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Channels for the Impact of the War in Ukraine on the Commercial Banking Sector in Poland – First Results of the Study

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ABSTRACT

The outbreak of war in Ukraine raises questions about its impact on the economies and financial systems of countries directly and indirectly involved in the war, but also on the economies of non-participating countries. The article aims to identify the channels through which the war in Ukraine has affected commercial banking in Poland. The original contribution of this paper to the literature dedicated to the impact of the outbreak of war on financial sector consists in the identification of channels of direct and indirect effects of war on commercial bank performance, adoption of unique empirical strategy to point out features of banks determining their sensitivity to the materialisation of geopolitical risk as well as groups of banks whose shares move along similar trajectories during the war. The conclusions emphasize that the long-term negative indirect effects of the war outweigh the short-term indirect ones. The policy implications consist in the benefits of introduction of new reporting standards for banks that focus on the exposure of their clients to the geopolitical risk, augmentation of scope of risks to be covered by regulatory capital by geopolitical risk as well as creation scenarios of stress tests that would include geopolitical risk. Facing war, the implications for commercial banks' managers come down to the necessity to prioritize cyber risk management and implement a new paradigm of credit and market risk assessment, taking into account the impact of geopolitical factors.

KEY WORDS:

banking sector, banking crisis, war, credit portfolio, capital market, liquidity.

JEL Classification: G21.

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1. Introduction

The Russian aggression on Ukraine, which began on 24 February 2022, is an unprecedented event in the history of 21st century Europe. In addition to the military dimension, the war occurs in cyberspace, the media, and the economy. Russia's ongoing full-scale war in Ukraine is causing severe losses, damages and sufferings on human, social, and economic levels. With a part of the physical in-

frastructure and the capital stock destroyed, damaged or occupied, millions of people displaced, and important trade routes blocked, it is not surprising that the economy is shrinking at an alarming pace (Kirchner et al., 2022). Since the banking sector is a key component of the financial system stability and the ability to finance the real economy affects economic growth, this paper focuses on the banking sector's performance during the first months of the war.

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The aim is to identify the channels for the impact of the Ukraine war on the Polish banking sector and to draw initial conclusions regarding the ranking of risk factors for banks. There are several reasons for choosing the Polish banking sector. Firstly, Poland is a direct neighbor of the war-torn country. Secondly, Poland is one of the countries with the greatest political and economic support given to Ukraine. Thirdly, even before the outbreak of the war, a considerable number of Ukrainians resided in Poland, which increased considerably due to the wave of refugees. Polish banks identified this customer group before the Russian aggression and included it in their marketing strategies (by the end of 2021, banks in Poland had 672,000 bank accounts for Ukrainian citizens - see Boczoń, 2022). After 24 February 2022, the offer has been expanded. As of the end of July 2022, approximately one million Ukrainians that reside momentarily in Poland already have a Polish bank account, of which 450,000 accounts were already opened after the outbreak of war (Mórawski, 2022b). Fourthly, two Polish commercial banks have subsidiaries in Ukraine: PKO Bank Polski (PKO) owns Kredobank in Lviv, and Getin Holding Group owned 6.392% of the share capital of Getin Noble Bank SA as of 31.12.2021 (at the same time, 9.99% of the shares in Getin Holding SA were held by Getin Noble Bank SA), controls Idea Bank Ukraina in Lviv. Fifthly, a group of companies financed by Polish banks had strong trade relations with countries at war. As mentioned above, due to the geographical proximity of Poland and the warring countries, as well as the direct investments of Polish banks and companies in Ukraine and the cooperation of Polish companies with counterparties from Ukraine, Belarus and Russia, the war is expected to negatively affect the condition of the Polish banking sector and its capitalisation.

Due to the availability of market data, only commercial banks listed on the Warsaw Stock Exchange were included. Together, they account for more than 80% of the Polish banking sector, considering both the balance sheet total and own funds (as of 31.03.2022).

The issues related to the impact of war on the banking sector are particularly relevant from both

a theoretical and practical point of view. Considering the theoretical sphere, it is crucial to identify the channels of the impact of armed conflict on the condition of banks and to sort out and clarify the interdependencies between them. The practical implications of the study's conclusions are important primarily for the institutions that make up the financial safety net. It is because a deterioration in the standing of even individual banks can have an impact on increasing systemic risk, ultimately impacting on increasing pressure on the state as a source of support for the banking sector. Even if bank losses do not put banks at risk of insolvency, a decline in capital adequacy ratios may contribute to a credit squeeze and increase the likelihood of stagflation.

The considerations in the article are part of the research trend of the capital market reaction to 'black swans' in relation to banks. In the academic literature, war is one of the most significant events among other 'black swan' events (e.g., financial crises, health crises, natural disasters, elections, and terrorism attacks) that influence the equity markets globally (Yousaf et al., 2022). This study is one of the few in the literature that focuses on the impact of the war in Ukraine on the performance of the banking sector of a country that is not a member of the euro area yet borders warring countries and is significantly experiencing the various consequences of war. The reaction of the capital markets towards the banks to the news of the outbreak of war has been taken into account, and an attempt has been made to interpret it. This is the first comprehensive and multidimensional analysis of the materialisation of various risk factors in the banking sector of a country indirectly but significantly experiencing the consequences of war: from credit risk through the market and operational risk to cyber risk. The original contribution of this paper to the literature comes down to three main issues. The first is the identification of channels of direct and indirect effects of war on commercial bank performance. The second is the applied empirical strategy of combining ACAR/ABHAR analysis with DTW for individual banks, which allows for identifying the characteristics of financial institutions that determine their sensitivity to the materialisation of

geopolitical risk in the form of the outbreak of war, as well as groups of banks whose shares move along similar trajectories during the intensity of armed conflict. Previous studies of responses to the outbreak of war have primarily addressed the issue of variation in abnormal rates of return by industry of the economy (Saini et al., 2023), or stock index (Ozili, 2022) or type of commodity (Izzeldin et al., 2023). The added value is both the set of data analysed and the method of analysis, which allows for a holistic approach to the problem and has not been applied to such an issue before. A third important finding relates to the fact that the outbreak of war is perceived as an event that will have a particularly negative impact on the standing of commercial banks (relative to other industries). This is the initial reaction of investors, but it is corrected over time.

The article consists of five sections. The first one provides an overview of the literature on the effects of war on the banking sectors of countries directly involved in the war and those bordering on and, therefore, indirectly engaged in a war. The following section presents the methodology of the study by referring to the descriptive part dedicated to the channels of the impact of the war on the sector and the empirical analysis aimed at assessing the capital markets' response to the outbreak of the war is measured by the use of CAR and BHAR as well as the result comparison using DTW approach. The study results are then discussed, while the fourth part discusses the conclusions with the research results. The conclusions section summarises the results, outlines the possibilities and rationale for their application in business practice, presents the limitations of the conducted studies, and determines directions for further research.

2. Literature review

The outbreak of war affects banks indirectly (through a deterioration of macroeconomic parameters determining a decrease in the credit standing of debtors and a decline in the value of equity investments), directly (credit and equity exposures in warring countries) and through a change in the valuation of bank shares (also against the shares of companies representing other

sectors). Therefore, the literature on the subject of war's impact on banks, particularly on the ongoing war in Ukraine, can be divided into three strands: (a) the impact of the war on the economy (indirect channels), (b) the effects of the war on the banking sector (both direct and indirect channels), and (c) the reaction of capital markets to the outbreak of war.

2.1. *The Real Sphere of the Economy During the War*

War affects not only the economies of the countries that fight it. Prohorovs (2022) says that Russia's aggression against Ukraine exacerbated the instability of the global economy resulting from the US-China trade confrontation, the economic impact of the COVID-19 pandemic and loose monetary policy. The war has increased inflation and negatively impacted economic growth, creating the threat of stagflation. Estrada Ruiz et al. (2022), anticipating the outbreak of war in Ukraine, developed a PEI Simulator of its consequences operating, among others, with the following indicators: GDP change, war losses, economic wear from war, and the total economic leaking from war. They assumed the scenario of a full war between Russia and Ukraine and evaluated its economic consequences. Ciuriak (2022) finds that "the short-term costs of the invasion may be tabulated in the trillions of dollars, with no offsetting benefits for any of the parties. The longer-term dynamic costs add considerably to the negative total". A relatively large number of studies so far are dedicated to the macroeconomic effects of the outbreak of war in Ukraine (mainly the magnitude of the change in GDP and inflation by country, region or globally). Among these, mention should be made of the article by Tank (2022), who estimates the spillover effects of sanctions using our Global Econometric Model (NiGEM). Sedrakyan (2022), using the gravity models of bilateral trade and direct investment conducting data analysis using the Poisson pseudo-maximum likelihood econometric technique, finds that sanctions against Russia will result in a significant decline of exports from transition economies, Russian imports to transition economies, and Russian

direct investments to transition economies. At the same time, surprisingly, the direct investments to Russia from transition economies sharply increase. Khudaykulova et al. (2022) draw attention to the opportunity cost of military investment, the humanitarian loss of the financial system, and the burden of repairing post-war damage in Ukraine. Mbah and Wasum (2022) notice that while sanctions have been imposed on Russia, their effects will be felt globally in the form of increased inflation, reduction in household consumption, supply chain disruptions, uncertainty, reduction in investment and stock swings. Ozili (2022) concludes that Russian aggression contributed to an unexpected increase in the global PMI and the growth of the world prices of food and food ingredients. At the same time, the Euro Area manufacturing PMI decreased in the month of the invasion. Aliu et al. (2023) focus on the impact of war on global trade and African countries, given their energy and food balances (how much each country depends on energy and food imports). Even though the war in Ukraine is local in nature, the effects are global due to the parties' involvement, including trade (Orhan, 2022). Ruiz Estrada and Koutronas (2022) prove the negative impact of the Russo-Ukraine military conflict on the bilateral trade and the decrease in investment between the Russian Federation and the European Union. Cárdenas and Hernández (2022) point out that despite a positive environment for commodity exporters, Latin America and the Caribbean countries are likely to suffer from the war in Ukraine. It results from greater global economic uncertainty, increased probability of a flight to safe assets putting pressure on exchange rates as well as sharp growth of inflation, forcing central banks to increase interest rates. In addition, there are difficulties to be reckoned with in terms of bringing down inflation due to government policies that subsidise energy purchases. Junaedi (2022), analysis impact of the war on the Indonesian economy comes to the conclusion that the war in Ukraine causes a decrease in the rupiah exchange rate, a decline in the capital market, loss of income due to a decline in exports as well as there is reported an impact of rising oil prices on the state budget and an increase in imported wheat. Focusing

on the FX market Aliu et al. (2023) show that from November 1, 2021, to May 1, 2022 the EUR/RUB significantly influenced the Euro devaluation. The FX rates used in the study (EUR/RUB, EUR/USD, EUR/JPY, EUR/GBP, and EUR/CNY) hold long-run cointegration. In the short run, only EUR/RUB, EUR/USD, and EUR/CNY possess significant relations with other parities.

2.2. *The Impact of War on the Banking Sector*

The changing role of the banking sector in the context of war was recognised at an early stage, particularly with regard to the financing of public debt. Paradoxically, wartime is not only associated with devaluing consequences. For the banking sector of the victorious countries, wartime can be a period of prosperity. Whittlesey (1943), for example, in the context of the entry of the United States into the First and Second World Wars, notes that US banks have significantly increased their profitability by financing military expenditures and aid to other countries, as well as by providing credit and loans on the domestic market. The contemporary literature on the effects of a war on the banking sector is dominated by the analysis of the situation in countries affected by the wars started in the 21st century, such as in Armenia (Badadyan, 2021), Afghanistan (Sahak & Choudhury, 2021), Iraq (Damar, 2007, Saeed & Shanan 2020), Yemen (Raga et al., 2021, Saif-Alyousfi, 2020), Lebanon (Sakr-Tierney, 2017), Darfur/Sudan (UN, 2012), Syria (Al Mashhour et al., 2020, Gobat & Kostial, 2016), etc. In the predominant number of cases, the authors note that in addition to the most serious consequences of armed actions – loss of population, mental and moral suffering, economic destruction, uncontrolled migration, excessive aggression and social pathologies, etc. – the entire banking sector suffers heavy losses. Ouedraogo et al. (2021) studied the potential impact of war and political instability on the systemic banking crisis in 92 developing countries from 1970 to 2016. These authors stress that: „conflicts and political instability are indeed associated with a higher probability of systemic banking crises”. Specifically, they find that “the odds of a banking crisis are 2.5

times greater when a country is affected by a conflict". They add that conflicts and political instability in one country could negatively impact neighbouring countries' banking systems. Furthermore, they come to the conclusion that the channel of transmission is likely to be the occurrence of fiscal crises following a conflict or political instability. Rother et al. (2016) underline the significant worsening of the financial performance of individual banks as a result of armed conflict and the weakening of the ability of banks to carry out basic functions such as receiving deposits, granting credit and giving their customers access to the payment system. These authors also point out the frequent runs on banks taking place in such circumstances as capital flight, the dynamic growth of non-performing loans, the deterioration of financing conditions due to declining collateral and a downturn in the economy. Beim (2001), analysing 10 cases of war from 1980 to 1999 also focuses on the negative consequences of armed conflict. Beim shows that in most countries there was found a clear crisis in the banking sector, with some banks going bankrupt, closing down or being privatised. At the same time, non-performing loans grew dynamically in all the countries studied. Damar (2007) examines whether a large geopolitical event, such as the war in Iraq, can affect foreign bank lending from developed countries to emerging markets. Using country-level data he analysed the effects of economic shocks and the Iraq war on the availability of foreign bank credit to five countries in the Middle East and North Africa. He notices that the war has had a nonuniform effect on foreign banks. Although the war has led to higher U.S. lending, it has also discouraged British and Italian banks from lending to the region. Saif-Alyousfi et al. (2021) prove that oil and gas price rises directly affect bank performance through the channel of price-induced bank deposits and related lending to business activities. The negative impact on bank performance due to a drop in oil and gas prices is greater than the positive effect of a rise in prices. Saeed and Shanan (2020) examine the impact of macroeconomic conditions on banks' profitability (ROA, ROE) in the pre-war, transition and post-war period using the example of Iraq. Their findings

show that during pre-war and post-war interest rate has a negative significant effect on bank performance, implying that interest rate plays a significant role in the generation of bank profitability during the pre-war and post-war periods; and suggesting that the unexpected increase in interest rate discourage bank customers' borrowings which then affect bank performance. Furthermore, GDP growth positively affects bank performance in all periods, indicating that rise in GDP growth during the economic boom improves the banks' performance. Moreover, the inflation rate has positive significant effect on bank performance, implying that the banks effectively anticipate the changes in inflation to regulate their interest rates accordingly, which then improve the bank performance. In addition, the exchange rate has a negative significant effect on bank performance, implying that high exchange rates caused by economic instability and destabilized macroeconomic policy of the government have a negative effect on bank performance. In the case of Ukraine, many companies are no longer operational, which leads to a recession and an increase in unemployment. In addition, banks will suffer significant losses as their physical assets are damaged, and many loans may not be repaid, resulting in the loss of a large part of their capital (Astrov et al., 2022). A report issued by the European Central Bank [ECB] (2022) summarises that the war in Ukraine increases financial stability risks through its impact on all aspects of economic activity and financing conditions. While euro area banks have limited direct exposure to Russian borrowers, the quality of loan portfolios will be significantly affected by disruptions in energy and commodity markets. The Boston Consulting Group [BCG] (2022) itemises the potential consequences of the Russian invasion in Ukraine stating for financial institutions stating that the direct impact is limited while the more important issues seem to be: cyberattacks, rising interest rates, recession risk, increased market volatility, slowdown of M&A market, IPO and debt issuance as well as global financial decoupling. According to research conducted during the first quarter of 2022 through coordinated actions of the regulator and banks:

regulation of the foreign exchange market, ensuring the liquidity of the banking system, the operation of the electronic payment system and support for social benefits, the liquidation or preparation for the nationalization of Russian-controlled banks in Ukraine (Druhov & Druhova, 2022), the Ukrainian banking system operates stably enough and ensures the continuous operation of financial institutions under martial law. According to the National Bank of Ukraine, the financial sector's losses under martial law are moderate. Despite the military risks, banks have a fairly high level of liquidity, which allows for further continuous implementation of non-cash payments and other liabilities. In the future, the main factor of negative impact on the financial condition of banks will be credit risk, which can significantly reduce the level of bank capital due to the losses of part of the loan portfolio (Erkes et al., 2022). Pham et al. (2022) state that as early as 2014, armed actions that were not comparable in scale to the war of 2022 led to severe destruction of banking infrastructure in war areas. In addition, Ukrainian banks suffered significant losses and problems due to credit defaults and significant outflows of deposits in the Donetsk and Luhansk regions. The impact on sectors in other European countries, on the other hand, is not likely to be so strong. S&P credit rating agency (2022) notices that European banks are sufficiently resilient to cope with the wider economic impact of the ongoing Russian-Ukrainian war. In contrast, the agency expects lower credit and overall business growth with limited operating and risk costs increases in selected corporate portfolios. The agency adds that banks holding exposures to war-affected countries and companies from those countries would suffer financial losses. Still, these would be covered by other sources resulting from the diversification of their operations. Berben et al. (2022) analysing the effects of the Ukraine war on the situation of Dutch banks, also see no significant risks. In their opinion, although some individual banks have relatively larger exposures, the adequately capitalised Dutch banking sector is expected to be able to absorb any setbacks well. Guénette et al. (2022) underline the impact of the Ukrainian war on banks that granted loans to

Russian companies. According to these authors: „large equity losses for exposed banks seem probable, as implied by drops in the equity prices of European banks perceived to be exposed to Russia following the introduction of sanctions. Institutional investors' profits and liquidity positions will also be impacted by write-downs on Russian assets with encumbered liquidity and by the need to hold additional margin against implicated exposures”. The specialists from Oliver Wyman (2022) point to another problem. As one of the biggest risks for banks, they call heightened cyber threats, requiring elevated defences

2.3. War and Capital Markets

The war in Ukraine significantly affected equity markets. Research conducted on a sample of 2,316 commercial banks from 90 stock markets on six continents shows a significant decline in market return of almost 1.5% on the war date. All continents exhibit similar patterns, but Europe had the most severe drop of about 4% (Boubaker et al., 2023). Ozili (2022) comes to similar conclusions stating that the index of global stock markets plunged on the day of the Russian invasion. Also, Izzeldin et al. (2023) suggest that stock markets and commodities responded most rapidly to the outbreak of the war in Ukraine. Still, post-invasion crisis intensity is noticeably smaller compared to both the COVID-19 and the Global Financial Crisis. Deng et al. (2022) showed that in the run-up to Russia's invasion of Ukraine, and especially in the weeks afterwards, stocks more exposed to the regulatory risks associated with the low-carbon transition performed better. It means that investors expected the pace of the energy transition to slow down. Such an effect was observed in the US, while in Europe, stocks of companies with high energy transition potential gained relatively more due to the expectation of stronger regulatory support for renewable energy. Federle et al. (2022) come to a conclusion that the closer location of the company to Ukraine, the more negative its equity return in a four-week window around the start of the war. World Bank (2022) points out that European bank stocks lost more than a fifth of their value since the onset of the war, but high capital adequacy

and liquidity ratios have cushioned the impact. It stresses, however, that unknown risks could materialize in the financial system, potentially arising from under-appreciated exposures to Russia, such as leveraged over-the-counter products that depend on underlying Russian assets. Davies (2022) points out that the significant fall in bank share prices in Europe and the US (twice as large a reduction in capitalisation as the S&P index) is not related to investor concerns about the banking sector's direct involvement in lending to the Russian and Ukrainian economies. The real reason is fear of global economic disruption. The war in Ukraine shows that the European financial system is still fragile to external shocks. Despite the fact that the rouble is not among hard currencies, its position strengthened during the invasion on Ukraine to the importance of Russian gas to the Eurozone. It means that even weak currencies can be influential depending on the geopolitical and economic situation (Aliu et al., 2023). Saini et al. (2023) examine the influence of the war in Ukraine on the Indian economy and suggest that on the outbreak of the war, India experienced negative average abnormal returns that persisted up to the fifth-day post the aforementioned event day. The banking sector is on second (after the automotive industry), which hurt the most in terms of the negative abnormal return.

Analysis of the response of the capital market to the outbreak of war and a review of the literature allows the formulation of the following hypotheses:

H1: The war in Ukraine has both direct and indirect impacts on the performance and thus, valuation of Polish banks.

H2: Because of the marginal geopolitical exposure the war in Ukraine does not lead to significant write-downs and liquidity disruption in the Polish banking sector.

H3: Immediately after the outbreak of war, bank shares are subject to greater declines than major WSE indices.

H4: It is possible to identify some characteristics of commercial banks that determine the different response of individual institutions to the outbreak of war in Ukraine

3. Methodology

This article uses the desk research methodology which is based on a critical review of literature, legal acts and other studies, as well as a multi-criteria analysis aimed at synthesising conclusions on the impact of the Russian aggression on the Polish banking sector. To determine the effects of the war in Ukraine on the quotations of the banks' shares, additional returns were calculated by use Cumulative Abnormal Returns (CAR) and a Buy-and-Hold Abnormal Returns (BHAR). By additional returns we consider a widely accepted approach proposed by Dolley (1933) and introduced by Campbell et al. (1997), which is based on the efficient markets theory by (Fama 1970).

The essence of event analysis is calculating the additional rate of return of the bank's shares, i.e. the difference between real and expected rate of return on bank assets, if the event did not occur:

$$AR_{it} = R_{it} - E(R_{it}), \quad (1)$$

where:

AR_{it} - additional rate of return on shares of i -th bank achieved on day t ,

R_{it} - real rate of return on shares of i -th bank achieved on day t in case of information about war,

$E(R_{it})$ - expected rate of return on shares of i -th bank achieved on day t in case the information did not happen,

$i=1,2,..., N$ - where N means the number of sampled banks.

Measurements of additional rate of return used in the research are Cumulative Abnormal Returns (CAR) and Buy-and-Hold-Abnormal Returns (BHAR). These measures are very often used in the analysis, although they have their limitations in the form of, e.g. highly sensitive to input data (Wang & Ngai, 2020). Cumulative Abnormal Returns CAR_{iT} is calculated as the sum of daily abnormal rates of return from successive session days in the analysed period T :

$$CAR_{iT} = \sum_{t=1}^T AR_{it}, \quad (2)$$

where:

CAR_{iT} - cumulative abnormal returns on shares of i -th bank on day t ,

T - period of observation, time frame measured in

session days,

AR_{it} - abnormal returns of i -th bank shares on day t .

In addition, buy-and-hold Abnormal Returns ($BHAR_{iT}$) were estimated for all investigated banks. They are calculated as a difference between rate of return on investments in bank shares in period T and the expected rate of return:

$$BHAR_{iT} = \prod_{t=1}^T [1 + R_{it}] - \prod_{t=1}^T [1 + E(R_{it})] \quad (3)$$

where:

$BHAR_{it}$ - buy-and-hold abnormal returns on shares over the period T .

The average of cumulative abnormal returns for the whole analysed sample is calculated as an arithmetical mean of individual banks' cumulative rates of return:

$$ACAR_{NT} = \frac{1}{N} \sum_{i=1}^N CAR_{iT}, \quad (4)$$

Whereas the average of cumulative buy-and-hold abnormal returns with N shares in period T is defined as:

$$ABHAR_{NT} = \frac{1}{N} \sum_{i=1}^N BHAR_{iT}, \quad (5)$$

In the analysed cases, the behaviour of return rates on bank shares as a reaction to information about the war in the period from session day $-t$ to session day $+t$ for $t = 1, 2, \dots, 30$ was considered. Accepting such time horizons enables verification of such information's direct influence on bank shares' quotations. In the event of applying a wider range, mistakes resulting from other information's impact on the share exchange rate price might arise. Following MacKinlay (1997), estimating linear regression parameters for shares of each bank was based on the dependence of share return on stock exchange index return rate in the period from day $t = -250$ to session day preceding the first day of the analysed period. This estimation period could not be too distant from the observation period (the assumption of parameter invariability). Therefore, the analysis's estimation window varies from $t = -250$ to $t = -61$ trading days (for the session days ± 30 in the event window) to 279 (for the session days ± 1). WIG-banks sub-index have been accepted as an activity factor. Closing prices of bank and index share quotations from given stock exchange sessions were used for calculations.

A comparison has been made between quotation changes using Dynamic Time Warp (DTW) to find optimal alignment between two time series consists of the proposed measures in the considered period (Sakoe and Chiba, 2022). DTW is equivalent to minimizing Euclidean distance between aligned time series under all admissible temporal alignments. Therefore, using DTW, it is possible to match distinctive patterns of the time series and thus evaluate the similarity in the behaviour of the quotations of the banks' shares in terms of additional returns. The comparison was expanded to include bank clustering, considering their behaviour in the analysed period. The time series clustering technique used the DTW similarity as a distance measure. The main advantage of DTW is the possibility to group time series according to their patterns or shapes, even if these patterns are not synchronized. Such an approach provides an exceptional opportunity for in-depth exploration of banks' behaviour

over time, considering different response times to unusual events is undoubtedly the outbreak of war.

Due to the short time since the outbreak of the war on Ukraine we did not implement advanced econometric modelling. The study bases on data referring to 11 biggest Polish commercial banks that as of the end of March 2022 accounted for more than 80% of the Polish banking sector both in terms of total assets and own funds.

4. Results

4.1. Channels for the Impact of the Ukraine War on the Polish Banking Sector

The war in Ukraine has both direct and indirect effects on the Polish banking sector. The ability to clearly distinguish the direct and indirect channels of the impact of the war in Ukraine on the condition of Polish commercial banks and the separate quantification of this impact, as presented in the following discussion, demonstrates the veracity of H1. The direct implications relate mainly to the capital investments of Polish banks in Russia, Belarus and Ukraine as well as to credit exposures of these institutions to companies registered and operating in the

countries at the war and legal entities registered in Poland against which sanctions have been imposed or whose owners have been sanctioned. Direct consequences are also linked to the limits of Polish banks to Russian, Belarusian and Ukrainian. However, already long before the outbreak of the war, these limits were subject to significant reductions, mainly due to the insufficient ratings of Russian banks. The key issue of growing importance in this field seems to be cyber risk. Indirect effects are in turn, linked to the impact on banks' business activities such processes as a further war-related increase in inflation due to the rise in the prices of hydrocarbons, raw materials and food due to the food crisis caused by the blockade of Ukrainian ports and the ban on food exports as well as social changes.

4.2. Communication of the Polish Stock Exchange Banks with the Capital Market Following the Outbreak of the War in Ukraine

Given the relatively small direct impact of the situation in Ukraine on Polish banks, these institutions did not react with current reporting immediately after the outbreak of the war (Table 1) due to the late publication of the interim report and the ongoing sale process of the bank in Ukraine.

Data shown in Table 1 prove the lack of a uniform presentation approach, with the main topic of regular reporting, in addition to supporting refugees, of the credit risk associated with exposures to clients that are financially, organisationally and commercially associated with actors from countries at war in Ukraine. The banks pointed to the possible

Table 1

Reporting of Polish Stock Exchange Banks in Connection with the Ukraine War

		Current messages		Interim financial reports					
		Capital exposure	Others	Capital exposure	Capital exposure	Humanitarian aid	Offer for refugees	Cybersecurity	Others
1.	Alior Bank SA	-	-	-	x	x	x	-	-
2.	Bank Handlowy w Warszawie SA	-	-	-	x	x	x	x	-
3.	Bank Millennium SA	-	-	-	x	x	x	-	-
4.	Bank Ochrony Środowiska SA – BOŚ SA				x	x	x	x	
5.	Bank Polska Kasa Opieki SA – Pekao SA	-	-	-	x	x	x	-	-
6.	BNP Paribas Bank Polska SA	-	-	-	x	x	x	-	-
7.	Getin Noble Bank SA	x	-	x	-	-	-	-	-
8.	ING Bank Śląski SA – ING BSk SA	-	-	-	x	x	x	-	-
9.	mBank SA	-	-	-	x	x	x	-	-
10.	Powszechna Kasa Oszczędności Bank Polski S.A. – PKO BP SA	-	-	x	x	x	x	-	-
11.	Santander Bank Polska SA	-	-	-	x	x	x	x	-

Source: Own elaboration based on current and periodic reports of banks listed on the Warsaw Stock Exchange (last update of data on 20 May 2022).

future effects of the war due to the deterioration of macroeconomic parameters affecting the standing of borrowers.

4.3. Polish Capital Market Response to Russia's Aggression in Ukraine

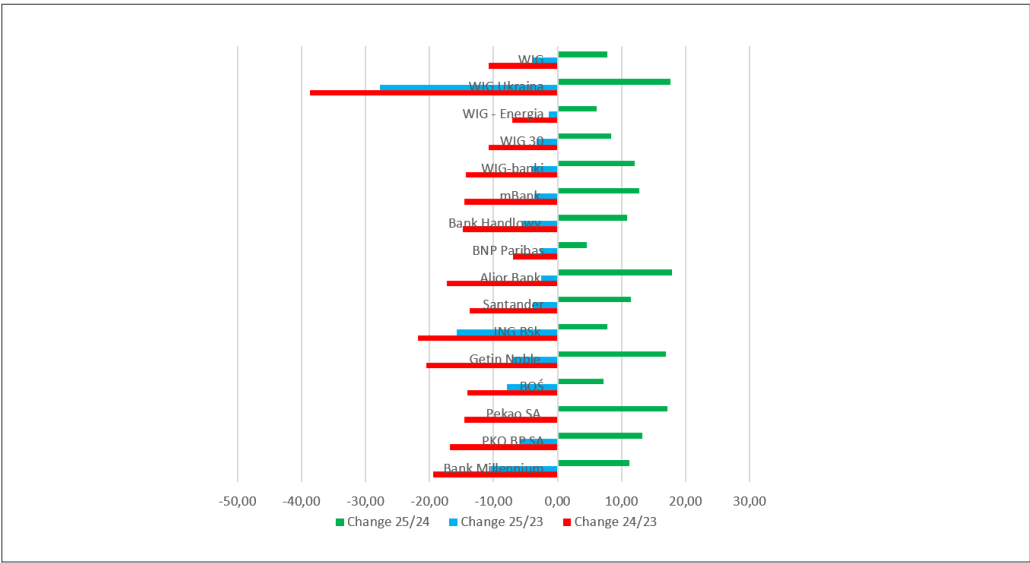
Since the performance of banks over the past three years depends on many idiosyncratic factors (including the impact of the COVID-19 pandemic, the structure and quality of the loan portfolio, risks associated with the CHF denominated mortgage portfolios, operating in an environment of initially low and subsequently rising interest rates, pressure on deposit rates and coping with state's initiative aimed at introduction of relaxation of repayment schemes of mortgage loans). And due to the fact the respective analysis has been conducted just after approx. 90 days following the outbreak of the war, only the immediate reaction of the capital market to the Russian aggression has been analysed.

The analysis of these three days (23 – 25 February 2022) shows that the outbreak of the war led to a sharp decline in the quotations of companies and indices, which is confirmed by the calculation of daily returns between 23 and 24 February

2022. For obvious reasons, the WIG-Ukraine index lost the most (almost 39%). The WIG-banks index shrank by 14,37%, and that was much more than the WIG (-10,73%) and WIG-30 (-10,78%). Among the three largest Polish banks, PKO BP SA's shares lost the most (16. 82%), which can be explained by the bank's direct capital exposure in Ukraine. At the same time, it should be noted that between 23 and 24 February 2022, the capitalisation of the two medium-sized banks (Bank Millennium SA and ING BSK SA) was most affected, partly because these banks, together with PKO BP SA, belonged to a group of institutions which had already published their results for 2021, just before the war. The first reaction of the capital market to the outbreak of war in Ukraine demonstrates the relatively high concern about the impact of the conflict on the performance of banks, as evidenced by the greater decline in the share prices of individual banks and the WIG-banks index than the plummet of the main indices of the Warsaw Stock Exchange. This conclusion confirms H3 and is consistent with the results of other studies using abnormal rates of return (e.g. Saini et al., 2023).

The decrease in the capitalisation of Getin Hold-

Figure 1
Quotations Patterns Immediately Before and After the Russian Aggression Against Ukraine (In Percentage Points)



ing SA was relatively small (drop by 12,5%), which was probably influenced by the fact that, on the day of the aggression, no information was known about the failure of the sale of Idea Bank Ukraina. The market expected this transaction as it considered it would improve the Polish bank's financial situation. The termination of the contract for the sale of the shares of Idea Bank Ukraina was announced on 28 February 2022, which led to further stock market sessions with a decline in the share prices of Getin Holding SA.

The day after the outbreak of the war, the stock market was corrected. It even referred to the WIG-Ukraine Index. While the initial response of the market indicated greater concerns about the situation of banks than the economy as a whole, the WIG-banks Index gained more than the WIG and WIG-30 indices on 25 February 2022. The observed significant increase in volatility determined by the expectation of the materialisation of geopolitical risks, but not supported by a deeper fundamental analysis, triggers certain policy implications. Firstly, a reduction in uncertainty would be possible by broadening the reporting on the composition of the credit and investment portfolio in relation to

geopolitical risk. Secondly, a reduction in return volatility could be achieved by introducing periodic restrictions on short selling (until the exposure to geopolitical risk is revealed).

At the same time, it is puzzling that all the banks analysed experienced a decline in their valuation as a result of the initial market's reaction to the outbreak of war. The aforementioned low transparency about the geopolitical risks incurred and the lack of knowledge by investors as to whether such risks are covered by regulatory capital are probably the reasons for this fire sale of banks' shares. Hence, capital requirements should also be considered for geopolitical risks.

The large and the state-controlled banks' stocks gained the most in value. In summary, the analysis points to a significant increase in bank share price volatility before and after the Russian invasion, without the market rating the war's risks as particularly acute for the banking sector (Figure 1). Also, Polish banks having subsidiaries in Ukraine did not experience any significant capitalisation losses.

In order to determine the impact of the Russian attack on Ukraine on the quotations of the banks' shares, additional returns were calculated.

Table 2

Average Cumulative Additional Return and Average Cumulative "Buy-and-Hold" Return in Periods ± 1 Day, ± 5 Days and ± 30 Days

No.	Specification	ACAR [%]			ABHAR [%]		
		-1 to +1 day	-5 to +5 days	-30 to +30 days	-1 to +1 day	-5 to +5 days	-30 to +30 days
1	Alior Bank S.A.	0.72	0.70	-0.02	1.90	0.73	0.05
2	Bank Handlowy w Warszawie S.A.	-0.93	0.47	0.27	-1.01	0.38	0.23
3	Bank Millennium S.A.	-3.65	-0.24	-0.03	-2.14	0.03	0.02
4	Bank Ochrony Środowiska S.A.	-2.59	0.75	0.15	-2.80	0.61	0.10
5	Bank Polska Kasa Opieki S.A. – Pekao S.A.	2.32	0.08	0.08	2.18	0.02	0.04
6	BNP Paribas Bank Polska S.A.	-0.23	0.75	-0.17	0.13	0.74	-0.12
7	Getin Noble Bank S.A.	-1.70	1.24	0.55	-0.06	1.24	0.57
8	ING Bank Śląski S.A.	-0.57	0.53	0.03	-0.07	0.54	0.04
9	mBank S.A.	-0.24	0.36	-0.05	1.15	0.47	0.02
10	Powszechna Kasa Oszczędności Bank Polski S.A. – PKO BP S.A.	-0.80	-0.56	-0.04	-1.38	-0.58	-0.07
11	Santander Bank Polska S.A.	-0.16	0.56	0.01	0.19	0.53	0.03

The method is based on the measurement of additional rate of return: the Cumulative Abnormal Returns (CAR) and Buy-and-Hold Abnormal Returns (BHAR). The analytical results are presented in Tables 2 and 3.

In the analyzed periods, the following trends are noticeable: i) nervous reaction of investors in the period -1 to +1 day, ii) positive reaction of market in the period -5 days to +5 days, thanks to which there was a possibility to cover previous losses, iii) relatively small additional rates of return in the pe-

riod -30 to +30 days, which may suggest that investors assessed the perspectives of commercial banks in Poland quite positively in the context of the war in Ukraine. The positive attitude of investors towards the banking sector can be proved by the fact that the majority of banks recorded positive returns during the period under review.

Apart from PKO BP SA, which is directly involved in the Ukrainian banking sector (control over Kredobank), in other cases, quotations were determined by different factors influencing the fi-

Table 3
Basic Characteristics of the Additional Returns Investigated

Specification	ACAR			ABHAR		
	-1 to +1 day	-5 to +5 days	-30 to +30 days	-1 to +1 day	-5 to +5 days	-30 to +30 days
Min [%]	-3.65	-0.56	-0.17	-2.80	-0.58	-0.12
Max [%]	2.32	1.24	0.55	2.18	1.24	0.57
Arithmetic mean [%]	-0.71	0.42	0.07	-0.17	0.43	0.08
Median [%]	-0.57	0.53	0.01	-0.06	0.53	0.04
Standard deviation [%]	1.59	0.50	0.19	1.57	0.48	0.19
V(x) variability coefficient	-223.52	119.04	278.26	-904.49	111.10	225.75

Table 4
Averages and Medians of Additional Returns, Broken Down by Nationality and Status of Main Shareholders

Specification	ACAR [%]			ABHAR [%]		
	-1 to +1 day	-5 to +5 days	-30 to +30 days	-1 to +1 day	-5 to +5 days	-30 to +30 days
				Average		
Domestic shareholders	-0.41	0.44	0.14	-0.03	0.40	0.14
Foreign shareholders	-0.96	0.40	0.01	-0.29	0.45	0.04
				Median		
Domestic shareholders	-0.80	0.70	0.08	-0.06	0.61	0.05
Foreign shareholders	-0.40	0.50	-0.01	0.03	0.50	0.02
				Average		
State controlled	-0.09	0.24	0.04	-0.02	0.19	0.03
Private	-1.07	0.52	0.09	-0.26	0.56	0.11
				Median		
State controlled	-0.04	0.39	0.03	0.26	0.31	0.04
Private	-0.57	0.53	0.01	-0.06	0.53	0.03

nancial situation of the individual banks (Table 4).

Similar tendencies as in Tables 2 and 3 are also noticeable in this classification. Basically, there are no clear differences between the additional rates of return in the selected groups of banks, although a slight preference of banks with domestic shareholders over banks with foreign shareholders is noticeable. On the other hand, investors in the first period rated state controlled banks much better. In the period -5 days to +5 days private banks reacted quite quickly to discounts. In the period -30 to +30 days the differences are minor.

Figure 2 presents the absolute values of ABHAR behaviour for individual banks in period $\pm t$ for $t = 1, 2, \dots, 15$. Trends for each bank are increasing, but the signs are not consistent between banks (see Table 2). The greatest values of absolute value of ABHAR most of the time is for Noble Bank SA. As Tables 2 and 4 show, so far the impact of the armed conflict in Ukraine on the stability of the banking sector in Poland has been limited. First of all, investors have paid attention to the capital exposure of commercial banks of Russia, Ukraine and Belarus, as well as a balance sheet and off-balance sheet exposures to entities from these countries (PKO BP

SA, Getin Noble Bank SA). It also seems to be the reason for the lack of decisive differentiation of banks in Table 4. The Polish banking sector shows a high capacity to absorb potential losses due to significant surpluses of accumulated capital, expected improvement in profitability in an environment of higher interest rates and significant write-downs of distressed assets, which significantly reduces the scale of their future potential losses. The behaviour of the banks' listings over the longer term (-30 to +30 days) has also already been influenced by the individual condition of specific banks (Getin Noble Bank SA, Bank Millennium SA), resulting primarily from the impacting legal risks associated with the portfolio of mortgage-backed residential securities (RRE (FX) portfolio). The largest price changes were recorded in the period +15 days (Figure 3).

However, immediately after the Russian aggression against Ukraine, banks reacted differently. The parameters of linear regression models determined for calculating ACARs and ABHARs measures are statistically significant for each considered number of quotation days. However, the results and related inference could depend on the length of the estimation window ending one day before the event. As

Figure 2

Absolute Value of Average Cumulative "Buy-and-Hold" Return in Period $\pm t$ for $t = 1, 2, \dots, 15$ (In Percentage Points)

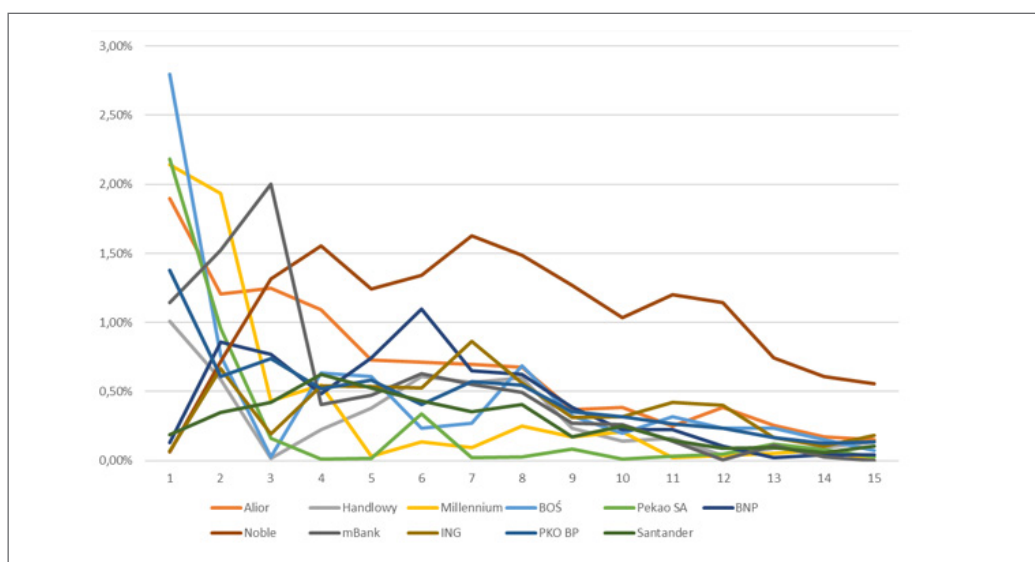
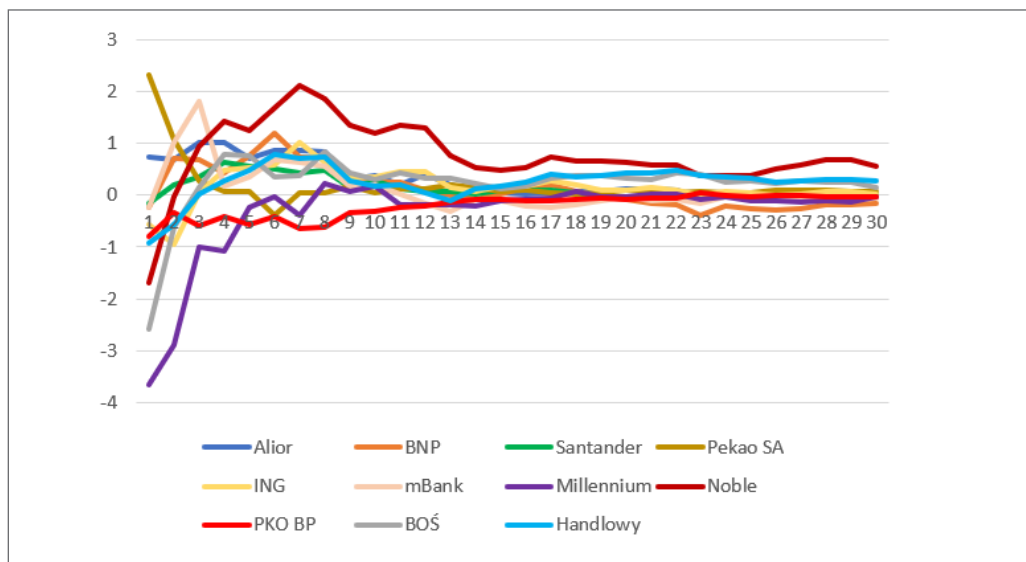


Figure 3

Average Cumulative Additional Return in Period $\pm t$ for $t = 1, 2, \dots, 30$ (In Percentage Points)



an additional robustness check, shorter estimation windows were also considered, covering the period from half to the whole year preceding the event. Comparing the range of discrepancies between the smallest and largest average ACAR values, the relative error oscillates between 23% and 309%. For ABHAR, the discrepancies are slightly larger and range from 60% to 348%, depending on the number of quotation days. Considering the quotations' volatility, such errors should be considered minor. Moreover, they do not affect the presented inference.

In addition to the classic approach using ACAR and ABHAR measures, the similarity in the behaviour of the quotations of the banks' shares in terms of additional returns was measured. For this purpose, the DTW was used. The DTW (using Euclidean measure) distance between each pair of banks is given in Table 5.

Using DTW distances it is possible to cluster banks into groups which are similar to each other. Based on ACAR measure in period $\pm t$ for $t = 1, 2, \dots, 30$ hierarchical cluster analysis was performed. To visually assess the cluster accuracy, a dendrogram was plotted (Figure 4). The most outstanding bank (in relation to the DTW measure) is Getin Noble

Bank SA, which forms an independent group (black colour). One of the groups (red colour) consists of the banks with a significant share of the corporate portfolio (Alior Bank SA, Bank BNP Paribas Bank Polska S.A., Santander Bank Polska S.A., Pekao SA, mBank SA, ING Bank Śląski S.A.). It is the group of banks considered to be the most similar (in relation to the DTW measure taking into account possible lags), but in the initial period after the outbreak of the war, these banks differ significantly (see Figure 5). The results show a marked difference in investor behaviour in relation to retail and corporate banks. The latter group is characterised by greater exposure to the effects of war in the short term. The performance of these banks will be influenced by the performance of corporate clients, especially those with exposure to warring states. At the same time, investors' view of the impact of the war on individuals is neutral (difficulty in assessment unequivocally at this stage). The above conclusions can be used in the construction of the capital requirements for geopolitical risk signalled earlier. The similarity of the behaviour of the prices of banks with a corporate profile and different pattern for the bank of weak financial standing in the first period after the outbreak of the war gives grounds to confirm H4.

Table 5

Euclidean Distance Between the Average Cumulative Additional Return of Pairs of Banks Computed Using Dynamic Time Warp

	Alior	BNP	ING	mBank	Pekao SA	Santander	Handlowy	Millennium	BOŚ	Noble	PKO BP
Alior	0.00	0.09	0.11	0.11	0.10	0.09	0.19	0.35	0.17	0.33	0.35
BNP	0.09	0.00	0.12	0.11	0.17	0.10	0.20	0.25	0.18	0.34	0.21
ING	0.11	0.12	0.00	0.14	0.18	0.07	0.11	0.21	0.12	0.29	0.17
mBank	0.11	0.11	0.14	0.00	0.17	0.09	0.21	0.23	0.22	0.35	0.17
Pekao SA	0.10	0.17	0.18	0.17	0.00	0.13	0.24	0.38	0.24	0.42	0.19
Santander	0.09	0.10	0.07	0.09	0.13	0.00	0.16	0.20	0.15	0.37	0.14
Handlowy	0.19	0.20	0.11	0.21	0.24	0.16	0.00	0.26	0.09	0.25	0.22
Millennium	0.35	0.25	0.21	0.23	0.38	0.20	0.26	0.00	0.21	0.55	0.16
BOŚ	0.17	0.18	0.12	0.22	0.24	0.15	0.09	0.21	0.00	0.25	0.28
Noble	0.33	0.34	0.29	0.35	0.42	0.37	0.25	0.55	0.25	0.00	0.53
PKO BP	0.35	0.21	0.17	0.17	0.19	0.14	0.22	0.16	0.28	0.53	0.00

Figure 4

Dendrogram Corresponding to the Hierarchical Cluster Analysis Based on the Cumulative Additional Return in Period $\pm t$ for $t = 1, 2, \dots, 10$.

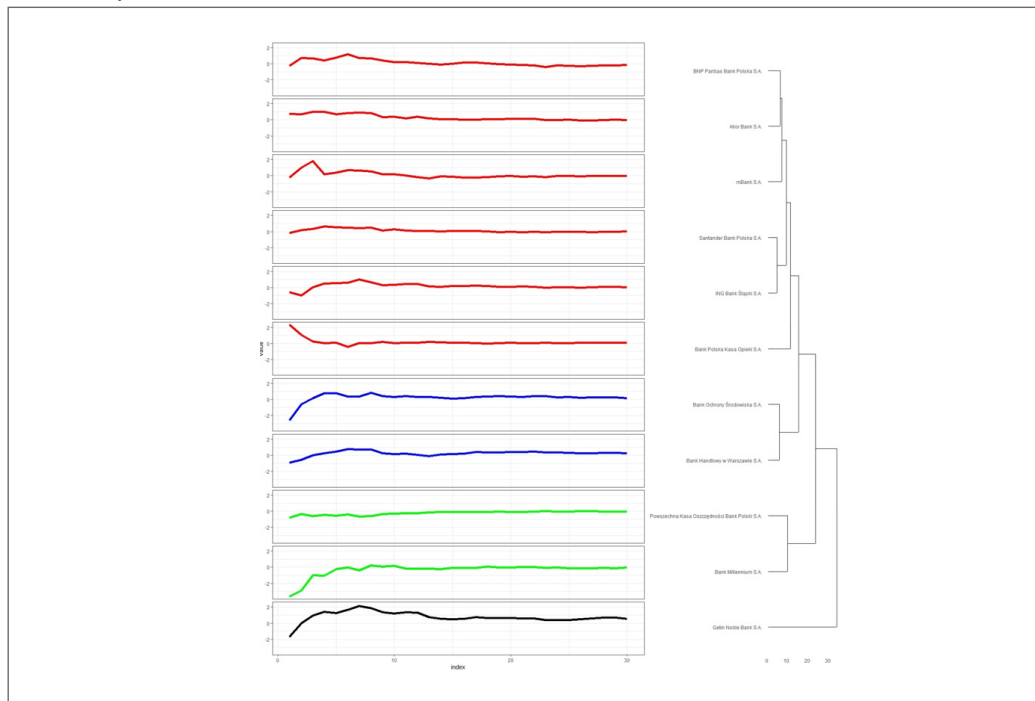
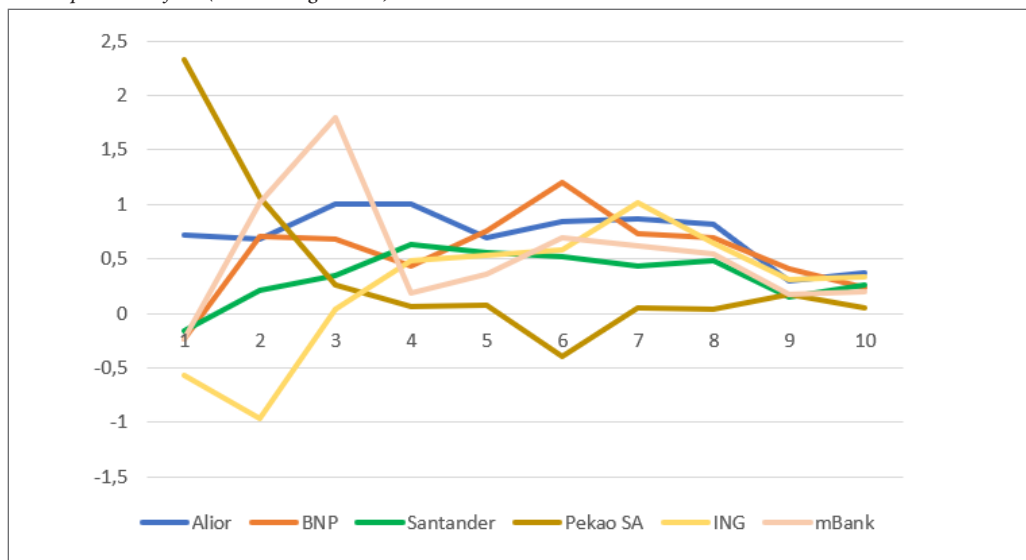


Figure 5

Average Cumulative Additional Return in Period $\pm t$ for $t = 1, 2, \dots, 10$ for Selected Banks with a Significant Share of the Corporate Portfolio (In Percentage Points)



There was a noticeable nervousness in the reaction of investors in the first few days after the outbreak of the war. However, investors were fairly quick to assess the potential impact of the war on the performance of banks operating in the Polish banking sector, helping to calm the situation around the ninth day of trading. On the one hand, an increase in the speed of interest rate rises by the Monetary Policy Council - due to increasing inflationary pressure - has a positive impact on banks' interest results, while on the other hand, the sector faces a deteriorating macro situation, which may have a negative impact not only on demand for business and personal loans, but also increase the percentage of non-performing loans. An additional problem for banks specialising in servicing business entities is the issue of a significant increase in energy prices, which may significantly affect the creditworthiness of existing and future borrowers.

4.4. Capital Exposures

Polish banks and credit institutions understood in this paper as entities with registered offices and conducting activities in Poland are relatively poorly represented in Russia, Belarus and Ukraine. The

capital exposure is actually limited to investments in Ukraine and concerns Kredobank SA of PKO BP SA and Idea Bank Ukraina SA, which is held by Getin Holding SA.

In addition to its headquarters in Lviv, Kredobank SA has 81 branches in 22 of the 24 Ukrainian counties, but these are mainly located in western and central Ukraine. In the area of direct warfare (as of 20 May 2022) Kredobank has 12 branches. According to PKO BP, at the beginning of March 2022, about half of Kredobank's branches were operational and its board had already prepared contingency plans. On March 9, 2022, the National Bank of Ukraine added Kredobank to the list of 16 system banks, stressing its importance for the Ukrainian banking system. The scale of Kredobank is described on the basis of selected financial data for 2021, i.e. a net profit of around PLN 114 million and a loan portfolio of around PLN 2,6 billion. In the report for the first quarter of 2022, PKO BP SA revealed write-offs related to the war in Ukraine.

The write-off connected with the shares amounted to PLN 52 million. The value of Kredobank on PKO BP SA's balance sheet was PLN 227 million (compared to a gross value of PLN 1,072 million).

The impairment of Kredobank's loan portfolio amounted to PLN 314 million (approximately 20% of Kredobank's exposures relate to war-affected regions), which contributed to an increase in PKO BP SA's risk costs. At the end of the first quarter of 2022, Kredobank's liquidity and deposits remained safe and stable. At the same time, it should be noted that the deterioration of Kredobank's standing, which accounts for around 1% of the balance sheet total and 0,4% of the profit of PKO BP SA, is unlikely to have a significant impact on the performance of the largest Polish retail bank (PKO, 2022). PKO BP SA also stated that it did not intend to withdraw from Ukraine (Money, 2022).

A similar statement on the continuation of activities in Ukraine was made by Getin Holding SA, owner of Idea Bank Ukraina. At the beginning of April 2022, 50-55 of the bank's 75 branches were open. The bank is headquartered in Lviv, its IT infrastructure, including IT systems, data centres and back-up centres, are located in western Ukraine (Lviv and Ivan Frankowsk), but some branches operate in areas of eastern Ukraine that experience heavy warfare, and these locations (about 20) remain closed. It should also be mentioned that Getin Holding SA intended to sell its Ukrainian bank, but did not do so because all conditions for the transfer of ownership of Idea Bank Ukraina were not met (including the approval of the National Bank of Ukraine and the Antitrust Committee of Ukraine – this one was met on 3 February 2022). Finally the pre-sale agreement was terminated on 25 February 2022.

Compared to the parent bank, the results of Idea Bank Ukraina were definitely better. The capital adequacy ratios show this at the end of September 2021 (Tier 1 = 8,45%; TCR = 14,90%) and the net profit at the end of 2021 of PLN 108 million. In its current message, Getin Holding SA announced that value adjustments on assets (Idea Bank Ukraina and New Finance Service sp. z o. o.) had been made at a consolidated level in the amount of PLN 222,9 million and at the standalone level in the amount of PLN 192,3 million. These write-offs had a negative impact on the net profit in the first quarter of 2022 (Getin Holding, 2022). At the same time, it should be mentioned that Idea Bank Ukraina is a much smaller bank than Kredobank, as can be seen from the balance

sheet total of around PLN 880 million and its own funds of around PLN 185 million (Forsal, 2022).

Ukrainian banks do not hold shares of banks operating in Poland. Russian banks are also absent from the capital structure of Polish banks, although representatives of Sberbank admitted in 2011 that they had an interest in acquiring shares of Bank Millennium SA and Kredyt Bank SA (Samcik, 2011). Finally, under the influence of the licensing policy of the Financial Supervision Commission, Sberbank decided in 2012 to focus on investments in Belarus, Ukraine, Turkey, Austria and (through the acquisition of the Austrian VBI) Bosnia-Herzegovina, Croatia, Slovenia, Serbia, the Czech Republic, Slovakia and Hungary. In the context of the countries of the region, Poland is in a relatively good position since it (like the Czech Republic, Hungary, Slovakia and Austria with regard to Sberbank Europe) does not have to start withdrawing the licenses of Russian banks, which is due to the ECB's recommendation, which is determined by the deterioration of the liquidity of Russian credit institutions.

However, the risk of capital exposure needs to be broadened. It cannot be ruled out that the current war in Ukraine will lead to a new geopolitical constellation, in particular to a more or less formal bloc of authoritarian states and a bloc of liberal democracies. In this context, cooperation between Russian and Chinese banks could be envisaged, for example. Both Russia and China spoke out against US dollar hegemony for many years, demanding, for example, that their currencies be included in the basket of the SDR. China has succeeded and since 01.10.2016 CNY has been part of the SDR basket (Reuters, 2009; Dollar, 2015). As part of its independence from the US financial infrastructure, in 2014 Russia introduced the System for Transfer of Financial Messages (SPFS) in 2014 as an alternative to SWIFT.

At the end of April 2022, the Bank of Russia announced that it would keep the names of its participants secret in order to facilitate the settlements for gas in roubles. It consists of around 400 participants. China also set up a similar system in 2015. CIPS (Cross-Border Interbank Payment System) processes payments in CNY and comprises a network of about 1,280 financial institutions. To date, however, CIPS continues to rely heavily on SWIFT for cross-border communication. The SPFS is national, and according to Reuters, Russia is negotiating with China to link its system to the CIPS in order

to circumvent the “nuclear option” referred to as the decoupling of Russian banks from the SWIFT system (Huileng, 2022). Cooperation between Russia and China cannot be ruled out in the field of capital investment in the European banking sector.

Apparently, spectacular, publicly accessible and transparent joint investments or the takeover of European credit institutions owned by Chinese banks by Russian banks are hard to be expected. The ownership structure of Chinese banks is non-transparent, and it is quite conceivable that Russian financial institutions could acquire stakes in Chinese companies, which themselves own European banks. This process was intensified after the subprime crisis when some banks had to be restructured and recapitalised. For these reasons, the Chinese fund Fosun is a major shareholder of the Portuguese BCP (which controls the Polish Bank Millennium SA) and Minsheng Financial acquired control of the Portuguese Novo Banco, Bison Capital Holding Co. Ltd. of China in 2018 bought Banif and Haitong became the main shareholder of Bank Espirito Santo de Investimento (Wise, 2016; O'Neill, 2015; Seaman et al., 2017). In Poland, Chinese banks such as Bank of China, Industrial and Commercial Bank of China and the China Construction Bank conductive business operations, whereas previously Haitong Bank was also active (Dziawgo, 2019).

Access to information and the real economic impact of Chinese banks, which are potential candidates for co-operation with Russian financial institutions, do not require the establishment of a network of banks registered in European jurisdictions. Cross-border lending, which in the case of China accounts for 18% of GDP, also offers

this possibility. Currently, 63 EMDEs (Emerging Market and Developing Economies) are dependent more from Chinese banks than from banks that represent any other nationality. Chinese cross-border lending accounts for 24% of the total amount of cross-border lending for emerging markets. These economies account for about 43% of China's cross-border lending in developed economies. By contrast, claims on advanced-economy borrowers held by Chinese banks are much smaller in relative terms. Their market share reaches just about 2,6%, and Chinese banks do not rank as top cross-border lenders to any specific advanced-economy borrower country (Cerutti et. al. , 2020).

4.5. Direct and Indirect Credit Exposure

There are 1073 companies with Russian capital operating in Poland (i.e. those in which a Russian company is the dominant shareholder or a Russian citizen is the ultimate beneficiary), of which about 48% were registered in the period 2019-2022. By the end of 2020, these investments were estimated at around PLN 239 million, representing less than 0,12% of all foreign direct investment in Poland (Godusławski, 2022; Centralny Ośrodek Informacji Gospodarczej, 2022; Narodowy Bank Polski [NBP], 2022a). Among the largest and best known investments are: Polonia Palace, MDM and Metropol Hotels in Warsaw, a significant shareholding in Grupa Azoty (as a result of the failed hostile takeover), the mineral wool factory in Wykroty, shares in EuRoPol Gaz and Novatek (Grzegorzcyk, 2022). Table 5 shows the sectoral structure of Russian investment in Poland:

Table 5
Russian FDI in Poland – Sectoral Structure (6 Most Frequently Represented Sectors)

Main PKD (CODE LIST OF CLASSIFICATION OF BUSINESS ACTIVITIES IN POLAND)	Number of entities
49.41.Z – ROAD TRANSPORT OF GOODS	79
62.01.Z – IT ACTIVITY	62
46.90.Z – WHOLESALE TRADING (NOT SPECIALISED)	44
70.22.Z – OTHER ADVISORY FOR ECONOMIC ACTIVITY AND MANAGEMENT	39
41.20.Z – CONSTRUCTION	37
56.10.A – RESTAURANTS	33

Source: COIG (2022)

The main sectors in which Russian capital is present in Poland are: energy and fuel, chemicals, IT and commercial real estate. Capital investment in Poland by Belarusian and Ukrainian companies is marginal. Polish direct investment in Russia is estimated at EUR 619,6 million as of the end of 2020, of which EUR 371,5 is related to the capital exposure (NBP, 2022a). The sectors of the economy most represented are: construction materials, household appliances and clothing. Polish direct investment in Ukraine reached almost EUR 400 million at the end of 2020 (NBP, 2022a). Before the outbreak of the war, there were more than a thousand Polish companies in Ukraine, mainly in the financial sector (banking and insurance), but also in the construction, automotive, furniture and clothing industries (Ministry of Development, 2020). Polish capital does not have a significant capital commitment on the Belarusian market.

Another issue is the entities which may be owned directly or indirectly by Russian or Belarusian persons and entities whose participation is difficult to

identify. It also applies to companies registered in tax havens and countries whose disclosure of capital structure is unsatisfactory.

Apart from Russian and Belarusian investors in Poland and Polish companies with assets in Russia and Belarus, companies trading with Russia, Belarus and Ukraine are of interest to Polish banks' credit risk managers. After the outbreak of the war in Ukraine, the banks began to review their credit portfolios, examining the capital exposure of their clients in the Russian, Belarusian and Ukrainian markets, the dominance of Russian, Belarusian and Ukrainian capital in the ownership structure of the clients and the share of costs or sales with counterparties from Russia, Belarus Ukraine. Analysis of the bank reports for the first quarter of 2022 shows that there is no consistent approach, as evidenced by the discrepancy between the thresholds set for revenues or costs from cooperation with entities in countries at the war (between 5% and 30%). Table 6 provides a summary of the review criteria and their reasons:

Table 6

Premises of Credit Actions Determined by the Outbreak of War in Ukraine

Shareholder			
Jurisdiction of operational activity or main direction of cooperation	Poland	Russia or Belarus	Ukraine
Poland	X (a)	X (d)	X (e)
Russia or Belarus	X (b)		
Ukraine	X (c)		
Reasons for the review (monitoring):			
X(a)	Dependence on raw material supplies or significant share of export to Ukraine, Russia and Belarus	X (d)	Sanctions
X (b)	Loss of revenues and/or assets	X (e)	Deterioration of the owner's financial performance
X (c)	Loss of revenues and/or assets		

Table 6 indicates the most important rationale for credit reviews at commercial banks following the outbreak of war in Ukraine. The most important of these is the dependence of Polish companies on the supply of raw materials and commodities from countries at war and the significant share of exports directed to these markets (X(a)). Of key importance here is the possibility of finding alternative suppliers or customers in other regions of the world relatively quickly. It is also important that the above change is not associated with a significant deterioration in the profitability or even unprofitability of the business. X(b) and X(c), in turn, refer to business entities operating in countries at war and, at the same time, controlled by Polish companies. In this case, the risk of inability to continue operations due to ongoing hostilities in the area in question (Ukraine) or international pressure (Russia and Belarus, so-called "letters of shame") may be expected. Moreover, in these cases, retaliation from Russia for freezing Russian assets in the form of asset nationalisation must be expected. The sanctions resulted in the de facto impossibility for entities registered in the European Union and controlled by Russian or Belarusian capital to do business in the European Union (X(d)). Most of these entities declared bankruptcy due to loss of liquidity (e.g. Sberbank subsidiaries). Finally, the significant deterioration in the standing of Ukrainian companies negatively affects the financial performance of their subsidiaries registered in Poland (X(e)).

Credit assessments shall be carried out at regular intervals (monthly or quarterly depending on the risk and the size of the exposure). The basis for determining the list of monitored clients is the information provided by the clients on ownership, costs and sales, as well as the results of the analysis of their accounts (direction of the money transfers). While the number of Russian, Belarusian or Ukrainian borrowers and the number of Polish companies investing in these markets is small, identifying borrowers dependent on supplies or distributing their products to Russia, Belarus or Ukraine poses a greater problem. Three questions are crucial in this context: (a) Is it possible to replace the supplier or the off-taker? (b) When may such a replacement take place? (c) How does the change of supplier/

off-taker affect the performance of the borrower? The first few weeks after Russia's aggression against Ukraine suggest that the changeover of business partners and the resulting deterioration in profitability remain real problems.

Analysis of the credit exposures at risk and scale of credit facilities already considered irregular does not provide a clear answer to the question of which bank in Poland is most exposed to the risks of the war in Ukraine. This is partly because the regulator has not set a standard that would allow investors to compare the risk borne by individual banks (being public companies). This standard should include the establishment of thresholds (participation, sale, costs) above which the borrower would be considered as part of the portfolio regularly monitored due to the risks of war in Ukraine.

All banks investigated, which until 20 May 2022 disclosed the scale of credit risks to companies affected by the war in found that:

- the size of the exposure is negligible in relation to the value of the bank's total loan portfolio, balance sheet total, capital and net profit,
- any provisions and write-downs on credit losses do not have a significant impact on the cost of risk and capital adequacy ratios which allows to confirm H2;
- the war in Ukraine has a negative impact on GDP, inflation, capital, currency and money markets, which is likely to lead to a deterioration of the credit portfolio in the next two to three quarters from mid-2022 onwards.

The opinions and forecasts of the banks are confirmed by the World Bank, among others. The report entitled "War in the Region" estimates the war-induced deviation in economic growth rates (deviation from pre-war forecasts). For 2022, this is minus 0.8 for Poland, minus 13.6 for Russia, minus 32.6 for Eastern Europe (including Ukraine) and minus 1.2 percentage points for Central Europe (World Bank, 2022). Similar conclusions characterise the projections made by the Organisation for Economic Cooperation and Development (OECD). For example, while the end of 2021 estimated Poland's GDP growth rate in 2022 at 5.25 per cent, this estimate was lowered to 4.44 per cent in June 2022. The war also prompted a revision of inflation

forecasts, with, for example, Poland rising from 6.2% to 11.1%, Lithuania from 3.2% to 15.6%, Estonia from 6.0% to 13.3% and Latvia from 4.9% to 13.3% (OECD, 2022). Forecasts of exchange rate depreciation in emerging market currencies also proved true. For example, between 23.02.2022 and 07.09.2022, PLN lost around 4% against EUR and as much as 18% against USD. The deterioration of macroeconomic parameters and the tightening of monetary policy will, according to more than half of the banks, trigger a significant deterioration in the quality of loan portfolios, the first symptoms of which will already be visible at the end of Q3 2022 (Wiśniewska, 2022).

At the same time it should be mentioned that some banks (e.g. Alior Bank SA, Bank Millennium SA), whose business profile is dominated by retail banking, have published information on the scale of their loan portfolio built up from exposures to citizens of Russia, Belarus and Ukraine employed in Poland. The total share of these loans (mainly mortgages and cash loans) in the total loan portfolio of the above banks does not exceed 1.5% and their quality has not deteriorated since the outbreak of the war.

4.6. Operational Cooperation of Polish Banks with Russian, Belarusian and Ukrainian Banks

Cooperation between Polish and foreign banks is based on three types of limits: (a) limits on treasury transactions (cash and forward), (b) settlement limits (limiting the accumulation of settlements for a given value date), and (c) limits on commercial transactions (letters of credit, guarantees issued by a foreign bank for the obligations of Polish bank customers).

After the collapse of Lehman Brothers in 2008, operational cooperation between the banks was reduced for the following reasons:

- regulatory rationale, including LCR and NSFR liquidity ratios, promoting a change in the structure of funding sources for banking activities towards a greater share of deposits from individuals and legal entities,
- significant tightening of the criteria for creat-

ing the list of acceptable counterparties in the inter-bank market.

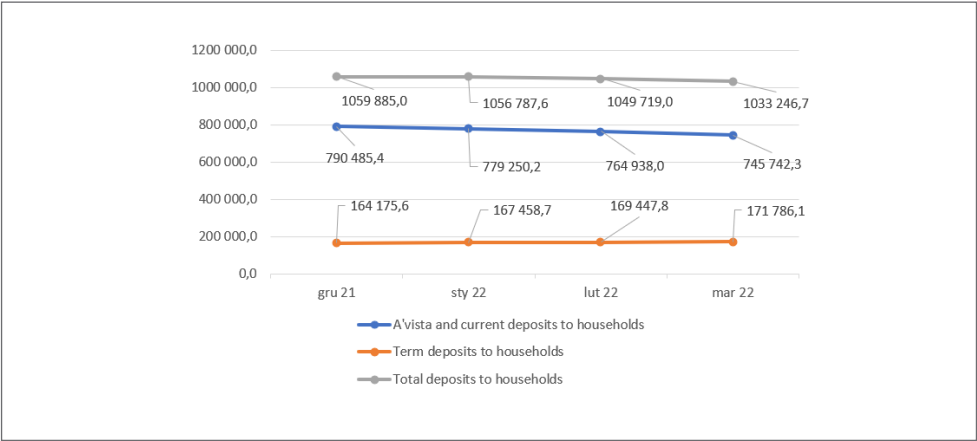
In view of the above considerations, Polish commercial banks reduced the spectrum of banks with which they cooperate, and limits were significantly reduced. The cancellation or significant reduction of treasury transaction limits and settlements limits for Russian, Belarusian and Ukrainian banks resulted from the high political risk associated with these jurisdictions, the low external ratings of these institutions, the unsatisfactory level of their transparency and reliability of financial statements, and the lack of business relationships. Trading limits fluctuate around several million EUR, their utilisation is relatively low, and their realisation is conditional, that is, recourse to these banks arises only in the event of the impossibility of enforcing claims against a customer whose liabilities are secured by guarantees of a Russian, Belarusian or Ukrainian bank.

A consequence of introducing sanctions in relation to Russian and Belarusian banks (cutting off from the SWIFT system and de facto impossibility to obtain foreign currency and transfer assets abroad) is, inter alia, non-execution of payments on behalf of clients to banks covered by sanctions. In addition, making foreign transfers to the accounts of counterparties holding accounts with sanctioned banks may result in delays in the execution of orders, the return of payments on the initiative of intermediary banks or the beneficiary's bank, and in extreme cases, even the loss of sent funds. Polish banks do not operate settlements and do not open accounts in roubles. In some cases, the termination of relations with Russian and Belarusian banks has been delayed, which has been motivated by the requests of clients wishing to settle their current trade liabilities. Another exception is the continuation of cooperation with banks located in Russia, belonging to Western European or American capital groups (e.g., ING, Raiffeisen and Citi).

4.7. Liquidity of Polish Banking Sector

The period immediately preceding and following the outbreak of the war in Ukraine saw an outflow of household deposits as shown in Figure 6:

Figure 6
Deposits of Households in Polish Banking Sector (Data in PLN mio)

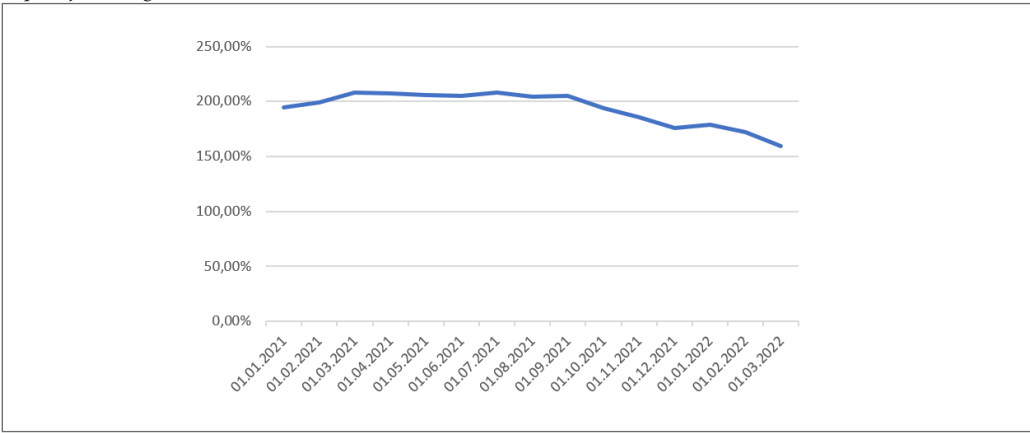


Source: Own elaboration based on: NBP (2022b)

The analysis of the data presented in Figure 6 indicates a decrease in the value of current deposits between 31 December 2021 and 31 March 2022 by approximately 5,7%. At the same time, there was an increase in the volume of term deposits by approximately 4,6% over the same period. The total reduction in the value of household deposits amounted to 2,5% or approximately PLN 26,6 billion. Withdrawals from banks were made by both Polish and Ukrainian citizens, and the demand was mainly for PLN and USD. These withdrawals did not significantly affect Polish commercial banks' liquidity and ability to settle their

obligations. No significant shortages of cash were recorded at ATMs and bank branches, and temporary individual problems were of a logistical nature. In the case of non-financial enterprises, on the other hand, a strengthening of the trend of augmenting balances in bank accounts was observed, reflecting an increase in uncertainty, a reduction in the redistribution of earned profits, despite the growth of investments compared to the previous year, although it must also be admitted that this is a growth from a low base (Kolany, 2022). Liquidity also deteriorated as measured by the net outflow coverage ratio (LCR, Liquidity Coverage Ratio):

Figure 7
Liquidity Coverage Ratio (%)



At the end of March 2022, the net outflows coverage ratio of the Polish banking sector amounted to less than 160%, which admittedly represents a decline of around 23% compared to the same period of the previous year, but the ratio is well above the regulatory requirement of 100%. This means that the war in Ukraine has not led to the disruption of the liquidity buffers of Polish banks as assumed in the H2.

4.8. Cybersecurity and Operational Risk in Wartime

So far, the main topic of discussion in the area of cyber threats has been the activity of organised crime. Currently, the risk of attacks carried out by entities linked to the Russian regime, politically rather than financially motivated (so-called state sponsored hackers), comes to the fore. Already at the end of February 2022, given the significantly increased frequency (around 1,000 events per week for a single bank) of hacking attacks, the Financial Supervision Authority (Komisja Nadzoru Finansowego [KNF]) issued a communication addressed to banks, sensitising managers to a significant increase in risk, resulting from the possibility of so-called massive distributed denial of service (DDoS) attacks, whose main objective is to disable internet services and block the ability to make online payments. In addition to DDoS-type attacks, the banking sector should reckon with attacks targeting the destruction of the boot sector of drives and files, attacks using malware (mainly via the e-mail channel), as this solution has been massively used by hackers in Ukraine. The KNF's initiative coincided with the government raising the cyber threat level from the lowest level (Level 1 - Alpha-CRP) to Level 3 on a four-level scale (Level 3 - Charlie-CRP) on 22 February 2022. The National Clearing House, responsible for the key infrastructure of interbank settlements, was also attacked. While the war in Ukraine has not seen an increase in hacking attacks compared to the few weeks preceding the Russian invasion, the elevated number of such incidents has persisted for several months. In view of these threats, the Polish Banks' Association (ZBP) has formulated a recommendation that includes a checklist for checking whether a bank has adequate resilience.

In the case of some banks in Ukraine (e.g. PrivatBank), maintaining business continuity required moving services and data to the cloud with the support of security platforms for accessing these applications,

which turned out to be possible in a relatively short period of time due to changes in regulations in this area. The argument in favour of this transfer of data and services is the risk of physical destruction of data centres while the solution used in the practice of many institutions, consisting in geographical dispersion of data centres and locating them in western and central Ukraine, is not a satisfactory mitigator of risk.

Banks in Poland used the first days of the war to verify and test business continuity plans, strengthen information systems security, duplicate data and create back-up centres, as well as ensure continuity of ATM services (Szafrński, 2022).

At the same time, it should be mentioned that the public will react to bank business continuity events. Fearing for the safety of their savings, there will probably be increased withdrawals of deposits or even a run on banks (Mórawski, 2022a). In this context, it is necessary to counteract fake news reporting, for example, on cash shortages in bank branches or ATMs.

Perhaps interestingly, the number of telephone fraud attacks from call centres in Ukraine decreased in the first weeks of the war. Ukrainian-Russian criminal groups also collapsed. The groups also had problems with transferring funds from Polish payment systems. This activity is being systematically restored. A likely target of cyber attacks in the near future may be Ukrainian citizens who have no experience in using electronic banking in Poland. Banks also point to problems related to the onboarding of Ukrainian citizens, resulting primarily from the lack of possibility to verify data of persons without identity documents. An operational challenge for banks is also the implementation of sanctions imposed on entities and persons designated by the European Union and the United States. The issue is their correct identification and freezing of funds (and, before that, finding an appropriate technical solution to ensure the establishment of such blocks), as well as the obligation to monitor deposits belonging to citizens of Russia and Belarus, persons residing in these countries and business entities based there (ZBP, 2022).

4.9. War in Ukraine and Corporate Social Responsibility of Banks

Polish banks and their employees have become involved in helping refugees from Ukraine. Such support was provided primarily on a voluntary basis, i.e. bank

employees donated their time and commitment, and the bank provided the necessary funding to implement these projects. The banks organised financial and in-kind collections (including medical equipment, ambulances, and medicines). Refugees were exempted from fees for using bank products and services (including transfer fees to Ukrainian banks), dedicated help desks in Ukrainian and counselling assistance. Mobile applications and electronic banking in Ukrainian were also implemented. The preparation by banks of an offer for Ukrainian customers was a response to the Communication on the position of the KNF on banking services for refugees from Ukraine of 4 March 2022. It indicated that banking products for Ukrainian citizens should include a basic payment account, payment instrument (payment cards), fee waiver and meeting the requirements for strong customer authentication (KNF, 2022). In addition, PKO BP SA, which has a bank in Ukraine, has taken care of and provided support to its employees and their families of approximately 900 people (PKO, 2022). Similar activities and customer onboarding were undertaken by BNP Paribas Bank Polska SA for employees and customers of Ukrsibbank, part of the BNP Group (BNP, 2022).

5. Discussion

Repercussions of the Russian invasion of Ukraine and ensuing sanctions continue to reverberate globally and will test the resilience of the financial system through various potential amplification channels, including direct and indirect exposures of banks and nonbanks; market disruptions in commodity markets and increased counterparty risk; poor market liquidity and funding strains; acceleration of cryptoization in emerging markets; and possible cyber-related events (IMF, 2022).

Among the consequences of the outbreak of war indicated by the IMF in the case of the Polish banking sector, the most important for its stability are credit risk and the risk of increased cyber attacks. However, so far there has been no run on banks as indicated by Rother et al. (2016), although an outflow of household deposits has been observed and no significant increase in the share of NPLs in banks' loan portfolios.

The war also affected the capital market, including bank shares. The reaction of the Polish stock market did not differ from what capital markets in other coun-

tries experienced, which in turn is described by Dummett (2022). He points out that, as in Poland, bank sector indices in Western European countries and the United States lost more than major stock indices. In Poland, the impact of the outbreak of war on capitalisation was not the same for all banks. It was relatively stronger in the case of PKO BP SA, which controls one of the systemic banks in Ukraine. A similar reaction was observed in other markets in relation to banks with capital exposure to warring states.

The analysis carried out in this article confirms the conclusions formulated, among others, by Ouedraogo et al. (2021), whose view is that the war destabilises the banking system of war-torn countries, also affecting the basic areas of assessment of the banking systems of countries bordering or economically linked to countries directly involved in the war.

Ahmed et al. (2022) also confirmed the study's findings. These authors also note quite pronounced differences in the quotations of companies included in the 'Financials' group in the initial post-invasion period, and this sector is characterised by the highest declines in cumulative abnormal returns over the event window [-3, +3]. At the same time, they add that significant negative abnormal returns are determined by a country's location and level of dependence on Russian energy resources.

The results of our research are also in line with the conclusions of the research carried out by Saini et al. (2022). According to them, the banking sector was on second (after the automotive industry), which hurt the negative abnormal return the most. Yudaruddin and Lesmana (2022) basing on data of 1126 banks show that banks' stock prices from both developed and emerging markets reacted negatively to the Russian aggression before and after the announcement. The banks from NATO states had a significant negative effect on market reaction. The study proves that investors possessing bank shares are very sensitive to the war, confirming our investigation's results.

The war in Ukraine does not impact the Polish economy's macroeconomic characteristics. It manifests itself, *inter alia*, in a reduction in the availability of goods, of which Ukraine and Russia were important producers before the war. These are primarily cereals, sunflower oil, semiconductors, noble gases (Ukraine is the world's largest producer of these, with a share of up

to 70% in the case of neon), fertilisers and steel. The post-pandemic process of rebuilding the continuity of supply chains as a result of the war has stalled and the problems have worsened as Russia and Ukraine are important producers of automotive components such as dashboards, windscreens, cables, bumpers, etc. (Kifer, 2022). The war also caused an exodus of Ukrainian workers.

As a result, problems in the continuity of operations of such industries as automotive, transport, construction, chemicals, agriculture and food processing, as well as industries cooperating with them, should be expected. In order to maintain the scale of operations and continuity of production, Polish enterprises operating in the above-mentioned sectors, which are financed by banks, need to find alternative suppliers in a relatively short period of time. However, even an easy substitution of contractors does not mean the absence of problems, as most often imports from Russia and Ukraine were cheaper than supplies from other geographical directions. A similar conclusion applies to exports, which were more profitable than cooperation with entities from Western European countries or the United States. Also, sanctions imposed on Russia will affect the global economy and financial markets with significant spillovers to other countries, even those not involved directly in the war (Georgieva, 2022). Adding to this picture the sharp rise in hydrocarbon and labour prices, bank customers' economic and financial performance is expected to deteriorate. In an environment of high and rising interest rates, with economic growth expected to weaken already in 2023 (analysts estimate that due to the war in Ukraine, Poland's GDP growth rate will fall by between 0,4 pp. and 1,0 pp.), the increase in NPLs share is foreseen. High and so far rising inflation forces tightening of the monetary policy in the form of interest rate increases. The war component of inflation is estimated at 1,5-2,0 p.p., and an analysis by the Polish Economic Institute indicates even 3,5 p.p. (Polski Instytut Ekonomiczny [PIE], 2022). High interest rates (despite government intervention) will also affect the quality of mortgage portfolios.

The war in Ukraine worsens the medium-term economic outlook, while in the short term its impact is less clear due to, *inter alia*, an increase in private consumption. The end or more likely freezing of the war in Ukraine should not stop the already observed processes

with a long-term horizon. Independence from Russian hydrocarbon imports should serve to accelerate the energy transition towards an increased share of green energy in the energy mix. This should be followed by an intensification of automotive electrification. The blockade of Ukrainian ports and trade routes makes it necessary to seek alternative solutions, in which Polish infrastructure plays an increasingly important role. The persistence of the current geopolitical situation will force the development of road, rail and port infrastructure in Poland. At the same time, Polish economic entities will be forced to seek trade routes bypassing Ukraine (until its infrastructure is rebuilt) and Russia.

It is also to be expected that no new foreign direct investments will appear in Ukraine, Russia and Belarus in the medium term. When the war finishes the reconstruction process in Ukraine will lead to FDI. Taking the above into account, as well as still relatively lower labour costs, tangible incentives from the state, membership of the European Union and NATO, and the attractiveness of local markets as well as possible participation in the reconstruction in Ukraine, should bring about an increase in direct investment in CEE countries. On the other hand, bordering countries at the war may cause Poland to be perceived by foreign investors and financial markets as a high-risk country, resulting in higher yields of treasury bonds, shorter weighted average maturity and increased volatility of PLN (PIE, 2022). The Russian aggression carried out militarily and in cyberspace will contribute to an increase in expenditure on defence and IT security. This process should be accompanied by an augmentation of expenditures on science. The influx and probable stay in Poland for a longer period of time or even permanent settlement of several hundred thousand or even several million refugees is a premise for the claim that the consumption of food and industrial products will increase, although on the other hand the persistently high inflation will cause a decrease in the purchasing power of consumers. The increase in the population (especially women and children) in Poland also means the necessity to increase spending on education, health and social transfers, which will not be conducive to stabilising the state budget unless funds from the European Union are obtained for this purpose (PIE, 2022).

The processes described above determine the map of attractiveness of industries and directions of spend-

ing on investments. At the same time, in the context of forecasts indicating continued high energy prices, energy-intensive industries dependent on fossil fuel consumption for their infrastructure will be characterised by a higher credit risk. This conclusion may constitute a premise for reorientation of banks' lending and sectoral policies and building effective solutions enabling banking services to a new group of clients, i.e. refugees from Ukraine.

The direct impact of the war on the condition of the Polish banking sector, related to capital investments or credit exposures to entities coming from war-torn countries, will not seem to be significant, similarly to the situation in the banking systems of Western European countries, as shown, *inter alia*, by Berben et al. (2022). More significant, long-term and most likely negative, will be the effects of the indirect channel associated with the deterioration of the financial standing of businesses and households caused by rising energy, commodity and food prices and the weakening of economic growth. The concerns indicated in this article about the long-term indirect negative impact of war on the banking sector are confirmed by Saif-Alyousfi et al. (2021).

6. Conclusions

The Financial Stability Committee (FSC), in a communication issued after its meeting on 25 March 2022, assessed that a new type of systemic risk (geopolitical risk) materialised, which was caused by the armed aggression of Russia against Ukraine on 24 February 2022. At the same time, the FSC concluded that the Polish banking sector was prepared for a possible crisis following the war, both in terms of capital and liquidity (Komitet Stabilności Finansowej [KSF], 2022). The results of this study confirm the conclusions of the KSF. Although the first reaction of the capital market to the outbreak of the war in Ukraine indicated concerns about the condition of the banking sector, later stock market sessions brought an increase in capitalisation, also under the influence of information provided by banks. The scale of capital investments of Polish banks in Ukraine is not large enough to significantly change the picture of the consolidated results of these capital groups. At the same time, none of the listed Polish commercial banks identifies the risk associated with the outbreak of war as significant from the point of

view of the quality of their corporate and retail portfolios. The outflow of retail deposits recorded in Q1 2022 did not cause liquidity tensions. The banking sector in Poland has also met challenges related to cybersecurity. While the impact of the war analysed in the short-term horizon cannot be assessed unequivocally (positive or negative), in the long-term perspective a negative impact of the war on the results, own funds and liquidity of commercial banks should be expected. This long-term impact will affect a broader spectrum of economic entities and individuals who are borrowers and will probably be more intense and longer lasting. This is due to forecasts of a permanent slowdown in economic growth, deterioration in public finances and high inflation. With rising inflation and further inflationary pressures, central banks are faced with a challenging trade-off between fighting record-high inflation and safeguarding the post-pandemic recovery at a time of heightened uncertainty about prospects for the global economy (IMF, 2022).

The channels of war impact on the banking sector defined in this article can be used in analyses conducted by supervisory institutions and institutions responsible for financial stability. The proposed methodological approach aimed at identifying and verifying changes in the level of credit risk is a useful tool for risk managers in commercial banks. In addition to the possibilities of using our results in business practice (primarily based on a new paradigm of credit and market risk assessment, taking into account the impact of geopolitical factors), the conclusions formulated have broad policy implications. Firstly, consideration should be given to introducing disclosure requirements for the structure of banks' corporate portfolios based on modified geographic and industry criteria. This modification would supplement information on the portfolio's composition according to the corporate client's jurisdiction and the industry in which it operates with exposure to specific foreign markets (both on the cost and the revenue side). A further step could be to set limits on clients with a high dependence on markets classified as geopolitical risk. A corollary to the recognition of geopolitical risk as one of the increasingly important risk factors in banking could be the introduction of capital requirements on this account (analogous to the concept currently under consideration of including climate risk in the estimation of capital requirements). Another

potential regulatory implication is the possibility to use identified cause-and-effect mechanisms in stress tests. Finally, the approach to cyber risk management should be prioritised, including the creation of uniform security standards and requirements for testing the resilience of systems to hacking attacks. From the point of view of capital market stability, a wider application of short-selling restrictions should be considered as geopolitical risks increase.

As already mentioned in the Introduction, this study is characterised by certain limitations, which at the same time set the directions for further research. One of them is the use of advanced statistical methods to find specific regularities. For example, the aim of such a study could be to determine the long-term impact of the outbreak of war on the quality of loan portfolios, bank capitalisation, liquidity, capital adequacy, the structure and level of deposits or the industry structure of the portfolio (depending on their profile or business model, the degree of involvement of the capital group in operations countries at the war).

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