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Assessing uncertainty and its effects on the public sector: guest editors' introduction to the thematic issue of Public Sector Economics

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Guest editors' introduction
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"... As we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tends to be the difficult ones."

Former U.S. Secretary of Defense Donald Rumsfeld (2002)

Economic uncertainty seems to be one of the most popular buzzwords lately. But what does the term uncertainty mean at all? As Knight (1921) defined it, uncertainty refers to the absence of quantifiable knowledge about future events or the probabilities of their occurrence. Uncertainty has been recognised as a determinant of economic behaviour even by classics such as Keynes (1937) and Hayek (1945). Economic uncertainty has also been one of the focal points of interest for central bankers. Suffice it to say that the former Chairman of the Federal Reserve Board Alan Greenspan (2003) and the current Chairman Jerome Powell (2018) labelled uncertainty one of the defining characteristics of today's economic landscape. However, standing on the shoulders of Knight (1921), both practitioners and academics have mostly perceived it as a latent, unobservable theoretical construct.

The Great Financial Crisis somehow became the tipping point after which empirical work on the topic of uncertainty started to gain momentum. Baker, Bloom and Davis (2016) soon published their seminal work on the Economic Policy Uncertainty Index, and other empirical proxies of uncertainty started to emerge, all facilitated by rapid developments in computing power, growth of user-generated online data sources and social networks, and state-of-the-art analytical techniques. Some of these novel approaches to measuring uncertainty involve social media data (Ma et al., 2022), web scraping (Sorić and Lolić, 2017), forecasting disagreement (Bachmann, Elstner and Sims, 2013), and market volatility (Bloom, 2014). Soon enough, uncertainty came into the spotlight of empirical researchers' attention.

Exact sciences like physics or chemistry rely on controlled experiments. Although there is a growing field of quasi-natural experiments in economics, the "dismal science" is often criticised by natural scientists as inexact because its objects are highly variable and random in nature, and as such incommensurable with those of natural sciences.

In that sense, we were intrigued by Haldane's (2017) inspiring lecture that links macroeconomic stability to the first law of thermodynamics. In one of its variations, this physical law states that in an isolated system, energy cannot be destroyed, only transformed from one form to another.

A parallel with economic uncertainty is obvious. It too cannot be completely eliminated; its absence could in fact lead to a stale economy with negligible profit

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margins (if any). So, what can prudent policymakers then do? Not being able to eliminate uncertainty completely, they can plan precautionary measures aimed at minimising the negative effects of uncertainty as it transforms itself and moves across the economic system. For example, it is hard to assess if and when a price bubble may develop in the housing market. Faced with that uncertainty, supervisory authorities can tighten the lending conditions for mortgage loans and require banks to strengthen their loss-absorbing capacity. With such prudential framework in place, there is some assurance for banks, households and construction firms that authorities will not let uncertainty about the housing bubble damage the economy. In that respect, we are pleased that this thematic issue has been able to consider several aspects of uncertainty relevant for the analysis of employment, macroprudential policy, foreign direct investment, and public budget management. This issue starts with two macroeconomic papers.

The first paper, "Traditional or social media: which capture employment better?" (by Marija Hruška and Mirjana Čižmešija) deals with the topic of measuring uncertainty *per se*. The authors evaluate the possibility of capturing the US economic uncertainty via big data. Their assessments capture two different data sources. The first is X (formerly Twitter) posts covering economic policy uncertainty, the second mines news media articles about the same topic, in the vein of Baker, Bloom and Davis (2016). Their econometric and machine learning models pinpoint the traditional media sources as the ones with higher predictive accuracy for the evolution of US employment.

In the second paper, "Macroprudential stance assessment: the case of Croatia", Tihana Škrinjarić provides a framework for assessing the effectiveness of macroprudential policy in Croatia. Apart from providing a meticulous review of related studies, this paper acts as a methodological guide for constructing a macroprudential policy index by assessing different empirical challenges of building such an indicator in great detail. The empirical part of the paper focuses on Croatia as a country with an active macroprudential policy, with the aim of performing an innovative assessment of the costs and benefits of macroprudential instruments.

Marijana Andrijić, in her paper "Uncertainty, populism and foreign direct investment: the state of play in economic research" takes a bird's-eye view of uncertainty and its wider socio-economic consequences. After a thorough theoretical examination of economic uncertainty and its empirical metrics, the author discusses the complex interplays among populism, foreign direct investment, and uncertainty. The literature review finds an important role for structural fiscal policies in moderating the discussed relationships.

Enkeleda Lulaj, on the other hand, focuses on the aspects of public budget management amidst uncertainty. In the paper "Thriving amidst uncertainty: a financial blueprint for the public budget", Lulaj econometrically examines survey responses from selected municipalities in Kosovo, finding that several budget-related con-

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structs are very important for efficient macroeconomic management. For example, as the respondents declared, budget preparedness significantly contributes to accurate budget management under uncertainty; budget empowerment feeds into employment opportunities and social stability; budget governance should reduce corruption and support sustainability; etc.

As the Editors of this special issue, we want to extend our deepest gratitude to the Editorial Board of *Public Sector Economics* for giving us the opportunity to prepare this issue and for their technical support, advice and guidance. We would also like to express our appreciation to the authors and reviewers who contributed to this issue for their hard work, dedication, and perseverance through several iterations of reviews.

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Traditional or social media: which capture employment better?

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Abstract

Political discourse has the ability to spread either uncertainty or calm among the population. Economic upheavals of considerable magnitude can also spread ambiguity. Both newspaper articles and Twitter posts reflect important events that have the potential to increase or decrease uncertainty from a citizen's perspective. We employ two measures of media uncertainty, one reflecting the uncertainty perceived by journalists and the other characterizing the uncertainty associated with Twitter users. More specifically, we use the Twitter Economic Uncertainty and the Economic Policy Uncertainty Index. To investigate which uncertainty source better captures employment variations, we apply a regression decision tree and linear regression. Our results speak in favour of the more traditional media uncertainty source. Linear regression outperforms the decision tree in both models. Namely, we find a statistically significant negative relationship between both uncertainty measures and employment, while controlling for other macroeconomic aspects.

Keywords: economic policy uncertainty, employment, machine learning, decision tree, Twitter economic uncertainty

1 INTRODUCTION

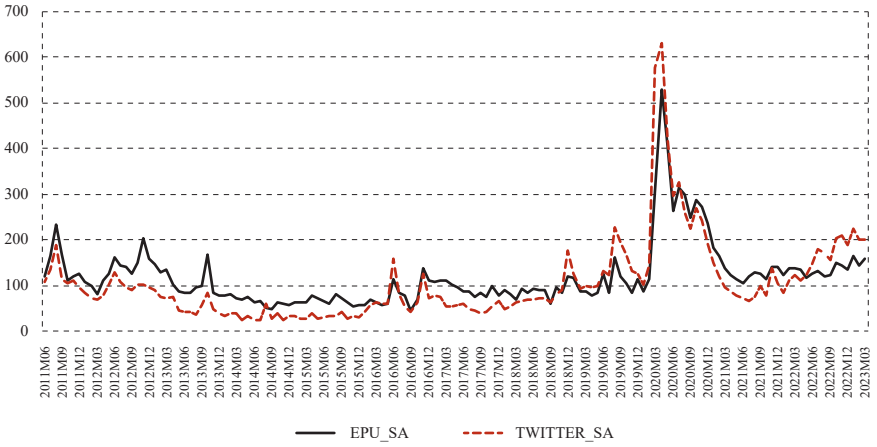
The media is believed to be the main source of information for economic agents seeking knowledge about various economic indicators and trends in economic policy. As a result, economic agents rely on newspaper articles to form their perceptions of the uncertainty inherent in economic policy. One method used to gauge uncertainty involves analysing the frequency with which predefined keywords related to uncertainty are found in media reports. Baker, Bloom, and Davis (2016) have done notable work in this area, seeking to measure uncertainty in economic policy by examining the content of widely accessible media reports. Baker, Bloom, and Davis (2016) use newspaper articles to quantify an index of economic policy uncertainty in an aggregate manner, and specific policy categories. To determine if an article reflects uncertainty in economic policy, they look for at least one keyword from each of three selected word groups: economy, policy, and uncertainty. For example, an article that contains the following paragraph: "When people argue that uncertainty about taxation and regulation is freezing corporate decision-making, they are generally arguing that more certainty would be a good thing for the economy" (Appelbaum, 2013) would be classified as an article that depicts economic policy uncertainty: it contains the following three words: "economy" [from the word group economy], "uncertainty" [from the word group uncertainty], and "regulation" [from the word group policy]. A negative relationship is found between media uncertainty measured via the Economic Policy Uncertainty (EPU) Index and macroeconomic variables such as output, investment, and employment by various authors such as Baker, Bloom and Davis (2016), Nilavongse, Michal and Uddin (2020), Colombo (2013), and Alam and Istiak (2020). There is growing literature that uses newspaper articles and media in general to measure economic uncertainty.

In July 2023, Twitter rebranded to X. However, below the name Twitter will be used as it coincides with the analysed data frame. Twitter users in the US account for about 22% of the total adult population (Baker et al., 2021), or about 76 million users (World Population Review, 2023). The US has the highest number of Twitter users in the world, followed by Japan and India. Therefore, the US Twitter posts could adequately capture the prevailing uncertainty in the US population. Baker et al. (2021) quantify economic uncertainty through Twitter posts. This indicator reflects the perceptions and attitudes of Twitter users. The limitation of the Twitter economic uncertainty (TEU) is the availability of Twitter posts only from June 2011 until mid-April 2023, while the newspaper uncertainty indicator is available from January 1985 and is updated on a regular basis. The limited time frame of the TEU index comes from the removal of academic research access to the Twitter application programming interface. On the one hand, the TEU index is a relatively new measure of uncertainty, and its impact on macroeconomic variables is still insufficiently explored. On the other hand, correlation, and causality between TEU and cryptocurrency markets has received considerable scientific attention (Gok, Bouri and Gemici, 2022), especially during the COVID-19 pandemic (Aharon et al., 2022). A common conclusion is that the TEU index has as negative effect on cryptocurrency returns (Bashir and Kumar, 2022).

Both the EPU and the TEU show similar movements and depict important events such as the US debt ceiling crisis, US-China trade conflicts, and the COVID-19 crisis. Therefore, Twitter users and journalists have similar perceptions of uncertainty in the economy. EPU and TEU are shown in graph 1.

Graph 1

Economic policy uncertainty and Twitter economic uncertainty in the US, June 2011 – March 2023



Source: Authors' according to www.policyuncertainty.com.

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Newspapers are available to a wide variety of people, while Twitter posts are read by only a part of the population. Therefore, we assume that there is a more intense transmission channel between the journalist's impression of uncertainty and the transfer of uncertainty perceptions to the readers of the newspapers than the transmission from the authors of Twitter posts to Twitter users. Due to consumer expectations, which are subjective and adaptive, higher media-related uncertainty would lead to a lower willingness to spend and decrease the estimate of individual's future income and mood or attitudes towards spending. In other words, higher media uncertainty will lead to lower consumption, employment, and output. The aim of this paper is to investigate the impact of uncertainty (measured through newspaper media and social media) to employment. Also, we test the effectiveness of parametric vs. nonparametric methodologies in capturing the uncertainty-employment relationship, and at the same time econometric and machine learning methods.

The remainder of the paper is organized as follows. First, a brief literature review is presented. Afterwards, the data and methodological approach are described. Finally, the results of our econometric and machine learning analysis are provided, followed by a concise conclusion.

2 LITERATURE REVIEW

This literature review is divided into three parts. First, we show the theoretical background of the relationship between uncertainty and employment. Second, we focus on the quantification procedure of EPU and the literature depicting the relationship between EPU and a set of macroeconomic variables. Finally, the TEU quantification procedure is presented, followed by a discussion of the few papers that tackle uncertainty measured through Twitter posts (hereafter tweets).

Rising economic uncertainty can slow down employment if employers decide to postpone job creation. The effects of economic uncertainty on employment are empirically investigated by Baker, Bloom and Davis (2016), and Jurado, Ludvigson and Ng (2015). The authors show a negative relationship between uncertainty and employment. The theoretical background for such conclusions lies in the theory of irreversible decisions via the real-options transmission channel. The real-options transmission mechanism is explained by Bloom (2014) as two solutions that can be applied to businesses or consumers depending on economic circumstances. If the economy is in stable conditions, i.e. there is no pronounced uncertainty, businesses will act, which means they invest and create new jobs. On the other hand, rising uncertainty in the economy leads to postponed actions on both sides, businesses and consumers. Businesses delay their activities as they decide to wait for better economic circumstances to employ and invest. Consumers can postpone their decisions regarding expenditures and increase their savings. Such mechanisms are present only in situations where the decisions are irreversible.

Baker, Bloom and Davis (2016) construct the newspaper media indicator of uncertainty, namely the EPU index. It should be noted that the newspapers used in

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uncertainty measuring include the 10 most popular US newspapers: USA Today, Miami Herald, Chicago Tribune, Washington Post, Los Angeles Times, Boston Globe, San Francisco Chronicle, Dallas Morning News, the New York Times, and the Wall Street Journal. The EPU indicator is constructed through a series of steps. Firstly, media articles must contain at least one keyword from each of the following three groups: economy, policy, and uncertainty. To qualify for inclusion, media articles must contain at least one word from all three word groups: "economic" or "economy"; "uncertain" or "uncertainty"; "Congress", "deficit", "Federal Reserve", "legislation", "regulation", "White House". After the frequency count, such time series are divided by the total number of all articles in each newspaper, and afterwards divided by their standard deviation. Further, the average across all ten newspapers is calculated. Finally, the series are normalized. Baker, Bloom and Davis (2016) have shown that the EPU indicator registers important events such as presidential elections, Gulf Wars, the 9/11 attacks, the Lehman Brothers collapse, and the debt-ceiling dispute. Also, EPU is closely related to other important uncertainty measures, such as the implied stock market volatility, and uncertainty measured via the Federal Reserve System's Beige Books.

Baker, Bloom, and Davis (2016) apply a VAR model to 12 countries and show that EPU innovations anticipate declines in investment, output, and employment. Numerous authors have also demonstrated a negative relationship between EPU and a set of macroeconomic variables.

Empirical research shows that European economies, as well as the economies of other countries around the world, react to changes in the US EPU index. Thus, industrial production (Nilavongse, Michal and Uddin, 2020), aggregate price indices (Colombo, 2013), and interest rates (Alam and Istiak, 2020) usually decline after a shock to the EPU index in the US. Stockhammar and Osterholm (2016, 2017) show significant negative EPU effects on GDP growth, especially on investment growth and export growth in small open economies. Using monthly micro-panel data for urban households in China, Aaberge, Liu, and Zhu (2017) find a negative correlation between aggregate consumption and EPU. With the emergence of Bitcoin and other cryptocurrencies, many researchers began to investigate the impact of the EPU index on Bitcoin returns (Demir et al., 2018; Wu et al., 2021). The authors find predictive characteristics of the EPU index in terms of Bitcoin returns and show that the relationship between those two variables is negative.

To sum up, previous research shows that macroeconomic variables react more strongly to changes in the US EPU index than to changes in domestic uncertainty indices (Colombo, 2013; Alam and Istiak, 2020).

Uncertainty shocks create short strong recessions and recoveries (Bloom, 2009). Namely, major crises and shocks increase uncertainty while production and investments decrease, and unemployment rises. After the shock, the increased dynamics of change cause an excess of production, employment, and productivity. This leads

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to output, employment, and productivity overshoot in the medium term. The impact of the EPU index on selected macroeconomic variables increases after the 2008 financial crisis (Coronado, Martinez and Venegas-Martinez, 2020; Kido, 2016). A general conclusion is reached that recession and crisis periods increase the impact of the EPU index on macroeconomic variables. Čižmešija, Lolić and Sorić (2017) have presented interesting results using the Toda-Yamamoto causality test between the EPU index and economic activity in the US and several European countries. Their conclusion is that causality exists in both directions only for the US, while only in one direction for France and Germany. The next conclusion is that the main result did not change during and after the 2008 recession. Further, Karnizova and Li (2014) apply a probit recession forecasting model and confirm that the EPU index can predict a recession up to five quarters in advance.

Researchers use different methodological approaches in investigating the effects of economic policy uncertainty shock on macroeconomic variables. Most authors apply the Structural VAR model (Nilavongse, Michal and Uddin, 2020; Colombo, 2013, Alam and Istiak, 2020; Coronado, Martinez and Venegas-Martinez, 2020). Lolić, Sorić and Logarušić (2022) made an additional contribution to the methodological improvement of the analysis of the relationship between EPU and macro-economic variables. These authors apply ensemble learning techniques (ensemble linear regression, and random forest) and gradient boosting techniques (Gradient Boosting Decision Tree and Extreme Gradient Boosting). Their main conclusion is that EPU is more strongly correlated to financial volatility measures than to consumers' assessments of uncertainty.

On the other hand, Baker et al. (2021) quantify economic uncertainty using tweets. Namely, the authors count the occurrence of the terms related to "economy" and "uncertainty" in tweets. Keywords related to uncertainty are: "uncertain", "uncertainly", "uncertainties", "uncertainty". The second set of terms is connected to economics: "economic", "economical", "economically", "economics", "economies", "economist", "economists", "economy". The data spans from June 2011 and is updated every day. Several measures of Twitter uncertainty are derived. First, an English-language version of the TEU indicator which captures only tweets written on English. The second indicator includes only posts from Twitter users located in the US. Nevertheless, many tweets are not specifically related to the area of the US. Baker et al. (2021) apply a random forest model for classifying tweets written in the US. The third variation of the Twitter uncertainty indicator uses weights for each tweet regarding the number of times it is reposted. Lastly, to control for changes in the intensity of Twitter usage over time, the fourth indicator scales the number of tweets each day by the total number of tweets. Baker et al. (2021) compare their four TEU indicators with the EPU index from Baker, Bloom and Davis (2016). The highest correlation is present in the case of TEU connected to Twitter users located in the US. In a monthly specification, the correlation coefficient is 0.90. Like the EPU indicator, the TEU reflects important economic disturbances such as the US debt ceiling crisis, US-China trade conflicts, and the COVID-19 crisis.

The TEU index was developed in the time of the COVID-19 pandemic and studied primarily in the context of predicting changes in financial markets, but it also has forecasting power in terms of firms' bankruptcy. Fedorova et al. (2022) employ machine learning methods in the sample of French, Italian, Russian, and Spanish firms to show that the inclusion of the TEU index into bankruptcy prediction models significantly increases their accuracy. Bashir and Kumar (2022) use a simple linear regression, quantile regression (QR), exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model, and sentiment analysis with the aim of investigating the impact of the TEU index on the performance of cryptocurrencies. Aharon et al. (2021) find a strong causal link between the TEU index and cryptocurrency returns. In their research, they use a battery of methods: quantile regressions, Granger-causality in distributions using copula functions, and directional predictability tests. The effects of TEU on stock and energy market are also investigated. Lee, Choi and Kim (2023) show that shocks in the TEU index are significantly related to future returns in the Chinese stock market, investment, consumption, unemployment, and output. The standard uncertainty index of the Chinese economy is less efficient than the TEU index. Further, the recent energy crisis has brought the need for better forecasting of energy prices. Uncertainty indices are also used for this purpose. The TEU index and the corresponding methodological modifications may significantly improve prediction accuracy for oil price future volatility (Lang et al., 2022).

The calculation of TEU is being methodologically improved, even though it is a relatively new indicator. Lang et al. (2022) developed the Twitter-based Market Uncertainty (TMU) index using a novel Markov-regime GARCH-MIDAS model, which showed excellent prognostic properties in predicting oil prices during COVID-19 pandemic. Yesiltas et al. (2022) formulated a Twitter-based high-frequency Economic Policy Uncertainty (TEPU) index based on tweets of experts opinions on the topic. Comparing changes in the TEPU index and in financial indicators (exchange rate and stock market index), the authors find that they are correlated. In addition, it is observed that fluctuations in the TEPU index can be a key indicator for predicting the country risk premium in emerging market economies.

The literature discussed above can be summed up as follows. There is a negative relationship between EPU and a set of macroeconomic indicators as investment, output, employment, interest rates, export, and consumption. There is also a negative relationship between TEU, and firm performance indicators and cryptocurrency returns. To the best of our knowledge, the previous literature has not tackled the question of which media uncertainty measure captures the macroeconomy better. To be specific, in this paper we investigate whether EPU or TEU has better explanatory power regarding employment in the US. To do so, we will apply two methodological approaches that are explained in continuation of this paper.

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3 DATA AND METHODOLOGY

In this section the analysed data and methodological approach are briefly explained. Our dataset includes the following variables for the US: employment, industrial production, S&P 500, interest rate, EPU, and TEU. Employment represents the employment-population ratio expressed as percentage in monthly frequency, and seasonally adjusted. The industrial production is in monthly frequency and seasonally adjusted. The Federal Funds Effective Rate (interest rate) is in percentage, aggregated from daily to monthly frequency using simple averaging, and seasonally adjusted using the ARIMA X-12 method. Also, the TEU index is in daily frequency, aggregated to monthly frequency using averaging. EPU index is in monthly frequency, while both media uncertainty indices are seasonally adjusted with ARIMA X-12. Employment, industrial production, and interest rate are from Federal Reserve Bank of St. Louis (FRED), while the S&P 500 is from finance.yahoo.com, and the EPU and TEU are from policyuncertainty.com. The data span is from June 2011 to February 2023. The augmented Dickey-Fuller test results are in the appendix shown in table A1. Due to the unit root test results, variables are included in their levels, except the S&P 500 and interest rate which are in first and second differences, respectively.

The analysis consists of two methodological approaches. The main idea is to use simple but powerful techniques to investigate whether parametric or nonparametric methods are more suitable for explaining employment via media uncertainty. Therefore, we use a linear regression model and decision tree model to determine the relationship between our variables of interest. The regression model is very common in economic analysis and a simple technique. The applied model is shown in equations 1 and 2.

$$emp_t = c + indp_t + kta_t + sp500_t + epu_t + \varepsilon_t \tag{1}$$

$$emp_t = c + indp_t + kta_t + sp500_t + teu_t + \varepsilon_t \tag{2}$$

The notation *emp* represents employment, *indp* industrial production, *kta* is interest rate, *sp500* S&P 500, *epu* and *teu* are the media uncertainty indices EPU and TEU. The model with a better fit indicates which uncertainty type is more successful in explaining employment in the US.

The variable selection is based on the economic theory and is driven by the idea of parsimony. If such a parametric approach meets high dimensional data, some of the variable selection procedures are usually applied (for example stepwise regression). A competitor to the linear regression, including stepwise regression, is a regression decision tree (Breiman, 2017).

Therefore, the second methodological approach applied in this paper is a machine learning technique. The decision tree model is developed by Breiman et al. (1984). It is a nonparametric approach that can be used both in classification and regression

tasks. Our variables of interest are continuous numerical values, which implies the application of a decision tree regression model. The main idea behind this machine learning model is to partition the input space by using a variable that provides the best split of the input data (regressors). The regression decision tree algorithm (Breiman, 2017) is shown below.

1) The mean squared error can be formulated as follows:

$$R(d) = N^{-1} \sum_{n} \left(y_n - d(x_n) \right)^2 \tag{3}$$

where y is the dependent variable, and $d(x)$ is the estimate of dependent variable.

2) We search for the value of $y(t)$ that minimizes $R(d)$. This is the average of y_n for all pairs (x_n, y_n) which minimize $y(t)$. This notation can be shown as follows:

$$\overline{y}(t) = N(t)^{-1} \sum_{x_n \in t} y_n \tag{4}$$

where $N(t)$ is the total number of pairs in t.

3) Therefore, the predicted value in any node t is $\overline{y}(t)$.

4) We replace the notation $R(d)$ with $R(T)$.

$$R(T) = N^{-1} \sum_{t \in \widetilde{T}} \sum_{x_n \in t} \left(y_n - \overline{y}(t) \right)^2 \tag{5}$$

$$R(t) = N^{-1} \sum_{x_n \in t} \left(y_n - \overline{y}(t) \right)^2 \tag{6}$$

$$R(t) = \sum_{t \in \widetilde{T}} R(t) \tag{7}$$

For every node t, the notation $\sum_{x_n \in t} \left(y_n - \overline{y}(t) \right)^2$ is the within node sum of squares, i.e. the total of squared deviations of y_n from the mean. The sum over all $t \in \widetilde{T}$ represents the total within node sum of squares. Multiplying this notation with N^{-1} gives the average within node sum of squares.

5) The best split from a set of splits S for a terminal node t in $\widetilde{T}$ is the one which the most decreases $R(T)$. Any split s of t that forms t_L and t_R can be written as:

$$\Delta R(s,t) = R(t) - R(t_L) - R(t_R) \tag{8}$$

6) The best split s^* can be defined as:

$$\Delta R(s^*, t) = \max_{s \in S} \Delta R(s,t) \tag{9}$$

This procedure includes iterative splitting nodes to maximize the decrease in the mean squared error ($R(T)$). We grow a tree starting from the root node, splitting the data into two branches that maximize the decrease in the $R(T)$. The estimated two models use the same variables as the regression models, i.e. the endogenous variable is employment, while candidates for exogenous variables are industrial production, interest rate, S&P 500, and EPU for the first model, while EPU is replaced with TEU in the second model. The decision tree model is estimated in the programming language R within the package *rpart*.

4 EMPIRICAL RESULTS

The previous literature (see, e.g. Baker, Bloom and Davis, 2016) shows negative connectedness between uncertainty measures and employment. A negative relationship is expected because higher uncertainty leads to more careful decision-making regarding different economic activities. This means that economic agents, i.e. consumers and firms, are more likely to spend less during uncertain economic times, and wait for better economic circumstances to invest, employ, and spend. The recent COVID-19 pandemic is an extreme example of an economic activity slowdown when most economic activities literally stopped. High uncertainty regarding health slowed down consumers spending, firms' investment and employment, export, and other economic activities.

The results of the econometric regression analysis in levels are shown in tables 1 and 3. The first estimated model, which is the newspaper media model that includes EPU as an exogenous variable, is shown in table 1. The first model depicts a statistically significant relationship between industrial production, interest rates, and EPU with employment. The social media model shows that the media variable is also statistically significant in the model shown in table 3. The relationship between TEU and employment is negative, as expected.

Table 1

Newspaper media regression analysis results in levels

Variable	Estimate
Intercept	36.195***
Industrial production	0.239***
Interest rate	-0.837**
S&P500	-0.001
EPU	-0.008***
R^2	0.735

*Note: ***, **, * depict 1%, 5%, and 10% significance levels, respectively.*

Source: Authors' calculation.

Table 2

Newspaper media regression analysis results with uncertainty in first lag

Variable	Estimate
Intercept	35.114***
Industrial production	0.250***
Interest rate	-0.373
S&P500	-0.001
EPU (lag 1)	-0.007***
R^2	0.731

*Note: ***, **, * depict 1%, 5%, and 10% significance levels, respectively.*

Source: Authors' calculation.

Table 3

Social media regression analysis results in levels

Variable	Estimate
Intercept	29.139***
Industrial production	0.304***
Interest rate	-0.955**
S&P500	-0.001*
TEU	-0.003***
R^2	0.685

*Note: ***, **, * depict 1%, 5%, and 10% significance levels, respectively.*

Source: Authors' calculation.

Table 4

Social media regression analysis results with uncertainty in first lag

Variable	Estimate
Intercept	30.821***
Industrial production	0.288***
Interest rate	-0.464
S&P500	-0.001
TEU (lag 1)	-0.004***
R^2	0.699

*Note: ***, **, * depict 1%, 5%, and 10% significance levels, respectively.*

Source: Authors' calculation.

Both analysed models show a statistically significant relationship between uncertainty measures and employment, as expected and as shown in previous studies (see, e.g. Baker, Bloom and Davis, 2016; Baker et al., 2021). The newspaper media regression model shows a better model fit. The coefficient of determination for the first model is 0.735, while the coefficient of the social media regression model is 0.685. Therefore, we could note that EPU is better in explaining employment variations than TEU. Although the US is the country with the largest proportion of population that uses Twitter, tweets still do not capture the prevalence of

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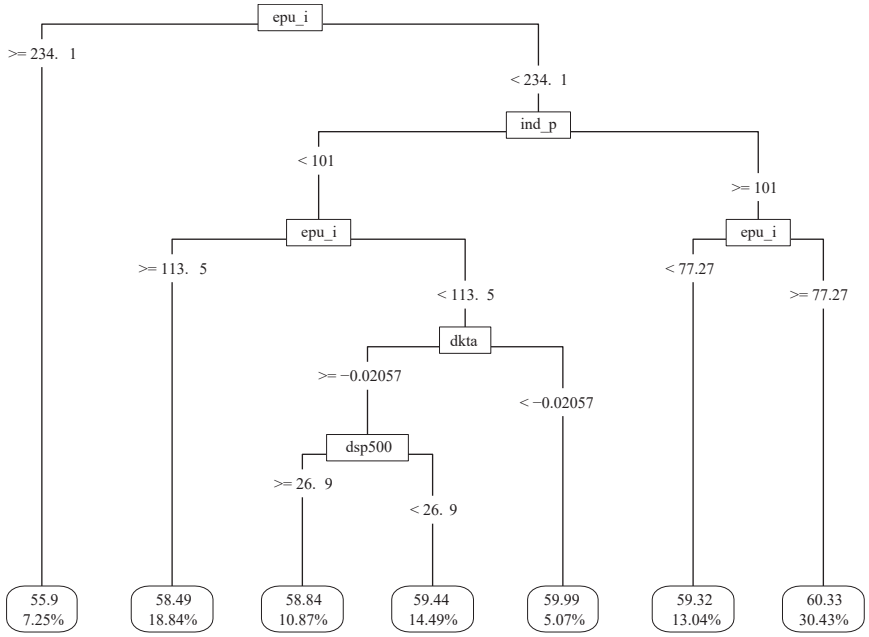
uncertainty in the population better than traditional media. Despite the high popularity of Twitter in US, the Twitter uncertainty indicator has not managed to outperform the uncertainty captured through classic newspaper articles. There are two possible reasons for such results. The first is that Twitter posts are not written and read by the total US population, rather one fifth of the US population. On the other hand, newspapers are widely available. In the time of globalisation and easy access to the internet, newspaper articles are more than ever before available to the public. The second reason for the better performance of EPU in explaining employment could be that there is additional space for improvement in the construction of the TEU indicator. Some methodological alternatives to Twitter uncertainty construction have already been suggested in the literature (for example Lang et al., 2022; Yesiltas et al., 2022).

The previous analysis shows the contemporaneous relationship between uncertainty measures and employment. Additionally, we investigate this relationship including one lag in both uncertainty measures, EPU and TEU. The inclusion of one lag in EPU and TEU in our models could show the predictive properties of EPU and TEU. The regression results with one lag in uncertainty measures are shown in tables 2 and 4. We can conclude that in both models, the relationship remains negative and statistically significant.

As an alternative approach to model the impact of uncertainty to employment, we estimate a regression decision tree model. Precisely, four regression decision tree models as comparison to the shown linear regression models. The estimated decision tree models are shown in graphs 2 – 5. Each leaf represents the average value of the dependent variable employment to total population ratio for the observations that are included in it.

GRAPH 2

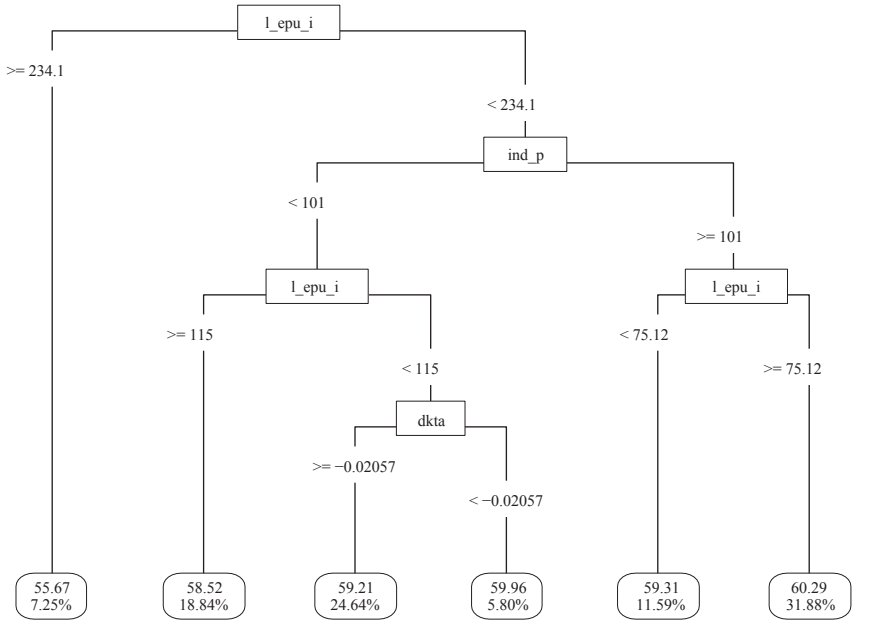
Newspaper media decision tree results in levels



Source: Authors' calculation.

GRAPH 3

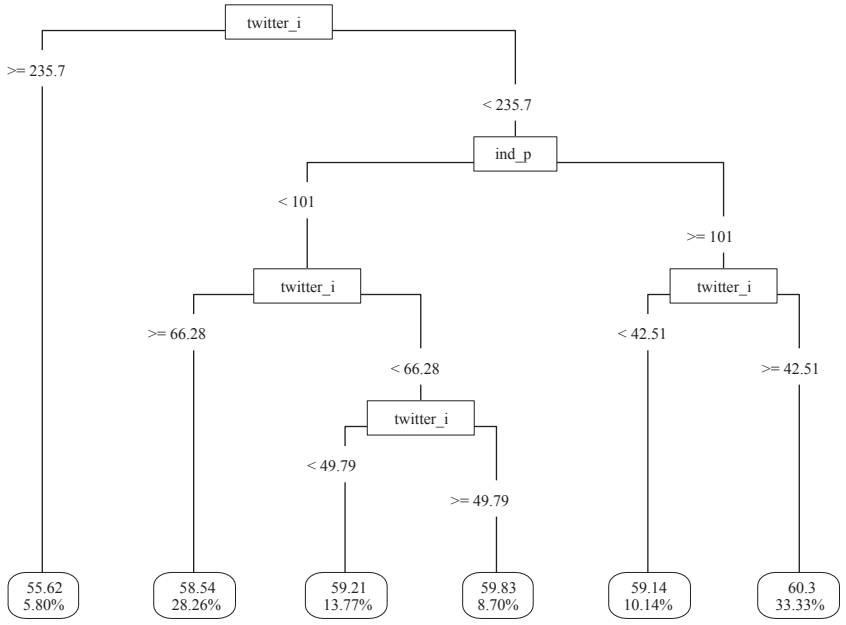
Newspaper media decision tree results with uncertainty in first lag



Source: Authors' calculation.

GRAPH 4

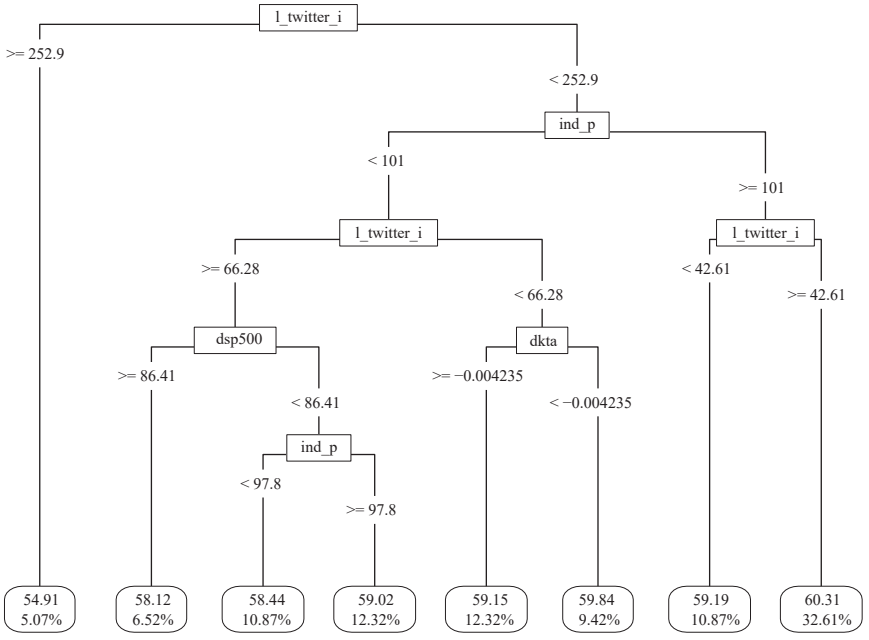
Social media decision tree results in levels



Source: Authors' calculation.

GRAPH 5

Social media decision tree results with uncertainty in first lag



Source: Authors' calculation.

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The newspaper media model (graph 2) shows that the variable EPU (in levels) is chosen at the root node. The left branch shows the scenario when EPU is greater than or equal to 234.1, while the right branch presents an EPU lower than 234.1. At the left branch, variable EPU maximizes the decrease in the mean squared error in this node. For EPU greater than or equal to 234.1 the employment to total population ratio is 55.9%. For lower uncertainty levels than 234.1 employment is between 58.49% and 60.33% depending on the levels of industrial production, interest rates, and S&P 500. As with the linear regression models, we can conclude that higher uncertainty levels lead to lower employment, and vice versa. Further, the combination of lower EPU levels and higher industrial production leads to higher employment. The second model shown in graph 3 uses the EPU in first lags. The conclusion remains the same, i.e. higher uncertainty levels lead to lower employment, and vice versa. The coefficients of determination for our regression decision tree model in levels and including one lag in EPU are 0.572, and 0.540, respectively.

Our second set of models, shown in graphs 4 and 5, considers TEU as an alternative uncertainty variable to EPU. The regression decision tree model is similar to the newspaper decision tree model, and the main conclusion stays the same. That is, higher uncertainty levels (higher TEU) are connected to lower employment levels in the US. The coefficients of determination for our regression decision tree model in levels, and including one lag in TEU are 0.610, and 0.638, respectively.

Comparison of our linear regression models with the regression decision tree models shows that linear regression provides a better fit. Therefore, the linear regression would be preferred for modelling employment variations via uncertainty and macroeconomic variables. The second conclusion is that EPU has better explanatory power than TEU. Therefore, newspaper articles are a better source for measuring uncertainty in the economy than tweets. Nevertheless, this might not always be true. There is additional space for improvement of the Twitter uncertainty indicator.

Media uncertainty indicators have also experienced negative criticism. Some of the negative connotations refer to media that favour negative over positive news. The media might be prone to publishing more negative news with catchy titles to attract more readers than positive news. But does this affect the media uncertainty indicators? The quantification procedure for both media indicators, namely economic policy uncertainty and Twitter economic uncertainty, considers the total number of articles or Tweets in each day/month so that the rising number of published articles or tweets through time has no effect on uncertainty levels. Another critique regarding media uncertainty indicates that media could be politically aligned more to the left or to the right. Hemphill, Culotta and Heston (2016) show that Democrats and Republicans use different Twitter hashtags to discuss overlapping issues. Authors Hemphill, Culotta and Heston (2016) calculate Twitter polarization scores based on the connectedness between hashtags and political parties.

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Twitter hashtags are effective measures for the estimation of political polarization. In contrast, Niven (2001) finds no media bias towards political orientation but shows the dominance of negative news over positive ones. Partisanship bias is a strong loyalty to a political party or ideology that can be more left or right aligned. Azzimonti (2021) shows that higher partisan conflict leads to higher uncertainty and consequently can cause economic crises. Further, this can pause reforms and disrupt economic activities. Political polarization is important not only for political scientist, but also for economists as it strongly impacts economic policies. Azzimonti-Renzo (2023) emphasizes that higher levels of partisanship can lead to more pronounced policy uncertainty, which delays consumer spending, employment, investment, and aggregate economic growth. Shultziner and Stukalin (2021) discuss partisan bias in the US media. Authors find that partisan bias can be easily observed through the types of newspaper articles that the media highlights on their cover page and in the sizing and emphasizing of articles.

As already mentioned, uncertainty is a latent variable and there is no such thing as a one fits all measure of uncertainty that is suitable for all macroeconomic and/or financial problems. This paper has shown that EPU is better at explaining employment in the US than TEU. Those two uncertainty measures are chosen as they depict the picture of macroeconomic uncertainty better than other known uncertainty measures. However, media uncertainty indicators can be constructed using different sets of keywords to depict specific macroeconomic topics. Therefore, one suggestion for future research could be to construct specific media uncertainty indices connected to employment. Constraints of this research are the application of two methodological aspects and limited data availability. This leads to another potential direction of future research which would include other machine learning and econometric methods.

Baker et al. (2021) point out that using Twitter as a database source for quantifying economic uncertainty has a few limitations. First, as already mentioned, the database has a limited time span, starting only in June 2011. Second, Twitter users are younger population, so they do not represent the whole US population. Therefore, we already point out that only about 22% of the total adult population uses Twitter, while newspapers are available to the total population. Finally, bots are a real problem in the online world. Bots can generate automated tweets and disseminate false information. Recently, bot detection has improved (see for example Antenore, Camacho Rodriguez and Panizzi, 2023).

5 CONCLUSION

Uncertainty can be measured through different approaches, for example through media articles, macroeconomic volatility or professional forecaster disagreement. This paper focuses on measuring uncertainty through newspaper articles and Twitter posts. We use the two constructed uncertainty measures from Baker, Bloom and Davis (2016), and Baker et al. (2021) to investigate which one has better explanatory power for employment in the US. We apply two methodological approaches,

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linear regression and a regression decision tree. The estimated models show statistically significant negative relationship between both uncertainty measures and employment while controlling for other macroeconomic variables like the industrial production, interest rates, and S&P 500. Our results speak in favour of linear regression and uncertainty measured through newspaper articles. Although Twitter is popular in the US population, the availability of newspaper articles to almost every citizen in the US could be one of the reasons why modelling employment with EPU provides a better fit. Our recommendation for future research is that it should focus on additional improvements in the Twitter uncertainty indicator so that it can better capture the uncertainty in the total US population.

Disclosure statement

The authors have no conflicts of interest to declare.

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TABLE A1

Unit root test results

	Included in test equation		
Variable	**Intercept**	**Trend and intercept**	**None**
Employment	-3.406**	-3.427*	0.161
Industrial production	-2.861*	-2.919*	0.430
d(S&P500)	-14.840***	-14.793***	-14.365***
d_2(interest rate)	-17.152***	-17.187***	-17.174***
EPU	-2.948**	-3.345*	-1.471
TEU	-2.780*	-3.542**	-1.619*

*Note: ***, **, * depict 1%, 5%, and 10% significance levels, respectively.*

Source: Authors' calculation.

Macroprudential policy stance assessment: the case of Croatia

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Article**
JEL: E32, E44, E58, G01, G28, C22
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Abstract

This paper contributes to the literature on empirical macroprudential policy (MP) stance assessment. The main purpose of this framework is to evaluate the potential benefits and costs of MP tools and instruments that have been employed in a financial system. We focus on a country that has a fairly active macroprudential policy to establish the initial framework for assessing the effectiveness of macroprudential policy in Croatia. A quantile regression approach is used in order to evaluate the efficiency of the MP stance, on quarterly data ranging from the mid-1990s until 2022. It is shown that somewhat different results could have been obtained if a variable definition has been employed. Measurement of the MP stance is difficult, then, as it depends on the definition of the macroprudential policy variable, selection of other important variables in the analysis, as well as other methodological factors.

Keywords: systemic risk, macroprudential policy, financial stability, financial conditions, quantile regression, policy assessment, macroprudential stance

1 INTRODUCTION

Today, most European Union countries have a fairly active macroprudential policy (MP), which has received more attention since the Global Financial Crisis (GFC) (see Carstens, 2021; Ampudia et al., 2021; or Portes et al., 2020). In the last couple of years, empirical work started to focus on answering the question how effective this policy is, and how its stance is to be measured. Compared to monetary and fiscal, macroprudential policy is still relatively new, and much more work must be done to answer this question (ESRB, 2021). To measure the MP stance, we should first define it. In 2019, ESRB defined the MP stance as "the balance between systemic risk and resilience relative to financial stability objectives, given implemented macroprudential policies; the stance metric represents residual systemic risk in the financial system, relative to a neutral level of risk considered sustainable in the long run", and it establishes a relationship between macroprudential policy actions and the financial stability objectives (ESRB, 2019, 2021)[1]. This is a useful concept, as it could enable the policymakers to get a better understanding of MP effects, it could foster better policy decision-making, by reducing the policy inaction bias and would enable cross-country comparisons. Swedish authorities (2022) agreed that one of the problems in the EU context is the policy inaction bias, and that the European Systemic Risk Board (ESRB) should make regular assessments of the macroprudential policy stance across countries.

To measure the MP stance, literature[2] developed the Growth-at-Risk framework (GaR), as it relates current macro-financial conditions in the economy and MP measures to the entire distribution of the future GDP growth. One important aspect that is looked upon here is the so-called tail risk, i.e. what the worst possible outcomes of future real growth are. This is important, as financial stability risks lie in those tail risks, which we call systemic risk. Reducing these risks in the financial

[1] However, there is still no consensus on this, as found in Arslan and Upper (2017).
[2] Besides the papers mentioned below, see, e.g. Škrinjarić (2023d, 2024).

system could lead to a lower probability of a future crisis[3], and MP could increase the financial system's resilience (Sánchez and Röhn, 2016). Thus, utilizing the GaR approach to measure MP stance could help in obtaining information on how this policy affects real growth, and macroprudential instruments could be tailored accordingly. GaR framework can be used to estimate the inter-temporal trade-offs of the application of MP instruments, as we can estimate the "benefits" of limiting the extreme negative outcomes of future growth and compare them to the potential "costs" of limiting mean future growth (Škrinjarić, 2024). Several central banks already started publishing this concept regularly in their financial stability reports (Bank of Japan, 2019; Banque centrale du Luxembourg, 2022; Deutsche Bundesbank, 2018; Central Bank of Ireland, 2022; ECB, 2019), regular IMF reports (e.g., see IMF (2017) for earliest applications, or IMF (2022a) for latest), ECB reports (ECB, 2019), and regular risk identification (see Banco de España, 2021). Besides this specific characteristic of the MP stance assessment, the *at-Risk* approach also has other benefits, such as better forecasting capabilities compared to linear models, and in generating scenarios, as well as calibrating them in stress testing (see IMF, 2020; Flament, Hurlin and Lajaunie, 2023). That is why empirical research[4] that utilizes this framework has significantly increased in the last couple of years.

The purpose of this paper is to construct a GaR framework and empirically evaluate MP effects and stance for the case of an active country with respect to this policy: Croatia. To evaluate the MP stance, we collected quarterly data on selected macro-financial variables, and the MP index that captures all of the instruments and tools that have been used since the mid-90s to increase the resilience of the financial system. Then, we employ quantile regression as the methodological apparatus to estimate the GaR model for the Croatian case. There are two reasons why this single-country analysis could be interesting for an international audience. Firstly, GaR can be estimated either on a single-country basis, or in a panel quantile regression setting. The "one size fits all" approach in which countries are merged in a panel setting is not always the best[5]. Certain specificities characterize individual countries and their experiences over time, and a such information could be lost in

[3] Also, financial crises are costly. Reinhart and Rogoff (2009) estimate that crisis episodes are related to significant increases in government spending, as government debt increases on average by 86% for three years following a banking crisis. Laeven and Valencia (2012) estimated that the cumulative cost of banking crises is about 23% of GDP during the first four years of their duration, and fiscal costs amount to about 6.8% of GDP (Laeven and Valencia, 2013). Jordá, Schularick and Taylor (2013) found that financial crises are costlier than other recessions, as after five years, the real GDP per capita is lower by 5% compared to other "normal" recessions. Recoveries from financial crises are slower when compared to other types of crises, as found in Kannan, Scott and Terrones (2013). Other relevant findings about the costs of financial crises can be found in Koh et al. (2020), Jordá, Schularick and Taylor (2012), Claessens, Kose and Terrones (2012), and Papell and Prudan (2011). To avoid the costs caused by financial crises, systemic risk should be reduced, in which endeavour macroprudential policy plays an important role.

[4] Other interesting and important variables have been analysed, such as inflation-at-risk (López-Salido and Loria, 2021), bank capital-at-risk (Lang and Forletta, 2019; 2020), house-price-at-risk (Deghi et al., 2020), unemployment (Adams et al., 2020), or capital flows (Eguren-Martin et al., 2021; Gelos et al., 2022).

[5] E.g., Plagborg-Møller et al. (2020) found significant country heterogeneity in their results. After a battery of forecasts and estimations made, the authors found a couple of significant mean growth predictors, and fewer still for the volatility of growth, alongside different signs of results, and great cross-country heterogeneity in the results, which prompted the authors to conclude that some caution needs to be taken when one tries to build a theoretical model on empirical results.

a panel setting. Ampudia et al. (2021) list some other drawbacks of panel settings, which include the high diversity in macroprudential measures across countries being truncated into simple indicators. Budnik et al. (2021) comment that panel GaR estimation could be biased if time-invariant country characteristics are omitted from the model. Moreover, research on the importance of structural[6] differences among countries that affect the GaR results is growing (O'Brien and Wosser, 2022; Gächter, Geiger and Hasler, 2022). Secondly, another reason is the unique experience of Croatia's macroprudential policy in the last 20 years: even in the pre-GFC period, Croatia was among those countries that had a relatively active macroprudential policy (Vujčić and Dumičić, 2016). A lot of measures were employed to tackle credit growth (Bambulović and Valdec, 2020), and higher activity of MP employing different measures started in 2003 (Kraft and Galac, 2011). This means that the MP stance assessment of Croatia includes an interesting period in which both tightening and loosening measures were included. Not many countries have such data luxury.

The main findings of the paper show that it is actually difficult to evaluate the MP stance, due to several reasons. The variable that captures the MP instruments that are applied in practice has methodological challenges, as it captures many different tools policymakers apply. The source of data collection for this MP variable also matters, alongside how this variable is transformed and used in the model. The majority of the results turned out to be insignificant. There is somewhat indication that there could be positive effects of tighter MP today; however, the full results are still inconclusive, as the change of the model specification results in different overall interpretations. Future work should increase the number of observations to re-evaluate what was done in this study or try to conduct a panel analysis with countries in which MP was conducted in a similar way in the same period.

The rest of the paper is structured as follows. In section 2 we review literature that is related to the empirical approach of this study, whereas in section 3 we talk about some challenges in measuring macroprudential policy in practice. It is important to take this into consideration, as to measure the effects of MP, one needs to correctly define the variable. The fourth section describes the methodology and datasets used in this study and the empirical results are shown in the fifth section. The final, sixth section concludes the paper with some recommendations for future policy evaluation and empirical analyses.

[6] As an example, a credit-to-GNI (Gross National Income) gap and y-o-y GNI growth rates are used for the case of Ireland instead of GDP (Gross Domestic Product), as GNI is a better representation for this case, as well as ICSI (Irish Composite Stress Index) instead of CLIFS (Country-Level Index of Financial Stress) in O'Brien and Wosser (2021).

2 LITERATURE REVIEW[7]

The main focus of this research is empirical evaluation of the macroprudential policy effects on future real growth, so in this section, we focus mostly on papers that are closely related. This stream of research is relatively new, and is still developing. Thus, before analysing the main findings, we briefly review some of the seminal papers that are important for this empirical framework. The size and scope of related literature has increased significantly in the last couple of years since then. Still, conclusions about the effectiveness of MP are that knowledge is still limited due to a high degree of uncertainty (Buch, Vogel and Weigert, 2018), and a short history of the policy itself (ESRB, 2019). Nevertheless, the European Systemic Risk Board (ESRB, 2019; 2021) started to develop a framework in which the macroprudential policy measures are related to future GDP growth, based on the definition of macroprudential policy and financial stability itself.

A few major conclusions emerge from the related work discussed below. Although the number of papers that employ a GaR framework has significantly increased in the last couple of years, only a small number of papers include the macroprudential policy variable to assess the stance of the policy. The reasoning could be found in the relatively short time series of the macroprudential policy indicator for some countries and problems defining and measuring this variable. On the one hand, some countries only have a couple of years of MPI data, which disables a single-country analysis. On the other hand, MPI measurement problems could discourage some authors from undergoing such analysis, as different results can be obtained concerning the definition and transformation of the MPI variable. A lot of reviewed literature introduces country-specific financial conditions or financial vulnerability indicators. Authors are motivated by some specific dynamics, characteristics, and/or problems of a single country, and to account for this, variables are modified to reflect this in the best possible way.

2.1 INITIAL CONTRIBUTIONS

Seminal papers that introduced the GaR concept within the macroprudential policymaking were actually focused on better GDP growth forecasting. The main motivation was to enhance the approach of obtaining forecasts of tail risks of GDP growth, as models applied in practice and empirical research did not take into consideration the non-linear relationships between the macro-financial variables. Besides the usual variables that can be used for GDP growth forecasts, specific financial variables were introduced to facilitate the short-term forecasting, such as the financial conditions, financial stress, and systemic risk indicators. All these measures have good short-term forecasting properties, but they do differ in their nature. Financial conditions measures can be defined as the ease with which finance can be accessed by non-financial corporations and households (BoE, 2021), systemic risk indicators can be defined as tools for identification of systemic events, defined as financial instabilities spreading to such an extent that they will spill over to economic growth (ECB, 2010); whereas financial stress indicators quantify the degree of aggregate stress in the financial system, and have been found to have short term predictability of an economic downturn (Chavleishvili and Kremer, 2023).

[7] Besides the works that are examined below, it is worth mentioning other preceding research that links financial conditions and financial vulnerabilities to the real economy. A comprehensive overview is given in Boyarchenko, Favara and Schularick (2022) and Škrinjarić (2022a, 2023a).

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Giglio, Kelly and Pruitt (2015, 2016) examine the predictive power of many systemic risk measures (like Covar, MES, SRISK, etc.) for the case of the USA and selected advanced economies. The main focus was to obtain information on which measures are successful in forecasting future GaR, with in- and out-of-sample comparisons. Probably the most famous papers in this group are those of Adrian, Boyarchenko and Giannone (2016, 2019), who argue that most growth forecasts are point estimates and ignore the heterogeneity of different quantiles of future growth distribution. The authors show that lower quantiles of future US GDP growth have greater volatility when compared to the upper ones, which are fairly stable over time. Deteriorating financial conditions are related to a decrease in future average GDP growth, with low upside risks regardless of today's financial conditions. This indicates a nonlinear relationship between financial conditions and future GDP growth distribution exists.

2.2 EXTENDING THE FRAMEWORK

These previous studies include only the financial stress/systemic risk measures/financial condition indicators in the analysis, with short-term forecasting capabilities. In order to talk about macroprudential policy stance, other indicators and variables need to be included in the modelling process. This also will have consequences on tailoring macroprudential measures. The inclusion of other important indicators that are able to capture the policy itself could facilitate the analysis of the timing of the MP effects. Aikman et al. (2018) thus provide one of first extensions towards this way. The study used aggregated measures of financial vulnerabilities in the UK (leverage in the private nonfinancial sector, asset valuations in property markets, and credit terms) in the GaR modelling. The process of the selection of the best variables drew on previous literature on early warning models and banking crises. The authors found different effects on future GDP growth across different parts of the growth distribution within the quantile regression approach, and the estimates were significantly different when compared to the OLS (ordinary least squares) estimate. As the results are intuitive and straightforward to communicate, such an approach could be used within macroprudential decision-making when looking at the results of such forecasting.

Other studies emerged afterwards, such as Plagborg-Møller et al. (2020), is an extensive study of future GDP growth distribution forecasting in 13 advanced economies, based on several nonparametric and parametric approaches, and a long list of GDP predictors for monthly and quarterly data from 1975[8] to 2019. This study covers a wide selection of in- and out-of-sample forecasts and nowcasts. The authors found a great degree of heterogeneity of results, not just between the countries, but between different indicators used within the same category for a given country. Aikman et al. (2019a, 2019b) extend the Adrian, Boyarchenko and Giannone (2019) approach by looking at different variables of medium-term vulnerabilities in the financial system. The authors include credit growth information, house price growth, current account imbalances, etc. Another novelty is that they constructed a measure of banking sector leverage to see how the increase in capital requirements affects bank capital and growth-at-risk. As capital requirements were

[8] For the US case, and 1980 for other countries.

the main tool to build up the resilience of financial systems after the GFC, using an indicator that captures this could be observed as an indicator of macroprudential policy, whose effectiveness could be evaluated within the GaR setting. Here, the main results indicate that greater capital requirements led to a 0.9 p.p. cumulative improvement of GDP-at-risk over three years. This prompted the authors to make a CCyB (countercyclical capital buffer) simulation as an example of capital requirements being increased before the GFC hit. Not surprisingly, the results showed that such a requirement would offset the GDP-at-risk significantly.

2.3 INTRODUCING THE MACROPRUDENTIAL POLICY INDICATOR IN THE ANALYSIS

Macroprudential policy does not solely utilize capital requirements, but many other instruments as well. Thus, MP variable as a full set of measures and instruments has been introduced in the analysis, and, in some cases, the variable is divided among several categories, such as tools that are mostly borrower-based ones, or capital based, etc. (for policy tool description, please see Claessens, 2014; Lim et al., 2011). Several authors examined GaR model to evaluate the effectiveness of different tools. Sánchez and Röhn (2016) examine not only MP, but also other policies and their effects on future GDP growth via panel quantile regression for the case of OECD countries. Main findings regarding MP effectiveness include lowering future mean growth (costs), but also lowering potential losses (benefits, in the form of a decrease in the amount of future GDP losses). However, since this policy is new compared to others in the study, it is concluded that it should be explored more in the future. Other policies, such as monetary, have longer datasets and so its effectiveness was able to be evaluated in different phases of business cycles. MP on the other hand, for some countries includes only the tightening phases after the GFC. Another study that observes all MP tools is Duprey and Ueberfeldt (2018). This is a concise note about GaR forecasting, in which both monetary and macroprudential policies are considered. This work includes both theoretical considerations of tightening both policies and empirical results for the Canadian case and period 1992 to 2020. Results show that MP tightening is more effective for reducing downside risks of future growth than monetary policy tightening. It means that in practice a tighter MP policy could be more effective in strengthening the resilience of financial systems, as if a crisis happens in the future, it will have fewer negative effects on real growth than monetary policy.

Two years later, the same authors (Duprey and Ueberfeldt, 2020) published a paper with more details on their previous work. Here, the main results show that both policies reduce left tail risks by not affecting the median growth. This means that in the medium-term neither policy has significant negative effects on the real economy. Furthermore, if both policies are tighter, this can reduce the future tail risk by targeting credit growth, and if the monetary policy is loose, the impact of low interest rates on financial stability could be partially compensated with tighter MP. All of this implies that MP really was effective in the Canadian case. Finally, there is an interesting simulation made at the end of this study, where the authors show how much benefit would have been obtained if a tighter MP had been in place before 2018, leading to a reduction of central risk.

2.4 RECENT FINDINGS ON MACROPRUDENTIAL POLICY EFFECTIVENESS

As more data on MP indicator has become available, a richer analysis has been possible, as in Galán and Rodríguez-Moreno (2020), Galán (2020a, 2020b). Here, the authors observe the MP effects at different phases of the financial cycle. Interaction terms between the MP indicator and other variables were included in the analysis to account for different phases of the financial cycle and financial stress levels in economies. Studies looked at EU countries in the period 1970 to 2019 and applied the panel quantile regression approach. The MP indicator was observed on an aggregated level (i.e. including all MP tools and instruments), but also from the borrower-based versus capital-based perspective. Some of the main findings here include that MP in general in the medium-term does not have significant negative effects on the mean growth, but has positive effects on the tail risks by reducing it up to 1.5 p.p.

Other studies that could observe richer results are those of Brandao-Marques et al. (2020), in which the authors utilize the quantile regression approach to propose a cost-benefit approach to macroprudential policy. In a panel setting (period: 1990-2016), they evaluate the effects of different types of policies on future GDP growth and inflation. The authors found evidence of MP trade-offs regarding lowering mean future growth and increasing the GaR growth (i.e. reducing the future losses). In particular, benefits were the results of BBM (borrower-based measures), whereas CBM (capital-based measures) were found to be better for building the system's resilience. Cucic et al. (2022) is an empirical case study of Denmark's GaR in the period 1982-2022. Both GaR and HaR (House price-at-Risk) were examined, and the effectiveness of the BBM and CBM measures was compared. The authors conclude that BBM measures shift the entire growth distribution right, whereas CBM measures have a trade-off between GaR and median growth.

Franta and Gambacorta (2020) goes into more details regarding BBM measures, as the authors apply the GaR approach to a panel dataset of 56 countries in the period 1980 to 2012 to evaluate the LTV (loan to value) and loan loss provisioning effects. The results show that LTV narrows the whole future distribution of the growth, whereas loan loss provisions only move the left tail of the distribution upward. Thus, LTV can be used to reduce the volatility of GDP growth, whereas loan loss provisioning decreases the GDP losses in the event of a crisis. Finally, as a last recent empirical work related to this research, we found Drenkovska and Volčjak (2022). It is a study of the Slovenian GaR case in the period 2003-2020. This paper is actually divided into two sections. In the first part, authors develop a financial stress indicator for the Slovenian case. Then, the second part uses this indicator alongside financial cycle and MP indicators to evaluate the MP stance. However, the authors did not find the MP indicator to be significant in the analysis. An explanation could be found in the utilisation of a single-country approach, with insufficient data being provided for the tail risk estimation part of the framework itself.

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3 CHALLENGES WITH THE MACROPRUDENTIAL POLICY INDEX

Before moving on to the empirical part of the study, we wanted to comment on some of the challenges of using the MP variable in GaR analysis. To evaluate the MP stance, we need to include the MPI (macroprudential policy indicator) in the model. MPI is built upon information about (de)activating MP tools over time, and detailed information about them can be found in several popular databases: ECB (2018) or IMF (2022b). To construct the MP indicator, one has to have in mind that MP cannot be measured as monetary policy through policy rate. Rather, it is measured through counting the number of measures over time, by constructing indices based on a binary variable, or a variable that takes a couple of values (e.g. -1, 0, or 1). This alone introduces the challenge of aggregation of heterogeneous measures, and on top of that, the intensity of different measures imposes an additional problem. First introduction of a measure, which is classified as a capital one, could have completely different effects to a borrower-based measure. Moreover, introduction of a measure for the first time has different effects compared to it being fine-tuned over time.

3.1 DEFINITION AND TRANSFORMATION OF THE MPI VARIABLE

First challenge is the definition of the MPI variable itself. One part of the research that uses the MP variable takes the MPI index (regardless of the form and transformation) and calls this the macroprudential policy stance. Examples include Akinci and Olmstead-Rumsey (2015): "... These cumulative variables sum the dummy variables (tightening net of easing) to get an idea of a country's 'macroprudential policy stance' in a given quarter..."; and Ćehajić and Košak, 2021): "we design our main macroprudential measures by summing all policy changes over time, both tightening and easing. This allows us to capture the overall macroprudential stance in a given country and time period." Although this is not wrong, such an approach is not in line with the definitions of macroprudential stance as used in the GaR literature. However, it introduces more complexity in comparison to results across studies. Another issue is that some papers do not explicitly describe in which form the MPI indicator enters the analysis (net values, cumulative, etc.).

When collecting data from established databases, one needs to assign numerical outcomes. This is because all measures in such databases are given in a descriptive form, whereas MPI is defined as a simple binary variable. Positive unit value indicates a tightening measure that took place in a given quarter and negative unit value indicates a loosening one. Finally, a zero value is assigned to ambiguous and/or absent measures (see formula 1). Descriptions on how the researcher can assign these values to different tools can be found in Cerutti, Claessens and Laeven (2017), Budnik and Kleibl (2018), Garcia Revelo, Lucotte and Pradines-Jobet (2020), etc. In a given quarter, we can define a measure mpi_i:

$$mpi_{i,t} = \begin{cases} 1, \text{if a measure } i \text{ is tightening} \\ 0, \text{absence of measure } i \\ -1, \text{if a measure } i \text{ is loosening} \end{cases} \quad (1)$$

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and by adding up the values in (1) over time, we obtain the cumulative value as follows:

$$MPI_{i,t} = \sum_{t=1}^{T} mpi_{i,t} \tag{2}$$

Usually, values in (1) are counted for a group or all MP tools. Thus, formula (2) can present the cumulative value of all MP actions. This is a starting point in a lot of research, reflecting a general policy direction. Based on Garcia Revelo, Lucotte and Pradines-Jobet (2020), several other variants of MPI can be defined as follows. The first variant represents quarterly MPI with three values: -1, 0, and 1, based on tightening, loosening, or absence of all measures:

$$\widetilde{MPI}_{i,t} = \begin{cases} 1, \text{if } MPI_{i,t} > 0 \\ 0, \text{if } MPI_{i,t} = 0 \\ -1, \text{if } MPI_{i,t} < 0 \end{cases} \tag{3}$$

This means that regardless of the overall sum in each quarter being +1 or more, it will be rescaled to +1, and something similar is true for negative values. Thus, this transformation looks only at the information if the macroprudential policy is tightening or loosening, regardless of the number of measures. A second measure is to divide the original $mpi_{i,t}$ by the number of measures in each quarter. This is suitable for cross-country analyses. Several other specifications on a single-country analysis are found in Ćehajić and Košak (2021) as follows:

$$\overline{MPI}_t = \begin{cases} 1, \text{if sum of all measures is positive} \\ 0, \text{otherwise} \end{cases} \tag{4}$$

and

$$\overline{\overline{MPI}}_t = \begin{cases} 1, \text{if sum of all measures is negative} \\ 0, \text{otherwise} \end{cases} \tag{5}$$

and they take into consideration only the tightening or loosening of the policy. A potential problem with these last two measures is found if there is not much data on one type of policy, usually loosening.

As many countries have a lot of zero values in the above MPI specifications, some authors (see Akinci and Olmstead-Rumsey, 2015) try to overcome this by using a cumulative MPI index as defined in (2). However, Plagborg-Møller et al. (2020) and McCracken and Ng (2016) comment that it is better to utilize stationary variables if possible. MPI defined in (2) is often not stationary, especially in MP active countries. That is why more research is looking at year-on-year changes in the cumulative index:

$$d\_MPI_{i,t} = MPI_{i,t} - MPI_{i,t-4} \tag{6}$$

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as found in Galán (2020a, 2020b), Vandenbussche, Vogel and Detragiache (2015), Cerutti, Claessens and Laeven (2017), Alam et al. (2019). Finally, the ESRB Report (2021) utilized a 20-quarter change of the cumulative MPI. This could be especially problematic, as quantile regressions as methodological apparatus for GaR modelling are estimated for growth up to 16 quarters ahead. This makes it difficult to interpret measures that were put into force 20 quarters ago, and their effects 16 quarters in the future (i.e., 9 years in total).

3.2 INTENSITY ISSUES

Another important challenge when using the MPI variable as defined in the previous sub-section is that the values of positive unit, zero or negative unit only reflect whether a measure is tightening or loosening. These values do not reflect the intensity of a measure and its relative importance, e.g., the introduction of a measure could have more significant effects on financial stability than fine-tuning events. As an example, we focus on capital buffer requirements. Introduction of these requirements had different effects on the banking systems, compared to fine tuning, i.e. their subsequent additional increases. Values were adjusted over time[9]. This means that in the majority of cases, the MP indicator does not reflect the magnitude of a measure, only the frequency of it.

A couple of papers emerged in the last couple of years that try to adjust the intensity of MPIs. Eller et al. (2020), Vandenbussche, Vogel and Detragiache (2015), and Richter et al. (2018, 2019) have been working on this. Fernandez-Gallardo and Paya (2020) follow Meuleman and Vander Vennet (2020), and in the first step assign a positive value for tightening actions, the opposite for loosening, and zero for ambiguous impact or no measures. For the intensity adjusting part, policy actions that are activated for the first time receive the highest weights, a lower value for changes in the level, even lower for changes in the scope, and maintenance of both level and scope is given the lowest weight. When a measure is deactivated, the cumulative index gets value zero. Galán (2020b) besides the usual analysis (see the literature review section), includes one section of robustness checking, in which the author looks at the intensity of the LTV ratio and its effect on GaR. Since the iMaPP (Integrated Macroprudential Policy) database that author uses in the study includes mean regulatory LTV ratios, the author opted to test its effectiveness during the upswing and downturn of the financial cycle, and obtained results that are consistent to the main ones in the first part of the study: in the expansion phase of the cycle, tightening of LTV limits would improve GaR by approximately 0.5 p.p. Negative effects on the median growth are also significant but negative.

[9] As explained in Škrinjarić (2024), another example of different effects could be that when comparing the countercyclical buffer (CCyB) actions, one country could immediately introduce a value of 2% to take place in a given banking system. This country would get +1 value in the quarter when this action is taken. If the country does not change CCyB in the next few quarters, the value remains at +1. On the other hand, if another country decides to introduce 0.5% CCyB value, and in each subsequent quarter increase it by 0.5 p.p., it will get positive unit value every quarter and could have a cumulative indicator greater than the first country.

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Unfortunately, a consensus on how to solve this important challenge has not yet been found because research states that "we assign a higher weight to policy actions we consider to be more important", as in Meuleman and Vander Vennet (2020). This is something future research needs to work on, trying to find an objective way to define such adjustments, and some solutions are summarized in Škrinjarić (2024).

3.3 ENDOGENEITY ISSUES

When policymakers and regulators make decisions about their tools and instruments, they take into consideration some typical variables such as credit growth or debt burden. Countries that experienced rapid credit growth (pre-GFC) have higher probability of having tighter MP (Akinci and Olmstead-Rumsey, 2018). The endogeneity characteristic of macroprudential variable is probably the biggest challenge in research that tries to evaluate MP effectiveness, regardless of the underlying methodological approach. As the MP policymaker reacts to the expected economic environment, MP cannot be used in the form described in the previous subsections to identify exogenous changes (Buch, Vogel and Weigert, 2018). However, the endogenous nature of MP is not new, and there have been different approaches to tackle this concern regarding monetary and fiscal policy. The main motivation is always the same: to identify the non-systematic monetary policy movements so one can estimate causal effects of policy on macroeconomic variables. Some earlier approaches to solution of the endogeneity issue are reviewed in Christiano, Eichenbaum and Evans (1999). Ramey (2016) on the other hand reviewed some newer approaches, such as narrative identification, regime switching approach, and many others, both for monetary and fiscal policy specifications. Prasad et al. (2019), one of the earlier GaR studies, comments that GaR is not a structural model, and cannot be used to talk about causality. Richter et al. (2018, 2019) define the following criteria in order to talk about causality: policy actions need to be uncorrelated with other possible shocks in the model, these policy shocks need to be unexpected, and they also need to be exogenous in reference to the current and lagged variables. Thus, there are a couple of ways to deal with this, explained below.

3.3.1 Obtaining non-systematic policy shocks

If the aim of the analysis is to discuss causality, then non-systematic policy shocks should be used. They can be defined as a random portion of the policy not related to the state of the economy (McCallum, 1999). Ever since the Lucas (1972) critique of monetary policy, in which the non-systematic component is the only component to be used when policy effects are evaluated, this part of the monetary policy has been evaluated in empirical research. To obtain non-systematic policy shocks, the procedure can be done in two steps. The first step observes the MPI as the dependent variable, and it is regressed on a set of specific variables that are important in MP decision making. Some examples include credit to GDP gap, house price dynamics, and other variables found in early warning literature (see Tölö, Laakkonen and Kalatie, 2018, and Škrinjarić, 2022a, for an exhaustive list). Residual values from the estimated model are collected and are observed as those policy actions that are not explained with the variables that were used in the model, and should be non-systematic shocks. In the second step, these residuals are used within the GaR model to talk about causality.

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Some examples of using this within MP stance assessment are the following. Brandao-Marques et al. (2020) utilized ordered probit regression to obtain the non-systematic MPI shock[10]. Previous quarter credit-to-GDP gap, house price gap and previous year cumulative value of MPI itself are used as explanatory variables in the regression. There was a similar approach in Gelos et al. (2022). Galán (2020a) utilizes regression to extract residuals from a model that includes all other regressors that enter the GaR equation. Here, however, all of the variables are assumed to affect MPI in the same quarter. This could be questionable, due to knowledge that in practice, data collection and decision making takes some time. Lagged values of explanatory variables should be considered in explaining macroprudential decisions today. However, the results in this study showed little difference in the results when the macroprudential policy variable was purged from specific effects from macro-financial variables to the results without any "cleaning" of the data. Reasoning could be as already mentioned challenge of regressing the MPI on variables from the same quarter. Duprey and Ueberfeldt (2020) also have an interesting approach, due to the MPI variable taking values -1, 0 and 1. The authors opted to use propensity score matching, such that the probability of MPI variable taking positive or negative values depends on the lags of other variables that are considered in the GaR part of the analysis.

Two important things to consider in this two-step approach are the variable selection to regress the MPI on and the lags of these variables. The model in the first step should be correctly defined, i.e. the chosen variables should reflect what the MP policy maker is actually considering when making decisions. Also, as MP reacts to macro-financial environment with a lag, this should be taken into consideration when doing this part of the analysis.

3.3.2 Considering dates of announcements and enforcements of measures

Some authors have a narrative approach for identifying macroprudential shocks, such as De Schryder and Opitz (2019, 2021). This approach asks from the researcher to read all of the policy tool announcements in order to distinguish those that are a true shock compared to those that are reactions to the financial environment. The focus is made on announcement and implementation dates. Some measures were introduced and implemented in the same quarter, and those that did not have the same quarter for introduction and implementation were excluded in MPI construction. The authors argue that banks can prepare themselves more if the announcement date is far away from the implementation date, which is not in line with the definition of unexpected shocks. These authors give an example of introduction of the LTV (loan to value) ratio as to why they observe announcement and implementation dates in the same quarter or not: banks could expand their lending when anticipating future credit restrictions, and the enforcement dates of a measure goes against unexpected nature of shock. Something similar is done in Duprey and Ueberfeldt (2020). Here, the authors estimate the model with MPI values that are based both on announcement and dates when measures were put in force.

[10] As it takes values {-2, -1, 0, 1, 2}.

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This approach is challenging in practice, as policymakers make decisions on some MP tools by analysing the risks that are accumulating over some time. Sometimes, before a new tightening measure is introduced, the policymaker could issue warnings or recommendations for certain behaviour. Financial stability reports often have special sections/boxes that analyse certain challenges to the financial stability of a system. This could prepare banks to change their behaviour over time, and when a formal measure is announced, it could have the same effect as for the case of observing the measure from the formal date it is put in force. Thus, future work should try to gauge if some change in bank behaviour has preceded even the formal announcement dates of a macroprudential measure.

3.3.3 Lagging values in models

Another approach is including the lagged values of some variables in the underlying GaR regression. Some authors lag the explanatory variables in the GaR regression, whereas others lag the dependent one (i.e. the MPI variable). Lagging the macro-financial variables that are used in the GaR regression is based on the explanation that the macroprudential policymaker makes decisions about tools with respect to tracking those variables. It takes some time to evaluate the dynamics of those variables. Thus, these variables are lagged in the GaR model specification, as if we assume that MPI is affected by previous values of, e.g. financial vulnerabilities in the system, it is an obvious choice to include previous lags of the latter variable in a model. Cerutti, Claessens and Laeven (2017) state that a greater number of lags of these variables should be included in the model. The question remains what a greater number is, and if we do not have long time series (usually a problem for MP empirical analyses), we cannot "afford" to include a great number of lags in the model itself. The second approach of lagging the dependent variable is found in Ossandon Busch et al. (2022), who only state that "causality concerns can be addressed, for instance, by lagging the variable policy (referring to MPI) in order to separate the policy decisions from current macro trends." A similar approach is used in Gelos et al. (2022), who add one year of lagged MPI data in the model, without explaining the reasoning. The only thing that comes to mind is the following. In modelling, in order to include effects of variables that are not explicitly included in the model (due to, e.g. data unavailability), one can include a lagged value of the dependent variable, as it includes in itself the effects of all factors, although data cannot be collected on some of them or else they are not directly measurable.

Furthermore, there are also some papers that lag both the MPI indicator and the rest of the macro-financials that are used in the GaR setting, such as Eller et al. (2020). Authors decide on the lag selection based on the BIC (Bayes information criterion). This is a purely statistical approach to the definition of the best model and should be complemented with MP knowledge from practice. It is still not completely clear which of these approaches are correct, as sometimes they do the opposite things (lagging MPI versus lagging variables that affect MPI), which leads to different economic interpretations, alongside having econometric consequences. As endogeneity has been examined for monetary and fiscal policy for some time now, future work that focuses on macroprudential policy should try to compare these approaches to see what should done next.

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3.3 DIFFERENT SOURCES OF MPI DATA ISSUES

Different databases have been developed in the last couple of years, in which a systematic overview of the type of the measure was put into place (or revoked), with a description of the measure and a general explanation of why the measure was used. The ECB (2018) and IMF (2022a) are commonly used[11]. The ECB database, called MaPPED (Macroprudential Policies Evaluation Database), is a comprehensive dataset, with 1925 hundred policy actions for EU countries since 1995 until 2017[12]. Supervisory authorities have submitted measures, their descriptions and other information on measures, and since macroprudential policy was somewhat formalized after the GFC, other measures before it have been retroactively categorized to fit macroprudential measures, or microprudential measures that had a macroprudential character. It also includes changes in measures, i.e. if fine tuning was done, so it presents a good starting point for an analysis.

The IMF database, iMaPP (Integrated Macroprudential Policy), combines information from various sources, including the Macroprudential Policy Survey, and the IMF member countries that submit information on a yearly basis. This database also has a detailed description of each submitted measure, alongside detailed classification, but some caveats are that not every measure is included (those that were introduced before the sample period started), and only those measures that were cross checked with official documents were included. However, the tools described in the IMF database are very different to those in the ECB version, as when we found something peculiar when doing research on this topic. The two mentioned databases have, differences, at least for the case of Croatia. All of the measures were compared, revised, and based on internal reports of the Croatian National Bank, the dates and data were adjusted to reflect the most accurate dynamics of MPI measures.

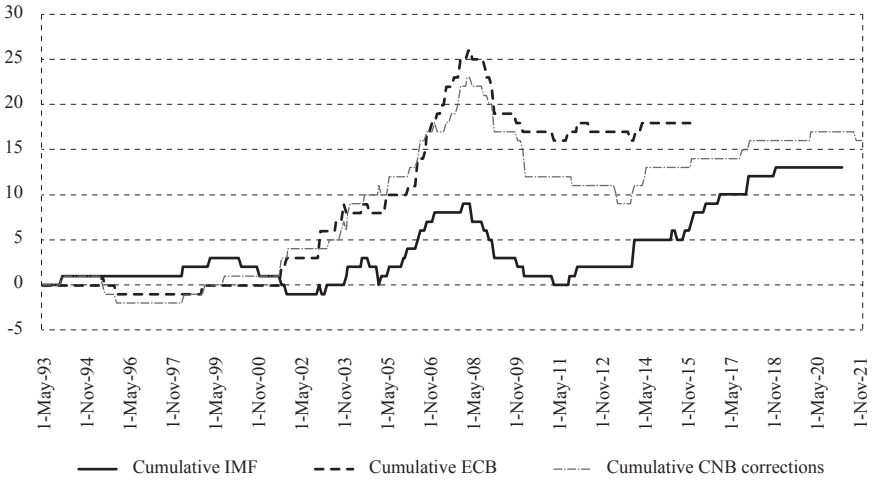
To depict the differences, a cumulative index was calculated based on formula (6) for the ECB, IMF and a combined revised version, and are shown in graph 1. The ECB database is not updated anymore, and that is why this index stopped in 2018. However, it is striking to see the differences between the two databases. The explanation is to be found in the different classifications of some measures; the IMF does not take into consideration some measures that could be broadly classified as "other" for the Croatian case, but which had macroprudential character, whereas the ECB did. The main differences, then, for the case of Croatia inhere in the ECB having a broader base of different tools that have not been strictly classified as macroprudential measures, but as having macroprudential purpose. On the other hand, the IMF did not include these measures, as we have seen when sifting through both datasets and reconciling them to obtain one final "clean" MPI dataset.

[11] Others include the ESRB database for EU countries: https://www.esrb.europa.eu/national_policy/html/index.en.html, or Cerutti, Claessens and Laeven (2015). Some other sources are listed and commented in Alam et al. (2019), in appendix I, table 4.

[12] This number comes from counting the total number of all tools in the Excel sheet provided in Budnik and Kleibl (2018).

Graph 1

Cumulative MPI values for Croatia, different sources



Source: ECB (2018), IMF (2022), "CNB corrections" is based on reports at Croatian National Bank.

Up until the writing of this research, no comments were found in related literature on this problem. Authors usually collect the MPI data without manipulating it additionally. However, one needs to bear it in mind if different sources are used, the estimation of final results can be very different, especially for active countries such as the example shown in graph 1. One future research direction would be to tackle this issue.

4 METHODOLOGY AND DATA DESCRIPTION

This section describes the methodology used in this paper in order to estimate GaR for the Croatian case. Quantile regression and related topics are described. After that, we describe the data used in this study for the empirical work done in the next section.

4.1 QUANTILE REGRESSION[13]

A linear quantile regression (QR) model can be defined as:

$$y_t(\theta) = \beta_0(\theta) + \sum_{k=1}^{K} x_{t,k}\beta_k(\theta) + \varepsilon_t(\theta) \tag{7}$$

where y_t is the dependent variable, θ is the quantile, betas are parameters that need to be estimated at each quantile, $x_{t,k}$ are conditional variables, ε_t is the error term. To estimate model (1), for every quantile $Q_\theta(y|X)$, $0 < \theta < 1$, a minimization problem is solved:

[13] Introduction to quantile regression, alongside advantages to other approaches, such as being robust to outliers, heteroskedasticity, non-normality, etc. can be found in Koenker (2005), Davino, Furno and Vistocco (2013), or Koenker and Bassett (1978).

$$\arg\min_{\beta_k(\theta)} \sum_{t:y_t \geq \hat{y}_t} \theta \left| y_t - \beta_0(\theta) - \sum_{k=1}^{K} x_{t,k}\beta_k(\theta) \right| + \sum_{t:y_t < \hat{y}_t} (1-\theta) \left| y_t - \beta_0(\theta) - \sum_{k=1}^{K} x_{t,k}\beta_k(\theta) \right| \quad (8)$$

where $\hat{y}$ is the estimated value of y. For the case of evaluating MP effects on future real growth y, the real growth is defined $t+h$ quarters ahead:

$$y_{t+h} = 100\% \times \left(\frac{r\_GDP_{t+h}}{r\_GDP_t} - 1 \right) / \frac{h}{4} \quad (9)$$

where usually $h = 1, \ldots, 16$. A basic specification of a QR model that describes y_{t+h} could be the following:

$$y_{t+h}(\theta) = \beta_0(\theta) + \beta_1(\theta) MPI_t + \beta_2(\theta) y_t + \beta_3(\theta) Stress_t + \beta_4(\theta) FV_t + \varepsilon_t(\theta), \quad \theta = 0.05, \ldots, 0.95 \quad (10)$$

where *MPI* is the macroprudential policy indicator, *Stress* denotes indicator of financial stress, and *FV* is a financial vulnerabilities variable. Mentioned variables are an example of which variables are usually used in this modelling. In other words, the GaR model in (10) usually includes the autoregressive term y, the MPI indicator in some form as commented on in section 3.1., and then a variable that corresponds to financial conditions, stress or systemic risk indicators, with a final variable of financial vulnerabilities or financial cycle indicator. This work will look into financial stress and several financial cycle indicators in the empirical section. To evaluate the values of coefficients at different forecast horizons h, the dependent variable on the left-hand side of equation (10) is changed, such that the h quarter growth from equation (9) is regressed on the same set of variables in equation (10). This is the local projection approach, as often used in macroeconomic literature and the plotted reaction of GDP growth to changes in explanatory variables is considered as the impulse response (see Jordà, 2023).

Goodness of fit of a QR model can be measured with pseudo-R squared, evaluated at each quantile θ:

$$R_\theta^2 = 1 - \frac{RASW_\theta}{TASW_\theta} \quad (11)$$

where $RASW_\theta$ is the residual absolute sum of weighted deviations of real values to the estimated ones, and $TASW_\theta$ is the total absolute sum of weighted deviations.

Rationales on why the MP effectiveness changes across the growth distribution and alongside different coefficients are in place both for financial conditions/stress and financial cycle indicators is as follows. The early warning methodology literature (see Tölö, Laakkonen and Kalatie, 2018) on which variables forecast financial crises has shown that financial cycle indicators have good predictive power of not only financial crises, but also subsequent economic downturns. This means that the

OLS estimates cannot capture those tail risks. If one used the threshold regression approach, the usual assumptions that hold for OLS should also hold here, which would not capture the heteroskedasticity in the data that is present, alongside other assumptions regarding the error term. Moreover, by applying threshold regression, one would need to sub select the dataset into more regions for which the model is estimated above and below a certain threshold, which would result in an insufficient number of datapoints for the tail risk. Moreover, one would also need to test for more than one threshold, which is not feasible for such a short time series. Furthermore, if one opted for time varying parameters, same assumptions on the error term need to be imposed as for OLS, which is again not satisfied in practice. Quantile regression does not rely on any assumption on the distribution of the datasets that are used, or about the error term. Next, the seminal contribution of Adrian, Boyarchenko and Giannone (2019) has shown that there is almost no effect on mean growth when the usual set of variables that are used is complemented with a financial stress indicator. On the opposite side, there is a significant negative effect on the downside growth risk. This was empirically tested on other economies in the following research, thus it made a stepping stone by which to move from linear models to the quantile regression approach. From the economic point of view, the reason on why the MPI would have different effects on GDP growth at different parts of the distribution is that if done properly, increases of MPI value (which means that the policy is tightening) in good times should increase the resilience of the financial system, which would prepare it to deal with a future crisis better by avoiding huge losses. However, increasing the resilience does come at a cost, by, e.g. banks having greater capital requirements would perhaps decide to reduce lending in some capacity, which would decrease the investment in the economy and thus, the mean growth would be reduced as a consequence.

4.2 FITTING THE CONDITIONAL DISTRIBUTION OF ESTIMATED GROWTH

The usual procedure after the QR estimation is to fit the skewed t-distribution of Azzalini and Capitanio (2003):

$$f(y;\mu,\sigma,\alpha,\upsilon)=\frac{2}{\sigma}t\left(\frac{y-\mu}{\sigma};\upsilon\right)T\left(\alpha\frac{y-\mu}{\sigma}\sqrt{\frac{\upsilon+1}{\upsilon\left(\frac{y-\mu}{\sigma}\right)^2}};\upsilon+1\right) \tag{12}$$

where $t(\cdot)$ and $T(\cdot)$ are the probability density function and cumulative density function respectively, μ is the location parameter, σ is scale, υ fatness, and α the shape parameter. Function (13) is used to smooth out the quantile function. In that way, the probability density function is obtained:

$$\underset{\mu,\sigma,\alpha,\upsilon}{\arg\min}\sum_{\theta}\left(\hat{Q}_{y_{t+h}}-F\left(\theta;\mu,\sigma,\alpha,\upsilon\right)\right)^2 \tag{13}$$

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by matching the quantiles of the skewed t-distribution to the empirical quantiles obtained from the estimation. The empirical quantiles are usually the 5th, 25th, 75th and 95th. Some exceptions can be made to the 10th and 90th, when dealing with fewer data. Although the QR model obtains more estimated percentiles, Adrian, Boyarchenko and Giannone (2019) opt to have fewer quantiles for (13) to avoid over-parametrization. Another approach is found in Lloyd, Manuel and Panchev (2022) and Mitchell, Poon and Zhu (2021), where a non-parametric approach is used: conditional quantiles are mapped to conditional density, and interpolations across adjacent quantiles are made to smooth out the density. These papers use a measure of model accuracy, the unconditional coverage (UC) test of Kupiec (1995), usually called a back-testing technique, to evaluate the quality of the model. The UC test null hypothesis assumes that, on average, the conditional quantile is a correct coverage of the selected percentile of the forecasted distribution.

4.3 DISTANCE TO TAIL CONCEPT

Once the full model is estimated, one could calculate a measure called distance to tail (DTT), as a measure of downside risks, captured by the difference between the median and GaR value (ESRB, 2021). Thus, the policymaker could observe additional information from DTT in the following way. When evaluating the results of MPI effects on the median and GaR growth, the difference between two can also be looked at, as the value should decrease if the MP does not have negative effects on the mean growth, and positive effects on the lower tail risk at the same time. This is due to the "pushing" of the left tail of future GDP growth distribution towards the mean outcome. The economic rationale behind this is that if the policymaker imposes tighter restrictions on the financial system in "good" times, i.e. when the economy is in the upward phase of the business cycle, it should not be burdensome to financial institutions to increase their resilience. Afterwards, if a crisis or another negative shock happens that will affect the real economy in the future, the increased resilience today would prevent an even greater crisis at the end, i.e. the GaR value should be in better shape than if we did not impose tightening before the shock. Thus, a tighter stance is characterized with a lower DTT compared to a reference distance. The question remains of what reference value is to be compared to the empirical DTT values we obtain in the analyses. No consensus exists today; thus, in the empirical part we compare the empirical DTT values to the average in the historical sample (something similar was done in Cucic et al., 2022).

4.4 DATA DESCRIPTION AND STYLIZED FACTS

For the empirical analysis, quarterly data on real[14] GDP for Croatia was collected from CNB (2023) for Q1 1991 to Q2 2022. Graph 2 depicts the dynamics of year-on-year growth in the entire period, where the consequences of the Croatian War of Independence at the beginning of the sample are visible, the banking crisis of 1998, the GFC, and the COVID-19 crisis are seen. The unconditional distribution of real growth is depicted in graph 3 (left panel), and it is evident that it is not a normal distribution, with a more significant left-sided skewness, which is corroborated in the right panel

[14] GDP deflator was used to deflate the original nominal GDP series.

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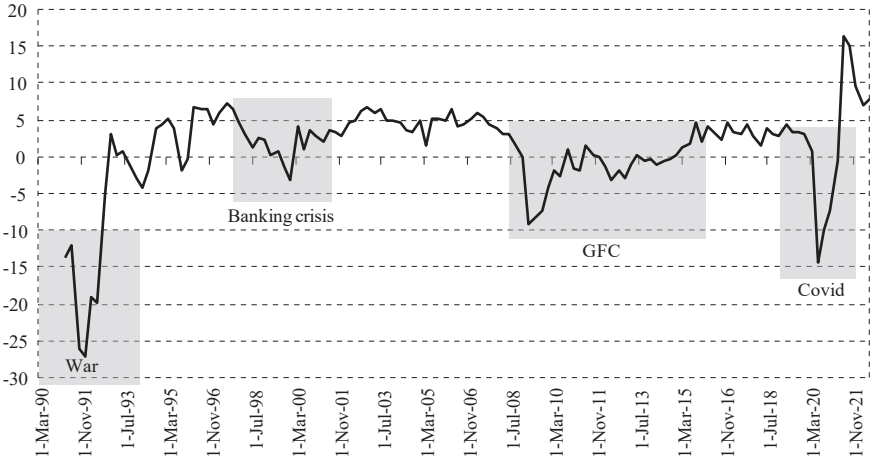
of graph 3. Quantiles of Normal distribution are contrasted to the empirical quantiles of real growth, and a significant departure is apparent. This is in line with related literature (Acemoglu, Ozdaglar and Tahbaz-Salehi, 2015; Sánchez and Röhn, 2016).

The second important variable in the analysis is the macroprudential policy index. The MPI observed in this study is based on the combination of the ECB and IMF databases, with incorporated corrections. The starting date for this variable is Q1 1994. Croatia has a relatively active macroprudential policy, so during the 2000s, due to the enormous credit growth (due to financial deepening and general increase before the GFC hit), among other factors, tightening measures were made taken often than loosening ones. Graph 4 depicts the number of tightening and loosening measures (panel a), whereas their signs are taken into consideration in panel b.

GRAPH 2

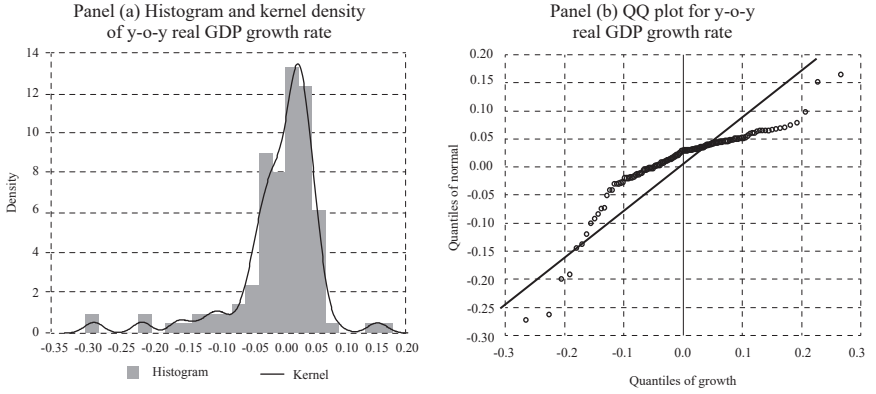
Real GDP growth, year-on-year, in %



Source: CNB (2023), author's calculation.

GRAPH 3

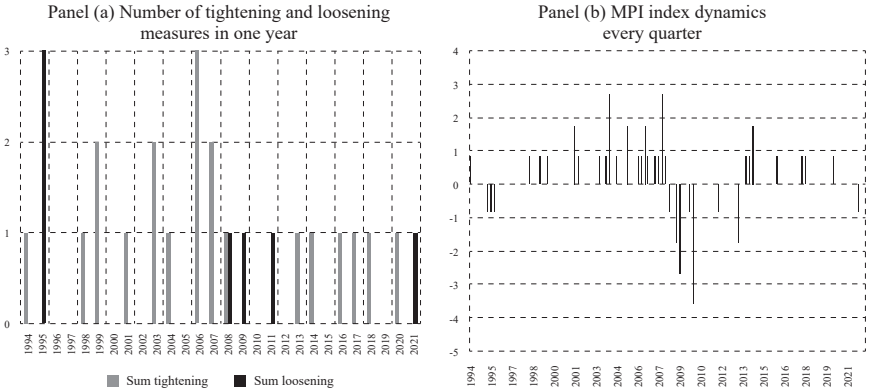
Histogram, kernel density and QQ plot for year-on-year real GDP growth rate



Source: Author's calculation.

GRAPH 4

Macroprudential policy index dynamics



Source: ECB (2018), IMF (2022), author's calculation.

Another relevant variable in the GaR approach is financial vulnerability. This variable is also problematic as well, as different authors utilize a wide range of variables that capture credit dynamics, house price dynamics, credit institution vulnerabilities, etc. ESRB (2021) uses d-SRI (domestic systemic risk indicator) as it is based on panel estimation and is more comparable across countries. Individual studies focusing on a single-country analysis often substitute this indicator for one better suited for that country. This study will do the same. Besides the usual[15] credit dynamics variables and d-SRI, this study observes ICSR (Indicator of Cyclical Systemic Risks) as a Croatian version[16] of the composite indicator.

Table 1 gives a brief overview of financial vulnerability measures tested in this study, with graph 5 showing their dynamics (more details on these measures for the case of Croatia can be seen in Škrinjarić and Bukovšak, 2022; Škrinjarić 2022b, 2023c). Dynamics in graph 5 shows that the credit growth was substantial in the 2000s due to financial deepening. Value of composite indicators of cyclical systemic risks increased during the 2000s, reflecting not only the rising credit dynamics but other relevant categories of financial vulnerabilities, such as house price dynamics, external imbalances, private sector debt burden, mispricing of risk, etc. (see Škrinjarić, 2023a). Indicators reached their maximal values in 2007 and dropped fast when the crisis hit. The prolonged recession lasted for a few years, and in 2017 a mild recovery started. Finally, something to keep in mind is the problem of the non-stationarity of the data. White, Kim and Manganelli (2015a, 2015b) assume that data for this analysis are stationary. The best option would be to have all variables transformed in such a way that they are stationary, as the predictability of time series is mostly based on the stationarity of the series itself. The d-SRI indicator is the variable commonly used, but it does not satisfy this assumption. All of the specifications in table 1 and graph 5 will be tested in section 5.2.1. to find which variable definition is the best in terms of model performance.

[15] See Škrinjarić and Bukovšak (2022) for Croatia's best individual credit dynamics indicators.
[16] See Škrinjarić (2022a, 2023b) for the composite indicator for Croatia.

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Table 1
Financial vulnerabilities variables

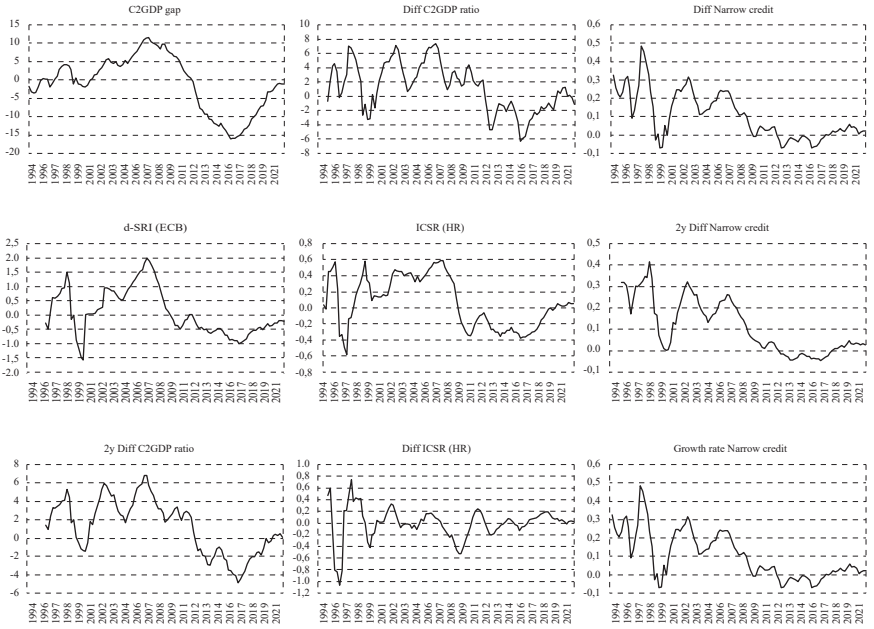
Abbreviation	Description	Transformation
C2GDP gap	Credit to GDP gap	Hodrick-Prescott filter gap, smoothing parameter for (narrow) credit series is 125K, for GDP is 1.600
Diff C2GDP ratio	Differenced credit to GDP ratio	One year difference of the (narrow) credit to GDP ratio
Diff Narrow credit	Differenced values of narrow credit	One year difference
d-SRI (ECB)	Domestic systemic risk indicator	See Lang et al. (2019)
ICSR (HR)	Indicator of Cyclical Systemic Risks	See Škrinjarić (2022, 2023a)
2y Diff Narrow credit	2-year differenced narrow credit	–
2y Diff C2GDP ratio	2-year differenced credit to GDP ratio	–
Diff ICSR (HR)	Differenced ICSR	–
Growth rate Narrow credit	One year growth rate of narrow credit	–

Source: Author.

The financial stress indicator for the Croatian case is somewhat problematic, as the ECB (2023) version has a very different dynamic compared to the one that the CNB developed (the period for this variable is Q1 1990 to 2Q 2022). Graph 6 contrasts the two indicators, where it is seen that during the GFC and the sovereign bond crises, the ECB version does not capture the stress, whereas the COVID-19 crisis and war in Ukraine are not much reflected in the CNB version. CLIFS is constructed based on three markets: equity, bond and foreign exchange market (see Duprey et al., 2015), whereas HIFS is the tweaked version of CISS (Holló, Kremer and Lo Duca, 2012), in which some minor things are changed based on data unavailability, and includes all five markets (besides the aforementioned ones in HIFS, money and bank markets).

GRAPH 5

Financial vulnerabilities in Croatia, different measures

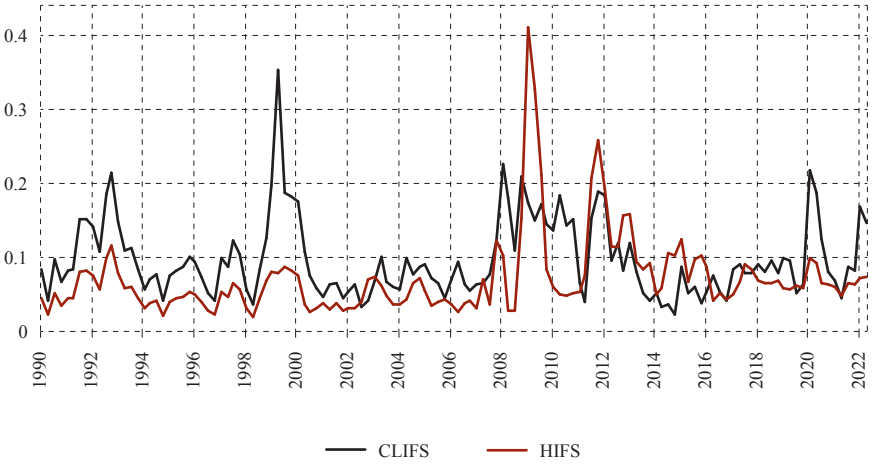


Note: C2GPD – credit to GDP, Diff – difference, i.e., year-on-year (y-o-y) difference, d-SRI – domestic systemic risk indicator, ICSR – indicator of cyclical systemic risk, 2y Diff – two-year difference. Growth rate of narrow credit is y-o-y.

Source: CNB (2023), author's calculation.

GRAPH 6

Comparison of CLIFS (ECB version) to the HIFS (CNB version) of financial stress



Source: ECB (2023) and CNB (2023).

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5 EMPIRICAL APPLICATION: CROATIAN CASE

This section provides the main empirical analysis of the paper. We firstly comment on reducing the endogeneity of the policy variable itself. Afterwards, we compare the goodness of fit with respect to different variables to measure financial cycle or vulnerability. When the best models are selected, we compare their results regarding the MPI effectiveness for the tail risk and median growth. Finally, we show how the distribution of GDP growth changes over time, and comment on the resulting distance to tail measure.

5.1 TRYING TO REDUCE ENDOGENEITY OF MACROPRUDENTIAL POLICY INDEX

Following the references in section 3.3.1., we obtain non-systematic shocks of non-cumulative MPI values (i.e. just counting the number of tightening or loosening measures) via ordered logistic regression, as the order of the MPI values matters. MPI was calculated based on formula (1) in each quarter, i.e. where the tightening measures were given the value +1 for each measure, loosening measures were given the value -1 per measure, and absence of any measure or ambiguous ones were given the value 0. Then, the net MPI is calculated by reducing the total amount of loosening from the total amount of tightening measures. $\widetilde{MPI}$ was calculated according to formula (3).

As previously remarked, the macroprudential policy cannot immediately react to macro-financial surroundings due to data lags, legislation bounds, etc. That is why we compare several model specifications to obtain the non-systematic policy shock in the first step, in which lagged values of real growth, financial stress (HIFS, the HR version), and financial vulnerabilities (y-o-y change of credit-to-GDP ratio) are used. We are interested in talking about causal effects, and since there exists a bulk of literature on monetary and fiscal policy that takes this approach in extracting policy shocks to talk about these effects, currently we opted to take this approach (see Ramey, 2016).

Table 2 lists AIC values[17] for both MPI specifications, where models M1 to M4 refer to how many lags of other variables are included[18]. Models with three lags of other variables have the lowest AIC value, so they will be used to obtain residuals of the macroprudential policy variable.

[17] SIC values resulted in the same ordering. As these are just ordinary regressions, the idea is to see the trade-off between the explanatory power of the model versus the number of parameters included in the model. Information criteria give us this information.

[18] I.e., we compare four models M_*i*, where *i* stands for how many lags of all variables on the right-hand side (RHS) of the ordered probit equation symbol were included. The explanatory variables included lagged value of the real growth itself, as it is usually put in GaR modelling, and the other variables included were: HIFS and YoY change of the credit-to-GDP ratio. E.g., M_3 means that all variables on the RHS were included with lags 1, 2 and 3 to regress the MPI dynamics on.

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Table 2
AIC values of several model specifications

Model	M1	M2	M3	M4
AIC MPI	241.23	236.14	**234.02**	234.88
AIC $\widetilde{MPI}$	175.57	171.90	**169.65**	171.36

Source: Author's calculation.

5.2 QUANTILE REGRESSION RESULTS

Results onwards include the following variables and transformations:

- Real GDP growth, forecasting horizons $h = 4$ and 12 to contrast short- and medium-term results in models.
- Residuals from models (M_3) in table 2 for MPI and $\widetilde{MPI}$.
- All nine financial vulnerabilities indicators from graph 5.
- Original values of MPI and $\widetilde{MPI}$ for models where lagged variables are included.

As many combinations of variables could be observed, to reduce their number, individual (one explanatory variable at the time) quantile regressions are estimated for the case of MPI and financial vulnerabilities. Finally, the best ones are selected for further analysis as follows.

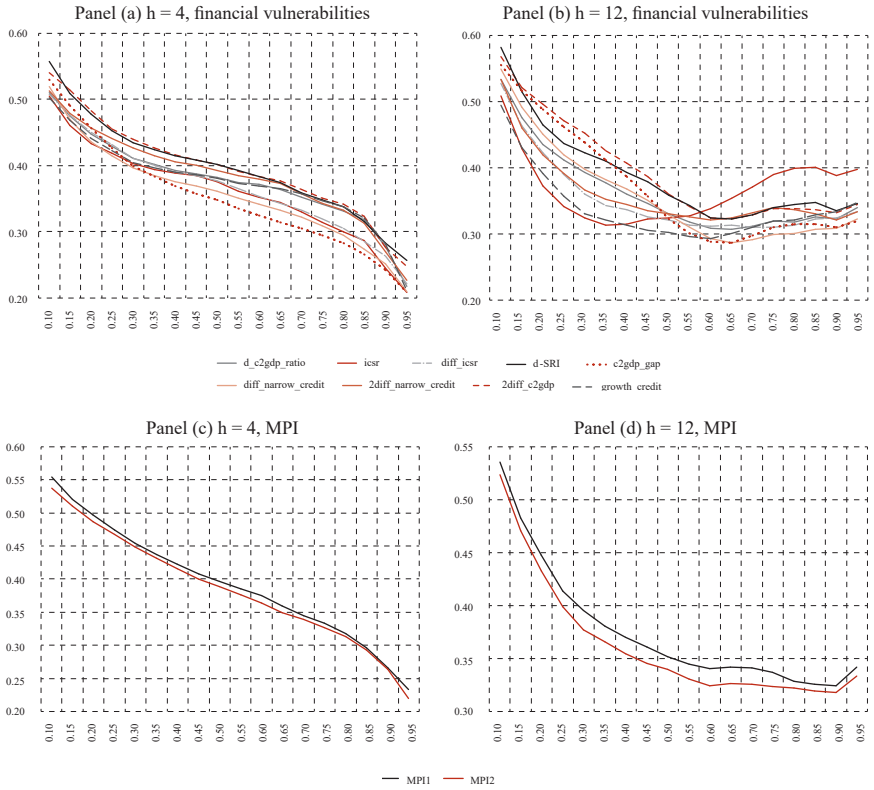
5.2.1 Selecting best variables for each indicator category

The selection criteria for the best models onwards are the following ones: we compare the value of pseudo R-squares on each quantile, ranging from 10th until 95th, firstly between all possible candidates of financial vulnerabilities. Then, the same is done for the financial stress variables (HIFS and CLIFS), and finally for the MPI 1 versus 2 (after purging effects of other variables in them from the previous subsections). These comparisons are done for $h = 4$ and 12 quarters ahead, to get an idea of the performance both in the short and medium run. Then, we try to select variables that have an overall better performance over all quantiles over both time horizons. For the comparisons, we estimate a quantile regression on an individual variable basis.

Pseudo R-squares are shown in panels (a) and (b) in graph 7. It is visible that selection of the best indicator is not straightforward, as some indicators are better at certain quantiles, but worse at others. Also, at one horizon one variable is better performing, but worse at another horizon. When comparing all the variables in panels (a) and (b), the best ones are the non-stationary variables: ICSR, d-SRI, and credit-to-GDP gap. They are followed by stationary ones: y-o-y and 2-year change of credit-to-GDP ratio. We opt to use stationary variables over the non-stationary ones, as the rest of the variables in the model exhibit stationary behaviour. Panels (c) and (d) compare the MPI variables, and here the picture is a bit clearer: MPI has better performance.

GRAPH 7

Comparing pseudo-R squares of individual variables



Note: MPI1 is the MPI variable, whereas MPI2 is defined in formula (4).

Source: Author's calculation.

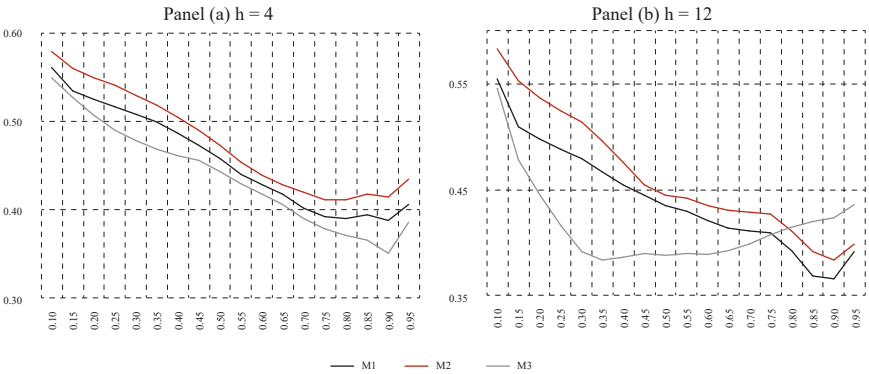
5.2.2 Selected models' results

Based on previous discussions, the following variants of the model are compared:

- Model (1): y-o-y change of credit-to-GDP ratio, HIFS, residuals of MPI
- Model (2): 2-year change of credit-to-GDP ratio, HIFS, residuals of MPI
- Model (3): ICSR, HIFS, residuals of MPI.

GRAPH 8

Pseudo R-squares for models (1) to (3)



Source: Author's calculation.

Graph 8 shows pseudo-R squares for all three models, for $h = 4$ and 12 quarter ahead growth forecast. There are small differences between M (1) and M (2), whereas M (3) is the worst performing one, as the overall pseudo R-squared is the worst. When looking at *p*-values of UC tests (see table 4), all three models perform well (the null hypothesis cannot be rejected in all cases), i.e. the estimated 10th percentile and median correctly cover the 10th percentile and median of the true growth realizations.

TABLE 4

UC test results (p-values) for all three models

Model	M1	M2	M3
10th percentile	0.54	0.81	0.43
Median	0.77	0.76	0.63

Source: Author's calculation.

When comparing the effects of MPI variables in models (1) to (3), graph 9[19] shows the estimated coefficients for $h = 4$ for the QR case (dotted curve), which is contrasted to the OLS results (red dashed line). In all three cases, the MPI QR estimates differ over quantiles and are different compared to the OLS lines. At first glance, the effects on the lower tail of the growth distribution are positive and greater than the median (central) value. This is in line with previous research showing that tighter macroprudential policy positively affects the future lower tail of GDP growth distribution (see Galán, 2020a, 2020b; or Galán and Rodríguez-Moreno, 2020). However, positive, albeit almost nonsignificant, results regarding the effect on the median could also be explained. When times are good, in terms of economic growth and the upward phase of the financial cycle, imposing higher reasonable macroprudential requirements cannot hurt future average growth, especially when credit institutions have fairly high own voluntary buffers.

[19] Although we are mostly interested in comparing the median and the GaR value, i.e. calculating distance to tail, we are showing all quantiles in graph 9 to get a better picture on the stability of the beta coefficients.

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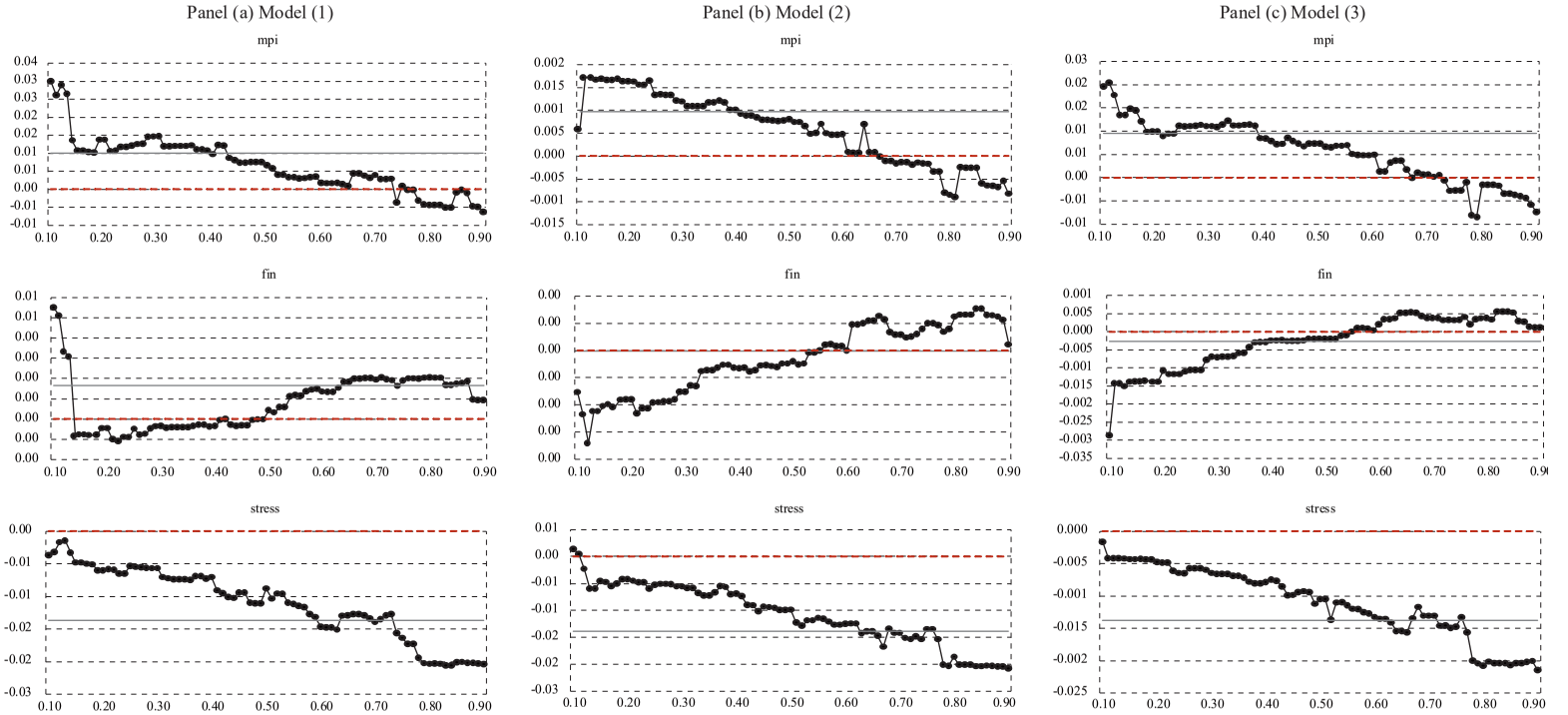
Graph 10 additionally examines confidence intervals for the MPI variable, across different forecasting horizons. Although the interval estimates include zero values in all cases, if the prudential authority thinks that the selected variables and model are reasonable, adding new data in the future could change these findings in favour of significant results. From the literature review so far, one would expect to have positive significant results on the GaR value, with an either negative or an insignificant effect on the median growth. Some reasoning on why the results are not (yet) significant could be a relatively short time series for a single-country analysis, and the definition of the MPI variable itself, without intensity adjustment. Although we have time series that start in mid-90s which is fairly good for macroprudential policy, there are still not enough datapoints to cover the richer structure of the GDP growth distribution. Moreover, the GDP drops observed for this country in particular have different origins, and the magnitude varied. So far, the worst realizations refer to the Covid-19 shock and the GFC. The methodology applied in this type of research is not meant to capture Covid shocks. Thus, effectively, the GFC is the main driver of results regarding the tail risk. Moreover, the MPI in this paper is used to reflect the number of measures, not their adjusting or fine-tuning. So far, there is no consensus on how to adjust the MPI values in the best way, as it is dependent on specific country and general macroprudential policymaker experience If this were done, perhaps it could change the results obtained here.

Moreover, beta values for the median growth case are constant over all observed horizons, around 1%, but not significant. This is in line with Suarez (2021), where MP stance and effects on future growth are explained from a theoretical point of view: if no effects on median growth are found, this could indicate that there are still some non-linear MP effects on growth that are not captured in the GaR setting. Another explanation is that there exists a natural limit to some MP tools that being applied in practice did not have negative effects on economic growth. As the Croatian macroprudential policy is fairly active, the latter could be true. The Croatian banking system has been one of the highest capitalized in the EU since the capital requirements were introduced after the GFC. Thus, this affects the results as well, due to the frequency of increases made over time, and this is in line with Aikman et al. (2018) who found positive effects of higher bank capitalization on GaR, with no significant reduction of median growth. Although not significant, the beta coefficients for the 10^{th} percentile start with the highest value for $h = 4$, and for each subsequent horizon decline. When compared to previous related literature (see literature review section), the signs of the estimated parameters are in line with related studies. However, the insignificance of the results could be also explained by the information that Croatia does not have borrower-based measures, which were found to be more effective in this analysis in previous related papers (Cucic et al., 2022).

GRAPH 9

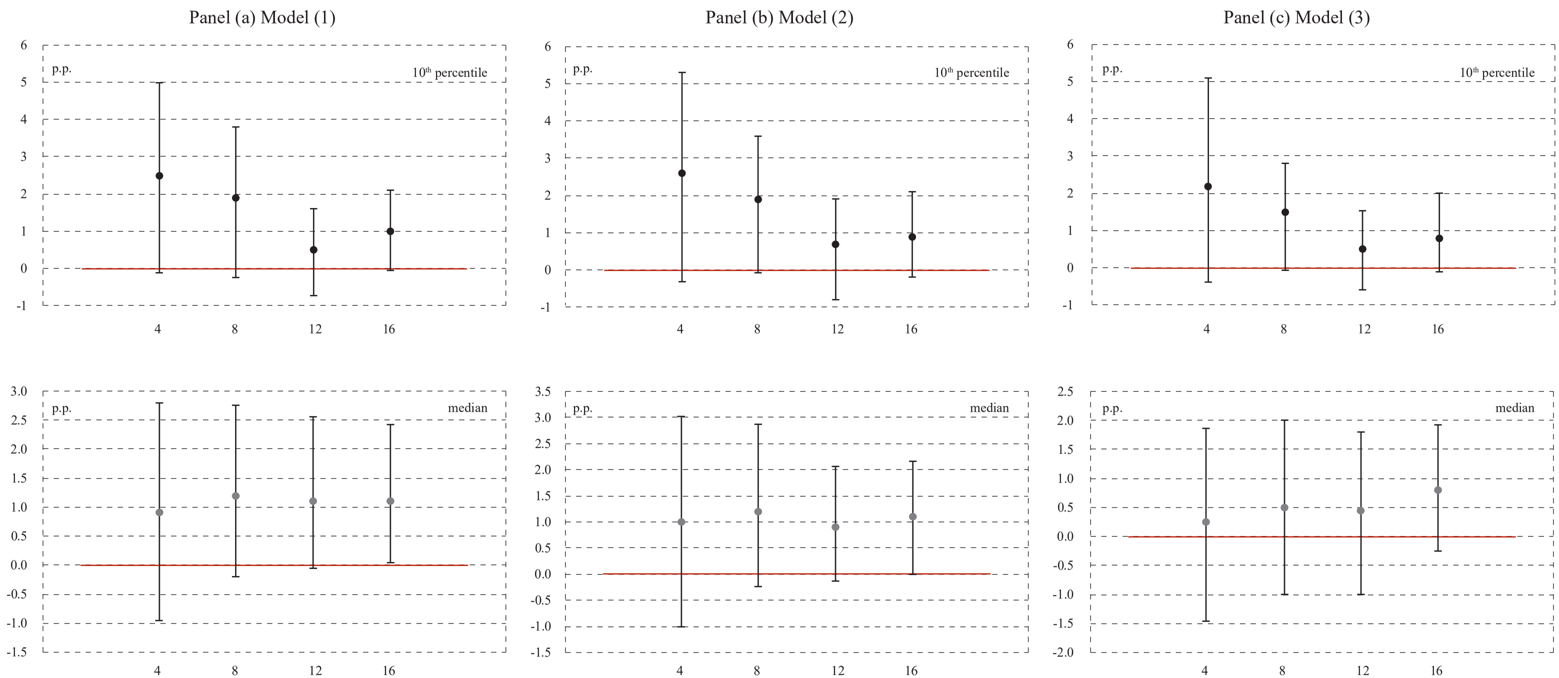
Estimated coefficients for models (1) – (3), h = 4 quarters ahead



Note: y-axes values should be multiplied by 100% to get p.p. growth interpretations. mpi – variant of macroprudential policy variable, fin – financial vulnerabilities variable as described in main text.

Source: Author's calculation.

Graph 10
Macroprudential policy effects on future growth



Note: Confidence intervals obtained via block bootstrapping with 1,000 replications. Block bootstrap is used to construct CIs as usual procedures like the xy-pair are not suited for the time series. The procedure applied here takes into consideration that time series exhibit autocorrelation and this should be included in the bootstrapping procedure, where the subsamples for the bootstrap are not constructed from random data picking. Rather, blocks are taken out as a time series. X-axis depicts the forecasting horizon of 4, 8, 12 and 16 quarters, whereas the y-axis shows the estimated coefficient besides the MPI variable in the GaR model specification.

Source: Author's calculation.

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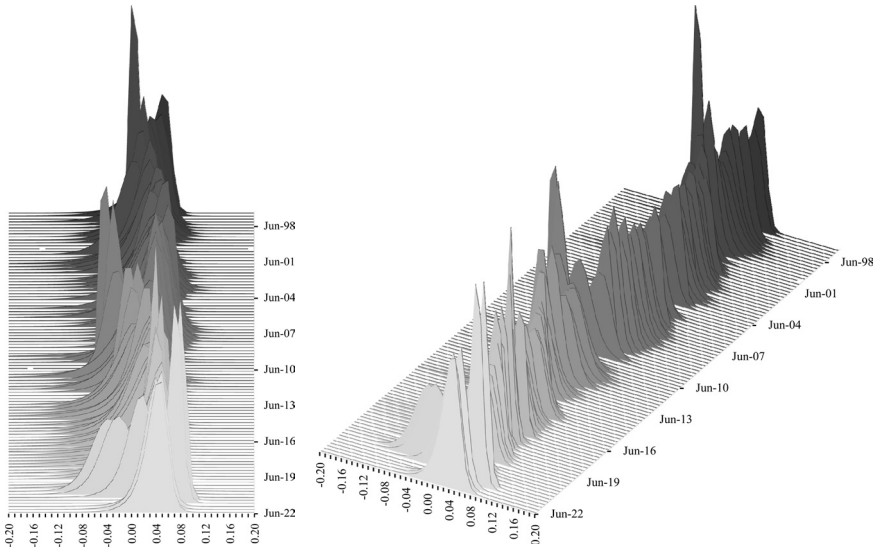
5.3.2 Distribution fitting results

Next, skewed t-distributions for every quarter from the GaR model were fitted as described in section 5.2. Graph 11 shows the distribution changes over time (right panel is the left one but rotated so that older values can be seen better). The model captures specific dynamics very well, as the distribution becomes heavily tilted to the left just before and during the GFC; the prolonged recession afterward is also visible, as the distributions were more left-tilted for a longer time. Finally, from 2015 onwards, the distributions became more compact until the COVID-19 shock shook it up again.

Graph 11

Fitted growth distributions from model (1), h = 4



Source: Author's calculation.

5.2.4 Macroprudential stance measure (distance to tail)

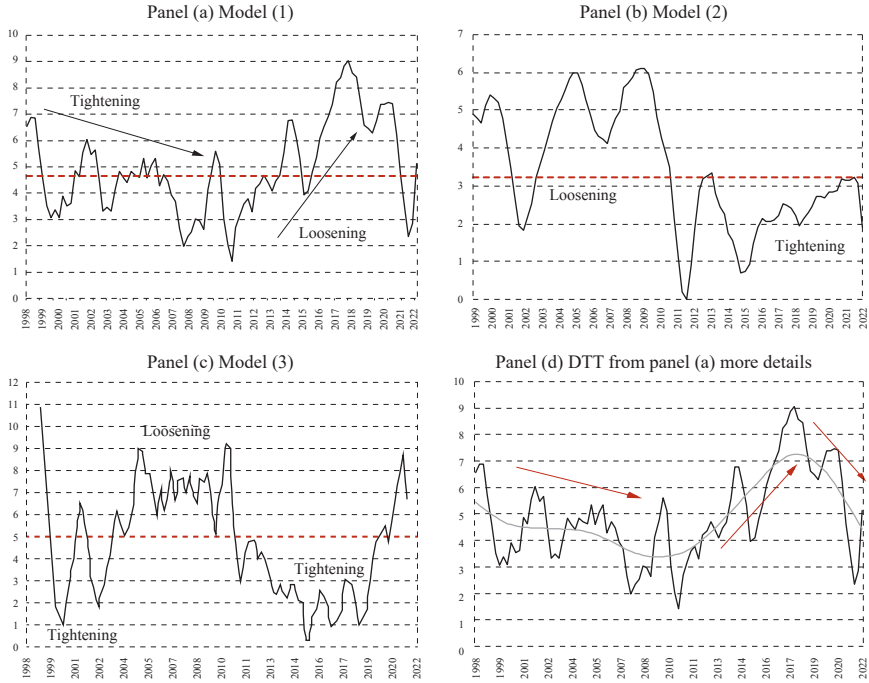
Using estimates from models (1) to (3), distance to tails (DTTs) have been calculated as the difference between the median and the 10th percentile growth for h = 4[20]. Results are shown in graph 12. All estimated DTTs are volatile, and it is hard to tell a story from them. Panel (a) shows that before the GFC, most of the time, DTT was below the median value and was tighter than in the period from 2015 to 2020. Covid-19 shock distorted the results at the end of the period, but the downward trend of DTT would likely have continued without this shock, as the rapid growth

[20] We use MPI "shocks" from a variable that was defined with values being equal to +1 or -1 (before purging out effects of other variables), and as we are not using moving sums as some studies do, there is no reason to believe that a measure that takes +1 value in, e.g. 1Q 2019 should have effects 12Q ahead, as this is way overstretching the effects that macroprudential policy has. Using moving sums or similar transformations would include a greater autocorrelation, i.e. memory of the variable and thus it would make sense to look at a longer time horizon. But to observe effects 3 years in future is really overstretching and we don't hear central banks saying that the macroprudential measures have significant effects on the GDP growth or in general the real economy so long in the future.

of consumer credit was in place before Covid hit. Moreover, this value is around the median[21] value, which could be a somewhat neutral level of macroprudential stance. Panels (b) and (c) tell completely different stories: in the pre-GFC period, the stance was looser due to higher DTT values, and in the second sub-period, the stance is tighter, with an increase of DTTs at the end of the observed periods. This cannot be true in practice. These results show how stance assessment is subject to data selection, transformation, and other relevant issues that were commented on in previous sections.

Graph 12

Distance to tail from models (1) to (3)



Note: Dashed lines indicate median values of distance-to-tails.

Source: Author's calculation.

Moreover, suppose one selected, e.g. the panel (a) DTT to be the true one, i.e. reflecting the actual effects of macroprudential policy on Croatian growth. In that case, the remaining question is how to evaluate this observed DTT to the neutral or optimal value? As the optimal DTT depends on the macroprudential policymaker's preferences, alongside the relative effectiveness of this policy on GaR compared to median growth, it is evident that this is a difficult empirical task. Future work will probably include the calibration of utility function parameters based on policymakers' revealed preferences. Currently, we are left with observing the results

[21] Here, we depict the median value of DTT as just a statistical value. It does not replace the theoretical "optimal" DTT value.

with respect to the historical distribution of DTT in graph 12, panel (d). It takes the DTT from panel (a) and adds a trend line (grey line). Cucic et al. (2022) similarly observed DTT by looking at the median value. Red arrows show the general direction of DTT dynamics over time. Before the GFC, the policy was introducing more measures as it was developing and trying to tackle the enormous credit growth. This decreased DTT over time. During the GFC, policy introduced loosening measures, which surely helped the DTT to decrease again after it spiked at the beginning of the crisis. A Croatia-specific situation afterward, the prolonged recession, could have affected the onward DTT, which was increasing until 2017. New tightening measures reduced the DTT onwards.

6 DISCUSSION AND CONCLUSION

Theoretical considerations about the effectiveness of macroprudential policy have been developing in the last couple of years, with explanations how this policy should work and affect future growth (see Suarez, 2021; and Checchetti and Suarez, 2021 as a starting point). However, practice so far has produced mixed results. An exhaustive literature overview in the first part of this paper sheds some light on the reasons why the results are very mixed. They could be different variable definition, selection, and transformation, and could also probably be due to the bird's eye approach to estimation (macro picture is observed, thus it is tough to capture some transmission mechanisms that way).

The inconclusive results of this study are in line with the comments of Reichlin, Ricco and Hasenzagl (2020), who agree that the relationship between financial and real variables is difficult to model. This is proven in this paper, where it is shown that the results vary with respect to variable definition, and model specification. One conclusion could be entirely different, if some of the changes are made. Such findings indicate that more work needs to be done before fully operationalizing the GaR approach to evaluate the MP stance on a regular basis. This is one of many papers that find GaR modelling challenging. This means that so far potential usage of this framework to tailor MP tools could be questionable. Alessandri and Di Cesare (2021) warn about the empirical problems and that MP instrument calibration based on such an approach should be very cautious. From this, we conclude that so far, MP tools should not be tailored according to the results obtained in this study. The initial results obtained from this study need to be taken with some caution. Results, although still insignificant, show that the effect of tighter macroprudential policy is positive on the lower tail of the future GDP growth, without effects on the median growth when focusing on a one-year-ahead forecast. This means that the distribution is reshaped to lower the magnitude of downside risks. Tightening in normal times does not disturb future average growth, but it could have greater positive effects on reducing the downside risks when they materialize.

When comparing the approach and results to the ESRB (2021) report, one needs to take into consideration a couple of things. Although it seems that the results in the report are stable and more usable than what was obtained here, there are caveats

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and challenges found in the ESRB approach. In the mentioned report, the transformation of the MPI indicator is rather questionable. All MP tools are converted into +1 or -1, with the final MPI variable calculated as a cumulative value of all tools that were observed over time for a given country. Then, a 5-year change is the basis for the transformation of the cumulative indicator. This 5-year change is used as the main policy indicator in the GaR model where the forecasts are made up until 4 years ahead. This would mean that the effects of macroprudential policy could take place over a 9-year period, which is too long. Furthermore, a 5-year change has a long memory and often is not stationary for countries like Croatia. The second challenge is the failure to solve the endogeneity issue of the policy variable. So, the results in the mentioned report are not comparable to those obtained here.

Some shortcomings of the approach taken in this research include the single equation approach. Future GDP growth is the only variable in this setting that is assumed to be endogenous. However, the interaction between the financial system and the real economy is two-sided. There has been some work on this that started emerging in the recent period: the ECB has been working on the quantile vector autoregression approach to deal with endogeneity of macro-financial variables and the feedback loops between the real and financial sector (Chavleishvili and Manganelli, 2020). In such a framework, one does not need to have a two-step procedure of purging the MP variable from macroeconomic shocks. Rather, the nature of vector autoregressive models can capture all interactions in one go.

Future work should mostly focus on resolving the MPI definition, i.e. how to translate different tools and their intensity into the final MPI value[22]; on solving the endogeneity challenge of the policy itself in order to talk about causality and measuring MP effectiveness. This could be done by trying to find a Taylor rule for macroprudential policy as a first step of the analysis. Although this was tried in this paper, one reason on why the results are still not satisfactory could be relatively short time series. If this is not solved when more data becomes available, it should be solved via the quantile VAR approach. Furthermore, as with other modelling, the recent COVID-19 shock has distorted some of the time series that are used in the empirical analysis. In this research, we did not do anything in this respect, i.e. the series were used without any "cleaning" beforehand. As GaR framework is not intended to capture such shocks, it is reasonable that the model used in this study could not forecast such shock in the GDP series. However, having this period in the dataset could affect the overall model results. Future work should try to see how to tackle this challenge.

Some authors warn that the empirical research relies on quantile regressions too heavily and found that GARCH (generalized autoregressive conditional heteroskedasticity) models outperform the QR one (Brownlees and Souza, 2021). Thus,

[22] Some initial steps have been done by Vandenbussche, Vogel and Detragiache (2015) and followed by Eller et al. (2020).

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future work could consider other methodological directions, like the MIDAS-QR (mixed data sampling), where higher frequency data could be used for forecasting purposes (Ferrara, Mogliani and Sahuc, 2022). Some authors are starting to focus on the DSGE (dynamic stochastic general equilibrium) modelling approach (Buch, Vogel and Weigert, 2018). However, others criticize this framework for not capturing tail risks (Blanchard, 2016), so an opportunity may exist to extend DSGE to GaR analysis. It is expected that the GaR framework will become more prevalent in climate change analysis. Bayoumi, Quayyum and Das (2021) and Kiley (2021) already provide an introduction. As climate disasters are becoming more frequent, it would not be surprising to see more and more applications capable of visualising the effects on financial stability.

Disclosure statement

There are no financial or other potential conflicts of interest.

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Uncertainty, populism and foreign direct investment: the state of play in economic research

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Abstract

This paper provides a synthesized, critical overview of the latest economic literature regarding the linkage between three concepts – uncertainty, populism and foreign direct investment. It starts with summarising ways to measure uncertainty in a direct and an indirect manner (with their respective advantages and limitations) and estimate its effects on populism and foreign direct investment. Later on, the paper focuses on the link between populism and foreign direct investment, exploring the possible role of uncertainty in this context. While heightened uncertainty and populism are typically associated with negative economic (including a decline in foreign direct investment) and non-economic outcomes, the nature of these effects and their interpretation are complex and leave room for further investigation. The implications of the research on this topic are wide reaching not only for economic stakeholders, but also for public sector policy practitioners.

Keywords: foreign direct investment, uncertainty, populism

1 INTRODUCTION

Recent global events have demonstrated the heightened uncertainty[1] of the contemporary world, to which terrorism, health issues, political tensions and wars have all contributed. For example, since the 2008 global financial crisis and the subsequent European debt crisis, economic and policy uncertainty has been rising (Ahir, Bloom and Furceri, 2022). It surged in 2016 with the unexpected Leave vote in the United Kingdom (UK), which was followed by the China – United States (US) trade tensions in 2018 (ibid, 2022). In 2020, the Covid-19 pandemic surged as a key driver of global uncertainty, dropping back recently only to be overtaken by uncertainty arising from the war in Ukraine, the renewed trade uncertainty associated with sanctions on Russia and the mounting Middle-East conflicts (ibid, 2024). While each episode is different, the common denominator is greater geo-economic division and more polarized politics, especially in Europe and the US. These trends are associated with the rise in global uncertainty, and it seems they are here to stay.

Another important phenomenon characterising the modern world is populism[2]. It has been on the rise globally, especially in the last decade (Guriev and Papaioannou, 2022). Populism became particularly salient with the rise of the Tea Party Movement in the US in 2010 (ibid, 2022), followed by Orban's rise to power in Hungary (Funke, Schularick and Trebesch, 2023). Populist parties had political success in

[1] Uncertainty is generally defined as lack of knowledge about the probabilities of the future state of events (Sniazhko, 2019). As explained more precisely by Knight (2021), there is a conceptual difference between risk and uncertainty, although they are sometimes used interchangeably. Risk refers to the situations where decision makers do not know the outcome, but they know the probability distribution governing that outcome. Uncertainty applies to situations characterised by both an unknown outcome and an unknown probability distribution.

[2] Although there is no consensus in the literature on what populism is (Guriev and Papaioannou, 2022), researchers usually quote Mudde and Kaltwaser's (2017) definition: a thin-centered (i.e. heterogeneous) ideology, considering society to be separated in two antagonistic groups – the pure people and the corrupt elite. There is no room for pluralism, protection of minorities and diversity of opinions. Other contemporary definitions which add authoritarianism, nativism, affinity for tradition and oversimplification of solutions to difficult problems are considered to be special cases of the above-mentioned description (Guriev and Papaioannou, 2022).

the 2014 European Parliament elections and they also did well in France and the United Kingdom (Guriev and Papaioannou, 2022). The year 2015 saw a populist coalition come to power in Greece and a populist party getting into office in Poland (Funke, Schularick and Trebesch, 2023). 2016 was associated with significant populist upswings manifeste by Brexit and the election of Donald Trump (Guriev and Papaioannou, 2022). Both 2017 and 2018 saw further strengthening of the positions of populist politicians and parties in France, Germany and Italy (Rooduijn et al., 2023). Incoming political elections in the US are exposing Trump's strengthening position in the race to be the new president, after his loss in 2020 US presidential election (Wolff, 2024). Apart from traditional strongholds of left-wing populist movements in Venezuela, Ecuador and Bolivia a surge of authoritarian far-right populism is visible in Brazil, Philippines, Turkey and India (Funke, Schularick and Trebesch, 2023).

The above-mentioned list shows that while populism was once a phenomenon confined to developing democracies, it is now gaining power in some of the world's most established democracies and most systemically important countries (Rooduijn et al., 2023; Funke, Schularick and Trebesch, 2023). While the effects of populism in power were once limited to a country's local political institutions, the effects of today's populism often reshape global financial and trade flows as well as foreign policy for years to come (Guriev and Papaioannou, 2022; Wolff, 2024).

It is no wonder then, that both uncertainty and populism, in their own right, have attracted the attention of social scientists. Academic exploration of uncertainty, its drivers and effects has gained ground especially in the last few years with the publication of uncertainty indexes based on text search (Cascaldi-Garcia et al., 2023), while research into populism assumed prominence after the 2016 election of Donald Trump and the strengthening of populist voting in Europe (Guriev and Papaioannou, 2022). However, the study of these two respective concepts has been done in a somewhat piecemeal way, focusing often on one determinant of uncertainty or populism and without trying to put these two concepts within the same contextual framework. We decided to fill the gap in this respect, and furthermore, to link the two with the concept of foreign direct investment (FDI)[3], which is considered to be especially sensitive to any source and form of uncertainty (Dixit, 2011; Choi, Furceri and Yoon, 2021; Gulen and Ion, 2016).[4]

Consequently, the aim of this survey article is to bring more clarity to the view on the relationship between uncertainty, populism and FDI by giving a synthesized, critical overview of the latest economic literature on the topic. While heightened uncertainty and populism are typically associated with negative economic (including a decline in

[3] Foreign direct investment is defined as net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments (World Bank, 2024).

[4] As described in greater detail in section 3.

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foreign direct investment) and non-economic outcomes[5], the nature of these effects and their interpretation are complex and leave room for further investigation.

The paper contributes to the research literature by offering a summarised presentation of the most important principles and latest findings, complete with the current scientific limitations and possible open questions regarding the topic. It can be of use to researchers in social sciences, (foreign) investors and other stakeholders including public policy practitioners, as it also strives to improve the basis for open discussions and informed decision-making in public policy creation and implementation regarding this complex and cross-cutting issue.

The paper is organised in the following way: after the introduction, section 2 presents various manners to measure uncertainty with their comparative advantages and limitations. Section 3 describes key features of the empirical relationship between uncertainty and FDI. Section 4 introduces the concept of populism by firstly defining it, then exploring its determinants and finally establishing whether uncertainty can also stimulate populism. Section 5 concentrates on the relationship between populism and FDI, focusing where appropriate on the role of uncertainty in this context. Looking ahead, section 6 offers a critique of the topic in the context of public sector (structural and fiscal) policies. The last section brings everything together and outlines avenues for further research.

2 UNCERTAINTY

Although uncertainty is one of the defining features of our times, the challenge of understanding its impact stems from the fact that it is not directly observable and thus not easy to quantify accurately. Researchers have grappled with this issue, relying on different methods to measure uncertainty (Cascaldi-Garcia et al., 2023). In general, it is possible to discern that empirical approximations of uncertainty regarding economic research in the field can be divided according to whether they are direct or indirect. Direct approximations draw on news, survey and econometric based measures, while indirect measures are based on analyses of markets and elections.

News based (text search) approximations of uncertainty are often based on frequency counts of specified search terms in important newspapers or reports (Baker, Bloom and Davis, 2016; Husted, Rogers and Sun, 2020; Caldara et al., 2020; Ahir, Bloom and Furceri, 2022). In particular, they use the daily count of articles containing uncertainty-related terms. Subsequently, the raw count has to be scaled by the total number of articles in the newspaper as well as normalised by its standard deviation. The resulting index may aggregate a set of newspapers and is also scaled to produce the final index with a mean of 100 (Cascaldi-Garcia et al., 2023).

[5] As described in greater detail in sections 3, 4 and 5 (including, inter alia, Avom, Njangang, and Nawo, 2020; Ogbonna et al., 2022; Julio and Yook, 2016; Jahn and Stricker, 2022; Bloom et al., 2019; Balduzzi et al., 2020; and Funke, Schularick and Trebesch, 2023).

News-based measures reflect the perceptions of large segments of society (including writers, editors and readers) and are effectively available in real time. Moreover, they are usually related to a broader sense of uncertainty (concerns about who will make a policy decision, what policy will be undertaken, when it will take place and what impact it will have) (Baker, Bloom and Davis, 2016; Husted, Rogers and Sun, 2020; Caldara et al., 2020; Ahir, Bloom and Furceri, 2022).

Specific examples include several indexes measuring economic policy, monetary policy and trade policy uncertainty as well as the world uncertainty index. So far, one of the most frequently used is the Index of Overall Economic Policy Uncertainty (EPU index)[6] constructed by Baker, Bloom and Davis (2016) for the USA (relatively more detailed) and 22 other countries and country aggregates. In a similar vein, Husted, Rogers and Sun (2020) created an index measuring uncertainty regarding Federal Reserve Board monetary policy, while Caldara et al. (2020) constructed a measure of uncertainty about USA trade policy. The latest index in this respect, the World Uncertainty Index (WUI), was constructed by Ahir, Bloom and Furceri (2022), counting the frequency of the word "uncertainty" in country reports by the Economist Intelligence Unit for 143 countries. They also scale raw counts by the total number of words in each report in order to make it comparable across the countries. The relative advantage of WUI index compared to EPU results from its wider time and country coverage – it includes not only developed but also developing countries and its data are available from 1952. Furthermore, it is based on the single source – the EIU reports, and is created following a standardized procedure and structure, making the values comparable across time and countries (Ahir, Bloom and Furceri, 2022).

Survey-based measures of uncertainty use surveys of individual businesses, households and market participants (Altig et al., 2022; Leduc and Liu, 2016; Scotti, 2016; Rossi and Sekhposyan, 2015). They directly measure the uncertainty respondents perceive with respect to economic activity, expenditures and sales, offering the relative advantage of more specificity regarding particular segments of society conveying uncertainty and the time horizon over which the uncertainty prevails. However, they can appear to be relatively outdated compared to other categories, especially in case of fast-breaking news and events potentially inducing uncertainty. This category can be subdivided in *ex ante* and *ex post* surveys. The former focus on the expectations about future, while the latter compare expectations and realisations (Cascaldi-Garcia et al., 2023).

Examples include the Survey of Business Uncertainty (Altig et al., 2022), which is a panel survey of one-year-ahead uncertainties companies perceive about their sales and employment as well as a measure of consumers' perceived uncertainty (Leduc and Liu, 2016) about car purchases over the next 12 months based on the University of Michigan Survey of Consumers. Scotti (2016) constructs a macroeconomic uncertainty index using weighted averages of the square of economic data surprises. The latter are

[6] Despite methodological concerns laid down by Čižmešija, Lolić and Sorić (2017).

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measured by computing deviations of recent economic data releases from consensus expectations in Bloomberg forecasts an hour before the data are released. Finally, Rossi and Sekhposyan (2015) construct a measure of professional forecasters' uncertainty based on the realizations of GDP growth, relative to the unconditional forecast error distribution from nowcasts and forecasts of the Survey of Professional Forecasters.

Instead of relying on the perceptions of market participants and forecasters, **econometric based measures** of uncertainty use a lack of predictability, more specifically, situations where market participants' economic activity is less forecastable and thus characterised by high uncertainty (Jurado, Ludvigson and Ng, 2015; Ludvigson, Ma and Ng, 2021). Such measures offer the relative advantage of being underpinned by statistical inference and a rather wide perspective. However, they are available at lower frequencies and can differ when estimated on *ex post* revised data versus real-time data (Cascaldi-Garcia et al., 2023). Jurado, Ludvigson and Ng (2015) and Ludvigson, Ma and Ng (2021) compute indexes of macroeconomic and financial uncertainty as respective aggregates of the conditional volatility of the unforecastable component of a set of US economic and financial variables. Those indexes distinguish between uncertainty and traditionally used measures of volatility.

Indirect approximations of uncertainty in the field include those that derive from studies of markets and those based on discussions of elections.

Market-based measures of uncertainty are derived from financial markets. They are usually calculated as a measure of volatility or other higher-order moments of returns in a market over a certain amount of time (Cascaldi-Garcia et al., 2023). One of the most widely known examples is VIX – the Chicago Board of Options Exchange's Volatility Index. This index measures market participants' expectations concerning the volatility of the S&P 500 index over the next 30 days. Researchers and market participants have often used it to measure fear or uncertainty regarding the US equity market. It has the advantage of being available in real time and at intraday frequency and consequently market participants tend to use it during crises, in the case of events that are unfolding rapidly.

Following the approach of Durnev (2010), Gao, Murphy and Qi (2019), Jens (2017), Julio and Yook (2012) as well as Çolak, Durnev and Qian (2017). Julio and Yook (2016) laid the foundation for the recent strand of literature **approximating uncertainty indirectly through elections** and measuring the outcomes pertinent for this study. The timing of elections becomes the alternative for measuring variation in political uncertainty. When opposing candidates in an election promote different policies, uncertainty about an election outcome also entails uncertainty about policies to be carried out after the elections. Thus, the outcomes of national elections are relevant for the decisions of market participants. This assumption tends to be supported by many authors who found that probability of policy changes appears to rise around elections (including Białkowski, Gottschalk and Wisniewski, 2008; Boutchkova et al., 2012; Baker, Bloom and Davis, 2016). The sources of election data are usually the Database of Political Institutions (Scartascini, Cruz and Keefer, 2021) or the Psephos dataset administered by Adam Carr (2024).

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However, even if researchers consider elections to be exogenous indicators for periods of high uncertainty and examine their impact on a dependent variable, it is still difficult to generalise these conclusions. This is because elections tend to be foreseeable events and can be anticipated up to a certain point, while many other uncertainty-generating events cannot be foreseen. Furthermore, according to Gulen and Ion (2016), the election indicator does not capture how much the level of uncertainty rises during the elections and it also assumes that uncertainty does not change during non-election times. Due to those drawbacks, some authors prefer to use uncertainty indexes (Hsieh, Boarelli and Vu, 2019).

3 UNCERTAINTY AND FOREIGN DIRECT INVESTMENT

Economic research on the impact of uncertainty has focused on various aspects such as macroeconomic issues (output, investment and inflation), microeconomic phenomena (firm level investment or the health sector) and financial topics (equity returns or corporate strategy) (including Rjiba, Jahmane and Abid, 2020; Arslan et al., 2015; Merow and Urban, 2020; Phan, Sharma and Tran, 2018).

In the context of the paper, at this point we turn our attention to the authors who studied the relationship between uncertainty and economic activity from a theoretical perspective, particularly with regards to investment. Firstly, according to Keynes (1937) investment tends to depend on the opinions regarding future events and therefore, any negative opinions about future events will consequently reduce the investment. There are several theoretical predictions about the relationship between uncertainty and investment. Traditionally, according to real-option theory, as explained by Bernanke (1983) and later expanded by Rodrik (1991), Bertola and Caballero (1994) and Bloom (2009), if investments are (even partially) irreversible, uncertainty increases the value of waiting and delaying investment until some of the uncertainty has been resolved. A complementary concept of the financial frictions theory (Arellano, Bai and Kehoe, 2019; Choi et al., 2018) specifies that a rise in credit spreads, because of the bondholder compensations required due to the increased uncertainty, sets off prolonged declines in investment. Conversely, there is the alternative option, to expand, as defined by Abel and Eberly (1996), which may prevail during disruptions, thus reversing the usual response to uncertainty. With this approach, firms may decide on costly expansion or pre-emption in some business aspects, instead of facing a costly reversibility that might delay their investment.

It can be argued that such theoretical considerations regarding the relationship between uncertainty and investment are even more pertinent for foreign direct investment which should be relatively more sensitive to uncertainty (Julio and Yook, 2016[7]; Dixit, 2011; Choi, Furceri and Yoon, 2021; Gulen and Ion, 2016). Just like domestic investors, foreign investors face fixed sunk costs, but these are considered higher for foreign investors (Choi, Furceri and Yoon, 2021). In particular, foreign

[7] Julio and Yook (2016), among other things, empirically prove that foreign flows of capital are more sensitive to uncertainty than domestic investment as magnitudes of FDI decline are significantly larger than those of domestic investment.

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investors have limited information about the host country as well as weaker protection from its legal and political institutions. Furthermore, they may even encounter legal bias and have to bear the risk of expropriation. Additionally, they are exposed to exchange rate risk. Potentially different tax treatments and restrictive regulations concerning capital repatriation also make FDI relatively irreversible.

As the above-mentioned theoretical predictions about the relationship between uncertainty and investment did not result in a consensus, the nexus between uncertainty and (foreign direct) investment appears to be primarily an empirical issue.

Empirical findings on the topic point out that, although heightened uncertainty seems to be generally associated with worse FDI outcomes, the nature and magnitude of the effects critically depend on the type of the uncertainty and the characteristics of the countries involved in the cross-border flows (e.g. their degree of economic and institutional development).

Using EPU as an indicator of uncertainty, Hsieh, Boarelli and Wu (2019) demonstrate that the increase in uncertainty in the US is associated with an upsurge in outward FDI. Additionally, an increase in the level of uncertainty in the host country results in a decrease in FDI from US companies into that geographical area. Employing WUI as a new measure of economic policy uncertainty, Avom, Njangang, and Nawo (2020) find that WUI reduces foreign direct investment globally. The magnitude of the effect is more important in emerging and developing than in advanced countries.

Using both domestic economic policy uncertainty and the world uncertainty index on a panel of developed economies, Canh et al. (2020) show that, although domestic economic policy uncertainty has a negative effect on FDI inflows, an increase in the global (world) economic policy uncertainty increases FDI inflows into the country. These findings may imply the existence of safe havens for foreign direct investors in globally turbulent times as well as a systematic aversion to global uncertainty. Jardet, Jude and Chinn (2023) also found evidence of flight to safety in case of persistent global uncertainty, implying redirection of FDI towards advanced countries. Apart from that, overall they established a negative relationship between global uncertainty and FDI in all the locations, while host-country uncertainty induced a negative effect on FDI flows only for emerging countries and to a lesser extent than the global outcome. Finally, Bonaime, Gulen and Ion (2018) confirm the strong negative association between EPU and mergers and acquisitions at macro and firm level. In accordance with a real-option theory, the effect is exacerbated for less reversible deals.

A particularly interesting strand of the literature explores how the relationship between uncertainty and FDI may vary, depending on the type and degree of institutional development. Looking at the economic governance institutions, Ogbonna et al. (2022) find that weak institutions in Africa intensify the adverse effect of uncer-

tainty on FDI instead of mitigating it. Regarding the role of financial development in the interplay between the uncertainty and FDI, the results are rather heterogeneous and seem to be primarily of an empirical nature. Choi, Furceri and Yoon (2021) have established that higher financial development in a host country mitigates the adverse effect of uncertainty on FDI inflows, while both Ogbonna et al. (2022) for Africa and Jardet, Jude and Chinn (2023) at the global level demonstrate that financial development does not play a significant role in this context. On the other hand, Nguyen and Lee (2021) establish the importance of disaggregating financial development into sub-categories of financial institutions and financial markets. According to their findings, the adverse effects of uncertainty on FDI inflows are likely to be exacerbated by a high development of financial markets.

In a similar vein, Zhu, Jia and Wu (2019) investigate how a specific type of investment irreversibility (bankruptcy costs) influence the relationship between uncertainty and FDI flows. According to their findings, higher bankruptcy costs can exacerbate negative effects of uncertainty (approximated through EPU) on FDI. In accordance with the real-option theory, the bankruptcy resolution channel does not exist for foreign portfolio flows. Furthermore, the above-mentioned channel only exists in high political risk countries.

While previously described findings reflect the usage of EPU, WUI and VIX indexes, there are also authors who undertook empirical research using elections as approximations of uncertainty. Key exponents of this approach are Julio and Yook (2016) who, in accordance with the real-option theoretical perspective, show a significantly negative effect of policy uncertainty (approximated through election time) on FDI just before an election in the host country and an increase in FDI after the uncertainty is resolved. While this effect is present for FDI (which is relatively irreversible), it does not exist for foreign portfolio flows. Chen, Nie and Ge (2019) as well as Honig (2020) also find the negative effect of uncertainty on FDI at the global level. Whereas Chen, Nie and Ge (2019) find the negative effect to be especially strong in less democratic countries, Honig (2020) finds more evidence of adverse effect in developing than in advanced countries. Agbloyor (2019) and Gossel (2020) focus on Africa, performing a similar analysis. While Gossel (2020) finds a negative effect of the election year on the FDI inflows in the sub-Saharan area, Agbloyor (2019) cannot find a significant influence of elections in this respect. Finally, Jahn and Stricker (2022), using both elections and WUI as an alternative measure of uncertainty, find that reinvested earnings significantly drop in an election period compared to other FDI sub-types, as predicted by the real-option theory. However, this only holds for high-income countries. In other countries, equity investment is negatively affected, while a higher political quality will moderate the effect.

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4 POPULISM

So far, the paper has focused on the relationship between uncertainty and FDI. Now we turn our attention to populism – another important phenomenon of modern times. We want to explore what happens when we throw populism in the mix between uncertainty and FDI. However, in order to do this, firstly it is necessary to define this concept, explore its determinants, and then establish if there is a link between uncertainty and populism.

Although there is no consensus in the literature on what populism is (Guriev and Papaioannou, 2022), Mudde and Kaltwasser's (2017) definition offers its most general description. Populism is presented as a "political style", rather than a set of policy proposals, considering society to be separated into two homogeneous, antagonistic groups: "the pure people and the corrupt elite". It implies heterogeneous objectives and offers no room for pluralism, protection of minorities or diversity of opinions. There is little need for independent experts or agencies, parliaments and media as they serve the elite and obstruct people's direct rule. Anti-elite sentiment also includes the opposition to globalisation and supranational institutions, considered "elite projects" distanced from normal people. The anti-elite aspect also means that populists reject the need for democratic checks and balances because they tend to favour simpler majority rule. Pastor and Veronesi (2021) define populism as a political ideology, which is nationalist, anti-immigrant and anti-elite, while Rodrik (2021) defines it as a political viewpoint claiming to represent "people's common interests". However, for right-wing populists the latter include opposition to minorities and foreigners, while left-wing populists display opposition to the interests of financial elites.

Academic interest in populism has resulted in the existence of various studies exploring the key drivers of populism. The latter can be boiled down to the insecurity generated by structural changes in the economy and culture. Consequently, key determinants of populism include trade and financial globalisation, technological progress, labour market deregulation, immigration, as well as cultural issues. The empirical literature on the topic is large and displays both consistent patterns and some conflicting findings.

Global, **cross-border trade** has grown steadily since the fall of tariff, quota and non-trade barriers in the late 1980s (World Bank, 2024). Trade growth was particularly fast in emerging economies, especially in China since its entry into the World Trade Organization in 2001 (World Bank, 2024; Pavcnik, 2017). The surge of China and other emerging economies as leading global exporters disproportionately affected low-skilled and middle-skilled workers in advanced countries, generating persistent unemployment and income losses in import-competing regions as the production of goods with low human-capital intensity shifted to low-wage countries (Pastor and Veronesi, 2021). Middle-skilled jobs were especially affected because their relatively higher wages made them prone to outsourcing and offshoring (Guriev and Papaioannou, 2022). At the same time, as noticed by Rodrik (2021),

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governments also became increasingly ineffective at delivering offsetting policies of compensation and redistribution for losers in the trade globalisation process. Those failures of compensation were compounded by the failures of representation (Hays, 2009), as a large fraction of voters felt that their problems were not being adequately understood and addressed in the existing political arena. Empirical works corroborating the positive effect of the trade globalisation shock on increased populist vote include Autor et al. (2020), Dippel et al. (2017), Barone and Kreuter (2021), Caselli, Fracasso and Traverso (2020), Malgouyres (2017), Colantone and Stanig, (2018a, 2018b), Steiner and Harms (2023).

Financial globalisation and the related crises have also been studied as a potential driver of populism. The free flow of short-term finance across national borders and the build-up of considerable financial liabilities led to the Global Financial Crisis of 2008-2009 (Barros and Santos Silva, 2019). It was followed by a brief recovery, and subsequently by the European sovereign debt crisis that resulted in the recession of 2011-2013 (Blanchard and Brancaccio, 2019; Åslund and Dombrovskis, 2011). Many private banks were bailed out using taxpayers' money, which reinforced the view that governments were really defending the interests of financial elites instead of the people (Gyöngyösi and Verner, 2022; Ahlquist, Copelovitch and Walter, 2020). The crisis exposed some European governments to a risk of default, leading to the enforcement of stronger fiscal discipline. It limited further the governments' ability to spend on welfare state and redistribution policies, while the weakening of social safety nets led to an extensive feeling of unfairness (Guiso et al., 2024; Dustmann et al., 2017; Lechler, 2019; Dehdari, 2022; Gidron and Mijs, 2019; Fetzer, 2019; Fetzer, Sen and Souza, 2023; and Dal Bó et al., 2018). The austerity was often the part of economic adjustment programmes imposed by supranational institutions – International Monetary Fund and European Union (Åslund and Dombrovskis, 2011). Whereas the citizens in southern Europe were opposing the idea of imposed austerity, taxpayers in northern Europe feared that they would end up paying the debts of profligate southern countries. The result of these two opposing perspectives was the pervasive decline of support for the European integration project and the parallel growth of anti-globalization and eurosceptic forces (Guiso et al., 2024; Fetzer, 2019; Fetzer, Sen and Souza, 2023; and Dal Bó et al., 2018). Conversely, Bergh and Kärnä (2021) find no association between populist parties and the globalisation index, while Funke, Schularick and Trebesch (2016) find that only financial crises cause vote swings towards far-right populist parties.

Technological progress through artificial intelligence, machine learning and robotization penetrates various industries as many tasks become routine and automation replaces jobs. The winners of this process have mostly been high skilled "knowledge workers", whose cognitive occupations complement technology, while losers have been low- and middle-skilled workers whose routine jobs are easier to automate (Im et al., 2019). In particular, the information technology revolution led to a job polarization, implying a decrease in the relative number of routine middle-income jobs and growth in the share of non-routine jobs at the two ends of

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the income distribution: cognitive, high-income type or the manual, low-income type (Autor, 2014; Frey, Berger and Chen, 2018; Anelli, Colantone and Stanig, 2019). Regarding wages, the former have seen their income diverging from those of the middle-class, which fell closer to the group of low-skilled and low-income workers (Gallego, Kurer and Schöll, 2018).

As described above, technological progress was intertwined with the transformation of labour relations and wages, in particular **labour market deregulation**. The presence of losers in such arrangements was significantly associated with populist voting (Gozgor, 2023; Dal Bó et al., 2018). Populist parties fared worse in countries that spent more on passive labour market policies (providing income for workers experiencing unemployment). Cuts to those programmes were strongly associated with increased support for populist parties (Foster and Frieden, 2024). Similar implications regarding the role of flexicurity arrangements as a tool against (right-wing) populism also stem from the work of Bergh and Kärnä (2022).

The existing studies on the relationship between **immigration** and the rise of populism offer mixed evidence. Studies finding that immigration increases populist support include Dustmann, Vasiljeva and Damm (2019), Barone et al. (2016), Halla, Wagner and Zweimuller (2017), Edo et al. (2019), Becker and Fetzer (2016). On the other hand, Colantone and Stanig (2018a), Alabrese et al. (2019), Steinmayr (2021), Vertier, Viskanic and Gamalerio, (2023) and Lonsky (2021) produced the opposite results. Guriev and Papaioannou (2022) explain the lack of consensus in several ways. Firstly, it may be the question of magnitude. If the concentration of immigrants in an area is small, the contact theory suggests that their encounters will lead to empathy and increased understanding. If, on the other hand, the concentration of immigrants is large, it may result in fear of non-integration and an increased populist vote (as demonstrated by Vertier, Viskanic and Gamalerio, 2023). Secondly, there is also a distinction between refugees in transit and settlement. While settlement implies increased contact and rising empathy, these factors are not likely to be present in case of refugees in transit (Guriev and Papaioannou, 2022). Moreover, host communities may also be more open to high-skilled immigrants as opposed to the low-skilled ones (Moriconi, Peri and Turati, 2022; Mayda, Peri and Steingress, 2022). Finally, immigration may affect the populist vote in different ways: either via the economic impact or through culture and identity issues. As demonstrated by Algan et al. (2017) and Margalit (2019), negative migration attitudes at the individual level are consistently driven mostly by previous exposure to economic shock (e.g. Chinese import shock, loss of employment due to automation). According to their findings, this type of economic distress also seems to prompts more cultural concerns about immigration.

Apart from monetary issues, people also care deeply about **non-monetary factors** such as culture (in this context culture is a generic term including also ideology, religion, moral values, status loss and social connection). Economic and cultural factors are often seen as highly intertwined (Rodrik, 2021; Colantone and Stanig, 2019). Although theoretical studies have modelled the interaction between culture,

economics and support for populism, high quality empirical analysis is rare (positive examples are Di Tella and Rodrik, 2020; as well as Grossman and Helpman, 2021). This type of econometric exercise can be problematic if culture is endogenous to the economic determinants and the issue is not addressed in an adequate methodological manner (Guriev and Papaioannou, 2022; Margalit, 2019; Colantone and Stanig, 2019). Further research is necessary in this respect, with economists increasingly collaborating with social psychologists as well as scientists investigating culture to explain politico-economic issues.

So far, the paper has focused on various drivers of populism such as trade and financial globalisation, technological progress, labour market deregulation, immigration and cultural issues. Can **uncertainty** also be one of the determinants of populism? According to Gozgor (2022), when studying the factors stimulating populist voting, it is important to distinguish between economic uncertainty and economic insecurity. It implies making the difference between (economic) uncertainty and (economic) grievances, losses, scarcity and crises that can cause (economic) insecurity, as discussed by Golder (2016). Consequently, Gozgor (2022) is the first author to study empirically the effects of uncertainty (as measured by the WUI index) on populist voting behaviour in EU countries. Using various econometric estimation techniques, controls and robustness checks, the author demonstrates that uncertainty increases total populism and right-wing populist voting behaviour.

5 POPULSIM AND FOREIGN DIRECT INVESTMENT: IS THERE A ROLE FOR UNCERTAINTY?

After explaining key characteristics of populism as well as its potential determinants including uncertainty, let us turn our attention to the relationship between populism and FDI focusing, where appropriate, on the role of uncertainty in this context.

Firstly, the existing research points towards substantial economic and noneconomic costs of populist countries. Funke, Schularick and Trebesch (2023) prove that in the medium and long run, practically all populist countries exhibit subpar economic and institutional results evidenced by a significant decline in real GDP and consumption, independence of the judiciary, election quality, press and media freedom. Research studies focusing on the effects of Brexit, Donald Trump's election victory in 2016 in the USA, populist episodes in Southern Europe (Italy, Greece) and Central and Eastern Europe (Hungary, Poland) also establish significant medium-term costs. They are visible in terms of lower inward FDI and overall investment, capital flight, stagnating wages, poor growth, rising inflation and weakening of institutions[8] (Sampson, 2017; Dhingra et al., 2017; Breinlich et al., 2020; Serwicka and Tamberi, 2018; Broadbent et al., 2023; Breinlich et al., 2022; Born et al., 2019a, 2019b; Fajgelbaum et al., 2020; Magyar, 2016; Brzezinski and Najsztub, 2017; Bloom et al., 2019; Balduzzi et al., 2020).

[8] With the exception of robust economic performance in Poland (according to Guriev and Papaioannou (2022: 806), possible reasons for which include previously implemented reforms in Poland, improved tax collection in the country and immigration of Ukraine workers due to conflict and subsequent war with Russia).

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Secondly, according to the latest findings in the area of international business, populist governments and policies can, in themselves, constitute a source and proxy of (political) uncertainty (Sallai and Schnyder, 2021; Sallai et al. 2024; Carballo Perez and Corina, 2023; Alcaraz, Maartinez-Suarez and Montoya, 2023; Devinney and Hartwell, 2020; Stöckl and Rode, 2021). Populist governments are unpredictable for multi-national companies (MNCs) because they can oppose business elites on their platform to defend "the people". For example, they can adopt policies discriminating against foreign companies (e.g. public procurement or subsidies favouring domestic companies) or even, in more extreme instances, impose special taxes on foreign operations in the host country or forced buyouts. Such measures can be adopted and enforced, without due legal procedures. Conversely, populists may use nationalist mobilisation as a rhetorical tool during the election campaign, but without any real intention to put it into practice once they have come into power.

Furthermore, populist policies affect different MNCs in different ways, as demonstrated by the literature on the topic (Sallai et al., 2024). At country level, political uncertainty for an MNC is especially high if there are domestic competitors or if there are alternative sources of FDI from ideologically aligned countries. At sectoral level, political uncertainty is relatively higher in less strategically important sectors (particularly in terms of inward technology transfer). Finally, at firm level, the lack of investment capacity or ownership advantages due to unique technology can increase the relative level of political uncertainty for an MNC. The absence of protection from home country or of the positioning in local community through social expenditure can also result in an increased level of uncertainty for an MNC.

There are only a few studies trying to establish econometrically the relationship between populism and FDI, and they have been done primarily at firm level in the context of international business literature. Alcaraz, Martinez-Suarez and Montoya (2023) analyse the relationship between populist leaders and populist parties in Latin America on the one hand and internationalisation decisions (green-field investment) by local companies in the countries of the region. Their research underlines the crucial role of domestic political factors for foreign investment decisions. According to their findings, populist leaders in the home countries tend to discourage green-field investment by Multilatinas, while at the same time populist parties usually have the opposite effect on the firms in this geographical region. The authors give several reasons for such outcomes: populist leaders in the home countries may discourage internationalisation decisions by Multilatinas because of political instability caused by the survival prospects of populists in the region, who are often forced to leave office in dramatic circumstances. Moreover, legislative acts introduced by populist leaders may considerably increase the time and resources needed by firms to determine the extent to which policy decisions can influence their operations, positively or negatively. In such circumstances, they may postpone their decisions until uncertainty has been resolved. On the other hand, populist political parties are often perceived by firms to be political outsiders without the skills and experience required for government and legislation. This perception may encourage firms to seek green-field investment abroad.

In the similar vein, Carballo Perez and Corina (2023) explore the relationship between populism and foreign investment by US firms in developed countries. They stress the importance of host country political factors as well as potential mitigating circumstances. The firm level FDI is moderately significant and undermined by populism in the host countries. This negative effect seems to be palliated by country level institutions and firm level internationalisation. The threat of the populist leaders to alter "the rules of the game" is less credible in host countries with strong institutions, while multinational companies with higher levels of internationalisation can develop broader perspectives on different economic and political conditions and have greater operational flexibility in the case of actual change in the operational environment promoted by populist rhetoric. This is currently the only study on the topic distinguishing between populism and other sources of aggregate uncertainty (controlled for through the EPU index). While the firm level FDI is moderately significant, the EPU index seems not to play an important role in this context.

6 UNCERTAINTY, POPULISM AND FOREIGN DIRECT INVESTMENT IN THE CONTEXT OF PUBLIC SECTOR (STRUCTURAL-FISCAL) POLICIES: A LOOK AHEAD

As described above, according to research, there has recently been a rise in both uncertainty and populism. They have become features of modern society policymakers have to contend with. Indeed, uncertainty has proven to be one of the factors prompting rising populist responses (Gozgor, 2022).

Within this context, a new public policy paradigm has started taking shape – economic security (Williams, 2023; Von der Leyen, 2020). The key idea is to try to reduce the uncertainty for the country's economy, brought about by market fluctuations, pandemics, geostrategic tensions and conflicts. Williams (2023) sees it as a response to four big shocks – the global recession of 2020, geopolitical shocks, energy crisis and artificial intelligence. The recession caused by the COVID pandemic, the collapse of supply chains and the surging inflation decreased confidence in the incumbent economic system seen as a source of instability and prompted governments to introduce public policies in order to address the challenges. The increased geo-economic tensions between China and USA, the war caused by Russian invasion of Ukraine and the ensuing energy crisis (coupled with rising inflation) as well as the conflict in the Middle East have also shattered the notion of successful economic and political integration. Finally, the artificial intelligence boom has amplified fear among workers for their jobs (Rodrik, 2021). All these events have increased the sense of uncertainty among both policy makers and the electorate.

In order to minimise uncertainty, the governments are trying to interlink national security and economic policy through increased self-reliance, economic security and strategic autonomy. As described by Williams (2023), apart from raising tariffs (Trump presidency), many governments are resorting to subsidies and domestic-content requirements to create national champions in strategic industries such as artificial intelligence, computer chips and electric vehicles. Western governments

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are using policy tools like bans on exports and international investment from geopolitical adversaries especially in sensitive industries used both for civil and defence purposes. Besides the digital transition, they are also building up clean technologies in the fight against climate and energy uncertainty. The examples include South Korea giving tax breaks to semiconductor companies, the Chips Act and Inflation Reduction Act in USA, Green Deal Industrial Plan in Europe and EU arrangements to assist communication and microelectronic sectors.

Juhász et al. (2022) empirically demonstrate that policy makers are turning their attention towards industrial policy measures in order to persuade companies to locate or expand activities in their respective countries, in strategic industries such as semiconductor industry or sustainable energy. Private companies, at the same time, respond to such government signals by talking about bringing back production to their home-country, leaving China or keeping higher stock of raw materials and finished goods in order to be able to draw on them in the event of supply chain failure. On the other hand, some firms will want to invest directly on foreign soil, when international trade is difficult, thus adapting to the protectionism elsewhere.

Furthermore, there will be limits to handouts by governments fiscally exhausted after the big fiscal stimuli undertaken in response to global shocks such as the global financial crisis (2007-2008 leading to the European debt crisis) and COVID pandemic (coupled with the energy crisis and geopolitical conflicts). In such circumstances fiscal policy is constrained, even more so, if we take into account fiscal challenges posed by demographic trends, defence concerns as well as green and digital transition. Moreover, fiscal and monetary policies are tools useful for regulating the macroeconomy in the short term, but it is structural reforms that should improve country's medium to long-term performance through increasing potential growth and resilience (Blanchard and Johnson, 2011).

According to macroeconomic theory, giving free-market oriented supply-side policies greater influence in the economy should stimulate productivity, increase economic incentives, initiate the adoption of efficiency-enhancing technology and increase investment in physical and human capital. However, Alesina et al. (2024) demonstrate a significant slowdown in structural reforms worldwide from the 1990s. They explain it by reform fatigue after significant structural reforms undertaken in previous decades as well as rising populist tendencies. Nevertheless, the structural reform agenda remains substantial worldwide. Consequently, the authors try to clarify why the liberalisation measures, which are theoretically so beneficial for treating weak productivity and growth, are so unpopular and difficult to carry out among both policy makers and the electorate. According to their findings, the electoral impact of reforms is contingent on their timing regarding the electoral and business cycles. Reforms seem to be politically costly, when carried out close to elections, but are typically benign when undertaken earlier in the political cycle. Furthermore, liberalisations implemented during recessions are more likely to be penalised by the electorate than reforms done during the robust part of the economic

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cycle. These findings are complementary to the evidence that growth payoffs from doing the difficult, technical work of structural reforms do not come quickly and the electorate does not perceive positively the lag between the reform and the visible economic benefits. Moreover, structural reforms cause immediate losses versus delayed economic benefits, and losers may be voicing their opposition very strongly (even if they are in a minority). Thirdly, the electorate may not be able to distinguish between various causes of recession and may attribute them wrongly to the implementation of the reform. Finally, policy makers should be especially wary of reforms that cause large distributional effects together with small and delayed growth benefits. Consequently, in the super-election year (EU Parliament, France, UK, USA, followed by elections in Germany expected for 2025), politicians will probably be chary about deep structural reforms, especially as they do not want to be blamed for the ensuing job losses, in the climate of mounting populist tendencies. Right now, it seems that rising uncertainty and (especially far right) populism are here to stay. Scientific research points towards their many shortcomings regarding economic performance and societal well-being. The policy makers have their work cut out for them to come up with an approach that will ultimately deliver the prosperity and security the electorate wants. If economists cannot contribute with the answers in the process, populist insurgents will.

7 CONCLUSION

Uncertainty is one of the defining features of our time; yet, it is not directly observable. Researchers in economics trying to establish empirically the effects of uncertainty have grappled with this issue in various manners, mostly trying to approximate it in direct and indirect ways at macro, sectoral and firm level. Each of those approaches has its merits and limitations. Studies focusing on the effects of uncertainty on FDI were rather eclectic in this respect, at first using elections as a measure of uncertainty, and with the appearance of uncertainty indexes, such as economic policy index and world uncertainty index, papers on the topic started gaining ground. The relationship between the two seems to be primarily an empirical issue. Although empirical studies in general establish a negative relationship between uncertainty and FDI, the nature and magnitude of the effects often hinge on the type of uncertainty and the characteristics of the countries involved in foreign capital flows.

Populism is another feature of modern politics evoking strong interest among researchers and societies affected by it. The key drivers of populism can be boiled down to the insecurity generated by structural change in the economy and culture. They can be subdivided into globalisation of trade and finances, technological progress, labour market deregulation, immigration and cultural issues. Very recent research has established that while studying the empirical determinants of populism, it is important to distinguish between (economic) uncertainty on the one hand, and (economic) losses, grievances scarcity and crises that can cause (economic) insecurity on the other, because both factors contribute to the strengthening of populism.

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The relationship between populism and FDI offers fertile ground for researchers interested in the role of uncertainty. For some of them, populism in itself constitutes a source of and a proxy for uncertainty, while few have made distinction between uncertainty and other sources of economic insecurity leading to populism, when exploring the nexus between populism and FDI. Looking from the macroeconomic perspective, the relationship between uncertainty, populism and FDI has been too little studied. In a similar vein, at the firm level, there have been only a handful of studies regarding the relationship between populism and FDI, only one of them applying the above-mentioned distinction.

Overall, the comprehensive survey of these three concepts and their empirical links demonstrates that there are still various open questions to be answered in order to reach a more structured understanding on the interconnection among uncertainty, populism and FDI. Those include the various types of FDI and their in-depth relationship with uncertainty; the role of home country, host country or global level uncertainty and their empirical links, policy implications regarding empirical findings on the determinants of populism, e.g. compensations for losers in the process of structural change that has added to their sense of economic insecurity. It would be useful to explore the interlinkage between populism, FDI, and the role of uncertainty in this context, not only from the firm or international business perspective, but from the macroeconomic perspective as well. There is also potential to include other researchers from behavioural economics, social and political psychology to study deeper the concepts of uncertainty and populism. More generally, as researchers are exploring new aspects of uncertainty and populism, it would be valuable to study policy solutions that deliver a better future both in economic and non-economic terms.

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Thriving amidst uncertainty: a financial blueprint for the public budget

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Abstract

This research explores strategies for thriving amidst uncertainty through a financial blueprint for public budgets, focusing on key factors like budgetary resilience (BR), stability (BS), sustainability (BSu), empowerment (BE), preparedness (BP), governance (BG), inclusion priorities (BIP), and agility (BA). Analysing data from 1,200 respondents and audited financial reports for 2023/24, statistical methods such as exploratory and confirmatory factorial analysis, and Cronbach's Alpha were used to assess relationships among these factors. Results highlight BR's role in economic development, while BS and BSu enhance financial stability and reduce debt. BE fosters employment and social stability, emphasizing robust planning. BP ensures accurate management in uncertain conditions, and BG reduces corruption and strengthens accountability. These insights offer valuable guidance for policymakers and financial managers aiming to enhance public budget stability and sustainability.

Keywords: public budget, financial blueprint, uncertainty, public finance, financial reports

1 INTRODUCTION

In today's unprecedented era of uncertainty, effective financial management within public budgets is more crucial than ever. This research aims to address this need by presenting a comprehensive financial blueprint specifically designed to navigate uncertainty effectively. Drawing upon factors identified in this study – such as budgetary resilience (BR), budgetary stability (BS), budgetary sustainability (BSu), budgetary empowerment (BE), budgetary preparedness (BP), budgetary governance (BG), budgetary inclusion priorities (BIP), and budgetary agility (BA) – this blueprint serves as a guide not only for uncertain times but also for the ability to thrive amidst them.

By meticulously examining the interplay between these factors, this study aims to uncover statistically significant relationships that elucidate their impact on sustainability and the financial blueprint for the public budget. Akroyd and Kober (2020) highlight the importance of personal control and control of results, further supported by control over personnel, results, and budget actions, which is crucial for thriving amidst uncertainty, particularly in managing public budgets. Chao, Yu and Yu (2009) indicate that adjustments in public sector wages and capital tax rates have welfare implications. Marchewka-Bartkowiak (2023) emphasizes the expected significant increase in budgetary needs for climate financing in the coming years and decades. Meanwhile, Lappi and Aaltonen (2017) suggest that agile projects create tensions in governance within the public sector and technology.

In summary, this research introduces a comprehensive financial blueprint tailored to address the challenges posed by uncertainty within public budgets. Unlike previous literature, which often focuses on individual aspects of financial management, this blueprint considers multiple factors – BR, BS, BSu, BE, BP, BG, BIP, and BA – in an integrated manner. The objective of this article is to provide a thorough understanding of how these factors interact and influence each other within the financial blueprint, thereby shaping effective financial strategies amidst uncertainty.

To achieve this objective, the research questions guide the inquiry. Firstly, the study aims to understand how these factors interact and influence each other within the financial blueprint. Secondly, it investigates the significance of each factor in shaping effective financial blueprint strategies amidst uncertainty. Furthermore, this study examines the gap in the existing literature regarding the comprehensive integration of various factors within a financial blueprint for public budgets amidst uncertainty, crucial for policymakers and budget managers in developing more effective strategies for navigating uncertain financial terrain.

2 LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

In the intricate realm of public finance, the imperative for governmental bodies to excel amid uncertainty is increasingly apparent. With fiscal environments in constant flux, characterized by unforeseen economic shifts, global crises, and evolving societal needs, the creation of a resilient financial blueprint becomes imperative. This literature review embarks on an exploration of the multifaceted dimensions of budgetary resilience (BR), stability (BS), sustainability (BSu), empowerment (BE), preparedness (BP), governance (BG), inclusion priorities (BIP), and agility (BU). Its primary aim is to identify existing gaps in research and develop hypotheses based on the interplay of these factors. Through this comprehensive examination, the review seeks to elucidate pathways toward enhanced fiscal fortitude and effective resource allocation strategies, thus ensuring the vitality and prosperity of public budgets amidst uncertainty.

2.1 BUDGETARY RESILIENCE

Within the framework of the financial blueprint for the public budget, budgetary resilience (BR) emerges as a pivotal factor in navigating uncertainty within public budgets. A well-prepared budget not only contributes actively to economic development but also facilitates increased public investment and improves the quality of public services in uncertain times. This assertion finds support in the work of Bracci and Tallaki (2021), who observe that financial shocks often prompt investments in management control systems, reinforcing or developing anticipatory and coping capacities. Similarly, Farhana and Siti-Nabiha (2023) underscore that perceived uncertainties typically influence budget responses. Moreover, Dzigbede, Pathak and Muzata (2023) point out that countries with more reliable budget processes and transparent public finances tend to exhibit higher estimates of economic recovery and resilience, thereby bolstering long-term budget resilience and fostering economic growth.

2.2 BUDGETARY STABILITY

Amidst the realm of public finance, budgetary stability (BS) plays a critical role in ensuring financial resilience, bolstering citizens' confidence, and effectively managing financial crises. Raudla and Douglas (2020) highlight the importance of budget stability in mitigating fiscal crises, often leading to tighter control and reduced budgetary flexibility. Expanding on this idea, Rugina (1997) highlights the collaborative efforts of government bodies in budget preparation, promoting economic, monetary, and financial stability, alongside enhancing citizens' trust in budget management. Additionally, Akosah (2015) underscores the adverse effects of unstable fiscal policies on fiscal stability, particularly evident during periods of uncertainty.

2.3 BUDGETARY SUSTAINABILITY

In the sphere of budgetary sustainability (BSu) and its associated variables, a well-prepared budget serves to minimize financial risks, aid in the reduction of public debt, and contribute to poverty alleviation. Additionally, studies underscore the positive relationship between budget transparency and the financial sustainability of governments, extending beyond conventional aims to enhance citizen trust and participation, as demonstrated by Cuadrado-Ballesteros and Bisogno (2022). Moreover, it is emphasized that participatory budgeting, as a facet of sustainable governance, necessitates a financially and administratively stable organizational process for its institutionalization, as highlighted by Sinervo et al. (2024). These insights align with the research aim of investigating the interplay among various budgetary factors and their influence on effective financial blueprint strategies for public budgets amidst uncertainty.

2.4 BUDGETARY EMPOWERMENT

Amidst the realm of public finance, budgetary empowerment (BE) plays a crucial role, with associated variables indicating that a well-prepared public budget not only enhances employment opportunities but also fosters social sustainability and improves the transparency of public finances. Abuamsha and Hattab (2024) point out that strategies such as promoting investment projects, reducing taxes on essential goods, and supporting local producers can effectively lower unemployment rates and stimulate economic growth. Additionally, Uddin (2019) underscores the importance of people's participation in the budgeting process, particularly at the local government level, to enhance budgetary empowerment. These insights align with the intention of investigating the interplay among various budgetary factors and their influence on effective financial blueprint strategies for the public budget amidst uncertainty.

2.5 BUDGETARY PREPAREDNESS

In the context of budgetary preparedness (BP) and its associated variables, the effectiveness of a clear and well-prepared financial plan in managing public budgets and alleviating the impacts of budget uncertainty is paramount. Mancini and Tommasino (2023) highlight the tendency of some public administrations to overestimate capital expenditure, emphasizing the need for a defined threshold to enhance accuracy in line with their plans. This not only aids in improving precision but also serves to mitigate the effects of uncertainty through the implementation of a meticulously crafted financial blueprint. Similarly, Charoenwong et al. (2024) underscore the significance of acknowledging the impact of uncertainty on investment dynamics within canonical models. They elucidate the notion of "time to build" in investment decisions, underscoring how uncertainty can detrimentally affect capital values and productivity within the realm of public budgeting. These insights align to investigate the interplay among various budgetary factors and their influence on effective financial blueprint strategies for the public budget amidst uncertainty.

2.6 BUDGETARY GOVERNANCE

Amidst considerations of financial stability amidst uncertainty, budgetary governance (BG) and its associated variables emerge as pivotal components. A well-prepared budget not only acts as a deterrent to corruption but also bolsters the financial accountability of public institutions, enhances accountability to citizens, mitigates wealth inequality, fosters environmental sustainability, boosts citizen participation in financial decision-making, advocates for social justice, and diminishes income inequality. Moreover, it necessitates mechanisms for monitoring and evaluating budget implementation. As highlighted by Lulaj and Dragusha (2022), a meticulous approach to tax collection from citizens and businesses is imperative to augment budget revenues, while prudent expense management is essential, especially during periods of uncertainty such as pandemics (Lulaj, 2022). Ozdemir, Reed Johnson and Whittington (2016) underscores the importance of calculating changes in well-being based on program preferences within special budget portfolios, particularly in uncertain times. These insights underscore the complexity of budgetary governance and its multifaceted implications, contributing to a broader discussion on effective financial blueprint strategies for the public budget amidst uncertainty.

2.7 BUDGETARY INCLUSION PRIORITIES

Amidst the discussion on effective financial strategies amidst uncertainty, budgetary inclusion priorities (BIP) and its associated variables emerge as crucial considerations. Fair distribution, which promotes gender equality and fosters long-term economic development, is paramount. Additionally, providing opportunities for public consultation during the budget process enhances transparency and accountability. Lulaj, Zarin and Rahman (2022) emphasize that program selection should be based on priorities rather than wishes and politics, ensuring effective resource allocation. These insights underscore the importance of considering inclusion priorities within the broader context of financial planning and strategy, contributing to discussions on navigating uncertainty in public budgets.

2.8 BUDGETARY AGILITY

Amidst discussions on navigating uncertainty in public budgets, budgetary agility (BA) and its associated variables become crucial considerations. Budget updates, addressing various budget needs, and effective communication are highlighted as essential aspects by Pedersen (2018). Ciric Lalic et al. (2022) emphasize that reducing challenges and providing support for the development of skills for overcoming obstacles can ease transformations and enhance the agile approach within the financial blueprint, particularly in times of uncertainty. These insights underscore the importance of considering budgetary agility within the broader context of financial planning and strategy, contributing to discussions on effective resource management amidst uncertainty.

2.9 DEVELOPMENT AND CONSTRUCTION OF HYPOTHESES

In the context of thriving amidst uncertainty within the financial blueprint for the public budget, a synthesis of existing literature provides a robust foundation for constructing hypotheses. These hypotheses elucidate the interconnectedness of budgetary factors, including budgetary resilience (BR), stability (BS), sustainability (BSu), empowerment (BE), preparedness (BP), governance (BG), inclusion priorities (BIP), and agility (BA), and their pivotal role in shaping effective financial blueprint strategies amidst uncer-

tainty. From this point of view, Valle-Cruz, Fernandez-Cortez and Gil-Garcia (2022) highlight the transformative potential of artificial intelligence in optimizing governmental budget allocations, emphasizing its capacity to bolster GDP growth, mitigate inflation, and address income inequality. Furthermore, Neaime's (2015) warning about potential fiscal crises in certain European Union nations underscores the imperative of fiscal prudence and forward-thinking budgetary management practices.

Moreover, Bom and Ligthart (2024) advocate for strategic investments in public infrastructure within the balanced budget framework, citing its dynamic macroeconomic ramifications. Anessi-Pessina et al. (2020) stress the predictive and adaptive functions of budgeting, positioning it as a crucial tool for enhancing government resilience in the face of unforeseen shocks. Grossi and Argento (2022) shed light on the evolving landscape of public governance towards more collaborative and digitally-driven frameworks, necessitating a re-evaluation of budgetary practices and accountability mechanisms. Papenfuß, Saliterer and Albrecht (2017) underscore the importance of local government resilience amidst uncertainty, advocating for the formulation of robust financial blueprints to navigate crises effectively. The need for financial reforms is critical to safeguard funds and address rising budget challenges, as noted by Lulaj (2021). Additionally, Lulaj et al. (2022) emphasize that the emergence of new information and communication technologies has significantly accelerated the transition to e-government. Furthermore, Mauro, Cinquini and Sinervo (2019) highlight the challenges stemming from fragmented stakeholder engagement in harnessing budgetary information for improved performance. Zhang et al. (2022) and Kumar et al. (2024) emphasize the transformative potential of financial technology and digital finance, respectively, in reshaping budgetary dynamics and citizen engagement paradigms.

In summary, a synthesis of the literature provides a comprehensive foundation for formulating hypotheses that explore the intricate relationship between budgetary factors and the part they have to play incrafting effective financial blueprint strategies amidst uncertainty. Drawing upon insights from various scholars, the following hypotheses are proposed:

> Hypothesis 1: There is a statistically significant and positive relationship among the budgetary factors.
>
> Hypothesis 2: The budgetary factors significantly shape effective financial blueprint strategies for the public budget amidst uncertainty.

H1 is supported by Valle-Cruz, Fernandez-Cortez and Gil-Garcia (2022) who emphasize the transformative potential of artificial intelligence in optimizing governmental budget allocations, and by Anessi-Pessina et al. (2020) who highlight the predictive and adaptive functions of budgeting, positioning it as a crucial tool for enhancing government resilience in the face of unforeseen shocks. Furthermore, H2 finds support in the arguments put forward by Bom and Ligthart (2024) advocating for strategic investment in public infrastructure within balanced budget frameworks, as well as by Grossi and Argento (2022) who shed light on the landscape of public governance, evolving towards more collaborative and digitally-driven frameworks, necessitating a re-evaluation of budgetary practices and accountability mechanisms. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are crucial for developing hypotheses H1

and H2, which examine the relationships between different factors: BR, BE, BP, BG, BSu, BS, BIP, and BA. Specifically, these hypotheses examine relationships such as: BR<-->BE; BR<-->BP; BR<-->BG; BR<-->BSu; BS<-->BE; BS<-->BIP; BS<-->BP; BS<-->BSu; BE<--> BIP; BE<-->BP; BE<-->BG; BE<-->BSu; BE<-->BA; BIP<-->BP; BIP<-->BG; BIP<-->BSu; BP<-->BG; BP<-->BSu; BP<--> BA; BG<-->BSu; BG <-->BA; BSu<-->BA; BR<-->BS; BS<--> BA, within the context of the financial blueprint for public budgeting. The primary objective of H1 and H2 is to analyze these interrelationships to enhance the performance and transparency of public funds. This can be achieved by implementing a robust financial blueprint for public budgeting. In summary, these hypotheses draw on a combination of empirical evidence and theoretical frameworks from diverse scholarly sources. This provides a structured methodology for understanding the dynamics between budgetary factors and developing effective financial strategies in uncertain environments.

3 MATERIALS AND METHODS

3.1 THE PURPOSE OF THE PAPER

The research focuses on thriving amidst uncertainty through a financial blueprint for the public budget using factors such as budgetary resilience (BR), budgetary stability (BS), budgetary sustainability (BSu), budgetary empowerment (BE), budgetary preparedness (BP), budgetary governance (BG), budgetary inclusion priorities (BIP), budgetary agility (BA). The intention is to explore and identify statistically significant relationships between factors to assess their impact on sustainability and financial performance, ultimately contributing to a better understanding of how effective financial management strategies can be developed for the public budget in uncertain times. The findings will empower policymakers and stakeholders by providing actionable insights to navigate unpredictable circumstances, ensuring an inclusive, responsive, and sustainable budget.

3.2 DATA COLLECTION

The study employed a dual methodology to collect data in the State of Kosovo. First, responses were gathered from 1,200 participants using a Likert scale questionnaire (ranging from 1 – strongly disagree to 5 – strongly agree). Second, audited financial-budgetary reports from both local municipalities and the central Budget Department (Ministry of Finance, Labor, and Transfers) for the 2023-2024 period were analysed. This secondary data played a key role in enriching the questionnaire by providing essential insights into the financial dynamics at both local and central levels.

All participants were willing to contribute to the understanding of the importance of public finances, the budget, and the role of public money in times of uncertainty. The sampling unit consisted of individual respondents from selected municipalities in Kosovo, with the sampling frame being the population lists from the municipalities of Peja, Gjakova, Prizren, Prishtina, Deçan, Junik, Klinë, Malishevë, Ferizaj, and Gjilan. To ensure representation from different municipalities and demographic groups, the sampling design employed was stratified random sampling. The number of respondents was distributed as follows: Peja (231 respondents), Gjakova (90), Prizren (111), Prishtina (200), Deçan (89), Junik (70), Klinë (109), Malishevë (50), Ferizaj (150), and Gjilan

(100). The survey was conducted within the geopolitical boundaries of these municipalities in Kosovo, providing a comprehensive understanding of budgetary factors in different regions of the country.

Among the respondents, 30.2% were male, 60.4% were female, and 2.1% preferred not to specify their gender. The age distribution was 65.7% for those aged 15-35 years, 20.5% for those aged 36-55 years, and 6.4% for those over 55 years. Regarding education, 1.7% had completed high school, 29.5% had undergraduate degrees, 56.5% had postgraduate degrees, and 4.9% had other degrees (Ph.D.). A table of the descriptive analysis of the respondents is presented in the table A3.

Table 1

Definition and description of the study variables

Item	Construct	Source
	Factor 1 **Budgetary resilience (BR)**	
BR1	Uncertainty is a major challenge for the public budget	Upadhaya et al. (2020) Farhana and Siti-Nabiha (2023) Agyemang et al. (2023)
BR2	A sustainable public budget protects the economy from negative effects	
BR3	A well-prepared public budget contributes to economic development	
BR4	A well-prepared public budget can increase public investment	
BR5	A well-prepared public budget improves the quality of public services	
	Factor 2 **Budgetary stability (BS)**	
BS1	A well-prepared public budget contributes to financial stability	Mauro, Cinquini and Sinervo (2019) Lulaj (2024)
BS2	A well-prepared budget based on a clear financial plan increases citizen confidence	
BS3	A well-prepared public budget helps to manage financial crises	
	Factor 3 **Budgetary sustainability (BSu)**	
BSu1	A well-prepared budget plan minimizes financial risks	Giosi et al. (2014)
BSu2	A well-prepared public budget helps to reduce public debt	
BSu3	A well-prepared public budget contributes to poverty reduction	
	Factor 4 **Budgetary empowerment (BE)**	
BE1	Employment opportunities are enhanced by a well-prepared public budget	Reddick (2004)
BE2	Social sustainability can be achieved through a well-prepared public budget	
BE3	A well-prepared public budget improves the transparency of public finances	
	Factor 5 **Budgetary preparedness (BP)**	
BE1	A clear financial plan is useful in managing the public budget	Agyemang et al. (2023)
BE2	A well-prepared financial plan can mitigate the effects of budget uncertainty	

	Factor 6 **Budgetary governance (BG)**	
BG1	A well-prepared public budget helps to reduce corruption	Lulaj (2019a) Kasperskaya and Xifré (2020) Drew (2017)
BG2	A well-prepared public budget increases the financial accountability of public institutions	
BG3	A well-prepared public budget increases accountability to citizens	
BG4	A well-prepared public budget helps to reduce wealth inequality	
BG5	A well-prepared public budget promotes environmental sustainability	
BG6	A well-prepared public budget increases citizen participation in financial decision-making	
BG7	A well-prepared public budget promotes social justice	
BG8	A well-prepared public budget reduces income inequality	
BG9	Mechanisms for monitoring and evaluating the implementation of the public budget are necessary	
	Factor 7 **Budgetary inclusion priorities (BIP)**	
BIP1	Necessity of public budget allocation for programs promoting gender equality	Looney (1987)
BIP2	The belief that public investment should prioritize long-term economic development	
BIP3	Public consultation plays a crucial role in the process of public budgeting	
	Factor 8 **Budgetary agility (BA)**	
BA1	Satisfaction with the frequency of updates on the implementation of the public budget	Barbera, Guarini and Steccolini (2020) Lappi and Aaltonen, (2017) Palsodkar, Yadav and Nagare (2023)
BA2	Satisfaction with the inclusiveness of the public budget in addressing diverse community needs	
BA3	Satisfaction with government responsiveness to public input during the budget process	
BA4	Information about services and programs funded by the public budget is easily accessible	
BA5	The government effectively communicates budget decisions to the public	
BA6	The government can meet future fiscal challenges	

Source: Author's own calculations.

Table 1 describes the variables examined in this study, which highlight the importance of factors such as budgetary resilience (BR), budgetary stability (BS), budgetary sustainability (BSu), budgetary empowerment (BE), budgetary preparedness (BP), budgetary governance (BG), budgetary inclusion priorities (BIP), and budgetary agile (BA) in thriving under uncertainty through a financial blueprint for the public budget. The analysis included three variables for the BS, BSu, BE and BIP factors, two variables for the BP factor, five variables for the BR factor, nine variables for the BG factor, and six variables for the BA factor. Variables that were not found to

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be significant were excluded from the model and the factors. In the introduction and literature review section of the study, each factor and its variables are discussed in detail, taking into account the contributions of different authors. The results and discussion section analyses the findings of this research for each factor and compares them with the findings of other authors.

3.3 DATA ANALYSIS

To thoroughly assess the model's significance and validate the hypotheses, rigorous data analysis was conducted using SPSS and AMOS software. This involved a series of tests including exploratory factor analysis (EFA), reliability analysis (Cronbach's Alpha), and confirmatory factor analysis (CFA). The econometric model was visually depicted for enhanced comprehension. Exploratory factor analysis (EFA), widely acknowledged across various disciplines, particularly economics, was initially utilized to scrutinize data, as emphasized by Spearman (1904, 1927). Subsequently, reliability analysis and associated tests were conducted, aligning with Floyd and Widaman's (1995) framework, which underscores the pivotal role of factorial analysis in assessing questionnaire instruments across multiple factors. Confirmatory factor analysis (CFA) followed, employing standardized regression (β) to elucidate the model's specified factors (BR, BS, BSu, BE, BP, BG, BIP, and BA). Multiple regression, as outlined by Cohen et al. (2003), played a pivotal role in this analysis. Lastly, covariance, correlation analysis, and model fit assessments were employed to rigorously test the hypotheses, ensuring robustness and validity in the findings.

4 EMPIRICAL RESULTS AND DISCUSSION

In navigating the intricacies of public budgeting, the concept of thriving amidst uncertainty emerges as paramount. The analysis, grounded in factors such as budgetary resilience (BR), stability (BS), sustainability (BSu), empowerment (BE), preparedness (BP), governance (BG), inclusion priorities (BIP), and agility (BU), underscores the necessity for a comprehensive financial blueprint. As the findings unfold in the following discussion, they will interact with insights from other scholars, offering a dynamic exchange that enhances understanding of effective budgetary management through the financial blueprint. Therefore, according to Mihaljek (2023), it is emphasised that recently public finances and inflation have been intensively discussed as common topics of economic research and policy analysis.

Regarding the budget in times of uncertainty and to support it through the financial blueprint, as for Christl et al. (2023) it is emphasised that macro trends will increase the pressure on government budgets; however, it is also shown that the current tax-benefit systems have the capacity to counterbalance rising income inequality and poverty risks caused by expected future developments in labour markets (Blank, Van Heezik and Blank, 2023). It is emphasised that the central government aims to improve efficiency and promote technological advancement within public organisations. However, certain local administrations allocate dedicated funds to support participatory budgeting initiatives, as emphasized by Sońta (2023). According to Lulaj (2019b) and Lulaj and Muthmainnah (2021), a transparent budget provides citizens with access to

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information, allowing them to comment on the government's revenues, allocations, and expenditures. However, if the budget is not transparent, accessible, or accurate, it cannot be properly analysed.

In Velkovska and Trenovski (2023), it is emphasised that the economy has a greater impact on reducing poverty than social spending, while social spending has a greater impact on reducing income inequality than economic growth. Regarding the factors of this research (BR, BS, BSu, BE, BP, BG, BIP and BA), Brezovar and Stanimirović (2022) emphasize that, in alignment with the municipal social sustainability agenda, the financial plan plays a crucial role in promoting not only equality and diversity but also coexistence, social cohesion, democracy, governance, and overall quality of life within the municipality. This interconnected approach ensures that social aspects are integrated with economic and governance frameworks, enhancing the municipality's overall sustainability. Moreover, Barbera, Borgonovi and Steccolini (2016) identify four key aspects of popular reporting that play a central role in strengthening governance. These aspects include the ability to ensure greater transparency, maintain neutrality, enhance participation, and increase influence in the decision-making process. Meanwhile, in Alsharari (2020), it is emphasised that the new budgeting systems are implemented based on the review of theoretical accountability procedures and the audit of public sector accounts (Işik and Koç, 2021). In Wällstedt and Almqvist (2017) and Barbera (2017) it is emphasised that in times of uncertainty, financial shocks for municipalities can be overcome relatively easily if they have a stable and resilient financial blueprint. On the basis of the discussions of the different authors on all the factors, the results of this research will be elaborated below for all the factors and their variables, helping to draw conclusions and recommendations for states, governments, institutions and all actors involved in the public budget.

Table 2
Confirmatory factorial analysis (CFA)

Observed variable	Latent variable	Standardized regression weights	Estimate	S.E.	C.R.	p-value	Confidence level
BR1	BR	0.597***	1.000				Statistically significant
BR2	BR	0.561***	0.914	0.061	15.104	p < 0.001	Statistically significant
BR3	BR	0.734***	1.335	0.074	17.972	p < 0.001	Statistically significant
BR4	BR	0.569***	1.005	0.066	15.266	p < 0.001	Statistically significant
BR5	BR	0.509***	0.945	0.067	14.027	p < 0.001	Statistically significant
BS1	BS	0.707***	1.000				Statistically significant
BS2	BS	0.714***	1.436	0.075	19.082	p < 0.001	Statistically significant
BS3	BS	0.633***	0.869	0.049	17.680	p < 0.001	Statistically significant
BSu1	BSu	0.580***	1.000				Statistically significant
BSu2	BSu	0.649***	1.021	0.063	16.238	p < 0.001	Statistically significant
BSu3	BSu	0.618***	1.071	0.068	15.749	p < 0.001	Statistically significant
BE1	BE	0.641***	1.000				Statistically significant
BE2	BE	0.604***	0.969	0.062	15.533	p < 0.001	Statistically significant
BE3	BE	0.503***	0.782	0.058	13.576	p < 0.001	Statistically significant
BP1	BP	0.559***	1.000				Statistically significant
BP2	BP	0.548***	0.921	0.068	13.586	p < 0.001	Statistically significant
BG1	BG	0.632***	1.000				Statistically significant
BG2	BG	0.500***	0.658	0.045	14.748	p < 0.001	Statistically significant
BG3	BG	0.579***	0.939	0.056	16.670	p < 0.001	Statistically significant
BG4	BG	0.580***	0.834	0.050	16.683	p < 0.001	Statistically significant
BG5	BG	0.658***	0.945	0.051	18.431	p < 0.001	Statistically significant
BG6	BG	0.624***	1.071	0.061	17.695	p < 0.001	Statistically significant
BG7	BG	0.555***	0.765	0.047	16.099	p < 0.001	Statistically significant
BG8	BG	0.619***	1.122	0.064	17.581	p < 0.001	Statistically significant

Observed variable	Latent variable	Standardized regression weights	Estimate	S.E.	C.R.	p-value	Confidence level
BG9	BG	0.672***	0.934	0.050	18.728	p < 0.001	Statistically significant
BIP1	BIP	0.541***	1.000				Statistically significant
BIP2	BIP	0.543***	1.016	0.079	12.792	p < 0.001	Statistically significant
BIP3	BIP	0.614***	1.115	0.081	13.678	p < 0.001	Statistically significant
BA1	BA	0.581***	1.000				Statistically significant
BA2	BA	0.514***	0.896	0.065	13.799	p < 0.001	Statistically significant
BA3	BA	0.587***	1.048	0.069	15.173	p < 0.001	Statistically significant
BA4	BA	0.630***	1.070	0.067	15.902	p < 0.001	Statistically significant
BA5	BA	0.514***	0.878	0.064	13.814	p < 0.001	Statistically significant
BA6	BA	0.592***	1.011	0.066	15.273	p < 0.001	Statistically significant

*Note: Standard error (S.E.), Critical ratios (C.R.), *** p<0.001 indicates statistical significance. The confidence interval is set at 99.9% (CI).*

Source: Author's own calculations.

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Table 2 presents the outcomes of the confirmatory factor analysis (CFA) concerning thriving amidst uncertainty through a financial blueprint for public budgeting across various factors: BR, BS, BSu, BE, BP, BIP, and BA. Each observable variable – BR (1-5), BS (1-3), BSu (1-3), BE (1-3), BP (1-2), BG (1-9), BIP (1-3), and BA (1-6) – can be seen to have a significant and statistically reliable influence on the latent variables (BR, BS, BSu, BE, BP, BIP, and BA), following Bollen (1989). The analysis underscores the statistical significance of all factor variables, with standardized regression weights surpassing 0.5 at a significance level of $p < 0.001$ (***).

Regarding the BR factor, the variable BR3 (0.734***) signifies that a well-prepared budget by governing bodies contributes substantially to a country's economic development. In the BS factor, BS1 (0.707***) and BS2 (0.714***) emphasize the importance of a well-prepared public budget with a clear financial plan, enhancing citizen confidence and financial stability. In the BSu factor, BSu2 (0.649***) and BSu3 (0.618***) hold the greatest significance, indicating that a well-prepared public budget aids in reducing public debt and poverty through proper allocation of expenses based on national interests. Moving to the BE factor, BE1 (0.641***) and BE2 (0.604***) show that a well-prepared public budget leads to increased employment opportunities, social stability, and citizen well-being. In the BP factor, BP1 (0.559***) and BP2 (0.548***) stress the importance of clear, effective, and well-prepared financial plans by governing bodies in managing the public budget accurately and mitigating budget uncertainty.

Within the BG factor, BG9 (0.672***) and BG5 (0.658***) signify the importance of monitoring and evaluating mechanisms for public budget implementation, promoting environmental sustainability when budgets are well-prepared. Concerning the BIP factor, BIP3 (0.614***) underscores the crucial role of public consultations in enhancing budget transparency, performance, and economic-financial development.

Lastly, in the BA factor, BA4 (0.630***), BA6 (0.592***), BA3 (0.587***), and BA1 (0.581***) highlight the significance of accessible budget information, consideration of citizens' reactions, and timely updates on budget implementation in facing future fiscal challenges effectively. A reliability level of 99.9% confirms the robustness of these results, underlining CFA's vital contribution to countries and institutional management bodies by emphasizing accurate budget allocation from planning to audit, thereby enhancing economic and financial development amidst uncertainty.

Table 3

Standardized total effects – two tailed significance

Variable	BA	BSu	BG	BP	BIP	BE	BS	BR
BA6	0.019*							
BA5	0.010**							
BA4	0.003**							
BA3	0.006**							
BA2	0.005**							
BA1	0.020*							
BSu3		0.009**						
BSu2		0.016*						
BSu1		0.018*						
BG9			0.009**					
BG8			0.007**					
BG7			0.010**					
BG6			0.008**					
BG5			0.003**					
BG4			0.007**					
BG3			0.012*					
BG2			0.007**					
BG1			0.006**					
BP1				0.012*				
BP2				0.006*				
BIP3					0.011*			
BIP2					0.010**			
BIP1					0.013*			
BE3						0.003**		
BE2						0.005**		
BE1						0.021*		
BS3							0.013*	
BS2							0.012*	
BS1							0.012*	
BR5								0.011*
BR4								0.015*
BR3								0.008**
BR2								0.007**
BR1								0.003**

*Note: *** p<0.001, ** p<0.01, * p<0.05.*

Source: Author's own calculations.

Table 3 shows the results of the standardized total effect for all factors (BR, BS, BSu, BE, BP, BG, BIP, and BA) and their variables related to thriving amidst uncertainty through a financial blueprint for the public budget.

As for budgetary agility (BA), all its variables demonstrate significant impacts at either the 1% or 5% levels. This implies that adjusting the frequency of updates on budget implementation, responsiveness to community needs, inclusiveness in government's

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response to public input, accessibility of financial information and programs, and effective communication of budget decisions can alter the budgetary agility factor. These findings stress the necessity of employing flexible budgetary practices to enhance government responsiveness and efficiency in budget management.

Moving on to budgetary sustainability (BSu), it is notable that all variables exert significant impacts at the 1% and 5% levels. This highlights how a well-prepared budget plan can mitigate financial risks, lower public debt, and alleviate poverty through enhancing budgetary sustainability. Effective budget planning is pivotal in upholding a nation's financial stability and fostering societal welfare by curbing public debt and poverty.

Regarding budgetary preparedness (BP), all its variables have a significant influence at the 5% level. This shows convincingly that a well-defined and prepared financial plan holds the capacity to effectively manage the public budget and alleviate the repercussions of budgetary uncertainty through modifications in the budgetary preparedness factor. Thorough budget preparation is indispensable for adept public budget management and the mitigation of budget uncertainty risks.

Budgetary governance (BG) emphasizes that all its variables have significant impacts at the 1% and 5% levels. Correct preparation of the budget can reduce corruption, increase financial accountability of public institutions, accountability to citizens, reduce wealth inequality, promote environmental sustainability, citizen participation in financial decision-making, social justice, and income inequality reduction. Good budget preparation is essential for good governance and achieving multiple objectives, including fighting corruption, improving financial and social accountability, reducing inequality, and promoting environmental sustainability.

The budgetary inclusion priorities (BIP) factor underscores the significant impact of its variables at the 1% and 5% levels. Alterations in allocating public budget towards programs promoting gender equality, prioritizing long-term economic development, and incorporating public consultations during budgeting can influence the BIP factor. This highlights the crucial role of policies and budget decisions in shaping overall budgetary policies and meeting BIP objectives.

Budgetary empowerment (BE) emphasizes that each of its variables has considerable significance, notably at the 1% and 5% levels. Enhancing budget preparation not only boosts employment prospects but also fosters social sustainability, enhances public finance transparency, and influences the BE factor. Effective budgetary policies and practices have a profound impact on both economic and social development.

Budgetary stability (BS) indicates that all its variables have a significant impact at the 5% level. Altering the budget preparation process positively contributes to financial stability, bolsters citizen confidence, and aids in managing financial crises. Therefore, a meticulous and effective approach to budget preparation and administration is recommended for fostering positive outcomes for both budget stability and the broader financial system.

Lastly, budgetary resilience (BR) underscores the fact that all its variables exert a significant impact at the 1% and 5% levels. This indicates that a well-prepared budget shields the economy from adverse effects, fosters economic development, bolsters public investments, enhances public service quality, and diminishes uncertainty. Robust budget preparation plays a pivotal role in safeguarding against economic uncertainties and challenges while enhancing public service quality and stimulating investments.

Table 4

Model fit summary

Tests/ Parameters	Default model	Tests clarification & equations	Threshold values	Interpretation
		CMIN		
CMIN (χ2) **α=.05**	71.862	$(N-1)_{FML}$ where $_{FML}$ is the value of the statistical criterion (fit function) minimized in ML estimation and (N – 1) Minimum discrepancy function by degrees of freedom divided (Steiger and Lind, 1980) $\chi^2 - \chi'^2 = \sum_{i=1}^{k} \frac{\chi_i^2}{m_i} - \sum_{i=1}^{k} \frac{\chi^2}{m_i'}$	–	–
df_M **(X2/df)**	28	Degrees of freedom are important for understanding model fit, ≤ 2 = acceptable fit Tabachnick and Fidell (2007)	n/a	n/a
χ^2_M	0.000	p-value Joreskog and Surbom (1996)	<.05	Significant
CMIN/DF	2.567	Chi-square divided by degree of freedom Kline (1998)	Between 1 and 3	Excellent fit
		RMR, GFI		
RMR	0.010	Root mean square residual ≤ 0.05 = acceptable fit Diamantopoulos and Siguaw (2000)	The smaller the RMR value the better	Perfect fit
GFI	0.989	Goodness of fit index A value ≥ 0.9 indicates a reasonable fit (Hu and Bentler, 1998) A value of ≥ 0.95 is considered an excellent fit $GFI = 1 - \frac{C_{res}}{C_{tot}}$ where C_{res} and C_{tot}, the residual and total variability in the sample covariance matrix	≤ 1 > 0.80	Good fit
AGFI	0.975	Adjusted goodness of fit index	> 0.80	Good fit
PGFI	0.420	Parsimony goodness of fit index	n/a	n/a

Tests/ Parameters	Default model	Tests clarification & equations	Threshold values	Interpretation
		Baseline Comparisons		
NFI	0.974	Normed fit index also referred to as delta 1 A value of 1 shows a perfect fit while models valued < 0.9 can be usually improved substantially (Bentler and Bonett, 1980)	> 0.80	Good fit
RFI	0.949	Relative fit index	>0.70	Good fit
IFI	0.984	Incremental fit index	>0.90	Perfect fit
TLI	0.968	Tucker-Lewis coefficient	0 to 1 >0.90	Perfect fit
CFI	0.984	Comparative fit index A CFI value of ≥ 0.95 is considered an excellent fit for the model $\mathrm{CFI} = 1 = \frac{\chi^2_{\mathrm{M}} - df_{\mathrm{M}}}{\chi^2_{\mathrm{B}} - df_{\mathrm{B}}}$	>0.95	Excellent fit
		Parsimony-Adjusted Measures		
PRATIO	0.509	Parsimony ratio	0 to 1 >0.50	Good fit
PNFI	0.496	Parsimony normed fixed index expressing the result of parsimony adjustment (Mulaik and Brett, 1982) to the Normed fixed index (NFI)		
PCFI	0.501	Parsimony comparative fix index		
		NCP		
NCP	43.862	Non-centrality parameter	17.3 – 106.1 CI 90%	Good fit
LO 90	22.582	Lower boundary		
HI 90	72.817	Upper boundary		
		FMIN		
FMIN	0.060	Index of model fit	.08 – .53 CI 90%	Good Fit
F0	0.037	Confidence interval		
LO 90	0.019	Lower boundary		
HI 90	0.061	Upper boundary		
		RMSEA		
RMSEA (90% CI)	0.036	Root mean square error of approximation values ≤ 0.05 are considered excellent (MacCallum, Browne and Sugawara, 1996) $\mathrm{RMSEA} = \sqrt{\frac{\chi^2_{\mathrm{M}} - df_{\mathrm{M}}}{df_{\mathrm{M}}(\mathrm{N}-1)}}$	<0.06	Excellent fit
LO 90	0.026	Lower boundary	CI 90%	
HI 90	0.047	Upper boundary	CI 90%	
PClose	0.987	Close fit hypothesis Browne and Cudeck (1993)	>0.05	

Note: PClose > 0.05, CFI > 0.95.

Source: Author's own calculations.

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Table 4 presents the results of the FIT model, aimed at identifying and evaluating relationships among variables (BR, BS, BSu, BE, BP, BG, BIP, and BA) pertinent to thriving amidst uncertainty through a financial blueprint for the public budget. The model exhibits a chi-squared value (CMIN/χ2) of 71.862 and (X2/df, 28) with a p-value of 0.000 at the 5% level, indicating a strong fit and statistical significance. Performance indices, including RMR (0.010), GFI (0.989), AGFI (0.975), PGFI (0.420), NFI (0.974), RFI (0.949), IFI (0.984), TLI (0.968), PRATIO (0.509), PNFI (0.496), and PCFI (0.501), collectively suggest a high level of fit. The RMSEA index of 0.0036 further supports this conclusion. These findings imply that the model aligns well with the available data structure, suggesting significant relationships and interactions among factors when testing alternative hypotheses.

Table 5 provides insights into future research implications derived from verifying the hypothesis. The hypothesis confirmed statistically significant and positive relationships among various budgetary factors, highlighting their importance in enhancing public budget conditions. Factors such as budgetary resilience, budgetary empowerment, budgetary preparedness and budgetary sustainability exhibited strong and positive correlations, underlining their significance. Conversely, weaker correlations were observed for budgetary stability and budgetary governance, suggesting a need for improvements in these areas to maintain stability and effective governance.

Examining both positive and negative relationships among different budgetary elements lays the groundwork for crafting future budget policies and strategies aimed at enhancing resilience, accountability, sustainability, and efficiency in public budget management. Emphasizing the improvement of these connections in future endeavours can foster a more robust network of positive interactions among diverse budgetary factors.

The acceptance of Hypothesis 1, indicating a statistically significant and positive relationship among budgetary factors, suggests a coherent model fit, supported by various statistical tests such as confirmatory factor analysis (CFA), exploratory factor analysis (EFA), and measures like composite reliability (C.I.), Cronbach's alpha (α), and lambda (λ), all indicating a strong model fit.

The findings from table 5 have substantial implications for future research and policy development. Future studies could explore the nuances of these relationships across different socio-economic contexts. Additionally, investigating the effectiveness of specific interventions aimed at strengthening budgetary resilience, stability, sustainability, and governance would offer valuable insights for policymakers and practitioners. Longitudinal studies tracking the evolution of budgetary factors over time could provide a more comprehensive understanding of their dynamics and impact on public budget management.

In conclusion, the analysis provides valuable directions for future research, emphasizing the importance of strengthening connections between budgetary elements to enhance overall budget conditions and promote effective public budget management.

Table 5

Hypothesis testing results

Test type	Description	Results
Hypothesis (H1)	There is a statistically significant and positive relationship among the budgetary factors	Accepted
	Model fit tests	
CFA	Confirmatory factor analysis	Significant results
EFA	Exploratory factor analysis	Significant results
C.I	Confidence interval	≈ 99.9%
α	Cronbach alpha	0.60 ≥ α
λ	Lambda	0.05 ≥ λ
	Significance levels	
$p < 0.001$		***
$p < 0.01$		**
$p < 0.05$		*
RMSEA	Root mean square error of approximation	90% CI, p = 0.049
χ^2	Chi-squared	χ^2, p = 0.000
CFI	Comparative fit index	CFI = 96%
	Relationships	
BR ↔ BE	Budgetary resilience ↔ Budgetary empowerment	Accepted
BR ↔ BP	Budgetary resilience ↔ Budgetary preparedness	Accepted
BR ↔ BG	Budgetary resilience ↔ Budgetary governance	Accepted
BR ↔ BSu	Budgetary resilience ↔ Budgetary sustainability	Accepted
BS ↔ BE	Budgetary stability ↔ Budgetary empowerment	Accepted
BS ↔ BIP	Budgetary stability ↔ Budgetary inclusion priorities	Accepted
BS ↔ BP	Budgetary stability ↔ Budgetary preparedness	Accepted
BS ↔ BSu	Budgetary stability ↔ Budgetary sustainability	Accepted
BE ↔ BIP	Budgetary empowerment ↔ Budgetary inclusion priorities	Accepted
BE ↔ BP	Budgetary empowerment ↔ Budgetary preparedness	Accepted
BE ↔ BG	Budgetary empowerment ↔ Budgetary governance	Accepted
BE ↔ BSu	Budgetary empowerment ↔ Budgetary sustainability	Accepted
BE ↔ BA	Budgetary empowerment ↔ Budgetary agility	Accepted
BIP ↔ BP	Budgetary inclusion priorities ↔ Budgetary preparedness	Accepted
BIP ↔ BG	Budgetary inclusion priorities ↔ Budgetary governance	Accepted
BIP ↔ BSu	Budgetary inclusion priorities ↔ Budgetary sustainability	Accepted
BP ↔ BG	Budgetary preparedness ↔ Budgetary governance	Partially accepted
BP ↔ BSu	Budgetary preparedness ↔ Budgetary sustainability	Accepted
BP ↔ BA	Budgetary preparedness ↔ Budgetary agility	Accepted
BG ↔ BSu	Budgetary governance ↔ Budgetary sustainability	Partially accepted
BG ↔ BA	Budgetary governance ↔ Budgetary agility	Accepted
BSu ↔ BA	Budgetary sustainability ↔ Budgetary agility	Accepted
BR ↔ BS	Budgetary resilience ↔ Budgetary stability	Accepted
BS ↔ BA	Budgetary stability ↔ Budgetary agility	Accepted
BR ↔ BIP	Budgetary resilience ↔ Budgetary inclusion priorities	Accepted
BIP ↔ BA	Budgetary inclusion priorities ↔ Budgetary agility	Accepted
BS ↔ BG	Budgetary stability ↔ Budgetary governance	Accepted

Note: PClose > 0.05, CFI > 0.95.

Source: Author's own calculations.

Table 6

Robustness checks and sensitivity analyses

Parameter estimates (tests of model effects)								
Factors	**Parameter**	**B**	**Std. error**	**95% Wald confidence interval**		**Hypothesis test (H2)**		
				Lower	**Upper**	**Wald Chi-Square**	**df**	**Sig.**
BR	(Intercept)	21.820	.0626	21.697	21.943	121364.364	1	0.000
	(Scale)	4.708[a]	.1922	4.346	5.100			
BS	(Intercept)	12.820	.0512	12.720	12.920	62658.178	1	0.000
	(Scale)	3.148[a]	.1285	2.906	3.410			
BSu	(Intercept)	13.140	.0403	13.061	13.219	106412.134	1	0.000
	(Scale)	1.947[a]	.0795	1.797	2.109			
BE	(Intercept)	12.927	.0395	12.849	13.004	107346.480	1	0.000
	(Scale)	1.868[a]	.0763	1.724	2.024			
BP	(Intercept)	8.840	.0265	8.788	8.892	111494.990	1	0.000
	(Scale)	.841[a]	.0343	.776	.911			
BG	(Intercept)	38.580	.1160	38.353	38.807	110592.581	1	0.000
	(Scale)	16.150[a]	.6593	14.908	17.496			
BIP	(Intercept)	13.073	.0379	12.999	13.148	119151.674	1	0.000
	(Scale)	1.721[a]	.0703	1.589	1.865			
BA	(Intercept)	25.933	.0716	25.793	26.074	131108.448	1	0.000
	(Scale)	6.156[a]	.2513	5.682	6.668			
Hypothesis2Model	(Intercept)	147.133	.2618	146.620	147.646	315844.526	1	0.000
	(Scale)	82.249[a]	3.3578	75.924	89.101			

Note: Dependent variable: BR (budgetary resilience), BS (budgetary stability), BSu (budgetary sustainability), BE (budgetary empowerment), BP (budgetary preparedness), BG (budgetary governance), BIP (budgetary inclusion priorities), BA (budgetary agility); Model: (Intercept); [a] Maximum likelihood estimate, Standard error (S.E), Intercept (Int.), Scale parameter (Scale Param.), Wald Chi-square value: Wald X^2.

Source: Author's own calculations.

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Table 6 presents a statistical analysis of how various budgetary factors shape effective financial blueprint strategies for the public budget amidst uncertainty. The factors examined include BR, BS, BSu, BE, BP, BG, BIP, and BA, each evaluated for its baseline impact, statistical significance, and influence variability. Thus, BR significantly influences financial strategies, with an intercept of 21.820 (S.E. 0.0626) and Wald X^2 value of 121364.364 ($p<0.000$), showing robustness and variability (Scale Param. 4.708).

Similarly, BS significantly shapes strategies, with an intercept of 12.820 (S.E. 0.0512) and Wald X^2 value of 62658.178 ($p<0.000$), indicating substantial influence and variability (Scale Param. 3.148). Moreover, BSu demonstrates a significant effect, with an intercept of 13.140 (S.E. 0.0403) and Wald X^2 value of 106412.134 ($p<0.000$), showing variability (Scale Param. 1.947).

Additionally, BE significantly influences strategies, with an intercept of 12.927 (S.E. 0.0395) and Wald X^2 value of 107346.480 ($p<0.000$), indicating variability (Scale Param. 1.868). Furthermore, BP significantly impacts strategies, with an intercept of 8.840 (S.E. 0.0265) and Wald X^2 value of 111494.990 ($p<0.000$), suggesting lower variability (Scale Param. 0.841).

Conversely, BG has a significant effect, with an intercept of 38.580 (S.E. 0.1160) and Wald X^2 value of 110592.581 ($p<0.000$), indicating considerable variability (Scale Param. 16.150). Similarly, BIP significantly shapes strategies, with an intercept of 13.073 (S.E. 0.0379) and Wald X^2 value of 119151.674 ($p<0.000$), suggesting moderate variability (Scale Param. 1.721).

Likewise, BA significantly influences strategies, with an intercept of 25.933 (S.E. 0.0716) and Wald X^2 value of 131108.448 ($p<0.000$), indicating variability (Scale Param. 6.156).

Therefore, the model (Hypothesis2Model) confirms the significant combined effect of these factors, with an intercept of 147.133 (S.E. 0.2618) and Wald X^2 value of 315844.526 ($p<0.000$), suggesting considerable variability (Scale Param. 82.249). This supports Hypothesis 2, emphasizing the critical role of budgetary factors in shaping strategies amid uncertainty.

In summary based on these results it is suggested that policymakers should prioritize budgetary factors such as resilience, stability, and sustainability to ensure effective financial strategies amidst uncertainty. Strategic planning efforts should focus on enhancing empowerment, governance, and inclusion priorities. Allocating resources strategically and implementing robust risk management practices are also crucial. Further research is needed to explore additional factors and long-term impacts, informing ongoing efforts to improve budgetary management and strategy development.

5 CONCLUSIONS AND FUTURE STUDIES

The research delved into the realm of thriving amidst uncertainty by proposing a financial blueprint tailored for the public budget, employing a comprehensive set of factors including budgetary resilience (BR), stability (BS), sustainability (BSu), empowerment (BE), preparedness (BP), governance (BG), inclusion priorities (BIP), and agility (BA). Through meticulous data collection from 1,200 respondents via Likert scale questionnaires and analysis of audited financial and budgetary reports for the years 2023-2024, the study aimed to elucidate the intricate relationships between these factors, thereby contributing to the understanding of effective financial management strategies in uncertain times.

Using advanced statistical techniques, including exploratory and confirmatory factor analysis, the research confirmed the importance of these factors in shaping the performance and sustainability of financial plans. These factors, each had values exceeding 0.50, which signified their pivotal role in navigating uncertainty. Furthermore, the reliability and validity of the model were established through various statistical tests, including Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity test, ensuring the robustness of the analysis. The high reliability demonstrated by Cronbach's Alpha reinforced the consistency of the data across all factors.

Confirmatory factor analysis (CFA) reinforced the significance of these factors, indicating a substantial influence on the overarching constructs. Notably, all factor variables exhibited statistical significance with standardised regression weights above 0.5, confirming their crucial role in the model. The findings underscored the importance of budgetary resilience (BR) in driving economic development, with well-prepared budgets being pivotal for a nation's financial stability and confidence in governance. Additionally, budgetary stability (BS) and budgetary sustainability (BSu) played crucial roles in fostering financial stability, reducing public debt, and mitigating poverty through prudent budget planning and allocation.

Budgetary empowerment (BE) emerged as a key determinant of employment opportunities, and social stability, emphasising the need for robust budget preparation to achieve societal well-being. Moreover, budgetary preparedness (BP) was identified as essential for accurate budget management and mitigation of uncertainty's effects, while budgetary governance (BG) significantly impacted corruption reduction, financial accountability, and sustainability.

Further analysis revealed significant positive relationships between these factors, reinforcing their interconnectedness in navigating uncertainty. Notably, budgetary resilience (BR) exhibited strong associations with other factors, emphasizing its pivotal role in shaping budgetary outcomes. However, certain relationships, while generally positive, exhibited nuances, necessitating clear governance strategies amidst budgetary stability and uncertainty. Overall, the study's robust FIT model and road diagram analysis affirmed the importance of these relationships, offering valuable insights for crafting effective financial blueprints to navigate uncertainty in public budget management.

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These financial blueprint recommendations prioritize budgetary resilience (BR), ensure budgetary stability (BS) and sustainability (BSu), promote budgetary empowerment (BE), enhance budgetary preparedness (BP), strengthen budgetary governance (BG), address budgetary inclusion priorities (BIP), embrace budgetary agility (BA) and aim to provide a comprehensive framework for navigating uncertainty in public budget management, drawing upon the identified factors and their interrelationships highlighted in the research. By incorporating these principles into financial planning and policy-making processes, governments can better position themselves to thrive amidst uncertain economic conditions and achieve sustainable development goals.

Finally, future studies could explore further the relationships between these factors and develop governance strategies amidst budgetary stability and uncertainty, thus enhancing the effectiveness of financial blueprints in public budget management. Overall, this research has provided a robust foundation for understanding and navigating uncertainty in public budgeting, with implications for policy-making and financial management strategies.

Disclosure statement

The author has no conflict of interest to declare.

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APPENDIX

Table A1 presents the descriptive statistics for the variables related to thriving amidst uncertainty through a financial blueprint for the public budget. This analysis includes 1,200 respondents, with non-significant variables excluded from the econometric and structural model.

Table A1

Descriptive statistics of variables

Items	Minimum statistic	Maximum statistic	Items	Minimum statistic	Maximum statistic
Nonsig	3.00	5.00	BG1	2.00	5.00
BP1	2.00	5.00	BG2	2.00	5.00
BR1	3.00	5.00	BG3	2.00	5.00
BP2	3.00	5.00	BG4	2.00	5.00
BS1	3.00	5.00	BG5	2.00	5.00
Nonsig	2.00	5.00	Nonsig.	2.00	5.00
BSu1	3.00	5.00	BG6	2.00	5.00
BR2	3.00	5.00	BG7	2.00	5.00
BS2	1.00	5.00	BG8	1.00	6.00
BS3	3.00	5.00	BG9	2.00	6.00
BR3	2.00	5.00	Nonsig.	1.00	7.00
BR4	3.00	5.00	Nonsig.	1.00	3.00
BSu2	3.00	5.00	BIP2	3.00	5.00
BE3	3.00	5.00	BIP3	2.00	5.00
Nonsig.	3.00	5.00	BA1	3.00	5.00
BE1	3.00	5.00	BA2	2.00	5.00
BSu3	3.00	5.00	BIP1	3.00	5.00
BE2	3.00	5.00	Nonsig.	2.00	5.00
BR5	3.00	5.00	BA3	3.00	5.00
Nonsig	3.00	5.00	BA4	3.00	5.00
			BA5	3.00	5.00
			BA6	3.00	5.00

Note: Nonsig. – non significant variable. N = 1,200.

Source: Author's own calculations.

Table A2 presents the results of the Exploratory Factorial Analysis (EFA) reliability analysis, detailing the Cronbach's Alpha values, Kaiser-Meyer-Olkin (KMO) test results, Bartlett's Test, and the variance explained (VE) for 42 variables categorized into eight factors: Budgetary resilience (BR), Budgetary stability (BS), Budgetary sustainability (BSu), Budgetary empowerment (BE), Budgetary preparedness (BP), Budgetary governance (BG), Budgetary inclusion priorities (BIP), and budgetary agile (BA). The survey included 1,200 respondents, with non-significant variables excluded from the econometric and structural models.

TABLE A2

Exploratory factorial analysis (EFA) reliability analysis (Cronbach's Alpha)

Item	Construct	Factor loading λ	KMO and Bartlett's Test	Variance explained (VE) Cronbach's Alpha	Interpretation
	Factor 1 Budgetary resilience (BR)				
BR1	Uncertainty is a major challenge for the public budget	0.701	KMO=0.794 χ^2= 1079.483 df=10 Sig.=0.000	VE=58.2% α=0.729	Valid results
BR2	A sustainable public budget protects the economy from negative effects	0.682			
BR3	A well-prepared public budget contributes to economic development	0.785			
BR4	A well-prepared public budget can increase public investment	0.673			
BR5	A well-prepared public budget improves the quality of public services	0.619			
	Factor 2 Budgetary stability (BS)				
BS1	A well-prepared public budget contributes to financial stability	0.783	KMO=0.763 χ^2= 747.742 df=3 Sig.=0.000	VE=64.5% α=0.724	Valid results
BS2	A well-prepared budget based on a clear financial plan increases citizen confidence	0.846			
BS3	A well-prepared public budget helps to manage financial crises	0.778			
	Factor 3 Budgetary sustainability (BSu)				
BSu1	A well-prepared budget plan minimizes financial risks	0.798	KMO=0.749 χ^2= 485.093 df=3 Sig.=0.000	VE=58.9% α=0.750	Valid results
BSu2	A well-prepared public budget helps to reduce public debt	0.767			
BSu3	A well-prepared public budget contributes to poverty reduction	0.736			
	Factor 4 Budgetary empowerment (BE)				
BE1	Employment opportunities are enhanced by a well-prepared public budget	0.783	KMO=0.725 χ^2= 379.184 df=3 Sig.=0.000	VE=55.7% α=0.800	Valid results
BE2	Social sustainability can be achieved through a well-prepared public budget	0.767			
BE3	A well-prepared public budget improves the transparency of public finances	0.684			

Item	Construct	Factor loading λ	KMO and Bartlett's Test	Variance explained (VE) Cronbach's Alpha	Interpretation
	Factor 5 Budgetary preparedness (BP)				
BP1	A clear financial plan is effective in managing the public budget	0.808	KMO=0.700 χ^2= 118.201 df=3 Sig.=0.000	VE=65.3% α=0.769	Valid results
BP2	A well-prepared financial plan can mitigate the effects of budget uncertainty	0.821			
	Factor 6 Budgetary governance (BG)				
BG1	A well-prepared public budget helps to reduce corruption	0.683	KMO=0.859 χ^2= 3092.409 df=36 Sig.=0.000	VE=55.3% α=0.837	Valid results
BG2	A well-prepared public budget increases the financial accountability of public institutions	0.566			
BG3	A well-prepared public budget increases accountability to citizens	0.645			
BG4	A well-prepared public budget helps to reduce wealth inequality	0.646			
BG5	A well-prepared public budget promotes environmental sustainability	0.703			
BG6	A well-prepared public budget increases citizen participation in financial decision-making	0.678			
BG7	A well-prepared public budget promotes social justice	0.622			
BG8	A well-prepared public budget reduces income inequality	0.666			
BG9	Mechanisms for monitoring and evaluating the implementation of the public budget are necessary	0.714			
	Factor 7 Budgetary inclusion priorities (BIP)				
BIP1	Necessity of public budget allocation for programs promoting gender equality	0.753	KMO=0.733 χ^2= 335.591 df=3 Sig.=0.000	VE=54.7% α=0.786	Valid results
BIP2	The belief that public investment should prioritize long-term economic development	0.715			
BIP3	Public consultation plays a crucial role in the process of public budgeting	0.752			

Item	Construct	Factor loading λ	KMO and Bartlett's Test	Variance explained (VE) Cronbach's Alpha	Interpretation
	Factor 8 Budgetary agile (BA)				
BA1	Satisfaction with the frequency of updates on the implementation of the public budget	0.669	KMO=0.823 χ^2= 1254.973 df=15 Sig.=0.000	VE=53.8% α=0.742	Valid results
BA2	Satisfaction with the inclusiveness of the public budget in addressing diverse community needs	0.580			
BA3	Satisfaction with government responsiveness to public input during the budget process	0.657			
BA4	Information about services and programs funded by the public budget is easily accessible	0.711			
BA5	The government effectively communicates budget decisions to the public	0.658			
BA6	The government can meet future fiscal challenges	0.688			

*Note: KMO = Kaiser-Meyer-Olkin, χ^2 = Chi-Square, df = degrees of freedom, *** p<0.001, α = Cronbach's Alpha.*

Source: Author's own calculations.

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Table A3 presents a comprehensive analysis of demographic factors essential for developing a financial blueprint for the public budget, aimed at fostering resilience amid uncertainty. The findings reveal that a majority of respondents (61.0%) have post-graduate degrees, indicating a well-educated population. Additionally, females make up 65.2% of the respondents, suggesting that gender perspectives may influence budget priorities. Furthermore, the predominant age group is 15-35 years old (70.9%), highlighting a younger demographic that may favor innovative financial strategies. These insights are crucial for tailoring financial approaches to effectively meet the needs of the community.

Table A3

Descriptive analysis for respondents

		Frequency	Percent
Education	High school	22	1.8
	Basic studies – faculty	382	31.8
	Post-graduate studies – master	732	61.0
	Other (Ph.D.)	64	5.3
	Total	1,200	100.0
Gender	Male	391	32.6
	Female	782	65.2
	Prefer not to answer	27	2.3
	Total	1,200	100.0
Age	15-35 years old	851	70.9
	36-55 years old	266	22.2
	Over 55 years old	83	6.9
	Total	1,200	100.0

Source: Author's own calculations.

Table A4 presents the covariances and correlations among various factors related to thriving amid uncertainty in the context of a financial blueprint for the public budget. These results reveal the relationships between different factors influencing the financial blueprint, showing significant positive correlations among various pairs. This interconnectedness underscores the importance of considering these relationships in budgetary planning and decision-making.

TABLE A4

Covariances and correlations

Path variables	Covariances					Correlation	Interpretation
	Estimate	S.E.	C.R.	P value		Estimate	
BR <--> BE	0.102***	0.008	12.041	***	p < 0.001	0.733	
BR <--> BP	0.070***	0.007	9.855	***	p < 0.001	0.602	
BR <--> BG	0.016**	0.006	2.738	.006	p < 0.01	0.101	
BR <--> BSu	0.099***	0.008	11.927	***	p < 0.001	0.764	
BS <--> BE	0.104***	0.009	11.121	***	p < 0.001	0.589	
BS <--> BIP	0.036***	0.007	5.324	***	p < 0.001	0.249	
BS <--> BP	0.107***	0.009	11.415	***	p < 0.001	0.720	
BS <--> BSu	0.116***	0.010	12.047	***	p < 0.001	0.701	
BE <--> BIP	0.057***	0.007	8.126	***	p < 0.001	0.456	
BE <--> BP	0.097***	0.009	11.105	***	p < 0.001	0.763	Cov (BR, BS, BSu, BE, BP, BG, BIP, and BA) Cor (BR, BS, BSu, BE, BP, BG, BIP, and BA) Positive and significant relationship The covariance's of the factors: BP<--> BG and BG <--> BSu are not statistically significant at the 5% level.
BE <--> BG	0.020**	0.007	2.872	.004	p < 0.01	0.117	
BE <--> BSu	0.094***	0.008	11.082	***	p < 0.001	0.670	
BE <--> BA	0.052***	0.007	7.662	***	p < 0.001	0.369	
BIP <--> BP	0.033***	0.006	5.381	***	p < 0.001	0.316	
BIP <--> BG	0.019**	0.006	3.174	.002	p < 0.01	0.133	
BIP <--> BSu	0.038***	0.006	6.405	***	p < 0.001	0.332	
BP <--> BG	0.010	0.007	1.446	.148	*nonsig.*	0.067	
BP <--> BSu	0.098***	0.009	11.380	***	p < 0.001	0.827	
BP <--> BA	0.061***	0.007	8.839	***	p < 0.001	0.518	
BG <--> BSu	0.010	0.006	1.549	.121	*nonsig.*	0.061	
BG <--> BA	0.023***	0.006	3.793	***	p < 0.001	0.142	
BSu <--> BA	0.053***	0.006	8.240	***	p < 0.001	0.405	
BR <--> BS	0.059***	0.007	8.159	***	p < 0.001	0.361	
BS <--> BA	0.040***	0.007	5.852	***	p < 0.001	0.244	

Path variables	**Covariances**					**Correlation**	**Interpretation**
BR <--> BIP	0.048***	0.006	8.025	***	$p < 0.001$	0.417	
BIP <--> BA	0.097***	0.008	11.466	***	$p < 0.001$	0.831	
BS <--> BG	0.036***	0.008	4.628	***	$p < 0.001$	0.176	
BR <--> BA	0.053***	0.006	8.644	***	$p < 0.001$	0.405	

*Note: *** p<0.001, ** p<0.01, Standard error (S.E.), Critical ratios (C.R.), Covariance's (Cov), Correlations (Cor),* C.I. *= 95%, nonsig. – not significantly different from zero at the 0.05 level (two-tailed).*

Source: Author's own calculations.

Central bank balance sheet and inflation in a euroised small open economy: a cointegrated SVAR analysis

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Abstract

The Bank of Albania has not employed traditional balance sheet policies; however, it has taken a series of policy actions that have increased the proportion of non-borrowed relative to borrowed components of the monetary base and its balance sheet liabilities. We aim to investigate whether these changes in the structure of the central bank balance sheet gave rise to additional monetary shocks with direct effects on inflation. The hypothesis is tested by estimating a small structural VAR model with cointegrated I(1) and I(0) policy and non-policy variables. We identify long-run restrictions based on the embedded structure of the data generating process, as defined by cointegration relationships. Our findings suggest that an increase in the share of non-borrowed components of the monetary base has direct and indirect positive effects on inflation. We argue that the identification of this monetary shock has significant implications for the central bank and its monetary policy.

Keywords: monetary policy, structural VAR, cointegration, permanent monetary injections, central bank balance sheet

1 INTRODUCTION

For most of the past two decades, monetary authorities around the world were mainly concerned with low inflation and below-target inflation expectations resulting from negative and persistent shocks such as the Great Financial Crisis (GFC) and the Covid pandemic. To support the economy and bring inflation back to target after the onset of such shocks, central banks in advanced economies first lowered policy interest rates to close to (or even below) zero, and then, as a new policy tool, started expanding their balance sheet.

Unlike central banks in advanced economies, central banks in small, open and highly euroised emerging market economies such as Albania had limited options in terms of policy instruments, financial markets, or indeed the motivation to apply such balance sheet policies.[1] Nevertheless, in its effort to achieve the inflation objective and preserve financial stability, the Bank of Albania (BoA) undertook a series of policy actions aimed at increasing the level of international reserves, reducing the extent of euroisation, and containing the negative effects of exchange rate shocks on inflation. These actions provided additional liquidity to the banking system outside the traditional framework of monetary operations. They also changed the structure of the monetary base and of BoA liabilities in favour of non-borrowed or permanent funds.[2] The main hypothesis of this paper is that increasing the share of non-borrowed components of BoA balance sheet liabilities via permanent monetary injections had the effect of an additional monetary shock, above and beyond the expansionary effects of policy rate cuts.[3]

[1] See Sejko (2021) for a detailed discussion of how implementation of balance sheet policies is constrained by shallow, underdeveloped financial and capital markets and the lack of tradable securities.

[2] The literature typically refers to permanent vs. non-permanent monetary injections. In this paper we use the terms non-borrowed and permanent injections interchangeably, in the sense that permanent funds comprise currency in circulation plus all bank reserves that are not borrowed from the central bank.

[3] For the purpose of this paper monetary shocks are referred to as balance sheet structural shocks. The early literature on the topic that emerged in the late 1990s referred to monetary base rather than balance sheet shocks.

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The discussion on non-borrowed versus borrowed monetary injections has been framed in the literature mainly in terms of permanent versus temporary monetary injections in advanced economies (Krugman, Dominquez and Rogoff, 1998; Bernanke, 1999; Eggertson and Woodford, 2003; and Svensson, 2003). One finding of this literature is that increases in the monetary base via permanent injections have positive effects on prices and aggregate demand, the reason being that, if these injections had been perceived as temporary, no such effects would have materialised. Bernanke and Mihov (1998) discuss a similar topic in terms of borrowed vs. non-borrowed bank reserves. There are no studies that explore this topic in the context of emerging market economies in central and south-eastern Europe. Our research aims to fill this gap by investigating whether changes in the structure of central bank balance sheet liabilities in favour of non-borrowed (permanent) funds impar additional monetary shocks with direct or indirect effects on inflation. We also contribute to the literature in terms of empirical methodology, by applying a recent structural vector error correction model (SVECM) to the identification method of Oularis, Pagan and Restrepo (2018).

Our results indicate that an increase in the share of non-borrowed funds in the monetary base acts as a separate monetary shock with direct and indirect positive effects on inflation. The direct effect is small. The indirect effect is stronger and works through the exchange rate channel. This suggests that the BoA can use increases in the share of non-borrowed funds as a monetary policy tool when the effectiveness of policy interest rates is constrained.

We test our hypothesis by estimating a small structural vector autoregressive (VAR) model with policy and non-policy variables. The latter include CPI inflation, GDP as a measure of economic activity, M3 as a measure of demand for money, and the lek-euro exchange rate as a multidimensional macro-financial variable with an important role in the Albanian economy. The main policy variable is the monetary policy interest rate. In line with Krugman, Dominquez and Rogoff (1998), Bernanke and Mihov (1998), and Eggertson and Woodford (2003), we introduce as the second policy variable a balance sheet structure indicator, defined as the ratio of non-borrowed monetary base to total monetary base, both in domestic currency. This indicator serves as a proxy for permanent as opposed to temporary liquidity injections. To achieve proper identification, we also use foreign prices in the model.

The identification of structural shocks in our VAR is guided by two insights. First, identification of the structural VAR (SVAR) is based on Oularis, Pagan and Restrepo (2018), who use cointegration relationships to identify long-run restrictions. This method has the advantage of using existing characteristics embodied in the data generating process – the order of integration of the variables and/or existence of potential cointegration relationships – rather than authors' beliefs on long-run relationships to identify long-run restrictions. We also rely on our knowledge of the policymaking process, described in detail in the BoA's annual and quarterly monetary policy reports, to decide the order and interaction of shocks in the model.

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The rest of the paper is structured as follows. Section 2 briefly describes the Bank of Albania monetary policy framework. Section 3 discusses our empirical framework and data. Section 4 presents and discusses our estimates. Section 5 summarises the findings and discusses some policy implications.

2 BANK OF ALBANIA MONETARY POLICY FRAMEWORK

The Albanian economy is a small, open, emerging market economy with a high level of euroisation in real and financial sectors, and underdeveloped capital and financial markets.[4] The euro area is Albania's main trade and financial partner, and real and financial shocks originating in it have significant spillovers on the domestic economy. In addition, developments in global energy and commodity markets strongly influence Albania's inflation.

Price stability is the BoA's primary objective. To fulfil this obligation mandated by law, the BoA relies on an inflation targeting framework, a free-floating exchange rate regime, and liberalised external current and capital accounts. The main monetary policy instrument is the repo rate, the interest rate on weekly repurchase agreements. Through repo or reverse repo open market operations and overnight deposit and lending facilities, the BoA aims to keep interbank and money market rates close to the policy rate, and at the same time ensure that the liquidity needs of the financial system are met. An important consideration is that monetary policy in Albania is implemented in an environment of a structural deficit of liquidity in the money market.

Like other central banks, during 2008-22 the BoA was mainly concerned with low inflation and inflation expectations falling below target. Following the GFC and the euro area sovereign debt crisis, it thus embarked on a prolonged period of expansionary policy, lowering interest rates from 6.25% in 2010 to 1% in June 2018, and further to 0.5% in March 2020 at the outbreak of the Covid pandemic. Throughout this period, inflation was stable but below its long-term target of 3%. It jumped above the target only in autumn 2021, under pressure from surging import prices.

A related concern for the BoA was the relatively weak transmission of its interest rate changes to economic activity and prices. This was largely a structural issue, reflecting the high euroisation of the real economy and the financial sector and exchange rate developments – a strong depreciation in the aftermath of the GFC, followed by sharp appreciation. These developments raised financial stability concerns: a large fraction of private sector borrowings and deposits – around 75% and 50% of the total, respectively – were already in euros. Depreciation and shrinking economic activity after the GFC first led to a sharp increase in private sector nonperforming loans (NPLs), which reached their peak at 25% of total loans in 2015, significantly damaging private and banking sector balance sheets.

[4] In the second half of 2022, foreign currency loans represented 51% of total loans and foreign currency deposits 46% of total deposits in the Albanian banking system (BoA, 2023).

The subsequent appreciation of the lek against the euro, as well as excess liquidity and low interest rates in the euro area at the time, encouraged foreign currency borrowing, especially by the public sector. After the second eurobond issue in November 2015 (valued at €450 million), the Ministry of Finance strategically shifted the refinancing of maturing, mostly lek-denominated, debt from domestic to foreign sources (BoA, 2015: 58). This resulted in 4 more eurobond issues reaching a total of €3.15 billion by end-2023. The share of eurobonds in total foreign debt thus increased from 13% in 2015 to nearly 40% in 2023.[5]

By the mid-2010s, it also became clear that the lek appreciation was one of the main forces behind low inflation. Bahmani, Miteza and Tanku (2020) showed, for example, that money demand did not react symmetrically to exchange rate developments: domestic currency balances would shrink when the lek weakened, but would not increase when the lek strengthened against the euro.

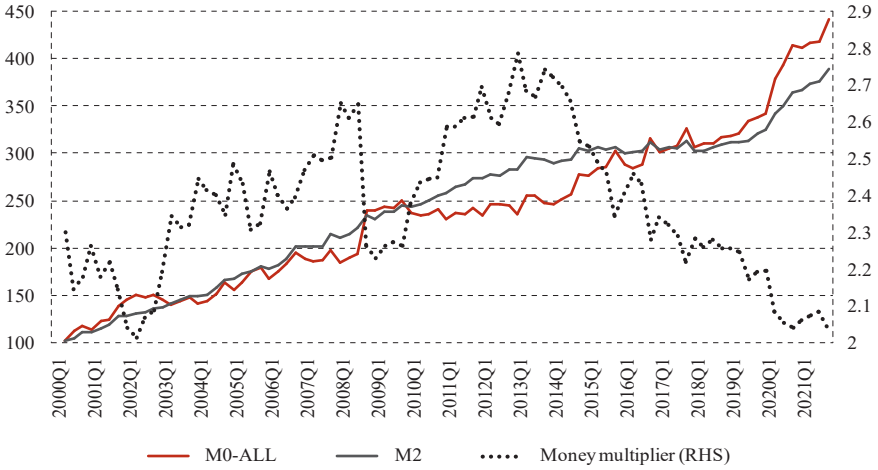
To address these concerns and shield the economy from potential foreign financial shocks, the BoA introduced three policy innovations. First, it mandated that, starting from 2017, the international reserves should cover not only current account transactions but also risks associated with foreign short-term debt and the foreign currency liabilities of the banking system. Second, in mid-2018 the BoA's Supervisory Board approved the use of interventions in the foreign exchange market to counteract the effects of lek appreciation and help achieve the price-stability objective.[6] Third, the BoA introduced a de-euroisation strategy by setting asymmetric reserve requirements on foreign (from 10 to 12.5%) and domestic currency deposits (from 7.5 to 10%).

These policy innovations, together with interest rate cuts, eventually changed the size and composition of the BoA's balance sheet and the sources of money creation in the economy. The balance-sheet expanded by 89% from the start of the GFC until end-December 2019, and by another 30% from the start of the Covid pandemic until end-December 2021.[7] This, however, did not result in a similar increase in monetary aggregate M2. Graph 1 shows that the money multiplier declined sharply after 2016. Bernanke (1995) argued that a falling money multiplier was a sign of disintermediation, indicating that banks had no interest in increasing reserves by further borrowing in weekly or longer-term repo auctions. This evidence of weak financial intermediation, together with effects of three policy innovations noted above, shifted the sources of money creation away from borrowed funds to non-borrowed or permanent monetary injections.

[5] Authors' calculations, based on Ministry of Finance (2023: 52).
[6] See BoA Supervisory Council Decision no. 49 (6 June 2018). Despite these interventions, the BoA held on to its free-floating exchange rate regime: it announced the amount and the calendar of interventions at the beginning of each year and executed them on schedule so as not to surprise the market (see Sejko, 2021; Tanku, Vika and Gjermeni, 2007; and BoA Annual Reports).
[7] While this is relatively small compared with balance sheet expansions of the Federal Reserve and the ECB, it is still significant given that the BoA decided not to implement standard quantitative easing (see Sejko, 2021).

Graph 1

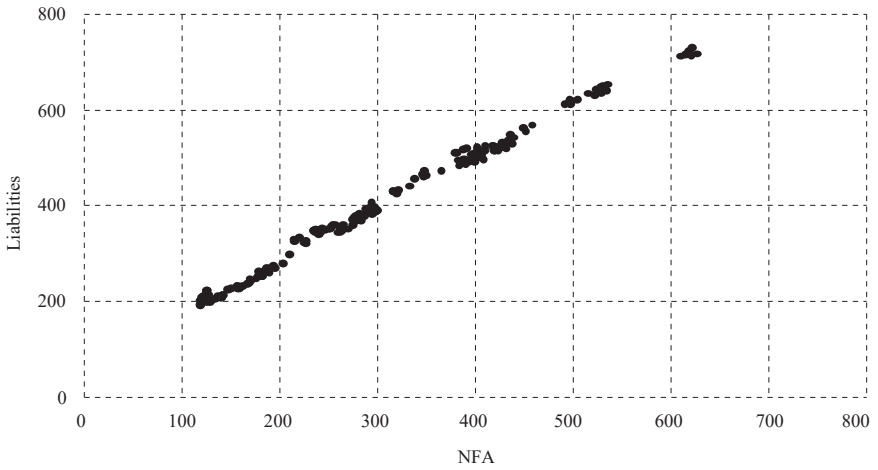
Financial intermediation and M0 money multiplier 2000 Q1=100 (in %)



Source: BoA and authors' calculations based on the BoA balance sheet data.

Graph 2

BoA liabilities and NFA, 2002-22, in billions of ALL



Source: Authors' calculations based on the BoA balance sheet data.

The identification of central bank policy actions as permanent monetary injections is widely discussed in the literature. Krugman, Dominquez and Rogoff (1998), for example, related permanent injections to purchases of assets or foreign exchange, while repurchase agreements and other open market operations that constituted borrowing at fixed-term maturity were considered temporary. Eggertson and Woodford (2003), and Buiter (2014) compared permanent monetary injections with "helicopter drops", i.e. with commitment to permanent monetary base

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increases.[8] Svenson (2003) expanded this notion to purchases of unlimited amounts of foreign currency in the forex market, relating permanent expansion of monetary base to a policy of currency depreciation and increases in net foreign assets (NFA) on the central bank balance sheet.

There is also a large body of literature discussing the effectiveness of permanent vs. temporary monetary injections under zero lower bound conditions or a liquidity trap scenario.[9] One finding is that permanent expansion or shocks in the monetary base can have positive impact on inflation. However, if monetary expansions were perceived as temporary, the increase in inflation would not materialise. Krugman, Dominquez and Rogoff (1998) showed that the distinction between permanent and temporary monetary injections was even clearer in a liquidity trap situation. These findings hold across a range of models, from classical and modern quantity theory of money, to new Keynesian.

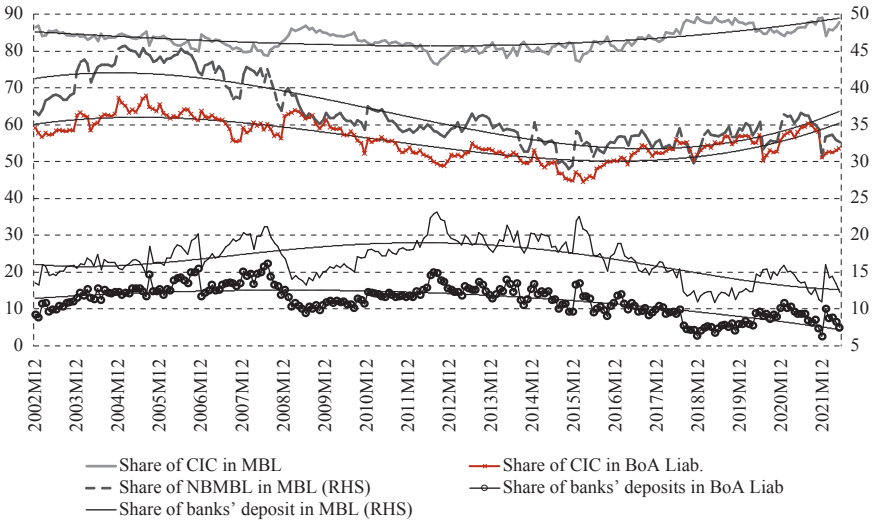
BoA's monetary statistics indicate that NFA became a significant source of base money creation and balance sheet expansion by the mid-2010s, and that increases in NFA and the size of the balance sheet were highly correlated, as shown in graph 2. Over time, these developments resulted in a change in the structure of BoA liabilities in favour of permanent or non-borrowed funds. Graph 3 shows a decrease of 10% in the share of banks' deposits on the BoA's balance sheet between end-2015 and Q1:2022, with the share of currency in circulation increasing by around 10% over the same period. The same pattern can be observed in terms of the monetary base in lek.

We investigate empirically whether changes in the structure of the monetary base can be identified as a monetary shock. To this end, we must show that the observed changes in inflation were not directly or indirectly driven by the three policy innovations undertaken by the BoA. The empirical model must account for these effects if they are present in the data. Exchange rate management in favour of the inflation objective is a good example to illustrate the issue. The direct effect of the exchange rate on inflation is accounted for by including the exchange rate in model specification. However, unsterilised purchases of foreign exchange simultaneously lead to higher NFA and the expansion of the central bank balance sheet and monetary base. Through the money multiplier, the increase in monetary aggregates could raise inflation. This effect could materialise regardless of the permanent vs. temporary nature of monetary injections.

[8] "That is … a permanent increase in the stock of base money through an irreversible open market purchase by the central bank of non-monetary sovereign debt held by the public – that is, QE" (Buiter, 2014:1).
[9] See, e.g. Beekworth (2017), and Sumner (2021).

Graph 3

Monetary indicators, as percentage of BoA liabilities and monetary base in lek (MBL)



Source: Authors' calculations based on the BoA balance sheet data.

The same could be true of policies to increase international reserves to cover short-term foreign liabilities, and to differentiate reserve requirements across foreign and domestic deposits. They are not traditional monetary policy interventions and as such should not affect inflation directly. Yet both rely on the monetary transmission mechanism, and hence their indirect effects on inflation could not be excluded. However, as we argue below, such indirect effects are unlikely under conditions prevailing in Albanian money and financial markets.

The decision to increase international reserves aims to address financial stability concerns and one can therefore exclude an intentional and direct influence of this policy on inflation. However, as with forex purchases, higher reserves increase NFA and thereby contribute to the expansion of the central bank balance sheet and monetary base, which can have an indirect effect on inflation.

Differential reserve requirements are aimed at reducing euroisation rather than affecting inflation. Nevertheless, as they are also a monetary policy instrument, changes in reserve requirements could affect inflation directly. This effect is likely to be small, however, because decreases in requirements on domestic currency deposits are offset by equivalent increases in requirements on foreign currency deposits, leaving total required reserves and M3 more or less unchanged.[10] Changes in reserve requirements have, however, two indirect effects on the Central bank balance sheet and hence potentially on inflation: they permanently release a fraction of required reserves in domestic currency, and they permanently increase NFA.

[10] Note that the lek and foreign currency deposits account for about 50% of total deposits each.

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In sum, all three policy innovations have an indirect and immediate effect on M0. In normal circumstances, the increase in M0 would lead to an increase in other monetary aggregates and eventually inflation. In Albania, however, the growth rate of M2 has been lower than that of M0 since mid-2010 (graph 2).[11] This implies that BoA policy innovations could not have had the impact on money (M2) and the inflation expected under the traditional monetary transmission mechanism.

3 EMPIRICAL FRAMEWORK

Our main goal is to test whether structural changes in the central bank balance sheet described above are identified as a potential second monetary policy shock in the presence of, and in addition to, the interest rate shock. If that were the case, the evidence would provide empirical support for the hypothesis that permanent liquidity operations have positive effect on inflation in the context of a small open emerging market economy such as Albania. We test this hypothesis on a small-scale structural SVAR with identification based on Oularis, Pagan and Restrepo (2018). The methodology is relatively new and has not been previously applied in empirical studies of economies such as Albania.

3.1 EMPIRICAL MODEL

The traditional VAR(p) is represented by a system of simultaneous equations:

$$z_t = A_1 z_{t-1} + A_2 z_{t-2} + ... + A_p z_{t-p} + \mu + \varepsilon_t \quad (1)$$

where z_t is a vector of n endogenous variables; $A_1,\ldots, A_p$ are matrices of size (n x n) of the parameters to be estimated; μ is a vector of n constants; and ε_t represents a vector of (n x 1) error terms. The VAR model of equation (1) can also be thought of as a structural vector autoregressive model (SVAR) represented:

$$A z_t = A_L + B u_t \quad (2)$$

where matrix A represents the structural links; A_L represents the time lag structure expressed as $A_1 z_{t-1} + ... + A_p z_{t-p}$; and B is the matrix that defines the constraints related to the impulse response functions of the orthogonalised shocks u_t. Assuming no restrictions are imposed on the matrices Aj, for $j = 1, ..., p$, of the A_L, SVAR takes the form:

$$A \varepsilon_t = B u_t \text{ ose } A \varepsilon_t = B \eta_t \quad (2.1)$$

where η_t defines the innovations that have unit variance relative to u_t, which has no unit variance.

The traditional identification schemes impose restriction on matrices A and/or B. Gali (1992) was the first to observe that the presence of cointegration constituted

[11] See Krugman, Dominquez and Rogoff (1998) for an early discussion of the breakdown in money multiplier and the inability of monetary policy to influence inflation and economic activity.

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a special case of restrictions in the data generation process. Cointegration means that nonstationary time series coexist in a long-run equilibrium. This long-run equilibrium imposes limitations on the behaviour of variables and on the way shocks are transmitted within the system. Gali used this system to identify structural constraints in the SVAR long-term behaviour matrix. However, Oularis, Pagan and Restrepo (2018) showed that when cointegration was present, the correct form of the model was vector error correction (VECM) rather than VAR, so that Gali's identification method was incorrect.

The use of SVAR thus requires the conversion of the VECM to a standard VAR model. Assuming the existence of r cointegrating relationships (for $r < n$), the VECM model takes the following form:

$$\Delta\zeta_t = \alpha\beta'\zeta_{t-1} + \Phi_1\Delta\zeta_{-1} + e_t \tag{3}$$

where α and β represent matrices (n x r) describing the cointegrating relationship, i.e. the matrix of coefficients of the error term and the matrix of cointegrating vectors; ζ_{t-1} is the vector of the level of non-stationary variables in period $t - 1$; and ζ_{-1} is the vector of the first differences of z_t. Assuming that $\Phi_1 = 0$ and multiplying both sides of equation 3 with the matrix of simultaneous coefficients allow the structural form of the VECM, i.e. SVECM, to be written as follows:

$$\Phi_0\Delta\zeta_t = \alpha^*\xi_{t-1} + \varepsilon_t \tag{4}$$

where $\alpha^* = \Phi_0\alpha$ and $\varepsilon_t = \Phi_0 e_t$ (Φ_0 is the same as matrix A in equation (2), while $\xi_t = \beta'\zeta_{t-1}$ represents the error correction terms in VECM. Oularis, Pagan and Restrepo (2018) split the vector ζ_t of endogenous variables z_t into vector ζ_1 ([$(n\text{-}r)$ x 1] of variables with stochastic trends, and vector ζ_2 [rx1] of variables that experience only transitory shocks. Therefore, a model of n variables of which r are cointegrated then takes the form:

$$\Phi^0_{i1}\Delta\zeta_{1t} + \Phi^0_{i2}\Delta\zeta_{2t} = \alpha^*\xi_{t-1} + \varepsilon_{1t} \tag{5}$$

where i = *(1, 2)* represents the first and the second block of equations in SVECM (composed, respectively, of the $n - r$ variables with permanent stochastic and r cointegrating relationships); ζ_{1t} represents the vector of $n - r$ variables with permanent stochastic trends; ζ_{2t} represents the vector of r transitory shocks; and $\xi_t = \beta_1'\zeta_{1t} + \beta_2'\zeta_{2t}$. One can further eliminate transitory trends from model 5 using the cointegration relationships and the fact that equations with permanent stochastic trends have the adjustment coefficient α^* equal to *0*; equation (5) can be written as:

$$\mathrm{A}^0_{i1}\Delta\zeta_{1t} + A^0_{i2}\xi_t = A^1_{i2}\xi_{t-1} + \varepsilon_{2t} \tag{6}$$

where $A^1_{i2} = \mathrm{A}^0_{i1}\alpha^*$ for i = *(1, 2)*, as described in equation (5). Equation (6) represents the SVAR form of the SVECM in equation (5). This SVAR consists of $n - r$

variables with permanent stochastic trends $\Delta\zeta_{1t}$ and r cointegrating relationships ξ_t, which replace r variables without stochastic trends. The matrices of coefficients A_{21}^0, A_{22}^0 *and* A_{22}^1 of the SVAR are not the original matrices Φ_j of the SVECM, however. Oularis, Pagan and Restrepo (2018) note that the shocks in the SVAR are similar to those in the SVECM, preserving their information value for empirical analysis. They show that the model can be easily extended to incorporate the presence of the stationary variables in the data generating process. In that case the SVAR would take the form:

$$A_{i1}^0 \Delta\zeta_{1t} + A_{i2}^0 \xi_{2t} + \Psi_{i3} w_t = A_{i2}^1 \xi_{t-1} + \varepsilon_{it} \quad (7)$$

where i = *(1, 2, 3)* with 1 and 2 as described above and 3 representing the block of stationary variables, and w_t representing the set of stationary variables. Equation (7) represents the functional form of our empirical model.[12]

3.2 DATA AND IDENTIFICATION OF SVAR

In selecting the variables, we follow the literature that uses a similar VAR methodology. Variables of interest are those broadly associated with monetary policy transmission and the relationship of money, exchange rates, and policy rates with the business cycle, real economic activity and inflation in Albania.[13] These include gross domestic product (GDP), consumer price index (CPI), the Albanian lek euro exchange rate (ER), monetary aggregate (M3), and the policy rate (REPO) as the main BoA monetary policy instrument. Both GDP and M3 are expressed in real terms. To test our hypothesis, we also include the balance sheet structural indicator to identify permanent vs. temporary monetary shocks (see below). This setup makes our model very similar to that of Bernanke and Mihov (1998).

Given the BoA's monetary policy framework, we frame the discussion in terms of the monetary base rather than borrowed vs. non-borrowed bank reserves, as for example in Bernanke and Mihov (1998). As our focus is on the BoA's monetary policy, we only look at the monetary base in domestic currency. We define the permanent monetary base in terms of non-borrowed funds, which we calculate as the arithmetic sum of currency outside banks and non-borrowed reserves of the banking system. The later equal the difference between total banking system reserves and borrowed reserves, which represent the net effect of repo, reverse repo and all other lending facilities extended in each period to all other depository corporations reported in the BoA's balance-sheet.[14]

Following Bernanke and Mihov (1998), we define the balance sheet structural liquidity indicator (LI) as the ratio (in percent) of the non-borrowed monetary base to total

[12] Oularis, Pagan and Restrepo (2018) emphasise that we must specify equation (7) in terms of Δw_t if we want the shocks of stationary effects to have a permanent effect in the system.
[13] See for example Kolasi, Shijaku and Shtylla (2010), Shijaku (2016), Bahmani, Miteza and Tanku (2020), and Miteza, Tanku and Vika (2023).
[14] Calculations are based on the sectoral balance sheet data.

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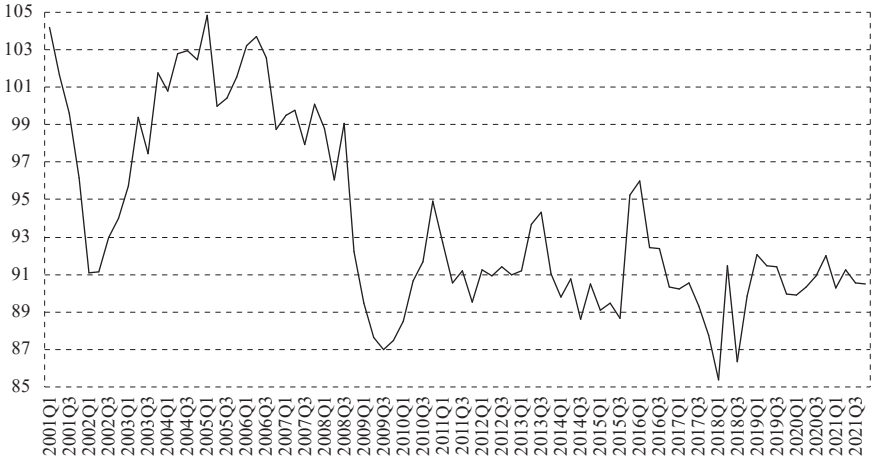
monetary base, both in domestic currency. The balance sheet indicator is shown in graph 4. The mean of the series differs before and after 2008, indicating a likely structural break. This is not surprising in view of the differences in monetary operations: before 2008, in an environment of abundant liquidity, BoA's open market operations were mostly repurchase agreements; following the GFC, they switched to reverse repos. Non-borrowed monetary base stayed above 90% in 2010-13 as the economy adjusted to the negative effects of the GFC and financial intermediation shifted away from foreign currency. The rise in the indicator in 2017-18 reflects the introduction of policy innovations, which lifted the indicator again to above 90%.

Graph 4

Balance sheet structural indicator



Source: Authors' calculations based on the BoA balance sheet data.

Data come from the BoA and the Albanian Institute of Statistics. Commodity prices (PCOM) are included to account for foreign price shocks; they are sourced from the IMF. We use quarterly data from Q1:2000 to Q4:2021. All series, with the exception of the policy rate, are expressed in logs and are seasonally adjusted. Seasonal adjustments, tests, and estimations are carried out in EViews. Appendix graphs A1 and A2 depict individual variables and their bilateral relationships, while table A1 provides summary statistics of variables.

Previous studies found that prices, money, GDP, exchange rate, and the policy rate in Albania were cointegrated in the long run.[15] We use this information for structural identification in our SVAR. We start with a detailed analysis of statistical properties of the dataset. Unit root and cointegration tests reveal that there are four permanent stochastic trends and only one cointegration relationship in the system (tables A2 and A3). CPI, GDP, ER, and PCOM are non-stationary in level and stationary in the first difference and are thus considered to be integrated of order 1. The balance sheet

[15] See, e.g. Shijaku (2016), Bahmani, Miteza and Tanku (2020), Miteza, Tanku and Vika (2023).

indicator is stationary before and after the structural break in Q3:2008. The policy rate is trend-stationary in level. Surprisingly, seasonally adjusted M3 is also stationary in level. Previous research found it to be a unit root process, but our test results are very robust, indicating there is no stochastic trend in M3 and, hence, no permanent influence of money on I(1) variables, including CPI. Regarding the presence of cointegration among I(1) variables, both trace and max-eigenvalue test statistics suggest the existence of one cointegrating relationship among CPI, GDP, ER and PCOM. In line with Tanku and Vika (2020), and Miteza, Tanku and Vika (2023), we decided that the CPI carried over the cointegration relationship.

Following Ouliaris, Pagan and Restrepo (2018) we proceeded with estimation using ARDL based on Pesaran, Shin and Smith (2001). The results are reported in table 1. Test statistics confirmed the existence of a cointegration relationship. The reported F statistic of the bound test is above its threshold value; in addition, the estimated coefficient on the error correction term is negative and statistically significant. On this basis, and given that our identification relies on long-run restriction methodology, we drop M3 from the model and estimate a mixed SVAR of four cointegrated I(1) and 2 stationary variables. This is helpful in view of the short time span of the dataset.

Our identification strategy requires substituting the cointegrating relationship (labelled CPI^{lr} in reported impulse response functions) for the CPI in our original VAR. With this transformation, we end up estimating the SVAR form of SVECM with three stochastic shocks (PCOM, GDP, and ER), one cointegrating relationship (standing for the CPI), and two stationary variables (the REPO and LI).

We use this information to specify the identification scheme in our structural VAR on the following assumptions:

1. The presence of cointegration means that the cointegration relation exerts no long-run influence on the other I(1) variables in the VAR;
2. I(0) variables, REPO and LI, exert no long-run influence on either I(1) or I(0) variables in SVAR;
3. Domestic variables are exogenous to PCOM, given the small size of the Albanian economy.

Table 1

Estimates of linear ARDL equation (1)

Panel B: Long-run coefficients				Panel C: Diagnostic statistics		
Constant	**LGDP_SA**	**LER_SA**	**LPCOM_SA**	**F-Bound test statistic**		**ECM**
0.59***[b]	0.18***	-0.12***	0.016**	11.23***		-0.48***
(2.27)[a]	(5.15)	(5.64)	(2.56)	I(0) at 1%	I(1)at 1%	(6.83)
				5.17	6.36	

[a] *Figures in parenthesis show the value of t statistic,* [b] ***/** *indicate significance at 1% and 5% respectively.*

Source: Authors' calculations.

These assumptions impose 13 restrictions on the long-run matrix out of a total of 15 needed for identification of the system. To identify the remaining two restrictions, we rely on our knowledge of the monetary policy process and decision-making at the BoA. Monetary operations focus on keeping market rates close to the policy rate, and on keeping bank reserves consistent with the prevailing policy rate. Therefore, shocks in the balance sheet structure should not have any short-term impact on the policy rate. We thus set the corresponding coefficient in the short-run matrix of our SVAR to zero.

Similarly, in line with its free-floating regime, the BoA policy rate does not respond to exchange rate innovations. When the BoA is concerned about deviations of the exchange rate from its fundamental equilibrium, it intervenes in the foreign exchange market without adjusting the policy rate. As exchange shocks do not affect the policy rate in the short run, the corresponding coefficient in the short-run S matrix can be set at 0. The identification restrictions of our SVAR are summarised in F and S matrices in table 2.

The correct form of the SVAR requires that nonstationary variables and the corresponding error correction term, which substitutes for prices, are included in the model in their first difference (see Ouliaris, Pagan and Restrepo, 2018). The repo rate and the balance sheet liquidity indicator are stationary and may enter the model either in level or first difference, depending on whether we are interested in their permanent effects on nonstationary variables. This is certainly the case for the policy rate: we are interested in long-lasting effects of monetary policy and thus use REPO in levels. By contrast, the composition of the central bank liquidity is assumed to have no permanent impact on real GDP, CPI, the exchange rate and commodity prices, and thus enters the model in first differences.

Table 2

SVAR identification restrictions: long-run restrictions matrix F and short-run restrictions matrix S

F	ε_{PCOM}	ε_{GDP}	ε_{ER}	ε_{lr}	ε_{REPO}	ε_{LI}	**S**	ε_{PCOM}	ε_{GDP}	ε_{ER}	ε_{lr}	ε_{REPO}	ε_{LI}
PCOM	NA	0	0	0	0	0	PCOM	NA	NA	NA	NA	NA	NA
GDP	NA	NA	NA	0	0	0	GDP	NA	NA	NA	NA	NA	NA
ER	NA	NA	NA	0	0	0	ER	NA	NA	NA	NA	NA	NA
CPI^{lr} [a]	NA	NA	NA	NA	0	0	CPI^{lr}	NA	NA	NA	NA	NA	NA
REPO	NA	NA	NA	NA	NA	NA	REPO	NA	NA	0	NA	NA	0
LI	NA	NA	NA	NA	NA	NA	LI	NA	NA	NA	NA	NA	NA

[a] *Correct estimation of SVAR requires that CPI is substituted by the cointegration relationship, hence we added "lr" superscript to CPI (see also in footnote 17).*

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4 ESTIMATION RESULTS

Graph 5 reports the results of our benchmark model including the impulse responses of variables to one standard deviation shock for each endogenous variable in the model.[16] The shocks are labelled as follows: shock (1) = commodity prices (ε_{PCOM}); shock (2) = real gross domestic product (ε_{GDP}); shock (3) = exchange rate (ε_{ER}); shock (4) = domestic prices (ε_{lr});[17] shock (5) = policy interest rate (ε_{REPO}); and shock (6) = balance sheet liquidity indicator (ε_{LI}).

Substituting the cointegrating relationship for the CPI changes the interpretation of responses of prices to shocks in other model variables. The "new" price variable represents the response of CPI in line with shocks to cointegrated variables. The IRFs in graph 5 indicate that CPI^{lr} responds to shocks in PCOM, GDP, and ER, whereas in perfect equilibrium it should not respond to these shocks. However, the slightly positive response of CPI^{lr} to a GDP shock is not statistically different from zero; the negative initial response of CPI^{lr} to a commodity price shock is consistent with price stickiness, which gradually tapers off; and the positive response to the ER shock is consistent with exchange rate overshooting, which gradually tapers off.

Importantly, we observe that shocks in policy variables REPO and in particular LI have the hypothesised negative and positive effects on CPI^{lr}, indicating that Central bank policies other than the interest rate can also affect inflation in the desired direction. The direct effect is small and short-lived, but the indirect effect of these policies via the exchange rate is twice as strong. Finally, the small positive response of CPI^{lr} to a rise in policy interest rates 2-4 quarters after the tightening is also consistent with the usual delayed response of inflation to policy rates; note also that CPI^{lr} turns positive when CPI falls.

With few exceptions, the responses of other variables are in line with standard predictions. The repo rate, for example, increases in response to shocks in commodity prices and economic activity. GDP increases marginally in response to shocks in commodity prices (as Albania is itself a commodity exporter), and initially falls but subsequently bounces back in response to exchange rate depreciation, indicating a J-curve effect. However, GDP does not react to changes in the long-run equilibrium.

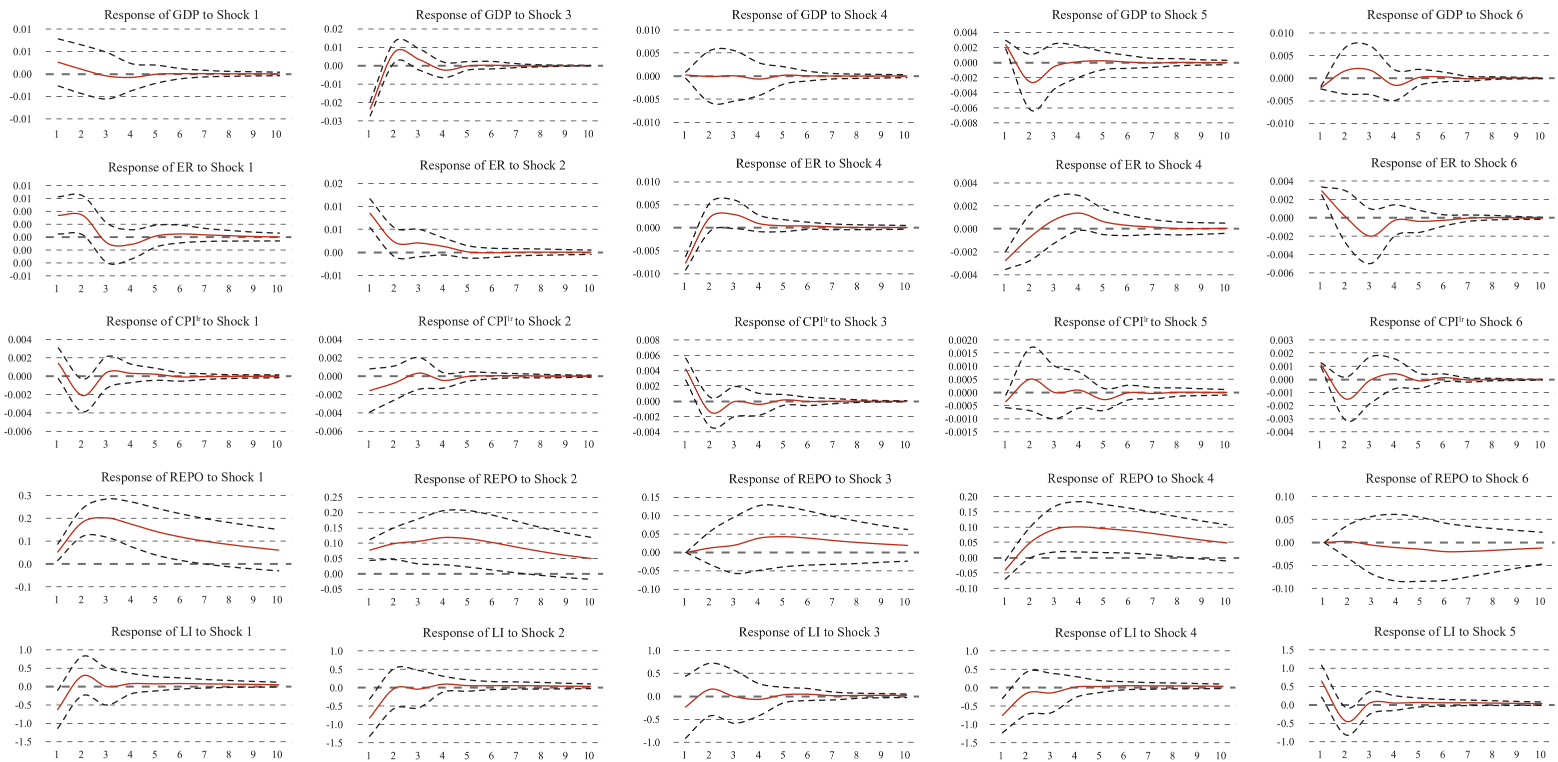
The exchange rate depreciates in response to shocks in commodity prices and GDP (the latter reflecting a large share of imports in consumer demand) and appreciates when domestic prices fall below the long-run equilibrium, or the policy rate increases. However, some impulse responses are counterintuitive, for example, GDP's lack of response to deviations of prices from long-run equilibrium (shock 4), or a slight increase in GDP in response to a policy rate shock.

[16] Oularis, Pagan and Restrepo (2018) show that shocks in the SVAR are the same as in the original SVECM, but estimated elasticities are different. Therefore, we focus on estimated impulse response functions and do not report the coefficients.

[17] We call this shock ε_{lr} (with *lr* standing for the long run) to highlight that it represents the cointegration relationship estimated by the ARDL method of Pesaran, Shin and Smith (2001).

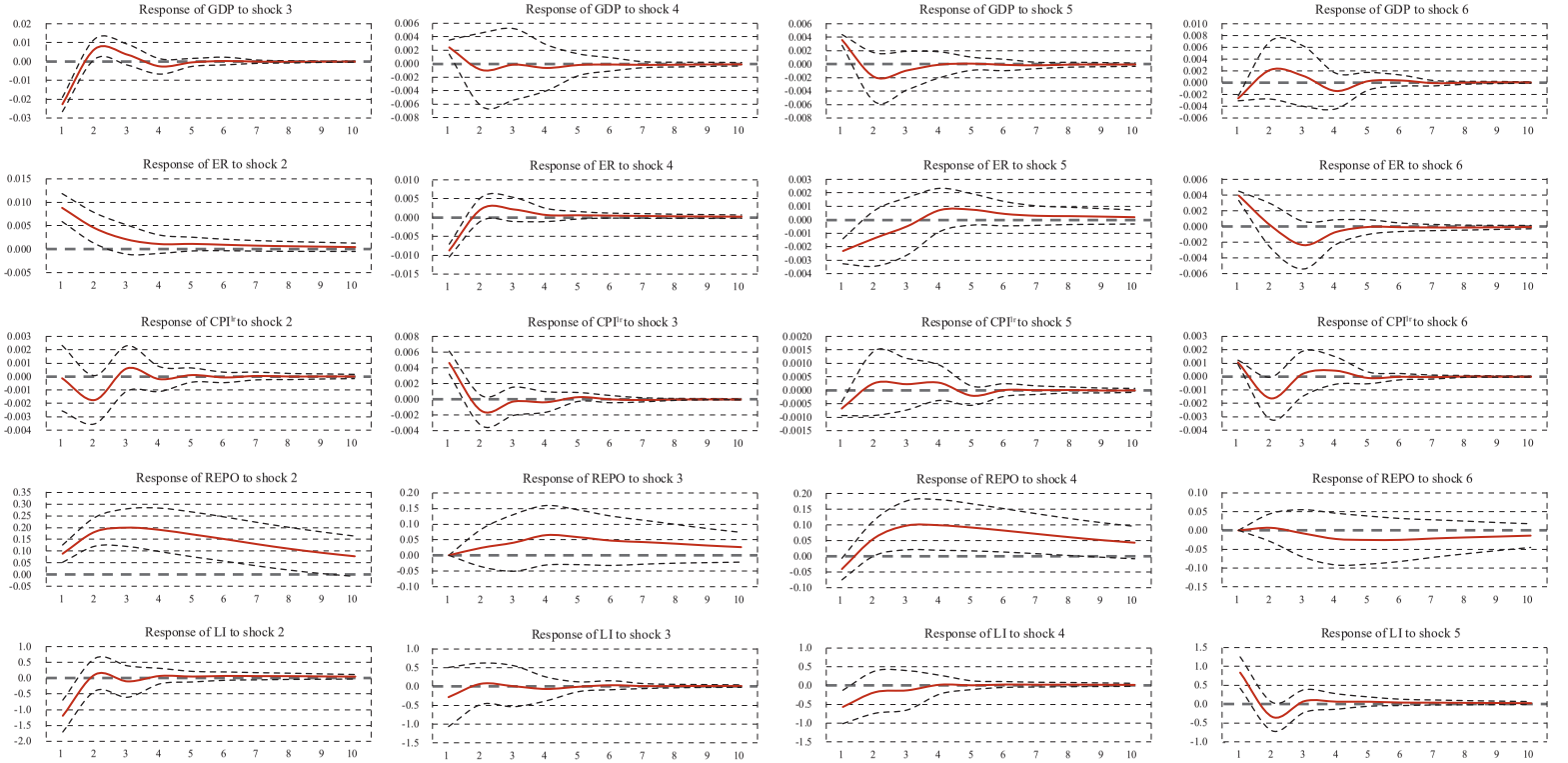
Graph 5

Response of variables to structural VAR innovations (shocks 1 – 6)



GRAPH 6

Response to structural VAR innovation (shocks are defined in the same way as in graph 5)



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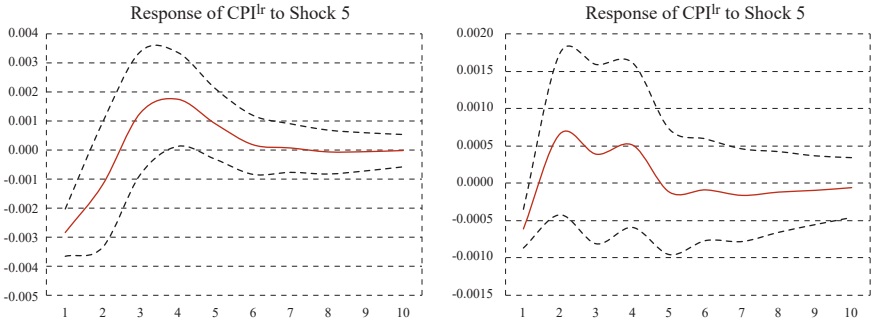
To investigate this further and as a robustness check, we estimate a nested model with foreign prices as exogenous. The results in graph 6 show that the responses of domestic prices to all shocks remain the same as in the original model. The same holds for responses of the policy variables and the exchange rate. The nested model shows the expected short-term increase in GDP when prices jump above long-run equilibrium, but the puzzling response to policy rate remains.[18]

In addition, following Gali (1992) we estimated SVAR using the *level* of cointegrating relationship. The results presented in graphs 7 and 8 show the ER and CPI^{lr} responses to REPO and LI (shocks 5 and 6, respectively). The responses are largely the same as in the original model, suggesting that monetary policy affects inflation both directly and indirectly via the exchange rate.

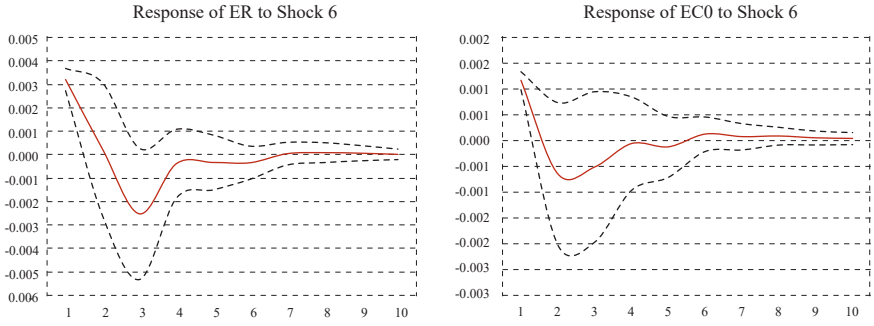
Graph 7

Response of ER to structural VAR innovations shock 5



Graph 8

Response of ER to structural VAR innovations shock 6



In sum, these findings provide support to our hypothesis that BoA policy innovations complement the policy interest rate when it falls close to zero. A cut in policy rates leads to a small increase in domestic prices and somewhat stronger exchange rate depreciation, which has a second-round effect on inflation. An additional

[18] We acknowledge that an alternative estimation approach, such as full information maximum likelihood estimator, could allow for more flexibility and precision in the specification of the correct functional form for the SVAR. However, we leave that extension for further research.

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policy shock that permanently increases the share of base money in the central bank balance sheet leads to a stronger increase in domestic prices and a larger depreciation of the exchange rate, reinforcing the impact of policy rate cuts. The responses to liquidity shocks last for two quarters and suggest the potential effectiveness of this balance sheet tool.

The muted response of M2 to changes in M0 implies that innovations by themselves did not directly affect prices through the traditional monetary transmission mechanism: the estimated effects of prices on the balance sheet structural indicator could not be driven directly by these innovations, and the estimation method ensures that the results are not driven by spurious factors.

5 SUMMARY AND CONCLUSIONS

This paper investigated the impact of changes in the liquidity composition of the BoA's balance sheet on domestic prices, and whether a shift toward permanent rather than temporary base money increases could be used as a monetary policy tool, notably when policy rates are close to zero. We constructed a balance sheet indicator that measures the share of permanent vs. temporary monetary injections in domestic currency, and tested the hypothesis that increasing the non-borrowed components of the central bank balance sheet can support the intended effects of policy rates. We tested the hypothesis by estimating an SVAR model with long-run restrictions that takes advantage of the vector error correction structure embodied in the data-generating process. Our VAR contains GDP, CPI, exchange rate, policy rate, balance sheet liquidity, and commodity prices, which enter the model as exogenous variables. The presence of cointegration in the data-generating process is the main source of identification in SVAR.

Our findings indicate that changing the structure of BoA liabilities in favour of permanent monetary injections enhances the effectiveness of interest rate policy and could give the BoA a better control of inflation. The supportive role of balance sheet policies would be particularly important in periods of financial stress or when the policy rate is close zero. Permanent monetary expansion affects prices through direct and indirect channels, notably the exchange rate. This suggests that persistent trends in the exchange rate, as well as shocks in the exchange rate that are driven by exogenous factors and are not aligned with fundamentals, should be considered in the policy context. Overall, these findings support the BoA policy stance, notably recent policy innovations with respect to the level of international reserves, the use of exchange rate interventions for policy purposes, and the use of differential reserve requirements as part of a de-euroisation strategy.

Disclosure statement
Authors have no conflict of interest to declare.

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APPENDIX

Table A1

Summary statistics

	CPI	M3	ER	GDP	REPO	LI	PCOM
Mean	83.03	906,759.2	131.35	298,645.3	4.30	93.95	118.40
Maximum	103.07	1,582.310	141.75	429,309.3	13.18	106.66	189.51
Minimum	59.79	289,340.6	121.55	143,213.3	0.50	85.39	48.82
Std. dev.	12.52	371,910.3	7.03	69,616.80	2.70	5.08	40.02
Skewness	-0.137	-0.18	-0.01	-0.28	0.40	0.67	0.05
Kurtosis	1.75	1.70	1.35	2.18	3.07	2.46	2.04
Observations	88	88	88	88	88	88	88

Table A2

Augmented Dickey-Fuller test results

		CPI	PCOM	GDP	ER	M3	REPO	LI[a]
Constant	Level	-2.117	-1.822	-2.089	-1.554	-3.786***	-1.937	-2.212
	First difference	-12.31***	-5.97***	-11.38***	-6.69***	-2.887	-5.152***	-3.24**
Constant and trend	Level	-1.833	-2.15	-2.475	-1.523	-1.527	-5.597***	-10.209***
	First difference	-13.06***	-5.94***	-11.61***	-6.68***	-8.475***	-5.074***	-10.159***

****/** indicate significance at 1% and 5%, respectively.*

[a] LI_SA turned out to be break-point stationary, with a structural break identified in 2008:Q3.

Table A3

Johansen cointegration test results

Sample: 2000Q1 2022Q1					
Included observations: 85					
Series: LGDP_SA LCPI_SA LER_SA LPCOM_SA					
Lags interval: 1 to 2					
Selected (0.05 level[a]) number of cointegrating relations by model					
Data trend:	None	None	Linear	Linear	Quadratic
Test type	No intercept	Intercept	Intercept	Intercept	Intercept
	No trend	No trend	No trend	Trend	Trend
Trace	1	1	1	1	1
Max-Eig	1	1	0	1	1

[a] Critical values based on MacKinnon-Haug-Michelis (1999).

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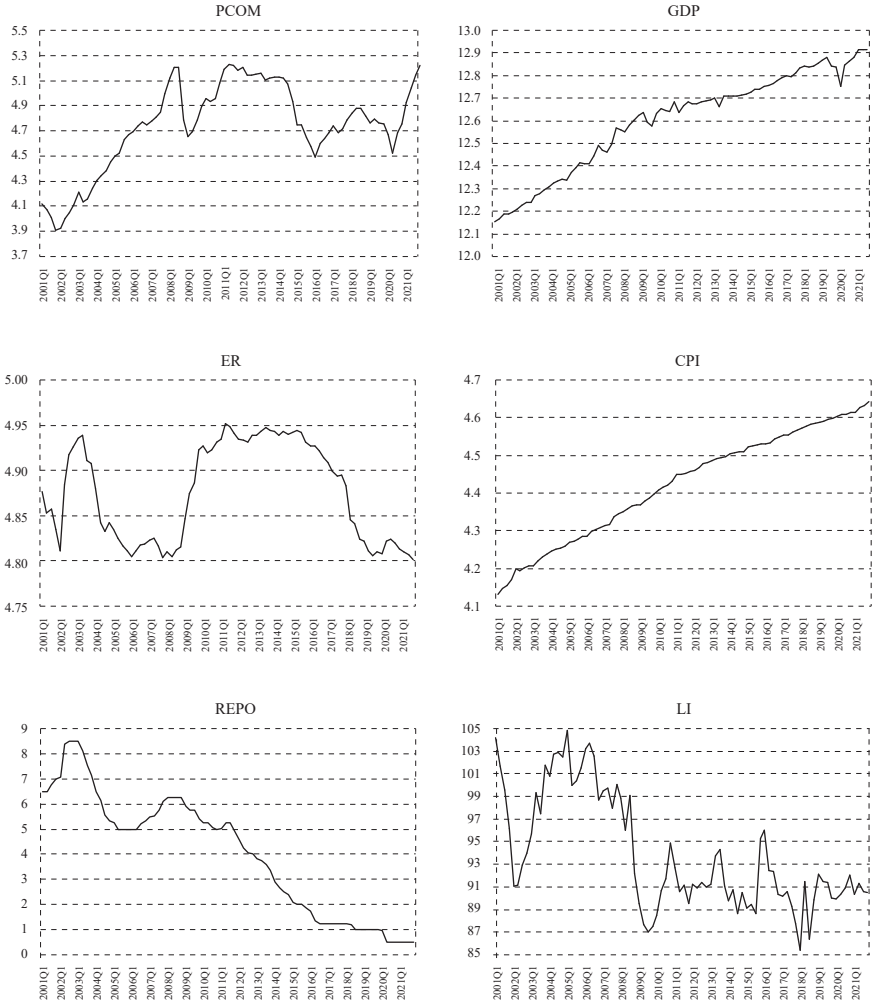
GRAPH A1

Time series of individual variables



Source: Authors' calculations.

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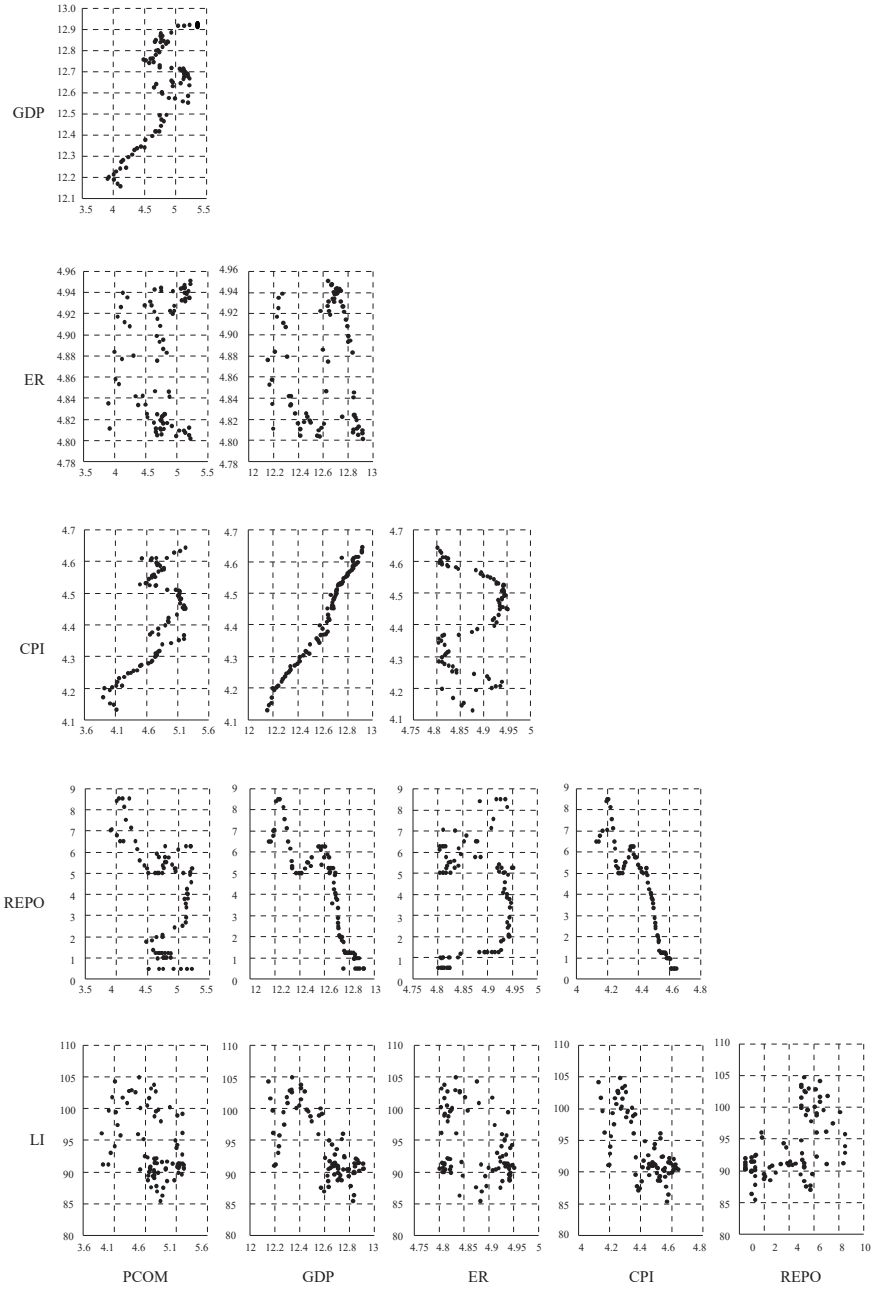
GRAPH A2

Scattered diagrams portraying first degree of autocorrelation and bilateral relationships



Source: Authors' calculations.

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