ECONOMIC THEMES (2024) 62(3): 413-428

DOI 10.2478/ethemes-2024-0022

THE IMPACT OF CLIMATE CHANGE ON THE FINANCIAL STABILITY OF THE REPUBLIC OF SERBIA: THE CASE OF THE MINING INDUSTRY

Vesna Martin

Economists Association of Belgrade, Republic of Serbia

✉ *martinv0803@hotmail.com*

UDC 336.76: 551.583: 622(497.11)

Original scientific paper

Abstract: The purpose of this paper is to examine how, using Serbia as an example, climate change impacts financial stability. Our sectoral analysis approach will be used to demonstrate if transition risk has an impact on climate change. Based on Serbian data, we identified that the mining sector generates the highest level of pollution. Since a sizable portion of domestic banks' loans are allocated to the mining industry, this industry is crucial for the development of banks' risk profiles with regard to the risk of climate change in the context of the shift to a green economy. From the perspective of financial stability, it is necessary to determine whether the credit activity of the mining sector is sustainable. For this purpose, we will use a one-sided Hodrick-Prescott (HP) filter and set the value of the parameter λ to 1,600 to calculate the long-term trend of the share of real mining credit in the real gross domestic product. If the ratio of real loans to real GDP is at least two percentage points above its long-term trend and the rate of credit growth does not promote economic expansion, then credit growth is seen to be excessive. The analysis findings revealed that between the third quarters of 2010 and the fourth quarter of 2022, when the analysis was conducted, there was a gap between the real mining loans and the real gross domestic product less than 2 percentage points. Based on the results that have been presented, we may conclude that lending to the mining sector does not now constitute a threat to financial stability.

Received: 05.10.2023
Accepted: 30.08.2024

Keywords: financial stability, climate change risks, mining industry, economic consequences, role of central banks, green transition.

JEL classification: K32, Q54

The views expressed in this paper are those of the author and do not necessarily represent the official view of the Economists Association of Belgrade.

1. Introduction

All areas of the economy are impacted by climate change, as has been seen on a worldwide scale. Climate risks brought on by climate change have an impact on the stability and security of financial institution operations. All financial market actors must therefore promptly identify risks related to climate change, evaluate their implications, and incorporate these risks into their business models. Central banks and other financial institutions are in consensus that they should respond to climate risks promptly and in accordance with statutory mandates in order to achieve and maintain price and financial stability. Climate change has a substantial impact on the banking industry, which dominates the financial system, through having an impact on the real economy. Today, an increasing number of companies define their business plans taking climate risks and their effect on future activities into consideration. Giving loans to projects that are focused on achieving sustainable development goals is also very important to banks.

Climate-related risks are now being considered and even regulated by several international organizations in charge of the regulation and oversight of financial institutions, despite the fact that they do not immediately stem from banking operations and financial markets. The main issue facing decision-makers, however, is related to the availability of data, the way to standardize climate-related risks, as well as the establishment of suitable mechanisms, and the fundamentals for their identification, measurement, monitoring, and management. This is due to the complex nature of the sources of these risks and the consequent complexity of their impact if they materialize. Additionally, from the standpoint of ensuring financial stability, regulators and supervisors should incorporate the subject into their operations in an appropriate manner.

To decrease the effects of climate change, several agreements and norms have been established. Private and public sector representatives came together in June 1992 for the United Nations Conference on Environment and Development to discuss how socioeconomic activities affected the environment. The Kyoto Protocol, which was signed by industrialized nations and emerging markets, was agreed in December 1997 and entered into force in February 2005 after a protracted ratification procedure. The Fifth Assessment Report: Climate Change of the Intergovernmental Panel on Climate Change, which provides an overview of the impacts of these changes and takes into account all feasible options for their mitigation and adaptation, was released in 2014. It is a report on the evaluation of scientific information pertinent to our understanding of climate change. The Paris Agreement was subsequently agreed during the UN Climate Change Conference (COP21), which took place in Paris in December 2015 and went into effect in November 2016. With the backing of 196 member nations, it is a legally binding agreement that deals with climate change on a worldwide scale. It was decided, in accordance with the Paris Agreement that the average global temperature increase

over pre-industrial levels should be considerably below 2°C. The aforementioned agreement also suggests a goal of keeping global warming to 1.5°C, the peaking of greenhouse gas emissions by 2025, and a 43% reduction in pollution by 2030 (UN Climate Change, 2023). New UN Climate Change Conferences were conducted from 2016 to 2022, with the exception of 2020, when the conference was postponed due to the Coronavirus epidemic, in an effort to further discuss climate change and recommend appropriate actions. Serbia has signed and ratified all major international environmental agreements including the Kyoto Protocol and the Paris Agreement. Aiming to improve climate risk management in the financial system, mobilize financial resources for sustainable development, and share best practices in managing climate change, the Network of Central Banks, and Supervisors for Greening the Financial System (NGFS) was established in December 2017. The National Bank of Serbia joined the NGFS in July 2021, expressing its commitment to escalating and stepping up initiatives to increase the financial system's resilience to environmental and climate-related risks. In the upcoming period, it is anticipated that representatives of the National Bank of Serbia will actively participate in the development of best practices and acquire knowledge and experience that they could apply to the financial system in Serbia by exchanging knowledge and experience with other central banks. Starting in June 2022, representatives of the National Bank of Serbia participated as observers in the Vienna Initiative Working Group on Climate, which is co-chaired by the European Investment Bank (EIB), the European Commission, the European Bank for Reconstruction and Development (EBRD), and the World Bank.

Improving the channels for unrestricted funding of environmentally sustainable projects is crucial to achieving the goals outlined in the Paris Agreement. Serbia issued a green instrument in September 2021, becoming one of the few European nations and the only one outside the European Union. The instrument was a green Eurobond valued EUR 1 billion with a maturity of seven years and the lowest coupon rate ever recorded at one percent. The issuance of the green bond complies in full with the International Capital Market Association's (ICMA) Green Bond Principles. Additionally, it is essential that central banks and financial regulators work together to ensure that each of them promotes the growth of green finance and the building of a green economy within the boundaries of their respective domains.

The aim of the paper is to illustrate, using Serbia as an example, how climate change affects financial stability. The central bank's participation in the battle against climate change as well as the economic effects of climate change are further topics of analysis. To assess how climate change may affect Serbia's financial stability, it is necessary to identify the industry that pollutes the country the most. Using a sectoral analysis, we found that the mining sector is the one that contributes the most to Serbia's pollution. The mining sector is essential for the development of banks' risk profiles with regard to the risk of climate change in the context of the transition to a green economy because a sizeable amount of domestic

banks' loans is assigned to this industry. We examined the proportion of the mining sector's real credit activity in the real gross domestic product in order to determine whether the mining industry poses a risk to the maintenance of financial stability. It utilized the one-sided Hedrick-Prescott (HP) filter and set the value of the parameter λ to 1,600 to determine the long-term trend of the share of mining real credit in the real gross domestic product in order to evaluate the sector's effects on financial stability.

2. Literature review

Climate change is one of the greatest risks to humanity today. It directly affects economic growth and development, quality of life and well-being, as well as the attainment and maintenance of price and financial stability. The decisions made today on the management of climate change will have a significant impact on how our lives will be in the future. Due to this, both the public and private sectors must contribute to the coordinated effort to mitigate the effects of climate change. All financial market participants must carefully evaluate how exposed they are to risks brought on by climate change (Pagnottoni, Spelta, Flori & Pammolli, 2021). The review of environmental and financial data for the quantitative assessment of climate risk and the identification of potential data gaps, as well as the definition and optional analysis of climate-relevant metrics for banks and the formulation of a climate stress test methodology for the banking system, all pose significant challenges for central banks. To determine how climate change would impact the economic sector, central banks and other regulators have started to create climate stress test scenarios (Sun, Fang, Iqbal, & Raza Bilal, 2022). Financial institutions can utilize scenario analysis to evaluate and pinpoint the possible effects of climate change as well as to gauge the economic sectors' resistance to risks associated with climate change (FSB, 2020). The movement of market prices is significantly impacted by climate change. If climate concerns are not fully disclosed or if investors are not aware of their existence the market pricing does not fairly reflect the link between return and risk. Consequently, a bigger risk premium results from a higher risk level. Market pricing will communicate the benefits of the shift toward a low-carbon economy when these risks are properly managed, and financial markets will efficiently allocate capital (Pointner & Ritzberger-Grünwald, 2019).

Given that the majority of central banks' missions have to do with maintaining price and financial stability, it's critical to detect any risks that could jeopardize the attainment of the stated objectives. Rising sea levels and melting glaciers, strong tropical cyclones, extremely high temperatures, droughts, and ecosystem collapse are all effects of climate change (DeFries, et al., 2019). When the temperature rises above a certain point, the effects of climate change on financial stability are not progressive; rather, they multiply and have a domino effect (Liu, Sun & Tang, 2021). In addition to the aforementioned effects, climate change may also result in

portfolio reallocation and a decline in the profitability of the corporate sector, which may have an influence on bond prices (Dafermos, Nikolaidi & Galanis, 2018). As a result, it is vital to include climate risks alongside traditional risks, of which two categories—physical and transitional—have been established from the standpoint of central banks. Natural catastrophes are considered physical risks since they can harm assets owned by individuals and the economy, whereas transitional risks refer to regulation changes or tightening that may result in a reduced estimate of the worth of a piece of property. Along with the aforementioned risks liability risks must also be emphasized since they reflect a scenario in which parties who have suffered losses as a result of climate change would demand reimbursement from individuals who think they are responsible for it (Carney, 2015). According to Löyttyniemi's analysis (2021), there are transition path-related risks, in addition to the traditional risks of climate change—physical and transitional, that result from the transition path that economic agents choose in order to achieve a low carbon economy. Future events will determine if their choice was wise or not, thus it is up to them to make the best choice possible. On the other hand, Fabris (2020) notes in his study that climate-related risks are linked to already-existing risks for financial institutions, such as credit risk, market risk, and operational risk. It is important to note that climate risks have existed for a very long time and that the longer remediation for climate change is delayed, the more expensive the remediation will be (Kedward, Ryan-Collins & Chenet, 2022).

Considering the central bank's position is an important issue in the management of climate change. Central banks must get more involved in the effort to combat the effects of climate change if they want to achieve the objectives outlined in the Paris Agreement. To effectively manage the risks of climate change and to encourage financial sector participants to drive investments in clean technologies and low-carbon infrastructure, central banks are expected to establish policies and strategies (Martin, 2022). In order to achieve the transition to a low-carbon economy, it is crucial that consumers and investors respond to price signals and appropriately estimate the risks associated with climate change. Actually, it is the basic responsibility of central banks to ensure that both requirements are met (Buch & Weigert, 2021). There are various difficulties in central banks' assessments of climate risks. First, the data required to perform climate stress testing is either lacking or not detailed enough. Second, a static evaluation of climate risk is impossible. According to Campiglio, Dafermos, Monnin, Ryan-Collins, Schotten, and Tanaka (2018), understanding the dynamic interaction of the financial system, macroeconomics, environmental policy, and climatic changes is necessary.

When risk accumulation threatens financial stability, the value of financial assets held as collateral by institutions can change significantly (Christophers, 2017). The study of climate risks must be based on three basic factors: (1) determining the primary drivers of climate change at the level of each specific country. In this regard, it is important to consider the financial sector's exposure as

well as to establish policy measures to adapt to those changes; (2) it is also important to identify the nations that are the primary global sources of climate risks in order to evaluate the impact on the global financial system; and (3) it is important to use financial risk metrics in order to monitor the assessment of the development of these risks for the purposes of climate scenarios (Mandel, Tiggeloven, Lincke, Koks, Ward & Hinkel, 2021). Economic models are most frequently used to assess several scenarios with differing greenhouse gas (GHG) emissions and estimate the cost of climate change mitigation. A speedier economic transition, particularly in the energy sector, is implied by a large reduction in harmful gas emissions over time (Bowen & Dietz, 2016).

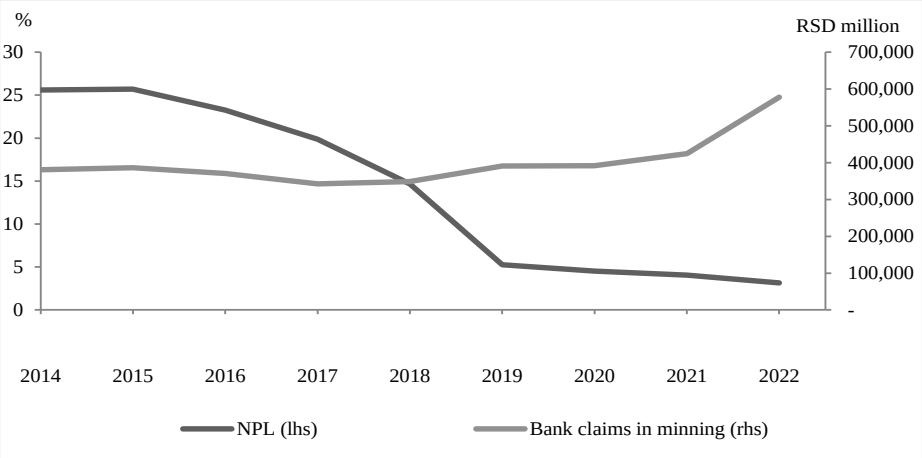
The effects of climate change have far-reaching effects. According to the assessment of the European Union, if actions were not taken to remedy the consequences of climate change during the lifetime of our children, the European Union would record that 400,000 people die prematurely due to air pollution annually, 2.2 million people would be exposed to floods every year, and economic losses on an annual level in the amount of EUR 190 billion (European Union, 2023). Globally speaking, there is a significant risk from climate change. In line with the United Nations, the average global temperature in 2021 was about 1.1°C above that of the pre-industrial era, which covers the period between 1850 and 1900. The highest temperatures to date have been recorded if we look at statistics for the period from 2015 to 2021 on a worldwide scale. Approximately 700 million people are predicted to be in danger of being displaced as a result of droughts by 2030 (United Nations, 2023). In our ongoing research, we'll examine if the mining industry's credit activity, which is responsible for the majority of the pollution, poses a risk to financial stability.

3. Materials and methods

In the analysis, we will start by examining the banking industry's credit exposure in light of the activity classifications used by the Agency for Business Registers. This method of sector grouping is demonstrated in the National Bank of Serbia's statistics, which are published on a monthly basis starting in August 2010 and exhibit information on bank loans on the corporate sector by sectors of economic activity. As of December 2022, the share of domestic loans to the mining sector ranged from 29.2% (September and October 2020) to 38.4% (September 2022). Based on the information provided, it can be said that Serbia's banking industry is heavily exposed to the mining industry. The trend of non-performing loans, which has shown a decreased tendency since August 2015, when the Strategy for resolving non-performing loans was introduced, also provides insight into the caliber of credit activity in that sector. The aforementioned strategy helped down the percentage of non-performing loans in the mining sector from 21.8% in August 2015 to 2.2% in December 2022, which is the lowest level ever recorded despite

the pandemic, the energy crisis, and significant geopolitical concerns (Graph 1). The low percentage of non-performing loans in the mining industry shows that banks were able to keep the quality of their assets.

Graph 1: Non-performing loans and bank claims in mining industry



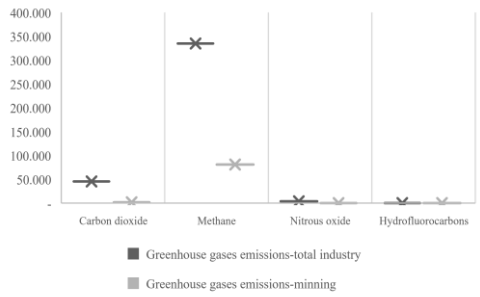
Source: National Bank of Serbia, https://www.nbs.rs/en/indeks/index.html, accessed: June 8, 2023

In addition to the high credit exposure of the banking sector to the mining sector, the sector's contribution to the overall level of pollution is significant. The mining industry contributes 21.5% of all greenhouse gas emissions, the majority of which is methane (24.1%), according to the most recent statistics on greenhouse gas emissions from the Environmental Protection Agency for 2014 that is currently available - Graph 2. According to the most recent figures for 2020, the mining industry contributes 93% of the total waste produced by all industries, which is a significant amount (Graph 3). The data shown illustrate the significance of mining's contribution to overall pollution. It is imperative to decarbonize the mining sector in order to lower carbon emissions. In order to retain the integrity of the data used for reporting on the environment, society, and governance, mining corporations can successfully decarbonize by utilizing a range of strategies (such as switching to renewable energy sources and carbon offsetting).

Besides the aforementioned, it is important to draw attention to the major contribution of the mining industry to the GDP and the development of the Republic of Serbia's economy. By the end of 2022, the mining sector have a 20% share of the overall real gross domestic product, making it the sector with the biggest individual contribution. By the end of 2022, the average gross (net) wage in the mining industry was 25.7% (27.6%) higher than the national average, demonstrating the sector's

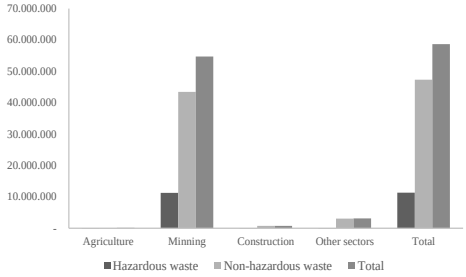
greater earning potential. The information above demonstrates how significant the mining industry is to the Republic of Serbia's economy.

Graph 2: Greenhouse gases emissions in 2014



Source: Environmental Protection Agency, http://www.sepa.gov.rs/#, accessed: May 26, 2023

Graph 3: Generation of waste by sectors (in tonnes) in 2020



Source: Statistical Office of the Republic of Serbia, https://www.stat.gov.rs/en-US/, accessed: May 15, 2023

Financial stability has become more significant since the global economic crisis, and its major objective is to reduce systemic stress in the financial system. When systemic risk is examined closely, it may be seen in two dimensions: structural (the manner in which financial institutions are connected) and temporal (risk that changes over time and is dependent on the stage of the cycle). Due to the considerable exposure of domestic credit activity to the mining sector, this industry is crucial for the development of banks' risk profiles in relation to the risk of climate change in the context of the shift to a green economy. We have to investigate whether this credit activity is a cause of systemic stress in order to assess whether the banking sector's exposure to the mining sector's credit market poses a risk to the stability of the financial system. In order to do that study, we need to examine excessive credit activity, which represents a temporal aspect of systemic risk. One of the causes of financial crises is excessive credit growth, which is accelerated by taking on new commitments without corresponding increases in capital. If the ratio of real loans to real GDP is at least two percentage points above its long-term trend and the rate of credit growth does not promote economic expansion, then credit growth is seen to be excessive. The basic indicator of excessive credit activity is the credit gap (e.g., credit-to-GDP gap), which represents the difference between the share of real loans in real gross domestic product and their long-term trend.

Indicators having the strongest predictive value in forecasting prospective financial institution crises include the credit-to-GDP gap, according to a study by Drehmann & Tsatsaronis (2014). It might be determined that there is excessive credit activity that is not supported by economic growth and hence endangers financial stability if the calculated credit-to-GDP gap is greater than two

percentage points. This approach is consistent with the work of Borio & Drehmann (2009) and Borio & Lowe (2004), who found that the credit-to-GDP gap can be used as an early warning indicator (EWI) preceding banking crises.

It is required to do a thorough examination of the entire credit activity and calculate specific gaps in accordance with the currency structure of the credit provided to the mining sector to determine how much each contributes to the overall credit gap. In the analysis, we will use data on real loans granted to the mining industry and real gross domestic product. The National Bank of Serbia's statistics provide information on real loans made to the mining industry, while the Republic Statistical Office is the source of information on real GDP. We will use quarterly data for the analysis from the third quarter of 2010 to the fourth quarter of 2022. The Eviews software program was used for the analysis. The analysis's findings will be presented in the following section of the paper.

4. Results and discussions

We utilized the one-sided Hodrick-Prescott filter to calculate the credit gap, e.g., the difference between the share of real loans of the mining in real gross domestic product and their long-term trend. A common technique for determining the share of credit in gross domestic product based on its long-term trend is the Hodrick-Prescott filter. The examined series can be split into a trend component and a cyclical component by using the Hodrick-Prescott filter, resulting in the formula (1):

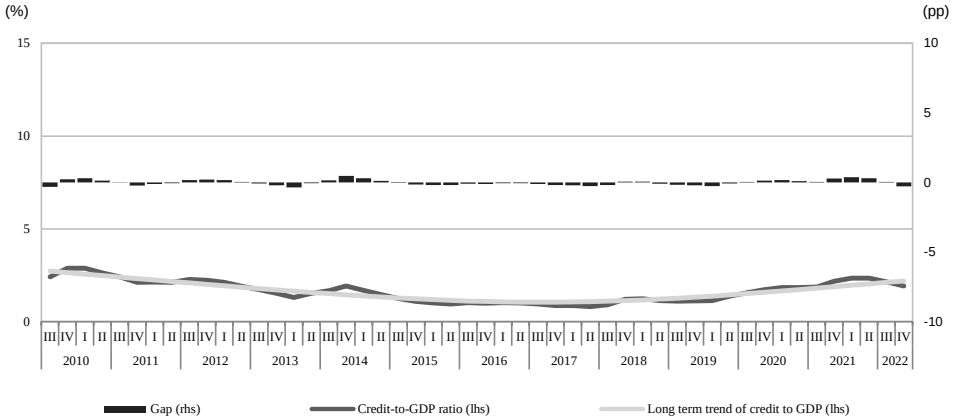
$$y_t = \tau_t + c_t \quad (1)$$

where: y_t – the series we observe over time; τ_t – trend component and c_t – cyclical component. In applying a one-sided Hodrick-Prescott filter, we used the parameter value λ of 1,600. This is the recommended value of the parameter by Hodrick & Prescott (1997) for that dynamic of data presentation because, as previously said, we based the analysis on quarterly data.

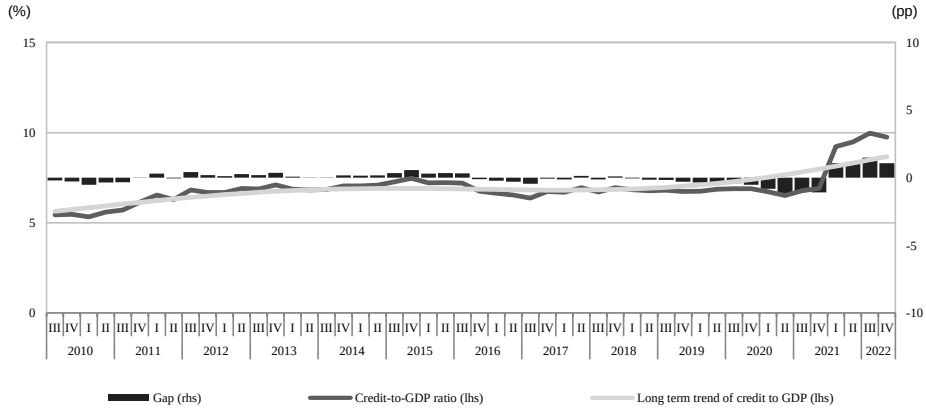
In order to determine the gap for all approved loans to the mining sector, as well as particularly for loans in foreign currency and foreign currency indexed loans, as well as loans in dinar, we used the one-sided Hodrick-Prescott filter (Graph 4).

Graph 4: Mining credit-to-GDP ratio and its long run trend (in %)

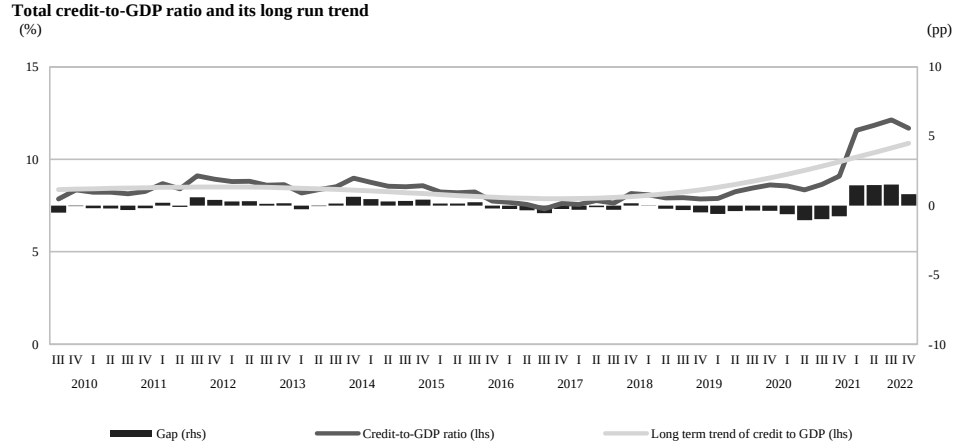
Dinar credit-to-GDP ratio and its long run trend (in %)



Foreign exchange and FX-indexed credit-to-GDP ratio and its long run trend



Total credit-to-GDP ratio and its long run trend



Source: Author's calculation prepared in the Eviews software package

This breakdown of the mining sector's overall credit activity is sufficient to identify the components that make up the overall credit gap. The results of the analysis showed that the total gap in the share of total mining loans in the fourth quarter of 2022 was 0.82 percentage points, while the share of total loans in the gross domestic product in the same period was 11.7%. At the end of the fourth quarter of 2022, the share of foreign currency and foreign currency-indexed loans of the mining sector in the gross domestic product was 9.8% with a credit gap value of 1.09 percentage points. If we concentrate on dinar loans in the mining sector, by the end of the fourth quarter of 2022, their share in the GDP was 1.9%, while the value of the gap was negative and equaled -0.26 percentage points. The greater contribution to the total credit gap that comes from foreign currency and foreign exchange-indexed loans compared to dinar loans can be explained by the higher share of these loans in the total loans of the mining sector compared to dinar loans. For the sake of comparison, at the end of the fourth quarter of 2022, the share of foreign currency and foreign exchange-indexed loans in the total loans of the mining sector was 83.5%, while 16.5% was related to the share of dinar loans. The analysis's presented findings show that the gap between the total credit activity of the mining sector and each of its individual components is less than the reference value of 2 percentage points, above which the growth of credit activity would be excessive. The results suggest that the current pattern of domestic loan activity in the mining industry does not constitute a threat to the stability of the financial system. If we examine the credit gap data for the whole study period (from the third quarter of 2010 to the fourth quarter of 2022), we find that the value of the gap was consistently under 2 percentage points.

The previously established result is in line with previous research and practical uses on the credit gap computation using the one-sided Hodrick-Prescott filter. The Basel Committee on Banking Supervision introduced capital buffers by implementing the Basel III standard, including the countercyclical capital buffer (CCyB), the systemic risk buffer (SyRB), the capital conservation buffer (CCoB), and the buffers for global and other systemically important institutions (G-SIIs and O-SIIs). According to the recommendations of the European Systemic Risk Board (ESRB, 2014), it is mandated that the calculation of the credit gap, serves as a reference indicator for the countercyclical capital buffer. It is advised to introduce the countercyclical capital buffer if the credit gap estimate is higher than 2 percentage points because credit activity is viewed as being excessive. In order to determine if the Serbian residential real estate market is experiencing a price bubble, previous research using the example of calculating the credit gap of housing loans in the gross domestic product (Martin, 2023) shows that the gap is less than 2 percentage points.

Technical literature (Ravn & Uhlig, 2001; Drehmann, Borio, Gambacorta, Jiménez & Trucharte, 2010) advises implementing a parameter of with a value λ of 400,000 in addition to the parameter value of 1,600. This method of computing the

credit gap is justified by the fact that a higher value of this parameter provides a solid signal for detecting banking crises by pointing out instances of excessive credit activity. Additionally, the two-sided Hodrick-Prescott filter can be used to enhance the credit gap computation because the one-sided Hodrick-Prescott filter application may result in a subsequent modification that could influence decision-makers. We previously discussed the use of the one-sided Hodrick-Prescott filter to decide on the rate of the countercyclical capital buffer, which has a direct impact on macroprudential policy decision-making.

5. Conclusion

Macroprudential policy's fundamental objective is to maintain and strengthen financial stability, which, along with price stability, the implementation of which comes under the authority of monetary policy, forms the framework for steady and sustained economic growth. Today, central banks are urged to actively contribute to the struggle against climate change in addition to the two objectives indicated above. In this regard, it is vital for central banks to take a proactive approach to mitigating the effects of climate change and the dangers that these changes bring. In accordance with their mandate, central banks should be aware of the causes, ways of transmission, effects on the financial system, and exposure of the financial system to climate change. The effort made by central banks to integrate climate risks in stress tests is very significant.

In this paper, we examine how climate change may affect financial stability, specifically using Serbia as a case study. We conducted the research using a sectoral method in order to determine whether transition risks have an impact on Serbia's financial stability. We examined the information on the creation of greenhouse gas emissions and waste to determine the degree of pollution in various industries. According to the information provided, the mining industry is responsible for the majority of pollution in Serbia. Since a sizable portion of domestic banks' loans are allocated to the mining industry, this industry is crucial for the development of banks' risk profiles with regard to the risk of climate change in the context of the shift to a green economy. Further investigation was conducted to ascertain whether the mining industry poses a risk to the financial system. In this regard, using a one-sided Hodrick-Prescott (HP) filter with a parameter value λ of 1,600, we examined domestic credit exposure to the mining industry and determined the long-term trend of the real mining sector loans share in real gross domestic product. The analysis's findings revealed that, between the third quarter of 2010 and the fourth quarter of 2022, the difference between the real loans made to the mining industry and the real gross domestic product was below 2 percentage points, which serves as a benchmark above which credit activity growth would be excessive. The results indicate that domestic credit activity to the mining industry does not pose a threat to Serbia's financial stability. The two-sided Hodrick-

Prescott (HP) filter and the value of the parameter λ of 400,000, which is in accordance with the suggestion of the reviewed technical literature, can both be used to further improve the use of the credit gap for the analysis of the sustainability of credit activity.

Given the effects of climate change on every aspect of daily life and professional life, monitoring these changes is a topic of utmost relevance today. Economic growth and development, social well-being, and the maintenance of financial stability are all directly impacted by the effects of climate change. Reducing greenhouse gas emissions and achieving objectives based on sustainable development are the key objectives of the action. Future studies on all of the aforementioned subjects will help the economy as a whole better respond to the effects of climate change.

References

Borio, C. & Drehmann, M. (2009). Assessing the risk of banking crises – revisited. *BIS Quarterly Review*, 29-46.

Borio, C. & Lowe, P. (2004). Securing sustainable price stability: should credit come back from the wilderness?. *Bank for International Settlement*, BIS Working Papers No 157, 1-51.

Bowen, A. & Dietz, S. (2016). The effects of climate change on financial stability, with particular reference to Sweden. *Grantham Research Institute on Climate Change and the Environment and London School of Economics and Political Science*, 1-41.

Buch, C. & Weigert, B. (2021). Climate Change and Financial Stability: Contributions to the Debate. *Deutsche Bundesbank*, 1-27.

Campiglio, E., Dafermos, Y., Monnin, P., Ryan-Collins, J., Schotten, G. & Tanaka, M. (2018). Climate change challenges for central banks and financial regulators. *Nature Climate Change*, https://doi.org/10.1038/s41558-018-0175-0

Carney, M. (2015, September 29). Breaking the Tragedy of the Horizon – climate change and financial stability. Speech given by Mark Carney Governor of the Bank of England and Chairman of the Financial Stability Board. downloaded from: https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability, accessed: July 20, 2023

Christophers, B. (2017). Climate Change and Financial Instability: Risk Disclosure and the Problematics of Neoliberal Governance. *Annals of the American Association of Geographers*, https://doi.org/10.1080/24694452.2017.1293502

Dafermos, Y., Nikolaidi, M. & Galanis, G. (2018). Climate Change, Financial Stability and Monetary Policy. *Ecological Economics*, https://doi.org/10.1016/j.ecolecon.2018.05.011

DeFries, R., Edenhofer, O., Halliday, A., Heal, G., Lenton, T., Puma, M., Rising, J., Rockström, J., Ruane, A., Schellnhuber, H., Stainforth, D., Stern, N., Tedesco, M. & Ward, B. (2019). The missing economic risks in assessments of climate change impacts. *The Grantham Research Institute on Climate Change and the Environment*, 1-15.

Drehmann, M. & Tsatsaronis, K. (2014). The Credit-to-GDP Gap and Countercyclical Capital Buffers: Questions and Answers. *BIS Quarterly Review*, March 2014, 55-73.

Drehmann, M., Borio, C., Gambacorta, L., Jiménez, G. & Trucharte, C. (2010). Countercyclical capital buffers: exploring options. *BIS Working Papers* No 317, 1-64.

Environmental Protection Agency, downloaded from: http://www.sepa.gov.rs/#, accessed: May 26, 2023

ESRB - European Systemic Risk Board. Recommendation of the European Systemic Risk Board of 18 June 2014 on guidance for setting countercyclical buffer rates (ESRB/2014/1). downloaded from: https://www.esrb.europa.eu/pub/pdf/recommendations/140630_ESRB_Recommendation.en.pdf, accessed: July 25, 2023

European Union. Climate change. downloaded from: https://climate-pact.europa.eu/about/climate-change_en, accessed: July 27, 2023

Fabris, N. (2020). Financial Stability and Climate Change. *Journal of Central Banking Theory and Practice*, https://doi.org/10.2478/jcbtp-2020-0034

FSB. (2020). The Implications of Climate Change for Financial Stability. Financial Stability Board. downloaded from: https://www.fsb.org/2020/11/the-implications-of-climate-change-for-financial-stability/, accessed: August 7, 2023

Hodrick, R. & Prescott, E. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29 (1), 1-16.

https://unfccc.int/process-and-meetings/the-paris-agreement, UN Climate Change, The Paris Agreement, accessed: June 2, 2023

https://www.nbs.rs/en/indeks/index.html, National Bank of Serbia, accessed: June 8, 2023

https://www.stat.gov.rs/en-US/, Statistical Office of the Republic of Serbia, accessed: May 15, 2023

Kedward, K., Ryan-Collins, J. & Chenet, H. (2022). Biodiversity loss and climate change interactions: financial stability implications for central banks and financial supervisors. *Climate Policy*, https://doi.org/10.1080/14693062.2022.2107475

Liu, Z., Sun, H. & Tang, S. (2021). Assessing the impacts of climate change to financial stability: evidence from China. *International Journal of Climate Change Strategies and Management*, https://doi.org/10.1108/IJCCSM-10-2020-0108

Löyttyniemi, T. (2021). Integrating climate change into the financial stability framework. *Center for economic policy research*, 175-183.

Mandel, A., Tiggeloven, T., Lincke, D., Koks, E. Ward, P. & Hinkel, J. (2021). Risks on global financial stability induced by climate change: the case of flood risks. *Climatic Change*, https://doi.org/10.1007/s10584-021-03092-2

Martin, V. (2022). Climate change and the role of central banks. *Bankarstvo*. https://doi.org/10.5937/bankarstvo2202086M

Martin, V. (2023). Residential real estate analysis in Serbia. The Annals of the Faculty of Economics in Subotica, https://doi.org/10.5937/AnEkSub2300019M

Pagnottoni, P., Spelta, A., Flori, A. & Pammolli, F. (2021). Climatic Change and Financial Stability: Natural Disaster Impacts on Global Stock Markets. *Research Square*, https://doi.org/10.21203/rs.3.rs-902973/v1

Pointner, W. & Ritzberger-Grünwald, D. (2019). Climate change as a risk to financial stability. Financial Stability Report 38, *Oesterreichische Nationalbank*, 30-45.

Ravn, M. & Uhlig, H. (2001). On adjusting the HP-filter for the frequency of observations. *Center for Economic Studies & Ifo Institute for Economic Research*, CESifo Working Paper No. 479, 1-21.

Sun, L., Fang, S., Iqbal, S. & Raza Bilal, A. (2022). Financial stability role on climate risks, and climate change mitigation: Implications for green economic recovery. *Environmental Science and Pollution Research*, https://doi.org/10.1007/s11356-021-17439-w

United Nations. Goal 13: Take urgent action to combat climate change and its impacts. downloaded from: https://www.un.org/sustainabledevelopment/climate-change/, accessed: September 15, 2023

UTICAJ KLIMATSKIH PROMENA NA FINANSIJSKU STABILNOST REPUBLIKE SRBIJE: PRIMER SEKTORA RUDARSTVA

Apstrakt: Cilj ovog rada je sagledavanje kako klimatske promene utiču na finansijsku stabilnost na primeru Srbije. Kako bismo dokazali da li tranzicioni rizici utiču na finansijsku stabilnost primenićemo sektorski pristup analize. Na podacima Srbije identifikovali smo da sektor rudarstva generiše najviši nivo zagađenosti. Budući da je značajan deo kredita domaćih banaka plasirano u rudarstvo, ovaj sektor je od ključnog značaja za formiranje rizičnog profila banaka po pitanju rizika klimatskih promena u kontekstu tranzicije ka zelenoj ekonomiji. Neophodno je da sagledamo da li je kreditna aktivnost sektora rudarstva održiva sa aspekta finansijske stabilnost i u tu svrhu izračunaćemo dugoročni trend učešća realnih kredita sektora rudarstva u realnom bruto domaćem proizvodu uz pomoć jednostranog Hodrick-Prescott (HP) filtera gde smo vrednost parametra λ postavili na 1.600. Kreditni rast se smatra prekomernim ukoliko je učešće realnih kredita u realnom bruto domaćem proizvodu veće za minimum 2 procentna poena od svog dugoročnog trenda, a stopa kreditnog rasta ne podržava ekonomski rast. Rezultati analize su pokazali da je tokom perioda analize, od trećeg kvartala 2010. do četvrtog kvartala 2022, jaz učešća realnih kredita sektora rudarstva u realnom bruto domaćem proizvodu ispod 2 procentna poena. Na bazi prikazanih rezultata možemo zaključiti da kreditiranje sektora rudarstva za sada ne predstavlja rizik po finansijsku stabilnost.

Ključne reči: finansijska stabilnost, rizici klimatskih promena, sektor rudarstva, ekonomske posledice, uloga centralnih banaka, zelena tranzicija

Author's biography

Vesna Martin finished bachelor, master, and PhD studies at the Faculty of Economics, University of Belgrade. From March 2008 to May 2012, she was employed at Raiffeisen Bank a.d. in the Treasury and Investment Banking Division, Treasury Sales Department. Since May 2012, Vesna Martin has been employed at the National Bank of Serbia, first at the Monetary Operation Department, Foreign Exchange Division, and at present at the Financial Stability Department, Division for Macroprudential Supervision. She owns the ACI Dealing Certificate, an authorized certificate for participants in the foreign exchange market, and was a participant in several useful lectures, seminars, and study visits organized by other central banks and financial organizations (Deutsche Bundesbank, De Nederlandsche Bank, Czech National Bank, and IMF). She is the author of more than fourty scientific research papers published in relevant national and regional journals of international importance and conference proceedings in the fields of monetary, macroprudential, and fiscal policy.