PANOECONOMICUS, 2025, Vol. 72, Issue 1, pp. 23-51
Received: 03 March 2022; Accepted: 14 June 2023.

UDC 338.23:336.74(4)
https://doi.org/10.2298/PAN220303016J
Original scientific paper

Željko Jović

University of Belgrade,
Faculty of Economics,
Serbia
zeljko.jovic@ekof.bg.ac.rs

Expansionary Monetary Policy vs. Bank Concentration: The Eurozone & Other European Countries

Summary: Expansionary monetary policy combined with unconventional measures led to a decline in the profitability of U.S. and European banks. This paper studies whether such measures also affect the asset concentration in the European banking sector. The findings of this research add value to previous research, taking a step deeper into examining the consequences of expansionary monetary policy. It is found that reductions in the European central bank's (ECB's) key policy rate can predominantly explain the concentration growth in the eurozone countries. Furthermore, the ECB's monetary policy had a more substantial influence on the growth of the concentration of banks outside the eurozone than those countries' own monetary policies. Thus, the expansionary monetary policy poses specific challenges to financial stability in Europe.

Keywords: Monetary policy regimes, Bank profitability, Bank concentration, Eurozone, VAR model.

JEL: E44, E52, E58, G21.

Acknowledgement: Valuable comments of Professor Zorica Mladenović (Faculty of Economics, University of Belgrade) and Professor Miloš Božović (Faculty of Economics, University of Belgrade) are greatly appreciated. Remaining errors are, however, my own.

Over the last decade, research show that low interest rates and unconventional monetary policies have several effects on the banking sector: increased risk-taking, declining profitability, rising lending, shifting operations to fee-generating activities, declining provisions for credit losses, and many more. This paper goes a step further in considering the effects of expansionary monetary policy on the banking sector in European countries. The initial thesis of the study explains that the previously confirmed reduced profitability has certain consequences - an increase in concentration in the banking sector. In this study, it is further examined whether banks were inclined to increase their concentration of assets to maintain profitability in the conditions of its decline caused by low interest rates, particularly whether a stronger effect comes from the spillover effects of monetary policies from developed countries or from their own monetary policy measures.

The rest of the paper is organized as follows: Section 1 gives a brief overview of the economic theory and a review of the empirical literature, Section 2 presents the methodological framework, Section 3 presents an analysis of expansionary monetary

policy and the data to be used in the survey, Section 4 gives empirical results and discussion of findings, and Section 5 summarizes concluding remarks.

1. Literature Overview

Theories of money and the monetary theory have a long history; their traces can be found in the works of David Hume, Adam Smith, Karl Marx, and others. However, the real theoretical possibilities for a comprehensive consideration of the impact of monetary policy in other areas of the economy were created in the XX century. In the 1940s, a connection between monetary theory and business cycle theory was made (Olivier Blanchard 2000). The main contribution to this integration was given by Keynes' theoretical result and its later quantitative elaboration using the IS-LM model. Then, there was a period of intensive development of monetary theory as one of the areas of macroeconomics. The development of monetary theory went from "the battles between Monetarists and Keynesians of the 1950s and 1960s to the Rational Expectations Revolution of the 1970s and the battles between New Keynesians and New Classicals of the 1980s" (Blanchard 2000). In parallel, the importance of central banks in controlling the money supply and its impact on the real economy is growing. Monetary policy is recognized as a macroeconomic policy and as a topic of importance for science through research into the mechanism of its transmission (for a detailed overview of monetary policy transmission channels, see Ben S. Bernanke 1983; Bernanke and Alan S. Blinder 1988; Jean Boivin, Michael T. Kley, and Frederic S. Mishkin 2010). Certain papers recognize that the risk-taking channel can be developed through the transmission mechanism of monetary policy, which is defined as the credit channel theory (Bernanke and Mark Gertler 1995). In addition, see also Anil K. Kashyap and Jeremy C. Stein (2000), Xavier Freixas and Jose Jorge (2008) and Joe Peek and Eric Rosengren (2010). This is the theoretical confirmation that monetary policy has its effects on topics in the field of financial stability (see also Douglas W. Diamond and Raghuram G. Rajan 2006; Nobuhiro Kiyotaki and John Moore 2012; Joseph E. Stiglitz 2016).

In his work, Mishkin (2017) introduced the "dichotomy between monetary policy and financial stability policy" as one of the several topics for reconsideration of monetary policy after the Great Recession. Overall developments after the global financial crisis have increased the relevance of prudential policy as a topic but have not fully answered a number of theoretical and empirical questions that accompany its use and relationship with other policies (Blanchard, Giovanni Dell'Ariccia, and Paolo Mauro 2013). Since then, monetary policy and prudential policy have been seen as two separate macroeconomic policies whose coordination is necessary (Freixas, José-Luis Peydró, and Luc Laeven 2015). These findings opened space for additional empirical consideration of the impact of monetary policy on prudential policy, within which the banking sector has a key and unavoidable role.

From the Great Recession until today, a number of papers have appeared, which analyze the impact of low interest rates and unconventional monetary policy measures on the banking sector. These are studies that deal with the impact on risk-taking (risk-taking channel) on the one side and the impact on banking profitability and other

changes in banks (credit growth, increase in non-interest income, etc.) on the other side.

First, these studies have empirically examined the existence of risk-taking channels. On the data from the U.S. and the European Union, Yener Altunbas, Leonardo Gambacorta, and David Marques-Ibanez (2014) obtained results confirming that low interest rates over time affect the risk in banks. There are two ways in which low interest rates can increase the risk in banks: (1) Banks have a more positive perception of income and cash flows of customers, resulting in the underestimation of risk; and (2) banks' search for yield (reduced risk aversion). The authors suggested that monetary policy has an impact on banks' risk and that monetary and prudential policy coordination is needed to achieve both policy objectives: price and financial stability. In his research, Silvo Dajcman (2017), using the bank lending survey (BLS) response to identify the risk-taking channel of monetary policy, showed that the environment of low interest rates affects the increase in risk-taking in banks. The author stated that "the results suggest that the risk-taking channel in the euro area is operational".

Some research showed that in conditions of low interest rates, banks with lower capital levels are more prone to take risks. By analyzing banks in the U.S. in the 1997-2011 period, Dell'Ariccia, Laeven, and Gustavo Suarez (2013) provided evidence that monetary policy creates a channel for risk-taking. According to the results of this paper, the environment of negative interest rates increases the risk-taking by banks. This effect is more pronounced in banks with lower capital levels. In addition, Gabriel Jiménez et al. (2014) confirmed the impact of monetary policy on credit risk-taking in banks. Their findings showed that low interest rates on overnight loans by banks affect low-capital banks granting higher amounts of collateral-free loans to riskier clients, increasing lending to clients who are riskier - later they will be more likely to default.

The nonlinearity of the relationship between monetary policy and risk-taking in banks has been examined by certain authors. On the data on European banks in the 2000-2015 period, Sophie Brana, Alexandra Campmas, and Ion Lapteacru (2019) confirmed that low interest rate policies and injecting large amounts of liquidity encourage risk-taking. They pointed out that the relationship between monetary policy and risk-taking is nonlinear; and below a certain threshold, this effect intensifies.

In addition to research examining the existence of risk-taking channels, there are papers dealing with the direct consequences of expansionary monetary policy, such as the impact on net interest margins and bank profitability. Concentration is typically considered as a determinant of banking sector profitability (see Philip Bourke 1989). Certain empirical research deal with the impact of expansionary monetary policy on net interest margins and bank profitability. According to the data from 47 countries in the 2005-2013 period, Stijn Claessens, Nicholas Coleman, and Michael Donnelly (2018) obtained results showing that the current decline in interest rates leads to a decline in net interest margins using regression models. The paper shows that a longer period in an environment of low interest rates increases the negative impact on the net interest margin. In their work, Claudio Borio, Leonardo Gambacorta, and Boris Hofmann (2017) examined the relationship between monetary policy and bank profitability based on data from over 100 international banks of 14 developed economies in the 1995-2012 period. The results of this research showed a positive relationship between

changes in interest rates and bank profitability, with the extremely important observation that "unusually low interest rates and an unusually flat term structure erode bank profitability". The results showed that in the 2011-2014 period, which coincides with the period of expansionary monetary policy, there was a negative impact of low interest rates on bank profitability measured by the rate of return on assets (ROA). The authors concluded that the long duration of low interest rates can be extremely negative for banks' profitability.

The question was whether the reduction in interest rates affected the approval of a larger number of loans, which would compensate for the banks' income through economies of scale. Franziska Bremus and Marcel Fratzscher (2015) showed in their work that expansionary monetary policy affects the increase in cross-border lending both in euro and non-euro area countries. In the context of the volume of bank lending (bank lending channel), conventional monetary policy measures are more strongly transferred to banks with lower capital, whereas unconventional measures are more strongly transferred to banks with higher capital levels (Ugo Albertazzi, Andrea Nobili, and Federico M. Signoretti 2021). On the data from the eurozone covering the 1999-2009 period, Gert Peersman (2011) found that the reduction in interest rates has a stronger impact on the growth of lending than the growth of the monetary base of the central bank. The author explained that this is a consequence of a stronger manifestation of risk-taking channels in the case of falling interest rates than in the case of a growing monetary base. Borio and Gambacorta (2017), in another paper, developed a model that analyzes the impact of interest rate changes on lending growth based on the data from international banks in the 1995-2014 period. The obtained results confirmed that in the zone of low interest rates, additional lowering of interest rates contributed less to the growth of lending. This further explains the decline in bank profitability in an environment of low interest rates.

There were studies showing some changes in banks because of falling interest income. Jacob A. Bikker and Tobias M. Vervliet (2017) examined how the long-term environment of low interest rates affects the profitability of U.S. banks in the 2001-2015 period. The authors confirmed that low interest rates have led to a decline in traditional banking income, such as net interest income. Because of such effects, banks reduced provisions for credit risk losses; thus, compensating for the decline in profitability. Carlo Altavilla, Miguel Boucinha, and José-Luis Peydró (2018) showed that low interest rates are not associated with lower bank profitability. They explained this by the fact that the impact of negative interest rates on the reduction of interest income is compensated by the growth of non-interest income and the decline in loan loss provisions. Michael Brei, Borio, and Gambacorta (2019) found that banks in conditions of low interest rates redirect their activities from those that generate interest rates to activities that generate commissions and trading activities after analyzing data on operations of international banks from 14 developed economies in the 1994-2015 period. The paper notes that because of these circumstances, risk-weighted assets and loan loss provisions are reduced, which may be related to evergreening. The reduction of loan loss provisions may be related to the tendency of banks to underestimate certain risks, having a more positive perception of income and cash flow in an environment of low interest rates (Altunbas, Gambacorta, and Marques-Ibanez 2014).

In addition, the environment of low interest rates affects the market value of banks' capital. Miguel Ampudia and Skander Van den Heuvel (2018), in their work, showed that the reduction of one-month and three-month EONIA (European Overnight Index Average) rates affects the increase in stock prices of banks in Europe. Altavilla, Boucinha, and Peydró (2018) also confirmed that "monetary policy easing surprises during the low interest rate period improves bank stock prices".

Certain studies have linked bank profitability to risk-taking. Research by Yen-Ling Chang and Daniel A. Talley (2017) suggested that banks (especially large ones) tend to take on riskier projects to protect their profitability. Natalya Martynova, Lev Ratnovski, and Razvan Vlahu (2020) concluded that "a more profitable core business allows a bank to borrow more and take side risks on a larger scale".

The impact of expansionary monetary policy on banks has been the subject of analysis by several central banks. In its Financial Stability Review (November 2015), the Bundesbank stated that low interest rates pose a risk to financial stability because they reduce the earnings of banks and insurance in Germany. However, it was pointed out that these adverse effects are limited, and the banking sector is resistant to these negative effects. The report emphasized that they must respond to these challenges to avoid a trade-off in the medium term between monetary policy and financial stability. It is recommended that in conditions of longer duration of low interest rates, banks be additionally protected by reducing costs and interest rate risk, increasing capital and reducing leverage.

In the review of previous works about the impact of expansionary monetary policy on banks, a confirmed impact on the increase in risk-taking and confirmation of the presence of risk-taking channels could be seen. Furthermore, the impact of expansionary monetary policy on the decline in bank profitability was recognized, as well as changes in bank operations because of falling profitability (increase in lending and non-interest income, decrease in loan loss provisions, etc.). The link between declining profitability and increasing banks' propensity to take risks has also been confirmed. These findings clearly identified the need for coordination of monetary policy and prudential policy measures. In all these research, in the context of realizing the consequences of falling profitability in an environment of low interest rates, there is a lack of papers that examine the impact on banking concentration. There are papers investigating whether the concentration of banks affects the efficiency of the transmission of monetary policy measures (Sean Severe 2016; Barbara Baarsma and Melvin Vooren 2017) but not whether monetary policy affects banking concentration. In the conditions of low interest rates, there is an increase in the volume of lending, but it has not been confirmed whether this growth is uniform across banks. If there is an increase in banking concentration, then the growth of larger banks was higher (or the only one present). Asymmetric credit growth in favor of large banks can have its prudential implications. Examining whether there is an increased concentration of banks in Europe and whether it opens some topics in the field of prudential policy is the basic research question of this paper.

The central banks of developing countries have largely followed the path of monetary policy expansion. In addition, some papers showed that the quantitative easing of central banks of developed countries was transferred to other countries through

global banks and the international credit channel (Peter Tillmann 2016; Carmela D'Avino 2018; Judit Temesvary, Steven Ongena, and Ann L. Owen 2018). Along with the effects of their own monetary policies, the effects of the monetary policies of developed countries were spilling over to developing countries (Pablo Anaya, Michael Hachula, and Christian J. Offermanns 2017). Fratzscher, Marco Lo Duca, and Roland Straub (2016) showed the effect of the ECB's unconventional monetary policy spilling over to other developed and developing countries on the stock market and confidence, whereas the impact on the bond market has been negligible. In the presence of the global financial cycle, the question on the independence of monetary policies of smaller countries arises, especially if those countries are largely dependent on external capital inflows (Hélène Rey 2015). Based on their analysis, Denmark, Sweden and Norway, Saskia ter Ellen, Edvard Jansen, and Nina Larsson Midthjell (2018) concluded that "although spillovers impose challenges on domestic monetary policy effectiveness, small open economies still have some control over their yield curve". Recent papers have shown the spillover effect of the ECB's monetary policy on European countries (see also Georgios Georgiadis and Johannes Gräb 2016; Roman Horvath and Klara Voslarova 2016; Oxana Babecká Kucharčuková, Peter Claeys, and Bořek Vašíček 2016; Galina Potjagailo 2017; Łukasz Goczek and Karol J. Partyka 2019). Małgorzata Walerych and Grzegorz Wesołowski (2021) confirmed that the ECB is the main foreign central bank influencing the markets of Central and Eastern European countries, whereas the Fed is "playing a very moderate role". Considering the findings of these research, this paper conveys a special research question whether the spillover of the ECB policy affects countries outside the eurozone (especially to emerging countries) in the context of banking concentration.

This paper contributes to empirical literature in four ways. First, it expands the scope of the analysis of the impact of expansionary monetary policy by considering the second wave of effects. Numerous empirical papers have confirmed that expansionary monetary policy affects the growth of risk-taking and the decline in bank profitability (the first wave of effects). This research examines whether reduced profitability and increased risk-taking have consequences in the form of increased banking concentration (the second wave of effects). Second, unlike other studies that mainly use money market interest rates (rates on interbank loans) as an indicator of the low interest rate environment, this paper uses only the key interest rate of the central bank as a variable. Money market interest rates contain mixed effects of the central bank's key interest rate and the volume of money on the market, whereas the use of only the central bank's key interest rate contains a pure effect of expansionary monetary policy (excluding effects of unconventional measures). Third, this is the first empirical study to assess whether bank concentration in emerging countries in Europe is more affected by the spillover effects of the ECB's monetary policy (and its consequences) than their own monetary policies. Finally, there are implications and challenges to monetary and prudential policies.

2. Methodological Framework

"In standard monetary theory, banks play no role - this is true even for models used by central banks" (Stiglitz 2016). However over time, economic theory has recognized

the many imperfections of the market and the theoretical models based on them so that theories have begun to emerge, which include the behavior of banks in the models (Bruce Greenwald and Stiglitz 1991, 1993a; Blanchard 2000). This opens the space to consider the behavior of banks in the framework of monetary policy (Greenwald and Stiglitz 1993b, 2003). This study deals with the topic of monetary policy, investigating how expansionary monetary policy affects the behavior of banks. Confirmation of the presence of this influence can be found through the increase in concentration on the banking market. Previous studies presented in the literature review have shown the impact of expansionary monetary policy on the decline in bank profitability and on the risk-taking channel. The aim of this study is to check whether all these changes had an effect in the direction of increasing bank concentration. In certain studies, it has been confirmed that the concentration of banks affects the effectiveness of the transmission mechanism of monetary policy (Severe 2016; Baarsma and Vooren 2017). In contrast to the already confirmed influence of bank concentration on the effectiveness of monetary policy, this research attempts to confirm the influence of a certain type of monetary policy on bank concentration. The confirmation of the hypotheses in this research would increase the importance of observing the concentration of banks in the context of analyzing the effectiveness of the transmission mechanism of monetary policy. In future research, the inclusion of bank concentration as a transmission factor in models for analyzing the effectiveness of the transmission mechanism of monetary policy could be considered.

The methodological framework in this paper includes defining an adequate measure of banking concentration and selecting an adequate procedure for the econometric analysis. For the purposes of measuring concentration in the banking market, HHI (Herfindahl-Hirschman Index) is used, an indicator created by the above-mentioned authors for measuring market concentration in general (see Albert O. Hirschman 1945, 1964). Although there were criticisms in the literature of this indicator and numerous alternative ways of measuring banking concentration (Gini coefficient, Concentration Ratio, etc.), HHI is one of the most frequently used indicators. Based on the Hannah Kay axioms, other measures of concentration have greater disadvantages compared with HHI (Leslie Hannah and John Anderson Kay 1977); however, HHI is still used as a measure of concentration. In practice, central bank reports contained this indicator as a measure of banking sector concentration (European Central Bank – ECB (2021); Bank of England (2021); etc.), as well as the procedures of anti-monopoly authorities in the U.S. and the European Union.

Based on the data from each observed year, a time series *COUNTRY_HHI* was created, wherein *COUNTRY* is the general designation for the country name. For each country, a time series with HHI values was obtained. The average HHI values was also calculated for certain groups of countries, such as the eurozone.

The econometric analysis was performed using VAR (Vector Autoregression). The use of VAR in analyzing the effects of monetary policy began with Christopher A. Sims (1980). A general guide to applying the VAR model was adapted from Hiro Y. Toda and Taku Yamamoto (1995), Helmut Lütkepohl (2005), William H. Greene (2017) and Lutz Kilian and Lütkepohl (2017). Since then, numerous papers have been written on the empirical analysis of monetary policy transmission using VAR. In the

context of the topic of this paper, emphasis is placed only on certain papers that analyze the effects of monetary policy in the U.S. (Bernanke and Blinder 1992; Bernanke and Ilian Mihov 1998) and the eurozone (Peersman and Frank Smets 2001). Considering that unconventional monetary policy has significantly influenced changes in the economy, what adequate model can be used to assess economic relations for such circumstances. "Assuming that the true model of the economy is unknown, it should be based on an unrestricted vector autoregression (VAR)" (Vito Polito and Mike Wickens 2012). The recent papers on the impact of expansionary and unconventional monetary policy in the EU have largely been written based on the use of VAR (we only mention a few, Peersman 2011; Gambacorta, Hofmann, and Peersman 2012; Dajcman 2017; etc.). In addition, the papers of Pavle Petrović and Zorica Mladenović (2015) were used as a methodological guide in the application of the VAR model.

Furthermore, in methodological terms, the procedures defined by Robert F. Engle and Clive W. J. Granger (1987) was used in cointegration testing.

This methodological framework was applied to test the following hypotheses:

- First, examination of whether the ECB policy rate (*ECB_PR*) affects the movement of the average HHI of the banking sector in the group of eurozone countries (*EZ_HHI*) where this indicator grew;
- Second, examining whether the policy rate of the central bank of a specific country outside the eurozone *(COUNTRY_PR*[1]*)* affects the HHI of a specific country *(COUNTRY_HHI*[2]*)*, respectively; and
- Third, examining whether the average HHI for selected eurozone countries (*EZ_HHI*) causes the movement of the average HHI for selected countries outside the eurozone *(COUNTRY_HHI)*.

The above stated hypotheses were examined using the following methodological framework: (1) development of bivariate models; and (2) development of trivariate models.

The procedure for developing bivariate models includes the following steps: (a) testing of cointegration if the time series are integrated of order I(1) (Engle and Granger 1987); and (b) application of Granger non-causality test according to the Toda and Yamamoto (1995) procedure and estimate a VAR with (k + d_max) lags. This methodological procedure implies that special bivariate models are developed for testing each individual hypothesis.

We will use following bivariate VAR model to test the three hypotheses:

$$\boldsymbol{Y}_t = \Phi_1 \boldsymbol{Y}_{t-1} + \Phi_2 \boldsymbol{Y}_{t-2} + \cdots + \Phi_p \boldsymbol{Y}_p + \alpha \boldsymbol{Z} + \varepsilon_t, \quad (1)$$

where Y_n is the vector time series of variable with order p[3] and dimensions 2 x 1 *((Y_t=[ECB_PR EZ_HHI] or Y_t=[COUNTRY_PR COUNTRY_HHI] or Y_t=[OEC_HHI EZ_HHI])*), Z is the vector of deterministic components, Φ is the matrix of parameters

[1] *POLAND_PR, HUNGARY_PR, BULGARIA_PR, etc.*

[2] *POLAND_HHI, HUNGARY_HHI, BULGARIA_HHI, etc.*

[3] The order of the model and the deterministic components will be specified in the empirical part of the paper. The value of p will be obtained as the sum of the lags (k) and the maximum order of integration of the time series (d-max).

along the vector of variables and α is the matrix of parameters along the vector of deterministic components.

The procedure for developing trivariate models includes the following steps: (a) application of the Johansen cointegration test (Soren Johansen 1996); (b) the development of the VEC (Vector Error Correction) model and testing constraints on model parameters (Lütkepohl 2005 and Kilian and Lütkepohl 2017) when cointegration is present; and (c) transformation of a cointegrated model and the computation of a reduced-form moving average representation model (Lütkepohl 2005; Kilian and Lütkepohl 2017).

An additional VAR model for testing the previous three hypotheses will include three variables and have the following specification:

$$\boldsymbol{Y}_t = \theta_1 \boldsymbol{MY}_{t-1} + \theta_2 \boldsymbol{Y}_{t-2} + \cdots + \theta_p \boldsymbol{Y}_p + \beta \boldsymbol{Z}^* + \varepsilon_t, \quad (2a)$$

where Y_n is the vector time series of variable with order p and dimensions 3 x 1 (Y_t=*[ECB_ PR OEC_HHI EZ_HHI]*), Z^* is the vector of deterministic components, θ_n is the matrix of parameters along the vector of variables and β is the matrix of parameters along the vector of deterministic components.

VEC model would have the following specification:

$$\triangle MY_t = \alpha\beta' \boldsymbol{MY}_{t-1} + \Gamma_1 \triangle \boldsymbol{Y}_{t-1} + \cdots + \Gamma_{t-p+1} \triangle \boldsymbol{Y}_{t-p+1} + a_t, \quad (2b)$$

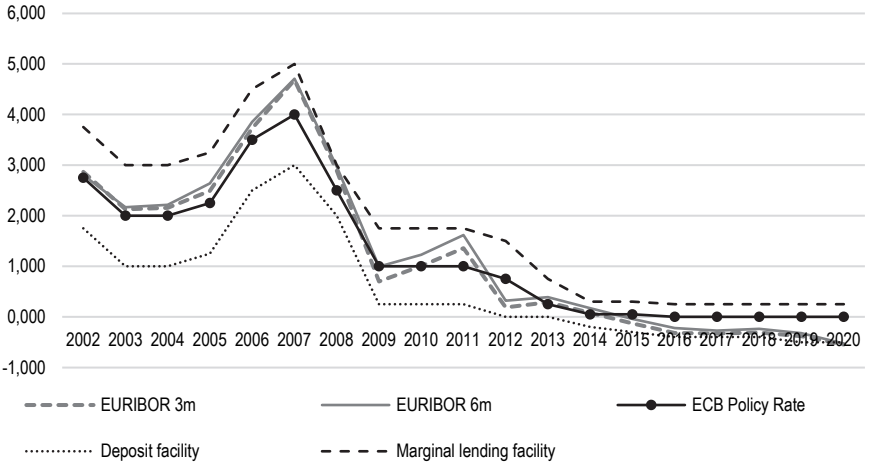
where β is the vector of cointegration parameters and α is the vector of adjustment parameters ($\Pi = \alpha\beta'$).

3. Expansionary Monetary Policy and Data Overview

After the methodological aspects, the data used in the empirical analysis were considered. First, the monetary policy of the ECB was presented, which is responsible for the eurozone in the period from 2002 to 2020 through the movement of the reference interest rate and its impact on key money market interest rates - three- and six-month EURIBOR (see Figure 1).

As can be seen (Figure 1), the decline in the reference interest rate is started by the ECB in 2007 with a sharp drop in the rate, and the reference rate is lowered to 0% in the following years. During the observed period, interest rates on the money market (three- and six-month EURIBOR) follow the movement of the ECB's policy rate. EURIBOR rates move within the monetary policy corridor, between the deposit facility rate and the marginal lending rate. The fall in interest rates is accompanied by the application of unconventional monetary policy measures - injecting large amounts of money into the system through a program of quantitative easing. The aim of this research is to examine the pure effect of key interest rates of the central bank on changes in the structure of the banking sector without the impact of unconventional monetary policy. Therefore, only the ECB's key interest rate will be used in this study. In addition, the visual analysis in Figure 1 shows that money market interest rates are predominantly driven by ECB's policy rate movements.

Below is an overview of the key central bank interest rates used in the survey (see Table 1).



Source: ECB (2021)[4], Eurostat (2021)[5] and Thomson Reuters (2021)[6].

Figure 1 ECB Policy Rate and EURIBOR

Table 1 Data Overview

Country/ Group of countries	Name of the observed policy rate	Data source	Period*
The eurozone	ECB policy rate (the interest rate on the main refinancing operations)	ECB	2002-2020
Slovenia	Representative return measure	The Bank of Slovenia	2002-2006
Cyprus	Rate on the main refinancing operations	Central Bank of Cyprus	2002-2007
Malta	Central intervention rate	Central Bank of Malta	2002-2007
Slovakia	Two week REPO tender limit rate	Narodna banka Slovenska	2002-2008
Latvia	Latvijas banka refinancing rate	Latvijas Banka	2002-2013
Czech Republic	Two-week repo rate	Czech National Bank	2002-2020
Denmark	The national bank's lending rate	Danmarks National bank	2002-2020
Great Britain	Bank rate	Bank of England	2002-2020
Poland	Reference rate	Narodowy Bank Polski	2002-2020
Sweden	Repo rate	Sveriges Riksbank	2002-2020
Bulgaria	Base interest rate	Bulgarian Central Bank	2002-2020
Romania	Monetary policy rate	National Bank of Romania	2002-2020
Hungary	Central bank base rate	Magyar Nemzeti Bank	2002-2020
Croatia	Discount rate	Croatian National Bank	2002-2020

[4] **European Central Bank.** 2021. https://sdw.ecb.europa.eu/home.do (accessed September 28, 2021).
[5] **Eurostat.** 2021. European Statistics. https://ec.europa.eu/eurostat (accessed September 28, 2021).
[6] **Thomson Reuters.** 2021. https://www.reuters.com/article/markets-euribor-idUSLDE6B71FM20101208 (accessed September 28, 2021).

North Macedonia	The interest rate achieved at the CB bills auctions	National Bank of the Republic of North Macedonia	2002-2020
Albania	Base interest rate	Bank of Albania	2002-2020
Serbia	NBS interest rate (key policy rate)	National bank of Serbia	2002-2020
Montenegro	ECB policy rate (the interest rate on the main refinancing operations)	ECB	2002-2020

Notes: * The selected period includes the phase of expansionary monetary policy of the observed central banks from 2007 to 2020, as well as the phase before that when there was an increase in key interest rates of central banks, which can be related to the restrictiveness of monetary policy. The linking at the beginning of the observation period for 2002 is mainly because of technical reasons related to the availability of publicly available data on key interest rates of central banks.

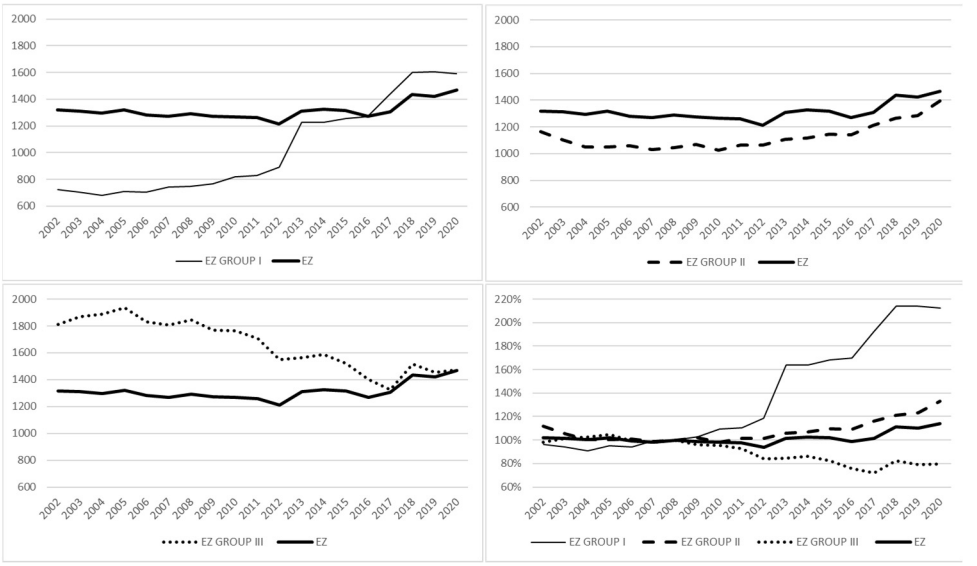
Source: See the Appendix.

The data used for the purposes of bank concentration analysis cover the 2002-2020 period, with a special focus on 2008 to 2020 when the expansionary monetary policy was intensively pursued for a longer period. The subject of the observation included monetary policies and data on the banking sector from 33 European countries, including the eurozone countries, EU countries and European countries outside the EU. The data source has publicly available statistics on the website of the European Central Bank (ECB 2021), Eurostat (2021) and Thomson Reuters (2021), as well as on the websites of central banks of non-EU countries (Bank of Albania 2021; Bank of England 2021; Central Bank of Bosnia and Herzegovina 2021; Central Bank of Montenegro 2021; National Bank of the Republic of North Macedonia 2021; National Bank of Serbia 2021; etc.). According to the relevant monetary policy, the countries were divided into eurozone countries where the monetary policy of the ECB is applied, and other European countries where each country has its own central bank responsible for conducting monetary policies.

The group of eurozone countries included all 19 countries as follows: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain. European countries outside the eurozone (other European countries) includes: the Czech Republic, Denmark, Poland, Sweden, Bulgaria, Hungary, Romania, Croatia, Great Britain and Balkan countries - North Macedonia, Albania, Montenegro, Bosnia and Herzegovina and Serbia.

In the previous section, example of papers were shown, wherein a direction of monetary policy has affected the decline in profitability and change in the structure of financial performance of banks in Europe. Now, the extent to which it may have further consequences toward the banking sector will be analyzed, visible through changes in the structure of the sector, which have implications on the conduct of prudential policy. In this sense, HHI is presented as an indicator of concentration in the eurozone banking sector (Figure 2). The overview is given by the average HHI value for all eurozone countries and an average indicator by groups of countries. The first group of countries (EZ GROUP I) includes countries that had twice an increase in HHI between 2008 and 2020 (Greece, Cyprus, Spain and Italy). The second group of countries (EZ GROUP II) includes countries having an increase in the HHI value between 10 and 50% in the 2008-2020 period (Germany, Lithuania, Latvia, Portugal, Slovakia, Malta and Ireland). The third group of countries (EZ GROUP III) includes countries that maintained

the same level or a decrease in the HHI value in the 2008-2020 period (France, Belgium, the Netherlands, Austria, Slovenia, Luxembourg, Finland and Estonia).



Source: ECB (2021).

Figure 2 HHI Values in Eurozone (EZ) Countries

The average HHI value for all eurozone countries (EZ) displayed mostly stable movement in 2008 to 2020, with occasional breaks at the end of the observed period causing a slight increase in value of about 14%. Visual comparisons did not identify the links between the movement of this indicator and the movement of the ECB reference interest rate, so there is no basis for further analysis and modeling of these relations. In addition, the HHI movement in the eurozone countries is so diverse that it would not be adequate to observe it using the average indicator for the eurozone. Hence, there is a need to single out certain homogeneous groups of countries according to the HHI movement after the Great Recession.

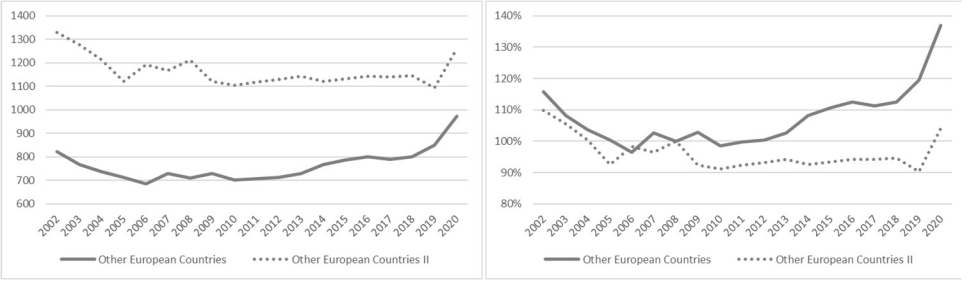
The explosive growth of HHI values in the first group of eurozone countries (EZ GROUP I) is not driven by the gradual action of factors coming from the monetary policy but by measures to stabilize the banking sector after the Great Recession produced strong effects on the banking systems of this group (Greece, Cyprus, Spain and Italy). Therefore, the movement of the time series describing the HHI value in EZ GROUP I is not suitable for further analysis and econometric modeling. In the context of this research, countries in this group can be treated as outliers.

The third group of eurozone countries (EZ GROUP III) is characterized by a stable movement or a decline in the HHI value (a decline on average). Countries with low HHI values had a stable movement of this indicator from 2008 to 2020 (France, the Netherlands, Luxembourg, Austria and Slovenia). Countries with high HHI values recorded a decline in this indicator during the same period (Belgium, Finland and

Estonia). The decline in the HHI value in these countries occurred in the first two to three years after the Great Recession, whereas the HHI value displayed a stable trend in the rest of the period. The HHI movement in these countries is neutral, suggesting that it cannot be related to the ECB's expansionary monetary policy.

The second group of eurozone countries (EZ GROUP II) showed an HHI movement during the 2008-2020 period, which can be related to expansionary monetary policy measures and can provide a basis for further analysis and modeling. Later in the analysis, the value of this series will be used, as denoted by *EZ_HHI*.

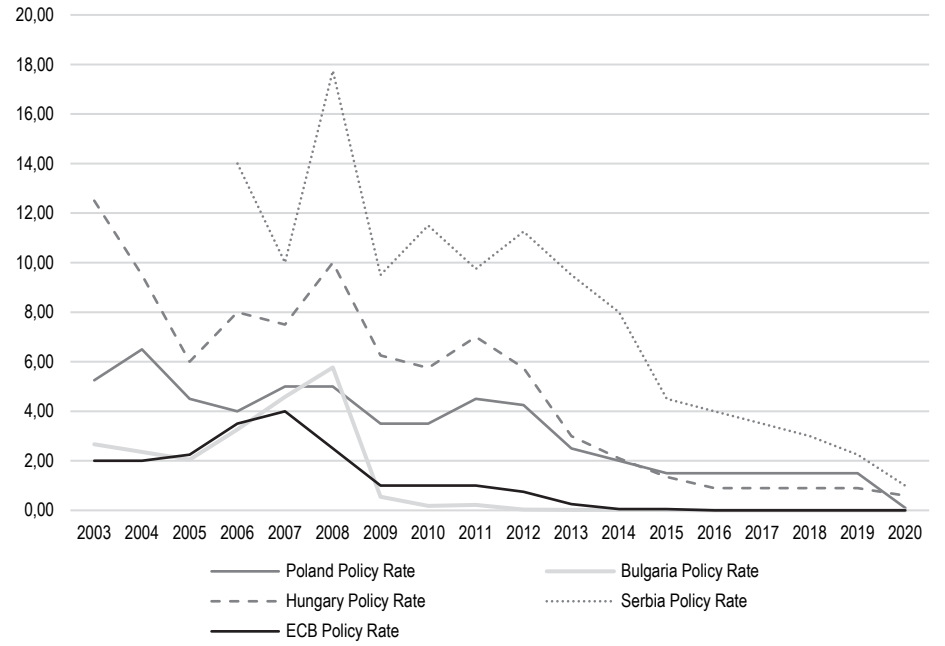
In countries outside the eurozone having their own monetary policy, including EU countries and other selected European countries, the existence of the banking market, which recorded an increase in HHI values in 2008 to 2020 was identified. Countries that had almost unchanged HHI values during most of the period were also identified (except for the jump in the year before the end of the period). The first group of countries (other European Countries - OEC) includes Poland, Hungary, Bulgaria and Serbia. The second group of countries (OEC II) includes the United Kingdom, Sweden, Denmark, the Czech Republic, Romania, Croatia, Albania, Bosnia and Herzegovina, North Macedonia and Montenegro (see Figure 3). It can be seen that in the second group, there are countries with a moderate level of banking concentration above 1,000 measured by the HHI. The first group includes countries with a low level of concentration (HHI below 1,000), so there was more space for market growth on the account of increasing concentration. For the purposes of further analysis, the time series describing the average movement of countries in the first group (OEC) can only be used, where an increase in the HHI value during the 2008-2020 period was present. In what follows, the value of the OEC series is denoted by *OEC_HHI*.



Source: Bank of Albania (2021), Bank of England (2021), Central Bank of Bosnia and Herzegovina (2021), Central Bank of Montenegro (2021), ECB (2021), National Bank of the Republic of North Macedonia (2021) and National Bank of Serbia (2021).

Figure 3 HHI Values in European Countries Outside the Eurozone

In what follows, the reference interest rates of the central banks of the countries belonging to the first group - the countries in the OEC group - were analyzed (see Figure 4). These will first be compared with the movement of the ECB policy rate. As observed in 2008, the reference interest rates of countries in this group were seen at different levels; however, during the 2008-2020 period, they all tend to fall. The Central Bank of Bulgaria had the closest movement to the ECB reference rate. The central banks of the other observed countries (Poland, Hungary and Serbia) had a similar tendency as the ECB, but the reference interest rates of these three countries remained



Source: ECB (2021) and National Bank of Serbia (2021).

Figure 4 ECB and Other Central Banks' Policy Rates

above the ECB policy rate during the observed period. Certainly, these trends provided a basis for examining whether the expansionary policy of the central banks of both these countries and the ECB has affected the increase in concentration in the banking sector. Further in their work, their logarithmic values were marked as follows: ECB policy rate - *ECB_PR*, policy rate of the Central Bank of Poland - *POL_PR*, policy rate of the Central Bank of Hungary - *HUN_PR*, policy rate of the Central Bank of Bulgaria - *BUL_PR* and policy rate of the Central Bank of Serbia - *SER_PR*.

4. Results and Discussion

4.1 Empirical Result

The results of the Augmented Dickey Fuller (ADF) non-stationarity test for the time series used in this research are given in the following table:

Table 2 ADF Test Statistics

Null hypothesis	I(1)	I(2)
ECB_PR		
without a constant	−0.86	−3.53***
with a constant	−0.91	−3.57***
with constant and trend	−3.21*	−3.41**

EZ_HHI		
without a constant	1.31	−4.21***
with a constant	1.73	−4.14***
with constant and trend	0,89	−5,76***
OEC_HHI		
without a constant	0.20	−3.81***
with a constant	−1.19	−3.63**
with constant and trend	−0,27	−5,98***

Notes: The asterisks ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively. In the first difference terms in the ADF tests, the same lag length in all tests are used (1 lag).

Source: Author's calculations.

As seen in the previous table, for the considered time series, the null hypothesis of the existence of one unit root was accepted, whereas the hypothesis of the existence of two unit roots was rejected for the defined significance levels.

To test the cointegration between the *ECB_PR* and *EZ_HHI* series, using the Engle and Granger (1987) procedure, a regression model was set up at the time series levels, in which the linear trend was included as a deterministic component. The considered variable is statistically significant at the 1% significance level. A series of residuals (RH) was created, which contained a constant as a deterministic component.

In Table 3, the results of the cointegration tests are provided.

Table 3 Cointegration Test Statistics

	DF (Dicky Fuller) residual test	Lags
ECB_PR	−4,79***	1

Notes: The asterisks ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

Source: Author's calculations.

Considering that the value of the DF residual test statistics is lower than the critical value at the 1% significance level, the null hypothesis of the existence of a unit root in the series of residuals was rejected. The series of residuals is stationary so there is cointegration in the movement between *ECB_PR* and *EZ_HHI*.

The analysis of the relationship between the ECB policy rate and the HHI for a selected group of eurozone countries (*EZ_HHI*) was continued by defining specification of the VAR model at the time series level using Toda and Yamamoto's (1995) procedure. In the VAR model specification, only the constant is included as a deterministic component (consistent with previous results in which the linear trend did not show statistical significance). Based on information criteria tests (general to specific), lag 2, lag 4 and lag 5 appeared to be significant at a defined confidence level of 5%. However, only lag 2 passed the normality, autocorrelation and stability tests (see Table 4).

In Table 1, it can be seen that I(1) is the maximum order of integration in the *ECB_PR* and *EZ_HHI* series. Based on the significant lag (k = 2) and the maximum order of integration (d_max = 1), the VAR (2 + 1) model was estimated.

Now, the non-causality was tested using the Granger test. The model had stability, and AR roots showed values below one.

Table 4 Lag Length in the VAR Model Specification I

k	Wald test	*p*-value (Wald test)	Doornik-Hansen normality test	Portmanteau autocorrelation test - Q(12)/adjusted Q(12)	Stability condition (no AR roots)
1	146.80	0.000			
2	9.01	0.060	0.08	0.97/0.31	Satisfy
3	12.74	0.012			
4	9.41	0.051	0.46	0.77/0.07	Not satisfy
5	6.77	0.148	0.78	0.31/0.00	Satisfy
6	15.09	0.004			

Source: Author's calculations.

Table 5 Analysis of Causality (*EZ_HHI* and *ECB_PR*) in Model Specification I

Granger non-causality test (H_0: Non-causality)	**VAR (2 + 1) p-value**
H_1: The impact of the ECB policy rate on the average HHI for a selected group of eurozone countries (*EZ_HHI*)	0.06
H_1: Influence of the average HHI for the selected group of eurozone countries (*EZ_HHI*) on the movement of the ECB policy rate	0.09
Normality, autocorrelation and stability tests	**p-value**
Doornik-Hansen normality test	0.29
Portmanteau autocorrelation test - Q(12)/adjusted Q(12)	0.93/0.19
Stability condition (no AR roots)	Satisfy

Source: Author's calculations.

Although the value of the Granger non-causality test was above 5%, the presence of causality cannot be ruled out, that is, the impact of the ECB policy rate on the movement of the average HHI for a selected group of eurozone countries. At the significance level of 10%, two-sided causality was observed.

When analyzing selected countries outside the eurozone (OEC), looking at the relationship between *pol_pr* and *pol_hhi* for Poland, *hun_pr* and *hun_hhi* for Hungary, *bug_pr* and *bug_hhi* for Bulgaria and *ser_pr* and *ser_hhi* for Serbia showed no cointegration. In addition, the application of the Granger test did not reject hypothesis of non-causality among the movements of the time series.

It remains to be checked whether the indicators of bank concentration in the eurozone have an impact on the concentration of banks in the four countries outside the eurozone. Therefore, the analysis was continued by looking at whether countries outside the eurozone (*OEC_HHI*) will show changes. As observed, the *OEC_HHI* time series had one unit root, so did *ECB_PR*.

To test the cointegration between the *ECB_PR* and *OEC_HHI* series, using the Engle and Granger's (1987) procedure, a regression model was set up at the time series levels. A series of residuals was created, denoted by R.

In Table 6, results of the cointegration tests are provided.

Table 6 Cointegration Test Statistics

	DF residual test
R	−5,32

Source: Author's calculations.

Considering that the value of the DF residual test statistics was lower than the critical value at the 1% significance level, the null hypothesis of the existence of a unit root in the series of residuals *R* was rejected. There is cointegration between the eurozone HHI and the HHI for non-eurozone countries.

In the following, a bivariate VAR model was developed, including *EZ_HHI* and *OEC_HHI*. As a deterministic component, only a constant was included, consistent with previously obtained statistics. Based on information criteria tests (general to specific), lag 2, lag 3, lag 4 and lag 6 appeared to be significant at a defined confidence level of 5%. However, only lag 2 and 3 passed the normality, autocorrelation and stability tests (see Table 7).

Table 7 Lag Length in the VAR Model Specification III

k	Wald test	*p*-value (Wald test)	Doornik-Hansen normality test	Portmanteau autocorrelation test - Q(12)/adjusted Q(12)	Stability condition (no AR roots)
1	111.87	0.000			
2	6.17	0.186	0.77	0.98/0.81	Satisfy
3	5.64	0.228	0.19	0.98/0.73	Satisfy
4	5.73	0.221	0.29	0.84/0.002	Not satisfy
5	16.94	0.002			
6	3.98	0.408	0.69	0.08/0.00	Not satisfy

Source: Author's calculations.

Based on the statistics from the previous table, a stable model can only be set for lag 2. According to the Toda and Yamamoto's (1995) procedure, it was VAR (2 + 1).

Below, the results of the Granger non-causality test are presented.

At the significance level of 1%, the null hypothesis of non-causality can be rejected, whereas the alternative hypothesis of the effect of EZ_HHI on OEC_HHI can be accepted. In addition, at the 5% significance level, a two-way causality was observed.

After the previously obtained results, a special model was developed, which included three variables: ECB policy rate (*ECB_PR*), eurozone bank concentration (*EZ_HHI*) and non-eurozone country bank concentration (*OEC_HHI*). As a deterministic component, only a constant was included, consistent with previously obtained results. Based on information criteria tests (general to specific), lag 2 and lag 3 appeared to be significant at a defined confidence level of 1%. However, only lag 2 passed the normality, autocorrelation and stability tests (see Table 10).

Table 8 Analysis of Causality (*OEC_HHI* and *EZ_HHI*)

Granger non-causality test (H_0: Non-causality)	**VAR (2 + 1) p-value**
H_1: Influence of the average HHI for the selected group of eurozone countries (*EZ_HHI*) on the average HHI for the group of non-eurozone (*OEC_HHI*)	0.00
H_1: Influence of the average HHI for the group of non-eurozone countries (*OEC_HHI*) on the average HHI for the group of eurozone countries (*EZ_HHI*)	0.01
Normality, autocorrelation and stability tests	**p-value**
Doornik-Hansen normality test	0.49
Portmanteau autocorrelation test - Q(12)/adjusted Q(12)	0.97/0.69
Stability condition (No AR roots)	Satisfy

Source: Author's calculations.

Table 9 Lag Length in the Trivariate VAR Model

k	**Wald test**	***p*-value (Wald test)**	**Doornik-Hansen normality test**	**Portmanteau autocorrelation test - Q(12)/adjusted Q(12)**	**Stability condition (no AR roots)**
1	166.53	0.000			
2	8.86	0.449	0.11	0.94/0.07	Satisfy
3	19.75	0.019	0.12	0.82/0.00	Not satisfy
4	61.50	0.000			

Source: Author's calculations.

After that, a test for the presence of cointegration using the Johansen test was done.

Table 10 Johansen Cointegration Test (*ECB_PR*, *EZ_HHI* and *OEC_HHI*)

	Trace test		**Eigenvalue test**	
	Statistics	***p*-value**	**Statistics**	***p*-value**
First step				
H_0: No cointegration H_1: There is at least one cointegration equation	49.14	0.00	28.24	0.00
Second step				
H_0: There is one cointegration equation H_1: There are at least two cointegration equations	20.89	0.01	19.33	0.01
Third step				
H_0: There is two cointegration equation H_1: There are at least three cointegration equations	1.56	0.21	1.56	0.21

Notes: A constant term enters the VAR model unrestrictedly. There are two lags in the VAR model.
Source: Author's calculations.

Based on the previous results of the Johansen test, the null hypothesis of no cointegration can be rejected in the first step. In the second step, the null hypothesis of the existence of one cointegration equation was rejected. In the third step of testing, the null hypothesis of the existence of two cointegration equations was accepted.

Estimated cointegration vectors and vectors of adjustment coefficients (Table 11) showed that there is a positive relationship between the concentration of banks in

the eurozone (*EZ_HHI*) and the concentration of banks outside the eurozone (*OEC_HHI)* in the first vector. In addition, in the first vector, there was a negative relationship between the ECB policy rate (*ECB_PR*) and the concentration of banks in countries outside the eurozone (*OEC_HHI*). In the second vector, a negative relationship between the ECB policy rate (*ECB_PR*) and the concentration of banks in the eurozone (*EZ_HHI*) was seen. The negative relationship between the concentration of banks outside the eurozone (OEC_HHI) and the concentration of banks in the eurozone (*EZ_HHI*) showed no appropriate economic interpretation.

Table 11 Estimated Cointegration Vectors and Vectors of Adjustment Coefficients

Variable	β_1	β_2
OEC_HHI	1	-0.669
EZ_HHI	-0.610	1
ECB_PR	-0.441	-0.521
Variable	α_1	α_2
OEC_HHI	-0.374 (-2.66)	0.777 (2.92)
EZ_HHI	-0.135 (-0.98)	0.318 (1.22)
ECB_PR	-0.051 (-1.95)	0.087 (1.76)

Notes: *t*-ratios are in parentheses.

Source: Author's calculations.

As the next step, the corresponding restrictions were imposed on cointegration vectors and vectors of adjustment coefficients. Because of the relationship without a suitable economic interpretation, in the second vector, it was defined that banking concentration outside the eurozone has a value of zero. In addition, restrictions were introduced in the vector of adjustment coefficients by defining the value zero for *ECB_PR* in both equations. The model is estimated under these restrictions, and the results are reported in Table 12.

Table 12 Model Estimated under Imposed Restrictions

Variable	β_1	β_2
OEC_HHI	1	0.000
EZ_HHI	−0.599	1
ECB_PR	−0.511	−1.489
Variable	α_1	α_2
OEC_HHI	−1.162 (−3.82)	0.591 (4.16)
EZ_HHI	−0.381 (−1,16)	0.243 (1.58)
ECB_PR	0.000	0.000
χ^2(2) statistics	**value: 4.98**	**p-value: 0.08**

Notes: *t*-ratios are in parentheses.

Source: Author's calculations.

Imposed restrictions were tested and not rejected. The development of a separate model including three variables led to additional findings about the dynamics of the relationship between the variables. It has been shown that the ECB policy rate affects the increase in banking concentration in the eurozone countries. However, the added value of this model shows the separate effects of ECB Policy Rates and HHI in

eurozone countries on the banking concentration of non-eurozone countries. Considering that the use of the ECB policy rate and HHI for eurozone countries can explain most of the change in the HHI of countries outside the eurozone, this largely justifies the absence of reference interest rates of individual countries outside the eurozone in the model.

4.2 Discussion

During the observed period of 2008 to 2020, which was characterized by the expansionary monetary policy of the ECB, 11 of the 19 countries of the current members of the eurozone saw an increase in concentration in the banking sector, measured by the HHI value. In addition, 4 of the 14 countries outside the eurozone recorded an increase in concentration in the banking market in the observed period. Low interest rates have already been confirmed in the literature as a determinant of declining bank profitability in Europe. This is defined as the first wave of the effects of expansionary monetary policy. The impact of falling profitability on the growth of concentration in the banking market is a secondary wave of the effects of expansionary monetary policy. This is indirect (additional) proof of that existence. Direct evidence of the existence of the impact of expansionary monetary policy in the increase of banking concentration was obtained using the previously presented results of VAR and VEC models. We will present these findings as follows.

Based on the results of econometric models (VAR and VEC), we concluded that 7 of the 11 eurozone countries (Germany, Lithuania, Latvia, Portugal, Slovakia, Malta and Ireland) can explain the increase in concentration in the banking sector by the ECB's low interest rate policy. In the remaining four eurozone countries (Greece, Cyprus, Italy and Spain), this relationship could not be modeled because of the strong impact of the Great Recession on the banking sector, wherein the impact of monetary policy was lost in many government activities to restructure the banking sector. The findings of this research show that with a certain time lag, the HHI value increase in the observed eurozone countries (Germany, Lithuania, Latvia, Portugal, Slovakia, Malta and Ireland) can be explained by the ECB's expansionary monetary policy, which can be attributed to the cumulative long-term manifestation of the present circumstances. Over time, the effect intensifies, confirming that the long-term environment of the expansionary monetary policy has a cumulative effect on the increase in the concentration of banks in the eurozone.

These finding were consistent with some previous research, cited in the literature review, confirming that low interest rates in Europe and the eurozone have had the effect of reducing bank profitability and increasing risk-taking. The result of this research gave a certain added value in relation to other research, showing the possible consequences of the drop in profitability. This research shows that one of the consequences of the decline in profitability caused by low interest rates is the increased concentration in the banking sector. The increase in concentration represents a rational reaction of banks to such circumstances, an attempt to neutralize the negative effects through the economies of scale.

This is a pure effect of the ECB's expansionary monetary policy because only the impact of the ECB's key interest rate on banking concentration were analyzed. This

research does not examine the impact of unconventional monetary policy measures, but the obtained results indicate that in the case of bank concentration, the effects of expansionary monetary policy dominate over the effects of unconventional measures.

This research also shows that the increased concentration in the banking sector of eurozone countries affects the increased concentration in the banking sector of certain countries outside the eurozone (Poland, Hungary, Bulgaria and Serbia). It was shown that the expansionary monetary policy of these countries outside the eurozone had no significant impact on encouraging concentration in the banking sector and the most significant impact on concentration in the banking sector of these countries came from the increased concentration in the eurozone. This confirmed that the indirect effect of the ECB's expansionary policy on these countries was dominant to such an extent that it excluded the importance of the operation of its own monetary policies. This finding on the spillover of the effects of concentration from the eurozone to countries outside the eurozone and about the predominance of the effects of the ECB's monetary policy over the monetary policies of specific countries represented an additional contribution to the field of research into the effects of expansionary monetary policy on the banking sector.

However, the decline in profitability and the resulting increased concentration in the banking sector brings with it a number of accompanying challenges for prudential policy makers. The increase in the volume of lending activities opened a risk-taking channel, requiring additional consideration by regulatory bodies. This is especially important when it comes to the growth of larger banks that are systemically important, which is exactly the case when market concentration is increasing. The prudential authority will have to pay special attention to whether the growth of a bank is accompanied by the growth of the concentration of loans in its portfolio. The question is to what extent the process of expanding the banking sector will improve the impaired performance of banks that will remain in the market. In addition, will it ultimately improve the overall performance of the banking sector or will it remain part of the weakened banks that this market mechanism will not absorb? If the consolidation process does not provide satisfactory results, a special issue for the prudential policy maker is the assessment of the potential for future recapitalization of banks and investments in the banking sector at such weakened rates of return on capital. The issue of fit and proper conditions for investors who want to participate in further consolidation in such circumstances also stands out. All these implications indicate that expansionary monetary policy can generate a number of challenges for prudential policy and coordination of these policies is necessary. This topic is especially important when the expansionary policy of developed countries (in our case the ECB) spills over to emerging countries, creating tasks for prudential policy makers in those countries. In such circumstances, there is no formal basis for the coordination of monetary and prudential policies, and there is probably a lack of motivation in the central banks of developed countries.

5. Conclusion

The growth of concentration in the banking market observed from 33 European countries in the 2008-2020 period was driven by the extent to which expansionary monetary policy reduced the profitability of banks (see Borio, Gambacorta, and Hofmann 2017).

This drive was supported by the greater capacity of larger banks to respond to such circumstances by growing their business volume, as well as the low level of market concentration in a particular country at the beginning of this period.

In the seven countries of the eurozone, the increased banking concentration during the 2008-2020 period (Germany, Lithuania, Latvia, Portugal, Slovakia, Malta and Ireland) can be explained by the ECB's expansionary monetary policy. The long duration of the expansionary monetary policy intensified its effect on the growth of banking concentration. Because the literature confirmed the impact of expansionary monetary policy on the decline in bank profitability in Europe (the first wave of effects), the findings of this study contributed to the literature in this area, expanding the scope of consideration of the effects of expansionary monetary policy on the growth of banking concentration (the second wave of its effects). The additional contribution of this research lies in the fact that by examining the impact of the ECB's key policy rate on banking concentration, the pure effect of expansionary monetary policy is analyzed. The use of other rates, such as money market interest rates (interest rates on interbank loans), would include the effects of unconventional monetary policy in addition to the expansionary monetary policy.

Although the central banks of countries outside the eurozone pursued an expansionary monetary policy, its impact on the movement of banking concentration was not recognized. In the four countries outside the eurozone (Poland, Hungary, Bulgaria and Serbia) where there was an increase in banking concentration in 2008 to 2020, the increase in banking concentration can be explained by the increase in banking concentration in the eurozone countries. This is an evidence of the spillover effect from the eurozone and an implicit confirmation that the ECB's expansionary monetary policy had a stronger effect on these emerging countries outside the eurozone than their own monetary policies.

These findings opened numerous challenges for conducting prudential policy and reiterated the need to coordinate monetary and prudential policies. The growth of concentration as an example of asymmetric growth of business volume in favor of larger banks opened prudential regulation issues, such as risk-taking channels, growth of systemic importance of the bank, fulfillment of prudential requirements by smaller banks and new investors, and others. In the event of spillover effects of the ECB's expansionary monetary policy in underdeveloped countries, a particularly important issue is how to ensure coordination of local prudential policy and the ECB's monetary policy.

The results showed that there is no single way of reacting to a change in the ECB policy rate at the level of the eurozone, but the reaction of eurozone countries depends on the characteristics of their national financial systems. All these indicated that the implications for conducting monetary policy and prudential policy were not unique at the level of the eurozone. This situation further complicates the coordination of the monetary policy conducted centrally and prudential challenges arising at the level of national financial systems.

The findings of this research opened space for further research. First, it is necessary to undertake further research into factors that determine whether a country will start to increase banking concentration in the conditions of low interest rates.

Furthermore, it could focus on whether increasing concentration in the banking sector affects the performance of the sector and whether there are banks or groups of banks that remain out of consolidation, facing numerous uncertainties in the environment of long-term expansionary monetary policy. The advantages and disadvantages of using concentration measures in assessing the efficiency of the transmission mechanism are topics that could be opened in further research. Whether the models for evaluating the effectiveness of the transmission mechanism of monetary policy with included measures of concentration would have a greater explanatory power compared with models without included indicators of concentration can also be tackled. Moreover, the room is open for additional research into the relationship between prudential policy in small countries and monetary policy of large central banks.

References

Albertazzi, Ugo, Andrea Nobili, and Federico M. Signoretti. 2021. "The Bank Lending Channel of Conventional and Unconventional Monetary Policy." *Journal of Money, Credit & Banking*, 53(2/3): 261-299. http://dx.doi.org/10.1111/jmcb.12766

Altavilla, Carlo, Miguel Boucinha, and José-Luis Peydró. 2018. "Monetary Policy and Bank Profitability in a Low Interest Rate Environment." *Economic Policy*, 33(96): 531-586. http://dx.doi.org/10.2139/ssrn.3052073

Altunbas, Yener, Leonardo Gambacorta, and David Marques-Ibanez. 2014. "Does Monetary Policy Affect Bank Risk?" *International Journal of Central Banking*, 10(1): 95-135. http://dx.doi.org/10.2139/ssrn.1574188

Ampudia, Miguel, and Skander Van den Heuvel. 2018. "Monetary Policy and Bank Equity Values in a Time of Low Interest Rates." European Central Bank Working Paper 2199.

Anaya, Pablo, Michael Hachula, and Christian J. Offermanns. 2017. "Spillovers of U.S. Unconventional Monetary Policy to Emerging Markets: The Role of Capital Flows." *Journal of International Money and Finance*, 73(B): 275-295.

Baarsma, Barbara, and Melvin Vooren. 2017. "Bank Competition and the Transmission of Unconventional Monetary Policy in the Euro Area." *European Competition Journal*, 14(1): 174-193. http://dx.doi.org/10.1080/17441056.2018.1463688

Bernanke, Ben S. 1983. "Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression." National Bureau of Economic Research Working Paper 1054.

Bernanke, Ben S., and Alan S. Blinder. 1988. "Credit, Money, and Aggregate Demand." National Bureau of Economic Research Working Paper 2534.

Bernanke, Ben S., and Alan S. Blinder. 1992. "The Federal Funds Rate and the Channels of Monetary Transmission." *American Economic Review*, 82(4): 901-921.

Bernanke, Ben S., and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of Economic Perspectives*, 9(4): 27-48. http://dx.doi.org/10.1257/jep.9.4.27

Bernanke, Ben S., and Ilian Mihov. 1998. "Measuring Monetary Policy." *The Quarterly Journal of Economics*, 113(3): 869-902. http://dx.doi.org/10.1162/003355398555775

Bikker, Jacob A., and Tobias M. Vervliet. 2017. "Bank Profitability and Risk-Taking under Low Interest Rates." *International Journal of Finance & Economics*, 23(1): 3-18. http://dx.doi.org/10.1002/ijfe.1595

Blanchard, Olivier. 2000. "What Do We Know about Macroeconomics that Fisher and Wicksell Did Not?" *The Quarterly Journal of Economics*, 115(4): 1375-1409. http://dx.doi.org/10.1162/003355300554999

Blanchard, Olivier, Giovanni Dell'Ariccia, and Paolo Mauro. 2013. "Rethinking Macro Policy II: Getting Granular." IMF Staff Discussion Note 13/03. http://dx.doi.org/10.5089/9781484363478.006

Boivin, Jean, Michael T. Kley, and Frederic S. Mishkin. 2010. "How Has the Monetary Transmission Mechanism Evolved over Time?" National Bureau of Economic Research Working Paper 15879. http://dx.doi.org/10.2139/ssrn.1783786

Borio, Claudio, and Leonardo Gambacorta. 2017. "Monetary Policy and Bank Lending in a Low Interest Rate Environment: Diminishing Effectiveness?" *Journal of Macroeconomics*, 54(B): 217-231. http://dx.doi.org/10.1016/j.jmacro.2017.02.005

Borio, Claudio, Leonardo Gambacorta, and Boris Hofmann. 2017. "The Influence of Monetary Policy on Bank Profitability." *International Finance*, 20(1): 48-63. http://dx.doi.org/10.1111/infi.12104

Bourke, Philip. 1989. "Concentration and Other Determinants of Bank Profitability in Europe, North America and Australia." *Journal of Banking & Finance*, 13(1): 65-79. http://dx.doi.org/10.1016/0378-4266(89)90020-4

Brana, Sophie, Alexandra Campmas, and Ion Lapteacru. 2019. "(Un)Conventional Monetary Policy and Bank Risk-Taking: A Nonlinear Relationship." *Economic Modelling*, 81(C): 576-593. http://dx.doi.org/10.1016/j.econmod.2018.07.005

Brei, Michael, Claudio Borio, and Leonardo Gambacorta. 2019. "Bank Intermediation Activity in a Low Interest Rate Environment." Bank for International Settlements Working Paper 807.

Bremus, Franziska, and Marcel Fratzscher. 2015. "Drivers of Structural Change in Cross-Border Banking since the Global Financial Crisis." *Journal of International Money and Finance*, 52(C): 32-59. http://dx.doi.org/10.1016/j.jimonfin.2014.11.012

Chang, Yen-Ling, and Daniel A. Talley. 2017. "Bank Risk in a Decade of Low Interest Rates." *Journal of Economics & Finance*, 41(3): 505-528. http://dx.doi.org/10.1007/s12197-016-9367-5

Claessens, Stijn, Nicholas Coleman, and Michael Donnelly. 2018. "'Low-for-Long' Interest Rates and Banks' Interest Margins and Profitability: Cross-Country Evidence." *Journal of Financial Intermediation*, 35(PA): 1-16. http://dx.doi.org/10.1016/j.jfi.2017.05.004

Dajcman, Silvo. 2017. "Bank Risk Aversion and the Risk-Taking Channel of Monetary Policy in the Euro Area." *Panoeconomicus*, 64(5): 607-621. http://dx.doi.org/10.2298/PAN150601016D

D'Avino, Carmela. 2018. "Quantitative Easing, Global Banks and the International Bank Lending Channel." *Economic Modelling*, 71(C): 234-246. http://dx.doi.org/10.1016/j.econmod.2017.12.015

Dell'Ariccia, Giovanni, Luc Laeven, and Gustavo Suarez. 2013. "Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States." International Monetary Fund Working Paper 143.

Diamond, Douglas W., and Raghuram G. Rajan. 2006. "Money in a Theory of Banking." *American Economic Review*, 96(1): 30-53. http://dx.doi.org/10.1257/000282806776157759

Ellen, Saskia ter, Edvard Jansen, and Nina Larsson Midthjell. 2018. "ECB Spillovers and Domestic Monetary Policy Effectiveness in Small Open Economies." *European Economic Review*, 121(C). http://dx.doi.org/10.1016/j.euroecorev.2019.103338

Engle, Robert F., and Clive W. J. Granger. 1987. "Co-integration and Error Correction: Representation, Estimation and Testing." *Econometrica*, 55(2): 251-276. http://dx.doi.org/10.2307/1913236

Fratzscher, Marcel, Marco Lo Duca, and Roland Straub. 2016. "ECB Unconventional Monetary Policy: Market Impact and International Spillovers." *IMF Economic Review*, 64(1): 36-74. http://dx.doi.org/10.1057/imfer.2016.5

Freixas, Xavier, and Jose Jorge. 2008. "The Role of Interbank Markets in Monetary Policy: A Model with Rationing." *Journal of Money, Credit and Banking*, 40(6): 1151-1176. http://dx.doi.org/10.1111/j.1538-4616.2008.00152.x

Freixas, Xavier, José-Luis Peydró, and Luc Laeven. 2015. *Systemic Risk, Crises, and Macroprudential Regulation*. Cambridge, M. A.: MIT Press.

Gambacorta, Leonardo, Boris Hofmann, and Gert Peersman. 2012. "The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis." Bank for International Settlements Working Paper 384. http://dx.doi.org/10.1111/jmcb.12119

Georgiadis, Georgios, and Johannes Gräb. 2016. "Global Financial Market Impact of the Announcement of the ECB's Asset Purchase Programme." *Journal of Financial Stability*, 26: 257-265. http://dx.doi.org/10.1016/j.jfs.2016.07.009

Goczek, Łukasz, and Karol J. Partyka. 2019. "Too Small to Be Independent? On the Influence of ECB Monetary Policy on Interest Rates of the EEA Countries." *Economic Modelling*, 78(C): 180-191. http://dx.doi.org/10.1016/j.econmod.2018.09.019

Greene, William H. 2017. *Econometric Analysis*. 8th ed. New York: Pearson.

Greenwald, Bruce, and Joseph E. Stiglitz. 1991. "Toward a Reformulation of Monetary Theory: Competitive Banking." *Economic and Social Review*, 23(1): 1-34.

Greenwald, Bruce, and Joseph E. Stiglitz. 1993a. "Financial Market Imperfections and Business Cycles." *The Quarterly Journal of Economics*, 108(1): 77-114. http://dx.doi.org/10.2307/2118496

Greenwald, Bruce, and Joseph E. Stiglitz. 1993b. "Monetary Policy and the Theory of the Risk-Averse Bank." Applied Economic Theory Working Paper 93-04.

Greenwald, Bruce, and Joseph E. Stiglitz. 2003. *Towards a New Paradigm in Monetary Economics*. Cambridge, M. A.: Cambridge University Press.

Hannah, Leslie, and John Anderson Kay. 1977. *Concentration in Modern Industry: Theory, Measurement and the U. K. Experience*. London: Macmillan Press.

Hirschman, Albert O. 1945. *National Power and the Structure of Foreign Trade.* Berkeley: University of California Press.

Hirschman, Albert O. 1964. "The Paternity of an Index." *The American Economic Review*, 54(5): 761-762.

Horvath, Roman, and Klara Voslarova. 2016. "International Spillovers of ECB's Unconventional Monetary Policy: The Effect on Central Europe." *Applied Economics*, 49(24): 2352-2364. http://dx.doi.org/10.1080/00036846.2016.1237764

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina. 2014. "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say about the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica*, 82(2): 463-505.

Johansen, Soren. 1996. *Likelihood based Inference in Cointegrated Vector Autoregressive Models*. Oxford: Oxford University Press. http://dx.doi.org/10.1093/0198774508.001.0001

Kashyap, Anil K., and Jeremy C. Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review*, 90(3): 407-428. http://dx.doi.org/10.1257/aer.90.3.407

Kilian, Lutz, and Helmut Lütkepohl. 2017. *Structural Vector Autoregressive Analysis.* Cambridge, M. A.: Cambridge University Press.

Kiyotaki, Nobuhiro, and John Moore. 2012. "Liquidity, Business Cycles, and Monetary Policy." National Bureau of Economic Research Working Paper 17394.

Kucharčuková, Oxana Babecká, Peter Claeys, and Bořek Vašíček. 2016. "Spillover of the ECB's Monetary Policy Outside the Euro Area: How Different Is Conventional from

Unconventional Policy?" *Journal of Policy Modeling*, 38(2): 199-225. http://dx.doi.org/10.1016/j.jpolmod.2016.02.002

Lütkepohl, Helmut. 2005. *New Introduction to Multiple Time Series Analysis.* Berlin: Springer.

Martynova, Natalya, Lev Ratnovski, and Razvan Vlahu. 2020. "Bank Profitability, Leverage Constraints, and Risk-Taking." *Journal of Financial Intermediation*, 44(4). http://dx.doi.org/10.1016/j.jfi.2019.03.006

Mishkin, Frederic S. 2017. "Rethinking Monetary Policy after the Crisis." *Journal of International Money and Finance*, 73(B): 252-274. http://dx.doi.org/10.1016/j.jimonfin.2017.02.007

Peek, Joe, and Eric Rosengren. 2010. "The International Transmission of Financial Shocks: The Case of Japan." *American Economic Review*, 87(4): 495-505.

Peersman, Gert, and Frank Smets. 2001. "The Monetary Transmission Mechanism in the Euro Area: More Evidence from VAR Analysis." European Central Bank Working Paper 91. http://dx.doi.org/10.1017/CBO9780511492372.004

Peersman, Gert. 2011. "Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area." Centre for Economic Policy Research Working Paper 8348. http://dx.doi.org/10.2139/ssrn.1934167

Petrović, Pavle, and Zorica Mladenović. 2015. "Exchange Rate Pass-Through and the Frequency of Price Adjustment across Different Inflation Regimes." *Panoeconomicus*, 62(4): 409-427. http://dx.doi.org/10.2298/PAN1504409P

Polito, Vito, and Mike Wickens. 2012. "Optimal Monetary Policy Using an Unrestricted VAR." *Journal of Applied Econometrics*, 27(4): 525-553. http://dx.doi.org/10.1002/jae.1219

Potjagailo, Galina. 2017. "Spillover Effects from Euro Area Monetary Policy across Europe: A Factor-Augmented VAR Approach." *Journal of International Money and Finance*, 72(C): 127-147. http://dx.doi.org/10.1016/j.jimonfin.2017.01.003

Rey, Hélène. 2015. "Dilemma Not Trilemma: The Global Financial Cycle and Monetary Policy Independence." National Bureau of Economic Research Working Paper 21162.

Severe, Sean. 2016. "An Empirical Analysis of Bank Concentration and Monetary Policy Effectiveness." *Journal of Financial Economic Policy*, 8(2): 163-182. http://dx.doi.org/10.1108/JFEP-08-2015-0045

Sims, Christopher A. 1980. "Macroeconomics and Reality." *Econometrica*, 48(1): 1-48. http://dx.doi.org/10.2307/1912017

Stiglitz, Joseph E. 2016. "The Theory of Credit and Macro-Economic Stability." National Bureau of Economic Research Working Paper 22837.

Temesvary, Judit, Steven Ongena, and Ann L. Owen. 2018. "A Global Lending Channel Unplugged? Does U.S. Monetary Policy Affect Cross-Border and Affiliate Lending by Global U.S. Banks?" *Journal of International Economics*, 112(C): 50-69. http://dx.doi.org/10.1016/j.jinteco.2018.02.004

Tillmann, Peter. 2016. "Unconventional Monetary Policy and the Spillovers to Emerging Markets." *Journal of International Money and Finance*, 66(C): 136-156. http://dx.doi.org/10.1016/j.jimonfin.2015.12.010

Toda, Hiro Y., and Taku Yamamoto. 1995. "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes." *Journal of Econometrics*, 66(1-2): 225-250. http://dx.doi.org/10.1016/0304-4076(94)01616-8

Walerych, Małgorzata, and Grzegorz Wesołowski. 2021. "Fed and ECB Monetary Policy Spillovers to Emerging Market Economies." *Journal of Macroeconomics*, 70(C). http://dx.doi.org/10.1016/j.jmacro.2021.103345

Appendix

Data Sources of the Key Central Bank Interest Rates Used in the Survey

Bank of Albania. 2021. https://www.bankofalbania.org/Statistics/ (accessed September 28, 2021).

Bank of England. 2021. https://www.bankofengland.co.uk/statistics (accessed September 28, 2021).

Bank of Slovenia. 2021. https://www.bsi.si/en/monetary-policy/monetary-policy-implementation (accessed September 28, 2021).

Bulgarian Central Bank. 2021. https://www.bnb.bg/Statistics/index.htm (accessed September 28, 2021).

Central Bank of Bosnia and Herzegovina. 2021. https://www.cbbh.ba/Content/Read/8?lang=en (accessed September 28, 2021).

Central Bank of Cyprus. 2021. https://www.centralbank.cy/en/monetary-policy (accessed September 28, 2021).

Central Bank of Malta. 2021. https://www.centralbankmalta.org/monetary-policy (accessed September 28, 2021).

Central Bank of Montenegro. 2021. www.cbcg.me/en/about-us/legislation/regulations/statistics (accessed September 28, 2021).

Croatian National Bank. 2021. https://www.hnb.hr/en/statistics (accessed September 28, 2021).

Czech National Bank. 2021. https://www.cnb.cz/en/monetary-policy/monetary-policy-reports/ (accessed September 28, 2021).

Danmarks Nationalbank. 2021. https://www.nationalbanken.dk/en/Pages/Default.aspx (accessed September 28, 2021).

Latvijas Banka. 2021. https://www.bank.lv/en/statistics/stat-data/key-macroeconomic-indicators (accessed September 28, 2021).

Magyar Nemzeti Bank. 2021. https://www.mnb.hu/en/arfolyamok (accessed September 28, 2021).

Narodna Banka Slovenska. 2021. https://nbs.sk/en/ (accessed September 28, 2021).

Narodowy Bank Polski. 2021. https://www.nbp.pl/homen.aspx?f=/en/onbp/polityka_pieniezna.html (accessed September 28, 2021).

National Bank of Romania. 2021. https://www.bnr.ro/Monetary-Policy-1864-Mobile.aspx (accessed September 28, 2021).

National Bank of Serbia. 2021. https://nbs.rs/en/drugi-nivo-navigacije/statistika/ (accessed September 28, 2021).

National Bank of the Republic of North Macedonia. 2021. https://www.nbrm.mk/statistika-en.nspx (accessed September 28, 2021).

Sveriges Riksbank. 2021. https://www.riksbank.se/en-gb/statistics/ (accessed September 28, 2021).

THIS PAGE INTENTIONALLY LEFT BLANK