the beneficiaries of QE, but translating this into real investment is only partial (we return to this point below).

Households (S14) responded primarily on the asset side: the induced increase in deposits and cash held by households was substantial. This is a natural consequence of the way funds injected into the financial system eventually reach the household sector, for example through the state budget (social transfers financed at lower cost thanks to cheaper public debt) or through higher savings driven by constrained consumption opportunities during lockdowns. By contrast, household liabilities did not increase – which is consistent with the fact that Polish households did not significantly expand their indebtedness in 2020–2021; if anything, demand for consumer credit declined. In our model this means that a large share of the additional liquidity settled in the form of higher household savings.

Combining direct and indirect effects, the matrix of financial multipliers implies that each additional 1 PLN of reserve money created by NBP under QE leads, on average, to an increase in:

– the banking sector's financial assets of 0.61 PLN and its liabilities of around 1.02 PLN,
– households' financial assets (primarily deposits) of 0.95 PLN,
– non-financial corporates' liabilities (i.e. financing for firms) of 0.83 PLN,
– general government's liabilities of 0.67 PLN, with smaller multipliers concerning the remaining sectors.

For the assessment of the effectiveness of NBP's open market operations, the key question is whether the Polish QE programme stimulated investment or primarily increased the stock of financial savings. To address this, we compute the previously defined sectoral measures of induced investment and induced savings. The results for 2020 and 2021 are summarized in Table 1.

Table 1
Estimated effects induced by NBP's SOOR by institutional sector (in PLN billion)

	2020	2021
Nominal value of SOOR (PLN billion)	107.1	36.9
Induced investments (asset purchases)	364.3	128.1
Induced savings (reserve money issuance)	439.3	87.7
Net effect	-74.9	40.4
Net effect by institutional sector		
Non-financial corporations	31.2	22.8
Financial institutions	23.0	23.0
General government	-65.3	21.6
Households and non-profit institutions serving households	-30.1	-33.0
Rest of the world	-33.8	6.0

In the first year of the programme (2020), the net effectiveness of QE was negative. We estimate that the increase in financial savings (approximately PLN 439 billion) exceeded the increase in

investment/expenditure (around PLN 364 billion) by about PLN 75 billion. This implies that a substantial portion of the additional liquidity generated by NBP was absorbed as savings within the financial system rather than being used to finance spending that would stimulate the economy. This result reflects the specific nature of the pandemic shock: despite the availability of money, supply constraints and lockdowns depressed investment and consumption, while heightened uncertainty encouraged precautionary saving. Households significantly increased their deposits (which grew at a record pace in 2020), and firms – despite cheap credit – approached new investment projects cautiously, relying instead on public support measures to survive. In our model, this shows up as a 'leakage' of a significant part of the monetary impulse into the financial sector and into household savings.

In 2021, the situation changed. We estimate a positive net effect of approximately PLN 40 billion, meaning that induced investment exceeded induced savings. This was driven by the economic recovery following the first pandemic wave: the government raised its expenditure (financing the deficit at low cost thanks to continued, albeit smaller-scale, bond purchases by NBP), firms resumed investment (especially in inventory rebuilding and adaptation to the new environment), and the pace of growth in household savings slowed (some of the funds accumulated earlier were spent as restrictions were lifted). Our results, therefore suggest that, in the second year, QE fulfilled its stimulative role – it contributed, on net, to higher spending in the economy.

From a sectoral perspective, the largest contribution to induced investment came from the general government sector (S13), reflecting higher deficit-financed public expenditure, a deliberate counter--cyclical policy facilitated by cheap funding, and from non-financial corporations (S11), which in 2021 began to utilise accumulated resources to rebuild their activities. Induced savings were concentrated mainly in the household sector (S14) and in banks (S122) – households continued to accumulate deposits, and banks held large reserve balances at NBP (these reserves effectively constitute 'idle' liquidity). The rest-of-the-world sector also increased investment, for example through capital inflows financing firms or public debt – though this partly reflects the impact of global QE, not only the Polish programme.

In summary, in its initial phase (2020) the Polish QE programme did not directly translate into higher investment spending, but rather increased financial buffers in the economy (savings). In the second phase (2021), some of these funds were used more actively, resulting in a net positive effect. The overall scale of this effect, however, remained moderate. NBP's QE ensured an adequate money supply and lowered funding costs, thereby creating favourable conditions for recovery. However, the strength of the rebound depended predominantly on demand factors and fiscal policy, rather than on money supply alone.

5. Discussion

Our findings are broadly consistent with international evidence, while highlighting the importance of the structural features of the Polish economy. Applying the input-output approach to QE evaluation enabled the capturing of effects that are hard to identify in standard macroeconomic models – in particular, the structure of financial flows and the sectors in which additional liquidity 'got stuck'. For Poland, the key limiting factor for QE effectiveness was the savings channel: households, whether by necessity or caution, increased savings rather than consumption, thereby dampening the demand multiplier. This is in line with the conclusions of Tsujimura and Mizoshita (2004) for Japan, who also

found that the effectiveness of Japanese QE depended on whether liquidity flowed to the corporate sector – generating investment – or remained in the household and banking sectors. In Japan, for a long time, the latter scenario dominated, which helps to explain the limited impact of repeated QE rounds on economic recovery in the 2000–2010 period.

In the international context, Poland's experience in 2020–2021 seems to confirm the view that QE is more effective as a tool for crisis prevention than for generating strong growth. Our negative net effect in 2020 suggests that, in the face of a deep shock and heightened uncertainty, a liquidity injection mainly plays a stabilizing role – it prevents an even deeper collapse, but does not immediately reverse the downward trend in investment (which NBP itself emphasized in its simulations, pointing to a reduction in the fall of GDP by 0.1 percentage point rather than an outright increase in GDP due to QE). Similar conclusions emerge for other emerging markets: BIS (2023) stresses that in smaller economies that adopted QE during the pandemic, the main achievement of such programmes was the restoration of order in bond markets and the avoidance of liquidity crises, whereas macroeconomic effects (on GDP and inflation) were relatively modest. Stefański (2023) finds that, in a sample of 16 such economies, QE generally had a neutral effect on bond yields (which may seem surprising, but reflects the fact that markets calmed down on their own after the initial shock and many countries quickly ended their purchase programmes) and only a moderate, statistically weak impact on the real economy. In his analysis, Poland stands out as a country with relatively credible policies, which may explain why sovereign yields in Poland fell significantly following NBP interventions and GDP rebounded more strongly than expected in 2021.

Another interesting aspect is a comparison of transmission channels across countries. In economies with highly developed capital markets, an important effect of QE is the rise in equity prices and the associated wealth effect, which can stimulate spending. The Polish stock exchange initially suffered sharp declines in 2020, but later – like many global markets – experienced a rally fuelled by abundant global liquidity. Stefański (2023) argues that QE had a strong impact on equity prices (around 40% increases) even in emerging markets. One can argue that rising equity and real-estate prices in Poland in 2020–2021 improved corporate and household balance sheets, which may have facilitated the subsequent recovery (for example, by making it easier for firms to issue equity and for wealthier households to increase consumption). At the same time, this raises the issue of inequality: the beneficiaries of this channel are primarily asset holders, which supports the view that the distributional effects of QE are uneven.

A comparison with the euro area is also enlightening. The ECB began large-scale net asset purchases in 2015, interrupted net purchases between January and October 2019 while continuing reinvestments, then restarted net purchases in November 2019, before increasing its interventions further during the pandemic through Pandemic Emergency Purchase Programme. A key challenge before the pandemic was persistently low inflation, and QE was intended to raise it towards the target. This happened only with a considerable delay and under the influence of other factors (most notably the supply shock in 2022). Critics, especially in Germany, argued that QE in Europe could create dependence of governments on cheap financing and undermine fiscal discipline. Our results for Poland show that within the short horizon analysed here, QE coincided with an adequate positive impact on investment in 2021 and with an improvement in financing conditions during the crisis. This result should not be interpreted as settling the broader question of longer-term fiscal dependence, which requires a separate evaluation using post-2021 evidence on public finances, inflation and the policy

mix. Unlike the ECB, NBP terminated asset purchases relatively quickly (the last operations took place in 2021) and did not conduct new rounds, which limits long-term risks. According to BIS (2023), the short duration of QE programmes in many countries helped avoid side effects such as distortions in bond markets or difficulties in exiting from accommodative policy. In Poland, the exit from QE also appears to have been relatively smooth. When rate hikes began in 2022, NBP was no longer buying assets and did not face major liquidity-management problems.

The interpretation of the results requires a clear distinction between short-run effectiveness and the broader medium-run assessment of the policy package adopted in Poland during the pandemic. Our findings indicate that NBP's structural operations were effective in stabilising the domestic bond market and in supporting a moderate revival of spending and investment. This conclusion should not be read as implying that all longer-run consequences of the 2020–2021 policy mix were necessarily positive. Some critics have argued that the prolonged maintenance of highly expansionary monetary conditions contributed to the inflation surge.

In conclusion, our discussion highlights the following: NBP's QE achieved its primary stabilisation objective, although its stimulative effectiveness was limited and delayed. The input-output model highlights the mechanism behind this limitation: a large share of the funds injected ended up as savings in the private sector. This can be interpreted positively (the financial system built up liquidity buffers, enhancing stability) or negatively (QE did not immediately boost the real economy). The literature suggests that improving the effectiveness of such policies requires coordination with fiscal policy – for example, using central bank purchases to support additional government spending, which is closely related to the concept of 'fiscally-backed' monetary policy, but raises concerns about central bank independence. In Poland, a de facto form of such coordination occurred: NBP purchased government bonds while the government expanded expenditure through various support schemes, which helped the recovery in 2021. At the same time, an open question remains whether, in the future, if QE were used again, liquidity could be more directly targeted at sectors that are likely to spend rather than save – for example, through purchases of a broader set of assets, including private instruments, which did not take place in Poland. This issue lies beyond the scope of our paper but constitutes an important avenue for further research.

6. Conclusions

The application of an input-output model based on the ALM has proved to be a useful tool for assessing the effectiveness of QE-type monetary policy. It enabled us to identify both the direct and indirect effects of central bank operations and to trace the paths along which money flowed through different sectors of the economy, thus providing a valuable complement to traditional macroeconomic models.

In 2020–2021, NBP's structural open market operations contributed to stabilizing the financial system and indirectly supported the economic recovery, but their net effectiveness varied over time. In 2020, a large share of the additional liquidity was absorbed as financial savings – the stimulative effectiveness of QE was low (a negative net effect). In 2021, the net effect turned positive, indicating a moderate increase in investment and spending.

The sectoral structure of the Polish economy shaped the transmission of QE. The bulk of the funds flowed to the banking sector (as reserves) and to households (as deposits), which limited the immediate

impact on demand. The main investing sectors – the government and non-financial corporations – did benefit from cheaper financing, but, especially in the early phase, the scale of their additional expenditure did not match the increase in private-sector savings. This suggests that assessing the effectiveness of QE cannot stop at analysing changes in the central bank's balance sheet; it is necessary to examine financial multipliers and intersectoral flows to see where the money actually went.

International studies and our results are consistent in indicating that QE is an effective tool for preventing financial crises and stabilizing markets. QE ability to generate sustained economic growth is limited. In countries with credible policies and adequate fiscal support, QE can produce a positive but moderate macroeconomic impulse (BIS 2023; Stefański 2023; Stefański 2022). In economies with lower credibility, the effects are likely to be weaker or less durable. In Poland, the programme helped avoid more serious disruptions and prepared the ground for recovery. It should be interpreted primarily as a crisis-management and financial-stabilisation instrument rather than as a comprehensive solution to ineffective demand.

The effectiveness of QE should be evaluated holistically, taking into account its side effects and longer-term consequences. Our study has focused on the short-run impact on financial flows and demand. We should also keep in mind the risks. A rapid increase in liquidity may lead to imbalances and unwinding QE poses challenges. In Poland's case, the relatively short duration of the asset--purchase programme may have mitigated some of these risks. The broader question of whether the programme ended at the best moment remains open. It requires a separate medium-term assessment that incorporates post-2021 inflation dynamics, fiscal developments, and the overall policy mix.

The evidence offered in this paper suggests that NBP's structural operations were effective mostly as a short-run crisis-management and financial-stabilisation instrument. Their macroeconomic stimulus was conditional on sectoral balance-sheet behaviour and became more visible only in 2021. The paper should therefore be read as an assessment of the short-run transmission and sectoral absorption of liquidity rather than as a final result on the full medium-term costs and benefits of QE in Poland.

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Appendix

Methods of intersectoral flows estimation

The idea of the compilation procedure of intersectoral flows tables, proposed by Tsujimura and Mizoshita (2003, pp. 51–67; 2004), is based on general equilibrium theory (see also Dąbrowski 2004, 2009) and the input-output methodology (see also Miller, Blair 2009; Leontief, Bródy 1993; Klein 2003, pp. 269–277; Okuma 2012). In this study, the approach was applied exclusively to estimate intersectoral flows related to financial instruments lacking data in a from-whom-to-whom format (see also Trębska 2018, pp. 313–316).

The sector-by-sector square matrices are constructed from a set of balance sheets of financial assets (**E**) and liabilities (**R**). Each element of the matrix $\mathbf{E} = [e_{ij}]$ shows the value of the i-th type of asset ($i = 1, 2,..., m$) held by the sector j ($j = 1, 2,..., n$). Rows of **E** matrix are therefore $1 \times n$ vectors $\mathbf{e}_i$, showing the i-th type of assets of individual institutional sectors:

$$\mathbf{E}_{m\times n} = \begin{bmatrix} \mathbf{e}_1 \\ \mathbf{e}_2 \\ \cdots \\ \mathbf{e}_m \end{bmatrix} \tag{1}$$

In turn, the rows $\mathbf{r}_i$ of the matrix $\mathbf{R} = \left[r_{ij}\right]$ are the vectors showing liabilities incurred by various sectors in a form i:

$$\mathbf{R}_{m\times n} = \begin{bmatrix} \mathbf{r}_1 \\ \mathbf{r}_2 \\ \cdots \\ \mathbf{r}_m \end{bmatrix} \tag{2}$$

The sum of $\mathbf{e}_i$ vectors' elements as well as the sum of $\mathbf{r}_i$ vectors' elements show the stock of i-th instrument:

$$s_i = \mathbf{e}_i \cdot \mathbf{i}_n = \mathbf{r}_i \cdot \mathbf{i}_n \tag{3}$$

where $\mathbf{i}_n$ is the summing vector (the $n \times 1$ unit vector).

The transition from the 'asset-by-sector' matrices of financial assets (**E**) and liabilities (**R**) to the 'sector-by-sector' square matrix requires a number of intermediate matrices determined on the basis of **R** and **E**.

1. $1 \times n$ vectors $\mathbf{d}_i$ showing the shares of liabilities of the sector j in the stock of the i-th instrument ($\mathbf{d}_i \cdot \mathbf{i}_n = 1$):

$$\mathbf{d}_i = \frac{1}{s_i}\mathbf{r}_i \tag{4}$$

2. $1 \times n$ vectors $\mathbf{b}_i$:

$$\mathbf{b}_i = \mathbf{e}_i \cdot \hat{\mathbf{z}}^{-1} \tag{5}$$

where $\hat{\mathbf{z}}$ is a diagonal matrix consisting of elements z_j, which are the stock of financial assets or liabilities of the j-th sector, whichever stock is larger; if z_j is a stock of assets, the given element of vector $\mathbf{b}_i$ shows the share of the i-th type of asset in total assets of sector j.

3. The $n \times n$ square matrix $\mathbf{C}_i = \left[c_{k_j,i} \right]$, whose elements show the shares of the k-th sector's i-th type of liabilities in z_j:

$$\mathbf{C}_i = \mathbf{d}_i^T \cdot \mathbf{b}_i \tag{6}$$

Finally, a square $n \times n$ matrix $\mathbf{Y}_i = \left[y_{k_j,i} \right]$ presents intersectoral financial flows in terms of the i-th financial instrument, each element $y_{k_j,i}$ reflects the flow of i-th financial instrument between sector j and k; or in other words $y_{k_j,i}$ is the value of i-th type of assets acquired by sector j from sector k and simultaneously the value of i-th type of liabilities incurred by sector k from sector j:

$$\mathbf{Y}_i = \mathbf{C}_i \cdot \hat{\mathbf{z}} \tag{7}$$

In each case (i.e. for each instrument), non-zero values of flows between non-residents that arise from the applied estimation method are removed from the matrix $\mathbf{Y}_i$ using the biproportional adjustment method.

Once the tables of intersectoral flows for all financial instruments (including those officially published by Narodowy Bank Polski) have been compiled, an aggregate table of total financial flows $\mathbf{Y} = \sum_{i=1}^{m} \mathbf{Y}_i$ can be constructed.

Table A1
Intersectoral flows of all financial instruments

Sector	j	$\sum_j y_{kj}$
k	$\mathbf{Y} = \left[y_{kj} \right]$ flows of funds from j-th sector to k-th one	k-th sector's stock of liabilities
$\sum_k y_{kj}$	j-th sector's stock of financial assets	

Source: elaboration based on Tsujumura, Mizoshita (2004).

Financial input-output model

The matrix $\mathbf{Y}$ constitutes the first quadrant of the financial input-output table, analogous to the matrix of inter-industry flows of raw materials and goods in the classical IO table. Alongside it, the table includes vector $\boldsymbol{\rho}$ of excesses of assets over liabilities of individual sector (if exist; 0 otherwise),

vector **ε** of excesses of liabilities over assets (if exist) and vector **z** of stocks of assets or liabilities, whichever is larger. For example, the household sector typically has a surplus of financial assets, meaning it is a net lender, while the government sector is usually a net borrower.

Table A2
Financial input-output tables

Asset-oriented system			
Sector	j	ρ_k	z_k
k	$\mathbf{Y} = \left[y_{kj} \right]$	**ρ**	**z**
ε_j	$\boldsymbol{\varepsilon}^T$		
z_j	$\mathbf{z}^T$		

Liability-oriented system			
Sector	k	ε_j	z_j
j	$\mathbf{Y}^T = \left[y_{jk} \right]$	**ε**	**z**
ρ_k	$\boldsymbol{\rho}^T$		
z_k	$\mathbf{z}^T$		

Source: elaboration based on Tsujumura, Mizoshita (2004).

The following balancing equations are true for financial input-output tables:

$$\mathbf{Y} \cdot \mathbf{i}_n + \boldsymbol{\rho} = \mathbf{z} \quad \text{and} \quad \mathbf{Y}^{\mathrm{T}} \cdot \mathbf{i}_n + \boldsymbol{\varepsilon} = \mathbf{z} \tag{7}$$

Taking into account the above relationships, as well as matrices of coefficients c_{kj} and c^*_{jk}: $\mathbf{C} = \mathbf{Y} \cdot \hat{\mathbf{z}}^{-1}$ and $\mathbf{C}^* = \mathbf{Y}^{\mathrm{T}} \cdot \hat{\mathbf{z}}^{-1}$ by analogy to equation (6), a financial input-output models based on an asset-oriented system and a liability-oriented system are obtained:

$$\mathbf{C} \cdot \mathbf{z} + \boldsymbol{\rho} = \mathbf{z} \quad \text{and} \quad \mathbf{C}^* \cdot \mathbf{z} + \boldsymbol{\varepsilon} = \mathbf{z} \tag{8}$$

Thus,

$$\mathbf{z} = (\mathbf{I} - \mathbf{C})^{-1} \boldsymbol{\rho} = \boldsymbol{\Gamma} \cdot \boldsymbol{\rho} \quad \text{and} \quad \mathbf{z} = \left(\mathbf{I} - \mathbf{C}^*\right)^{-1} \boldsymbol{\varepsilon} = \boldsymbol{\Gamma}^* \cdot \boldsymbol{\varepsilon} \tag{9}$$

Elements of matrix $\boldsymbol{\Gamma} = \left[\gamma_{kj} \right]$ are the financial multipliers, which indicate the supply of funds in sector *k* induced by the increase by unit in the *j*-th sector's supply of funds. Whereas the multipliers $\boldsymbol{\Gamma}^* = \left[\gamma^*_{jk} \right]$ indicate the demand for funds in sector *k* induced by the increase by unit in the *j*-th sector's demand for funds. The multipliers indicate not only the direct effects of the increase in the *j*-th sector's supply of funds, but also all indirect effects arising from the increase in this sector's financial assets and liabilities, as well as those of all other sectors. The column sums of matrices **Γ** and **Γ*** show the total effect – the sum of the increases in all institutional sectors' resources z_j.

Identifying the effects of quantitative easing requires treating the central bank (CB) as an exogenous sector in the model. This involves removing the row and column corresponding to the central bank's financial assets and liabilities from the matrix **Y**, and reallocating them to the second

and third quadrants of the financial input-output table. As a result of this reorganization of the financial input-output table, the first quadrant is reduced to dimensions $n-1 \times n-1$; analogously, the vector $\mathbf{z}$ has dimension $n-1 \times 1$.

Table A3
Financial input-output tables with exogenous central bank subsector (CB)

Asset-oriented system			
Sector	j	ρ_{k+CB}	z_k
k	$\mathbf{Y}_{-CB}$	$\boldsymbol{\rho}_{+CB}$	$\mathbf{z}$
$\boldsymbol{\varepsilon}_{j+CB}$	$\boldsymbol{\varepsilon}^T_{+CB}$		
z_j	$\mathbf{z}^T$		

Liability-oriented system			
Sector	k	ε_{j+CB}	z_j
j	$\mathbf{Y}^T_{-CB}$	$\boldsymbol{\varepsilon}_{+CB}$	$\mathbf{z}$
ρ_{k+CB}	$\boldsymbol{\rho}^T_{+CB}$		
z_k	$\mathbf{z}^T$		

Source: elaboration based on Tsujumura, Mizoshita (2004).

The fundamental equations are now expressed as follows:

$$\mathbf{C}_{-CB}\mathbf{z}+\boldsymbol{\rho}_{+CB}=\mathbf{z} \quad \text{and} \quad \mathbf{C}^*_{-CB}\mathbf{z}+\boldsymbol{\varepsilon}_{+CB}=\mathbf{z} \tag{10}$$

where $\mathbf{C}_{-CB}$ and $\mathbf{C}^*_{-CB}$ are the matrices obtained from the matrices $\mathbf{C}$ and $\mathbf{C}^*$ by removing the row and column containing elements concerning CB; $\boldsymbol{\rho}_{+CB}$ is the $n-1 \times 1$ vector being the sum of $\boldsymbol{\rho}$ vector and the column of $\mathbf{Y}$ matrix which constitutes the financial assets of CB (vector $\boldsymbol{\rho}_{CB}$ of elements $y_{k,CB}$); by analogy $\boldsymbol{\varepsilon}_{+CB}$ is the $n-1 \times 1$ vector of which element is the sum liabilities of CB and excess of liabilities over assets of sector j.

Solving each equation for $\mathbf{z}$ yields:

$$\mathbf{z}=\left(\mathbf{I}-\mathbf{C}_{-CB}\right)^{-1}\boldsymbol{\rho}_{+CB} \quad \text{and} \quad \mathbf{z}=\left(\mathbf{I}-\mathbf{C}^*_{-CB}\right)^{-1}\boldsymbol{\varepsilon}_{+CB} \tag{11}$$

where $\mathbf{I}$ denotes the $n-1 \times n-1$ unit matrix, $\left(\mathbf{I}-\mathbf{C}_{-CB}\right)^{-1}$ is the $n-1 \times n-1$ Leontief inverse matrix, which gives the ultimately induced supply of funds, and $\left(\mathbf{I}-\mathbf{C}^*_{-CB}\right)^{-1}$ gives demand for funds as induces by each institutional sector.

From the viewpoint of the object economy, the induced demand for funds means the gross induced savings (GIS), the amount of new savings required, while the induced supply of funds refers to the gross induced investment (GII) that enables us to make still more investments.

It is possible to calculate the effect of the central bank's quantitative easing policy using the Leontief universe within the same framework described above. Having the exogenous vectors of financial assets

held by the central bank (CB) $\mathbf{e}_{CB}$ and CB's liabilities $\mathbf{r}_{CB}$ (or vectors $\mathbf{f}_\rho$ and $\mathbf{f}_\varepsilon$), the induced investments ($\boldsymbol{\eta}_I$) and savings ($\boldsymbol{\eta}_S$) are calculated as follows:

$$\boldsymbol{\eta}_I = \left(\mathbf{I} - \mathbf{C}_{-CB}\right)^{-1} \mathbf{f}_\rho \quad \text{and} \quad \boldsymbol{\eta}_S = \left(\mathbf{I} - \mathbf{C}^*_{-CB}\right)^{-1} \mathbf{f}_\varepsilon \tag{12}$$

where:

$$\mathbf{f}_\rho = \mathbf{D}_{-CB}\, \mathbf{e}_{CB}\ \ \mathbf{D}_{-CB}; \quad \mathbf{f}_\varepsilon = \mathbf{D}^*_{-CB}\, \mathbf{r}_{CB} \tag{13}$$

$\mathbf{D}^*_{CB}$ are $n-1 \times m$ matrices obtained by removing the rows associated with the central bank from n × m matrices $\mathbf{D} = \mathbf{R}^T\hat{\mathbf{s}}^{-1}$ and $\mathbf{D}^* = \mathbf{E}^T\hat{\mathbf{s}}^{-1}$, respectively; **E** and **R** are matrices of financial assets and liabilities; $\hat{\mathbf{s}}$ is a diagonal matrix containing the holdings of individual types of financial instruments on the main diagonal.

The determination of vectors $\mathbf{f}_\rho$ and $\mathbf{f}_\varepsilon$ is intended to identify the sectors associated with a given central bank asset/liability. In the assessment of the impact of open market operations analysed here, intersectoral relationships are predefined; therefore, these vectors are assumed arbitrarily.

The difference between the gross induced investment (*GII*) and the gross induced savings (*GIS*) – net induced investment (*NII*) – measures the effectiveness of monetary policy:

$$NII = GII - GIS = \mathbf{i} \cdot \boldsymbol{\eta}_I - \mathbf{i} \cdot \boldsymbol{\eta}_S \tag{14}$$

where **i** is the summing vector (the $n-1 \times 1$ unit vector).

Financial input-output tables

Table A4

Financial input-output table[a] for Poland in 2020 (current prices, PLN million) with exogenous central bank subsector

	1	2	3	4	5	6	7	8	ρ_{+CB}	z
1	855 767	404 022	141 392	92 869	110 524	388 429	509 882	1 247 022	1	3 749 908
2	424 194	92 951	31 324	52 210	63 908	133 275	1 064 371	281 219	123 498	2 266 950
3	45 353	80 902	6 497	13 413	6 361	14 981	33 864	122 810	129	324 311
4	28 004	15 796	8 217	5 387	46 019	754	146 989	64 095	3 068	318 329
5	39 456	1 963	1 325	3 036	18 668	16 456	278 491	27 486	0	386 879
6	246 120	579 845	22 607	82 525	90 886	243 882	100 013	553 849	112 563	2 032 292
7	11 227	802 733	3 985	607	315	4 610	2 404	3 394	1 740 992	2 570 267
8	309 977	100 209	34 403	67 502	44 953	67 314	126 654	0	1 627 302	2 378 315
ε_{+CB}	1 789 810	188 528	74 560	780	5 244	1 162 590	307 600	78 440		
z	3 749 908	2 266 950	324 311	318 329	386 879	2 032 292	2 570 267	2 378 315		

Notes:
1 – non-financial corporations,
2 – monetary financial institutions other than central bank,
3 – other financial intermediaries (except ICPFs), financial auxiliaries, CFIs, and money lenders,
4 – non-MMF investment funds,
5 – insurance corporations,
6 – general government,
7 – households; non-profit institutions serving households (NPISH),
8 – rest of the world.
[a] Based on an asset-oriented system, whereas a liability-oriented system is its transposition.

Source: own calculations.

Table A5

Financial input-output table[a] for Poland in 2021 (current prices, PLN million) with exogenous central bank subsector

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	ρ_{+CB}	**z**
1	937 451	432 661	141 285	99 498	124 234	399 278	526 517	1 427 433	65	4 088 423
2	476 105	103 591	43 594	55 737	84 444	193 753	1 130 480	329 252	74	2 417 031
3	45 473	95 771	6 875	16 729	10 285	11 807	30 910	131 173	130	349 154
4	29 027	20 462	12 136	4 663	44 639	580	158 816	67 192	5 141	342 657
5	42 598	1 943	1 154	2 845	20 557	16 378	320 922	27 099	1	433 498
6	252 718	529 583	19 425	80 437	84 506	269 040	117 376	536 474	149 325	2 038 884
7	12 234	840 572	4 811	650	339	4 501	2 472	4 046	1 904 007	2 773 632
8	372 066	121 068	35 726	81 111	55 690	71 967	140 916	0	1 745 960	2 624 502
ε_{+CB}	1 920 749	271 381	84 149	985	8 804	1 071 579	345 223	101 832		
z	4 088 423	2 417 031	349 154	342 657	433 498	2 038 884	2 773 632	2 624 502		

Notes:
1 – non-financial corporations,
2 – monetary financial institutions other than central bank,
3 – other financial intermediaries (except ICPFs), financial auxiliaries, CFIs, and money lenders,
4 – non-MMF investment funds,
5 – insurance corporations,
6 – general government,
7 – households; non-profit institutions serving households,
8 – rest of the world.
[a] Based on an asset-oriented system, whereas a liability-oriented system is its transposition.

Source: own calculations.

Efektywność strukturalnych operacji otwartego rynku Narodowego Banku Polskiego w latach 2020–2021. Podejście input-output

Streszczenie

Celem artykułu była ocena efektywności strukturalnych operacji otwartego rynku Narodowego Banku Polskiego (SOOR) przeprowadzonych w latach 2020–2021 jako mechanizm luzowania ilościowego (QE) w reakcji na szok pandemiczny COVID-19. W latach 2020–2021 NBP przeprowadził 29 operacji skupu aktywów na rynku wtórnym, nabywając głównie obligacje skarbowe oraz papiery dłużne gwarantowane przez Skarb Państwa o łącznej wartości około 144 mld zł (około 107,1 mld zł w 2020 r. i 36,9 mld zł w 2021 r.). Program skupu miał stabilizować rynek długu, wspierać płynność sektora finansowego oraz wzmacniać mechanizm transmisji stóp procentowych (serii obniżek). W zrewidowanej interpretacji wyników podkreślono jednak, że wnioski dotyczą przede wszystkim krótkookresowej transmisji impulsu płynnościowego w latach 2020–2021, a nie pełnej średniookresowej oceny kosztów i korzyści z QE w Polsce.

Autorzy definiują efektywność jako zdolność programu skupu aktywów do wywoływania pożądanych zmian w przepływach finansowych w gospodarce – w szczególności do zwiększania inwestycji, tj. finansowania zakupów aktywów rzeczowych – w większym stopniu niż oszczędności. Fakt, że efekty w postaci wzrostu inwestycji i wzrostu oszczędności nie muszą być równe, wynika z asymetrii w sposobie, w jaki podaż pieniądza i popyt na niego rozprzestrzeniają się w systemie finansowym. W efekcie SOOR bank centralny jednocześnie zmienia swoje aktywa i pasywa, generując indukowany wzrost zarówno inwestycji, jak i oszczędności. Do oceny efektywności SOOR zastosowano finansowy model input-output w ujęciu zorientowanym na aktywa (egzogeniczny impuls w postaci wzrostu aktywów finansowych banku centralnego) i w ujęciu zorientowanym na pasywa (impuls popytu na pieniądz związany ze wzrostem zobowiązań banku centralnego). W pierwszym przypadku określany jest indukowany wzrost inwestycji (GII), w drugim zaś – wzrost oszczędności (GIS). Różnica pomiędzy GII i GIS określa efekt netto będący miarą efektywności SOOR. Analiza opierała się na danych Eurostatu z zakresu finansowych bilansów według sektorów instytucjonalnych, uzupełnionych informacjami NBP. Program skupu aktywów poprawił warunki płynnościowe i stabilność rynku obligacji, jednocześnie zwiększając rezerwy sektora bankowego oraz portfel papierów skarbowych w bilansie NBP. Wyniki symulacji mnożnikowych pokazały, że impuls płynnościowy był w pierwszej kolejności absorbowany przez sektor bankowy oraz pośrednio przez gospodarstwa domowe (wzrost depozytów i zasobów płynnych). Przełożenie na sektor przedsiębiorstw niefinansowych miało w dużej mierze charakter „bilansowy" (równoległy wzrost aktywów i zobowiązań), co wskazuje na częściową akumulację płynności zamiast natychmiastowego wzrostu inwestycji rzeczowych. Kluczowy rezultat dotyczy miary efektywności netto: w 2020 r. efekt netto był ujemny (dominacja oszczędzania nad finansowaniem wydatków inwestycyjnych), natomiast w 2021 r. był dodatni, co należy powiązać z odbudową aktywności gospodarczej i powrotem części impulsu do strumienia wydatków, zwłaszcza poprzez sektor rządowy i przedsiębiorstwa.

Polski program QE w badanym okresie zasadniczo był skuteczny jako instrument stabilizacji rynków finansowych i ograniczania problemów płynnościowych. Jego szacowany wpływ na realną

aktywność był warunkowy i w znacznym stopniu zależał od struktury powiązań finansowych oraz skłonności sektorów do zatrzymywania płynności w formie oszczędności. Zastosowane podejście input-output dostarczyło dodatkowej, międzysektorowej perspektywy oceny polityki pieniężnej. Umożliwiło identyfikację zarówno bezpośrednich, jak i pośrednich efektów operacji banku centralnego oraz prześledzenie ścieżek, którymi pieniądz przepływa przez różne sektory gospodarki. Stanowi zatem cenne uzupełnienie tradycyjnych modeli makroekonomicznych.

Słowa kluczowe: luzowanie ilościowe, Narodowy Bank Polski (NBP), macierz aktywów i pasywów, analiza input-output, międzysektorowe przepływy finansowe