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Follow the Money: A Holistic Investigation into Economic Agents' Responses to Uncertainty Shocks

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Abstract

This article explores the intricate relationship between uncertainty shocks and economic dynamics in North Macedonia, focusing on the impact of volatility in the MBI10 index on GDP and economic agents' responses. Drawing on a comprehensive dataset spanning from 2009 to 2023, encompassing variables such as interest rates, inflation, loan rates, oil prices and VSTOXX, the study employs an autoregressive distributed lag (ARDL) model to analyse both short-term and long-term relationships. The empirical analysis reveals significant findings regarding the effects of uncertainty shocks on GDP. Heightened volatility in the MBI10 index negatively impacts GDP, signalling adverse effects on investor confidence, consumer spending and overall economic activity. Conversely, positive impacts are observed from interest rates, indicating their role as drivers of economic expansion. Furthermore, the study identifies significant short-term relationships, highlighting the influences of past GDP values, inflation, interest rates, loan rates and oil prices on current GDP dynamics. The error correction method underscores the necessity of aligning with long-term equilibrium, offering critical insights for policymakers and stakeholders. This understanding of how economic agents navigate uncertainty empowers policymakers to develop effective strategies for fostering enduring economic growth and stability.

Keywords: Uncertainty Shocks, GDP Dynamics, Autoregressive Distributed Lag (ARDL) Model, Macroeconomic Variables, North Macedonia

JEL Codes: E32, E44, C22, C58

Introduction

In the intricate world of economics, uncertainty emerges as a powerful force shaping the decisions of individuals, businesses and policymakers alike. When the future is uncertain, it creates a fog of doubt that influences how people spend, invest and plan for the days ahead.

Understanding the macroeconomic effects of uncertainty has been a focal point in both academic research and economic policy discussions. We know that when uncertainty levels rise, economic activity tends to slow down. People become more cautious with their spending, and businesses may hold back on investments until they have a clearer picture of what's to come.

In recent years, the role of uncertainty shocks in influencing economic dynamics has garnered significant attention in economic research. Uncertainty shocks, characterised by sudden and unpredictable changes in market expectations and volatility, have been shown to have profound effects on economic agents' behaviour and overall economic activity. Understanding how economic agents respond to uncertainty shocks and the subsequent implications for key macroeconomic variables, such as Gross Domestic Product (GDP), is crucial for policymakers and researchers alike.

Numerous scholarly studies have investigated the intricate relationships between macroeconomic variables, financial markets and uncertainty across different countries and regions. For instance, (Milani, 2017) conducted an in-

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depth analysis of the United States using a Bayesian Model to explore the interactions between the macro economy and the stock market. Similarly, (Khan et al., 2023) employed an ARDL model to illustrate the pivotal role of economic, monetary and stock market uncertainties in determining long-term money demand in India. (Lakshmanasamy, 2022) found that the volatility in one market can cause volatility in other markets, highlighting the interconnectedness of macroeconomic variables and stock prices in the Indian market. Complementary studies, such as those by (Bonciani & van Roye, 2016; Rossi & Sekhposyan, 2015 & Tripathi & Chaudhary, 2016), further contribute to the foundational understanding and serve as a source of inspiration for our research methodology.

Hence, this study focuses on North Macedonia and aims to investigate the impact of uncertainty shocks on economic agents' responses and GDP. We want to understand not only how uncertainty affects economic activity but also how different players in the economy respond to it. For households, uncertainty might mean saving more and spending less, while businesses may delay hiring or expansion plans until they have more clarity about the future.

Moreover, we recognise that financial markets, including banks and lending institutions, play a crucial role in transmitting and amplifying the effects of uncertainty throughout the economy. When uncertainty levels are high, banks may become more cautious about lending, which can further dampen the economic activity. In doing so, we aim to contribute to a deeper understanding of the complex dynamics between uncertainty, financial markets and economic activity, ultimately empowering decision-makers with the knowledge needed to steer the economy through turbulent waters. We will particularly analyse the responses of economic agents through indicators such as GDP, providing a comprehensive view of how uncertainty ripples through the economy and affects its various components. By examining the interplay between uncertainty and economic agents' responses, we hope to uncover insights that can inform both academic research and real-world policymaking.

Our study draws inspiration from a diverse set of literature, including (Khan et al., 2023; Bonciani & van Roye, 2016; Rossi & Sekhposyan, 2015; Rohilla et al., 2023), synthesising insights from diverse methodologies such as ARDL models, DSGE models and VAR analyses. By adopting an ARDL model, we seek to capture the dynamic interplay between uncertainty shocks and key macroeconomic variables, offering a holistic perspective on how economic agents respond to fluctuations in uncertainty.

Through a combination of quantitative analysis, econometric modelling, and empirical research, this study aims to provide valuable insights into the channels through which uncertainty shocks propagate through the economy, influencing investment, consumption and overall economic performance. By focusing on North Macedonia, which is characterised by unique economic structures and challenges, this research offers a refinement perspective on the impact of uncertainty shocks on the Macedonian economy. Our findings aim to contribute valuable insights to both academia and policy formulation, ultimately enhancing our understanding of the intricate relationship between uncertainty shocks and economic dynamics.

The remainder of this paper is organised as follows: Section 2 analyses the existing empirical papers focused on the impact of uncertainty shocks on economic activity; the data and methodology are discussed in Section 3, Section 4 presents the results and analysis, detailing the main findings of this paper, while concluding remarks and future recommendations are given in the last section.

Literature Review

Recent academic research has delved into the intricate relationship between economic uncertainty and macroeconomic dynamics, exploring various dimensions and their implications for different economies.

(Khan et al., 2023) investigate India's economic landscape, utilising the ARDL model to confirm cointegration and establish a well-specified Money Demand Function (MDF). Their findings underscore the long-term significance of economic, monetary and stock market uncertainties in shaping money demand, emphasising a heightened demand for money as a precautionary measure against potential financial crises. In the context of China's business fluctuations, (Ding et al., 2022) employ Bayesian methods and a Dynamic Stochastic General Equilibrium (DSGE) model. Their study reveals a shifting landscape,

where the major driving force of economic fluctuations transitions from monetary policy to the expectation effect. The research highlights the growing importance of uncertainty, particularly the anticipated component, in shaping China's economic volatility, underscoring the need to distinguish between anticipated and unanticipated elements of financial uncertainty. (Dibiasi & Sarferaz, 2020) cross-country analysis constructs internationally consistent measures of macroeconomic uncertainty for 39 countries. Focusing on the impact of uncertainty shocks under varying degrees of employment protection legislation, the research highlights the role of labour market frictions in shaping the propagation of uncertainty shocks across economies. The findings suggest that the impact of uncertainty shocks is more pronounced in countries with lower employment protection compared to those with stricter regulations. (Bloom et al., 2018) contribute to the understanding of uncertainty shocks on business cycles, utilising a Dynamic Stochastic General Equilibrium (DSGE) model. Distinguishing between macroeconomic and microeconomic uncertainty, the study unveils a nuanced understanding of uncertainty's role as an impulse or amplification mechanism in driving economic fluctuations. The research indicates that recessions are best understood as a combination of negative first-moment and positive second-moment (uncertainty) shocks. (Sinha, 2016) analysis of monetary policy uncertainty employs a New-Keynesian DSGE model to examine its effects on macroeconomic variables and investor expectations. The study sheds light on the dynamic interplay between monetary policy and economic agents, demonstrating the implications of uncertainty on household savings, investment behaviour and asset yields.

Furthermore, (Bonciani & van Roye, 2016) focus on the Euro area, investigating the amplifying role of credit supply frictions in transmitting uncertainty shocks to the real economy. Utilising both empirical and theoretical methods, they employ a Vector Autoregressive (VAR) model and a Dynamic Stochastic General Equilibrium (DSGE) model to underscore the significance of credit supply frictions in intensifying the effects of uncertainty shocks. (Rossi & Sekhposyan, 2015) adopt a novel approach, introducing uncertainty indices based on now cast and forecast error distributions. Their methodology, centred on probability assessment and distinguishing between upside and downside uncertainty, provides insights into the nuanced nature of macroeconomic uncertainty. (Christiano et al., 2014) contribute by examining risk shocks through a dynamic stochastic general equilibrium (DSGE) model. Their study identifies fluctuations in the severity of agency problems associated with financial intermediation as a crucial driver of business cycle fluctuations, emphasising the role of risk in shaping macroeconomic outcomes. Together, these studies enrich our understanding of the intricate links between uncertainty, financial frictions and their broader implications for economic policy and decision-making in different regions and periods. The insights derived from these investigations provide valuable perspectives for policymakers and researchers aiming to navigate the complex landscape of economic uncertainty. Building upon the extensive literature that examines the intricate relationship between economic uncertainty and macroeconomic dynamics, this paper aims to contribute to the existing body of knowledge by focusing on economic agents' responses to uncertainty shocks. However, the focus on North Macedonia, as explored in this study, is novel. This ground-breaking research opens new vistas in the analysis of uncertainty shocks within the Macedonian context, highlighting the detailed responses of economic agents to these shocks. Our findings contribute a critical perspective to the existing body of knowledge, suggesting unique dynamics at play in small and open economies which have been under-explored thus far.

Data and Methodology

An empirical study is based on a data set covering the monthly period from 2009M01 till 2023M09. The uncertainty shocks are presented through the volatility of the MBI10 index. The data for the volatility of the MBI10 index is obtained from the Macedonian stock exchange database. The economic agents' responses are conferred with GDP data, which is gained from the State Statistical Office together with data for inflation. The reference (CB bills) interest rates and loan rates are obtained from the Central Bank database, and data for oil prices and VSTOXX, from West Texas Intermediate crude oil prices per barrel and the yahoo finance database, respectively. VSTOXX represents the EURO STOXX 50 real-time options prices and are designed to reflect the market expectations of near-term up to long-term volatility by measuring the square root of the implied variance across all options of a given time. All data is

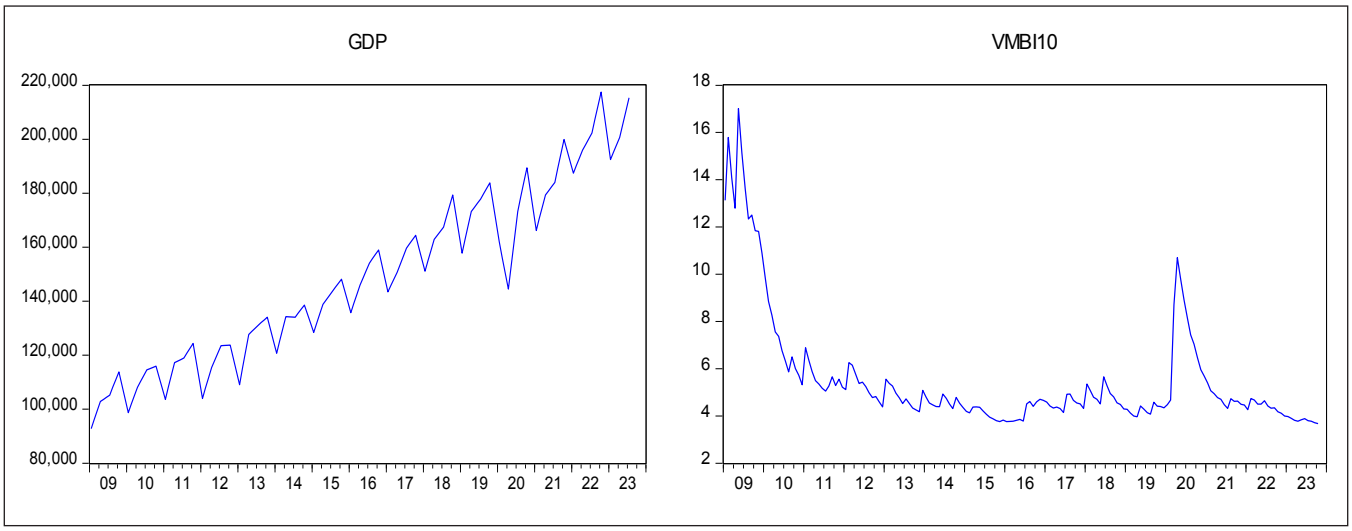
monthly except GDP, which is quarterly, and with linear interpolation the values for the months are obtained. Before testing the regression model and assessing the influence of uncertainty shocks, Table 1 presents basic descriptive statistics. Please note that the values in the descriptive statistics table reflect the statistics of the raw data. However, in subsequent analyses, some variables will be used after taking their natural logarithm.

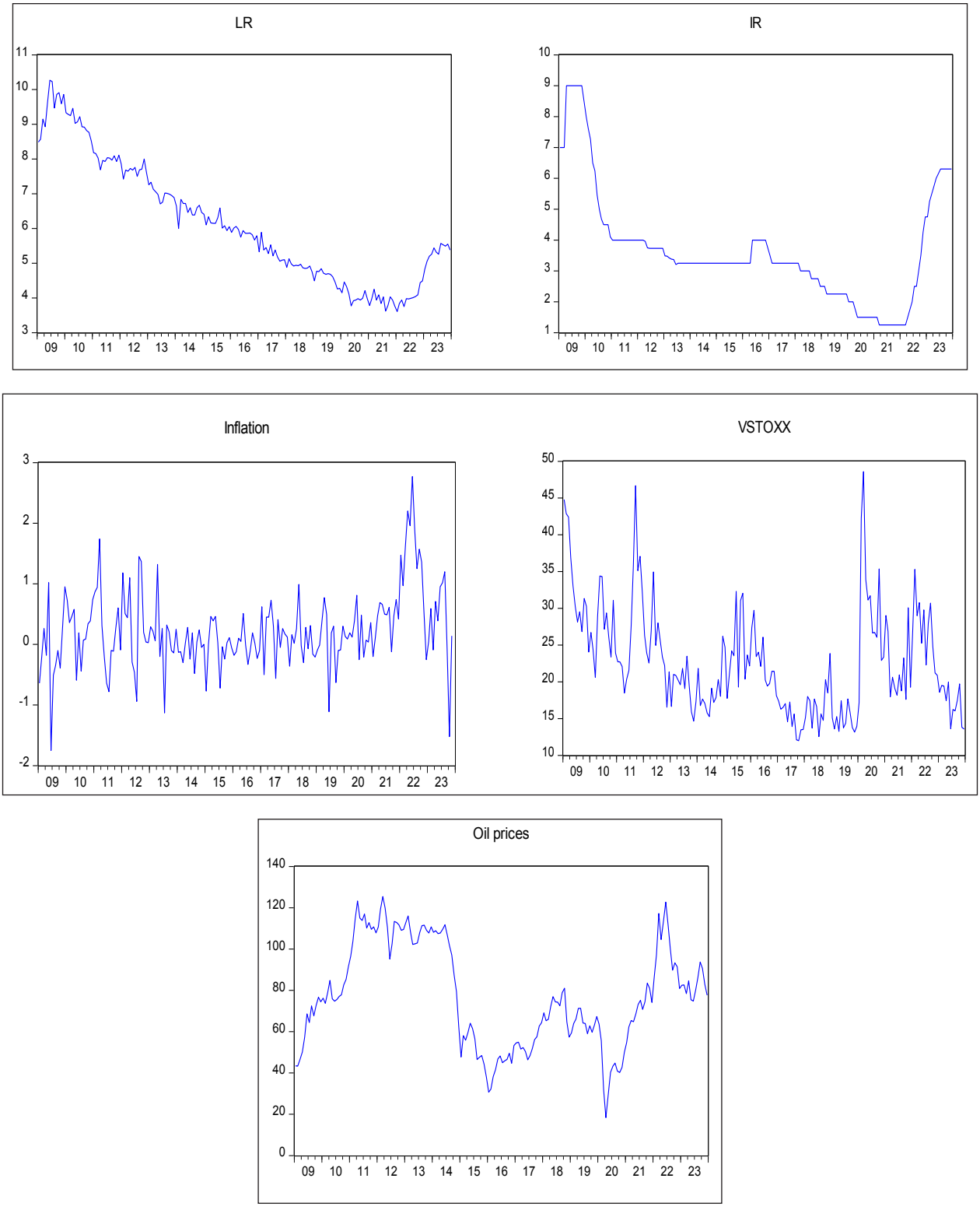
Table 1: Descriptive Statistics

Variables	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
VMBI10	5.57	2.49	3.76	17.01
GDP	148,206.65	31,359.38	92,764.00	217,461.00
Inflation	0.23	0.62	(1.75)	2.77
IR	3.61	1.82	1.25	9.00
LR	6.15	1.79	3.61	10.27
Oil prices	76.59	25.51	18.38	125.45
VSTOXX	23.01	7.31	11.99	48.59

Source: Authors calculations.

The descriptive statistics indicate VMBI10 has a mean value of 5.57 with a moderate standard deviation of 2.49. The values range between 3.76 and 17.01, indicating some variability in the data with a wide range. The average GDP is 148,206.65 billion dinars, with significant variability ranging from 92,764.00 billion dinars to 217,461.00 billion dinars. Its standard deviation of 31,359.38 billion dinars underscores fluctuations in economic output. Inflation, with a mean of 0.23% and a standard deviation of 0.63%, remains relatively low but exhibits notable variability. The data shows inflation rates ranging from -1.75% (deflation) to 2.77%. The reference interest rates (IR) and loan rates demonstrate moderate means of 3.61% and 6.15%, respectively, alongside standard deviations suggesting stability in lending environments. The volatility of oil prices, ranging from $18.38 to $125.45 with a mean of $76.86, and a standard deviation of $25.51. VSTOXX has a mean of 23.01 with a standard deviation of 7.31. The values range between 11.99 and 48.59. Furthermore, we will show the time series of the variables in graphical form.





Source: Authors calculations.

Graph 1: Time Series of the Variables

Based on the comprehensive literature review, several theoretical models are suitable for analysing these relationships between macroeconomic variables, financial markets and uncertainty. The Bayesian Model integrates prior information with new data using the formula $P(\theta \mid y) = [P(y \mid \theta)P(\theta)] / P(y)$, capturing interactions within a New Keynesian framework (DSGE model), Ding et al. (2022). The ARDL Model examines cointegration and short-and long-term dynamics among variables with $yt = \alpha + \Sigma(\beta iy\{t-i\}, i=1 \text{ to } p) + \Sigma(\gamma jx\{t-j\}, j=0 \text{ to } q) + \varepsilon t$, ideal for studying economic uncertainties over time. The VAR Model analyses interdependencies among multiple time series variables using $Yt = c + \Sigma(Ai\ Y\{t-i\}, i=1 \text{ to } p) + \varepsilon t$, revealing how shocks propagate through the system. This theoretical foundation guides the selection of the most appropriate model for our data set, leading to its implementation and testing in the following section.

Results and Analysis

The first step of the time series analysis is examining the stationarity of the variables. According to (Gujarati, 2003) a series can be considered stationary if its mean and variance are constant over time. In order to determine the integrative characteristics of the time series, the Augmented Dickey–Fuller (ADF) and the Phillips–Perron (PP) unit root tests, which were developed by (Dickey & Fuller, 1979; Phillips & Perron, 1988), respectively, are used in this study. The unit root test results are shown in Table 2. Note that the null hypothesis for the ADF and the PP tests is that the variable has a unit root (non-stationary) while the alternative hypothesis suggests stationarity. Combining two different unit root tests enables us to examine both the null hypotheses of the non-stationary. According to the test results, some of the variables are stationary at level, while some others become stationary after the first difference.

Table 2: Augmented Dickey–Fuller (ADF) Unit Root Test

	Variables	*VMBI10*	*GDP*	*Inflation*	*IR*	*LR*	*Oil Prices*	*VSTOXX*
In level	t-statistics	-2.82059	0.116855	-8.29832	-5.17128	-1.31968	-2.30777	-3.88169
	Test critical values 10% level	-2.57548	-2.59556	-2.57543	-2.57553	-2.57543	-2.57548	-2.57543
First difference	t-statistics		-16.1649			-17.58438	-10.0243	
	Test critical values 10% level		-2.59556			-2.57543	-2.57548	
	Stationarity	**I (0)**	**I (1)**	**I (0)**	**I (0)**	**I (1)**	**I (1)**	**I (0)**

Source: Authors calculations.

Table 3: Phillips–Perron (PP) Unit Root Test

	Variables	*VMBI10*	*GDP*	*Inflation*	*IR*	*LR*	*Oil prices*	*VSTOXX*
In level	t-statistics	-2.82193	-1.33512	-8.60601	-1.79483	-1.27962	-2.46942	-4.70481
	Test critical values 10% level	-2.57548	-2.59402	-2.57543	-2.57538	-2.57538	-2.57538	-2.57538
First difference	t-statistics		-24.3457		-10.3165	-17.5622	-9.81965	
	Test critical values 10% level		-2.59452		-2.57543	-2.57543	-2.57543	
	Stationarity	**I (0)**	**I (1)**	**I (0)**	**I (1)**	**I (1)**	**I (1)**	**I (0)**

Source: Authors calculations.

According to suggestions from the literature review and our financial system as well as time series of the data, the study employs an autoregressive distributed lag (ARDL) model similar to (Khan et al., 2023) to estimate both the short-run and long-run relationships between the GDP and volatility of the stock market. (Peseran & Shin, 1999) first proposed ARDL method, which has indeed gained wide application in empirical research. Furthermore, the required autoregressive distributed lag model has the following form:

$$ln(GDP) = a_1 ln(VMBI10) + a_2(L)CBBIR + a_3(L)INF + a_4(L)LR + a_5(L)\ln(OilP) + a_6(L)\ln(Vtsoxx) + \mu_t$$

Where μ_t is the error term that contains the remaining variables affecting the dependent variable, and they are not included in the independent variables, and are time delays defined as:

$$a_1(L) = a_{11}L + \cdots + a_{1p}L^p,$$

$$a_1(L) = 1 + a_{j1}L + \cdots + a_{jp}L^p, \qquad j \geq 2,$$

Firstly, to identify the existence of a co-integration relationship, ARDL model is based on the Wald-test (F-statistic); the critical values of the F-test are given by (Peseran et al., 2001). The lower critical value assumes that all variables are integrated of order zero I (0), so there is no cointegration relationship between the variables involved. Whereas the upper critical value assumes that all variables are integrated of the first order I (1), so that there is co-integration between the variables. Hence, when the resulting F-test value is greater than the upper critical value, the null hypothesis is rejected (H0), and the variables in the model are cointegrated. Conversely, if the resulting F-test value is below the lower critical value, then the null hypothesis cannot be rejected (H0), and when the value is between the lower and upper critical values, the conclusion is unsupported; the existence of a cointegration (long-term) relationship between the variables cannot be determined with certainty.

Namely, if we determine that there is a cointegration between the variables, this model will further allow us to estimate coefficients related to this long-term equilibrium, as well as estimate the short-term coefficients and the error correction term, the rate at which variables adjust to long-run equilibrium.

Hence, to determine the number of time lags for each of the variables, the Akaike information criterion is used. Thus, in this regression equation, the Akaike information criterion suggests the following model ARDL (4, 0, 4, 4, 4, 4 and 0).

The performed test yielded a coefficient of the F-statistic (4.02), which, when compared with the defined limits, indicates cointegration between the dependent and independent variables at a significance level of 5% (see Table 4).

Table 4: Cointegration Test (F-Bounds Test)

Test Statistics	*Value*	*Significance Level*	*I(0)*	*I(1)*
F-statistics	4.02	10 %	2.53	3.59
k	6	5 %	2.87	4.00
		1 %	3.6	4.9

Source: Authors calculations.

Furthermore, we proceed to estimate the long-term test with a constant and trend (Long Run Form, Case 5: Unrestricted Constant and Unrestricted Trend), which provides us with the long-term coefficients of each variable. These coefficients are shown in the following Table 5.

Table 5: Estimation of the Long-Term Test with Constant and Trend

Dependent Variable LGDP	*Independent Variable*
LVMBI10	-0.062**
IR	0.025**
Inflation	0.004
LR	-0.045
LOIL_PRICES	0.021
LVSTOXX	0.026
* , * * and *** mean rejection of the null hypothesis that the coefficient is not statistically different from zero at the 10, 5 and 1% level of significance.	

Source: Authors calculations.

From the estimation, the long-term coefficient only before the volatility of the MBI10 index and reference interest rate is statistically significant. The negative sign before the coefficient of MBI10 suggests that high volatility in the MBI10 index exerts a negative effect on GDP through multiple channels. First, heightened uncertainty stemming from increased volatility undermines investor and business confidence, leading to a cautious approach in decision-making processes. Second, uncertainty

surrounding market conditions discourages businesses from making long-term investment decisions, resulting in delayed investment projects and reduced capital formation. Furthermore, consumer confidence and spending patterns are adversely affected by heightened volatility, as consumers become more hesitant to engage in discretionary spending and big-ticket purchases, thereby dampening overall economic activity. In addition, financial market instability triggered by high volatility can disrupt efficient capital allocation, exacerbate risk aversion among investors and undermine market functioning, further impeding economic growth. The complexity of navigating uncertain market conditions complicates business planning and risk management strategies, making it challenging for businesses to forecast future revenues, costs and profitability accurately. Overall, addressing the negative impact of volatility in the MBI10 index on GDP necessitates policies aimed at enhancing stability, reducing uncertainty and fostering investor confidence to support sustainable economic growth. The positive effect of interest rates on GDP indicates that when interest rates are rising, domestic financial assets become more attractive to foreign investors seeking higher returns. This can lead to an inflow of capital from abroad, which can strengthen the domestic currency and provide additional resources for investment and economic development. Increased capital inflows can also help finance large-scale projects, infrastructure development and technological innovation, which are essential drivers of long-term economic growth. The rise of interest rates signals the commitment to price stability and sound monetary policy. By taking pre-emptive action to address inflationary pressures, the central bank demonstrates credibility and commitment to maintaining a stable macroeconomic environment. This can enhance investor confidence, reduce uncertainty and provide a favourable climate for investment, entrepreneurship and economic expansion. In addition, higher interest rates incentivise saving by offering higher returns on savings deposits and other interest-bearing assets. Increased saving provides a pool of funds that can be channelled into productive investment activities, such as financing new businesses, upgrading infrastructure and expanding productive capacity. Higher levels of investment contribute to productivity growth, job creation and overall economic prosperity over the long term. The influence of other variables, according to this analysis, is not statistically significant in the long term. Furthermore, through this model, we will examine the short-term relationships between the dependent and independent variables, as well as the dynamic adjustment coefficient, which indicates the speed at which short-term deviations are corrected to the long-term balance. The obtained results are presented in Table 6.

Table 6: Estimation of Short-Term Relationships and Dynamic Adjustment Coefficient

Dependent Variable LGDP	*Independent Variable*
ΔGDP_{-1}	0.599***
ΔGDP_{-2}	0.218***
ΔGDP_{-3}	-0.269***
ΔIR_{-3}	0.014*
ΔInflation	-0.006**
$\Delta Inflation_{-1}$	-0.006*
$\Delta Inflation_{-2}$	-0.007**
$\Delta Inflation_{-3}$	-0.008***
ΔLR_{-3}	0.013*
ΔLOIL_PRICES	0.057***
$\Delta LOIL\_PRICES_{-3}$	0.028**
ECT_{-1}	-0.268***
R^2	66.60%
* , * * and *** mean rejection of the null hypothesis that the coefficient is not statistically different from zero at the 10, 5 and 1% level of significance.	

Source: Authors calculations.

The error correction method results reveal several significant influences on GDP dynamics in the short term. Notably, past values of GDP with one, two and three-period lags; inflation with and without lags (1, 2, 3 periods); and interest rates with three-period lags exhibit significant effects on current GDP. Additionally, loan rates with a lag of three periods, oil prices without lags and oil prices, including those with three-period lags, emerge as influential factors affecting GDP. Importantly, the impacts of interest rates, loan rates, lagged values of GDP and oil prices on GDP are positive, indicating that changes in these variables contribute positively to GDP growth. Higher interest and lending rates may reflect increased economic activity and investment, aligning with the long-term ratio. Additionally, rising oil prices could suggest economic growth and increased consumer

demand, but the impact is ambiguous and requires careful consideration.

However, the negative impacts of inflation, both with and without lags, as well as GDP with three lags, suggest that high inflation rates and GDP values with three-period lags negatively affect current GDP, highlighting challenges in sustaining economic growth amidst inflationary pressures, as well as indicating the existence of cycles in the economy.

Understanding these influences is crucial for policymakers and stakeholders in devising effective strategies to foster sustainable economic growth and stability. The short-run estimation results imply that the error correction term is statistically significant with a negative coefficient, as it should be. The dynamic adjustment coefficient (the error term) has the expected negative sign at the 1% significance level.

Conclusion

The analysis presented in this study sheds light on the complex interplay between uncertainty shocks and economic dynamics in North Macedonia, offering valuable insights into the factors influencing GDP and economic agents' responses to uncertainty. Through a comprehensive examination of key macroeconomic variables, including the volatility of the MBI10 index, interest rates, inflation, loan rates, oil prices and VSTOXX, we have uncovered significant relationships that shape short-term and long-term economic outcomes.

Our findings indicate that heightened volatility in the MBI10 index exerts a negative influence on GDP, reflecting the adverse effects of uncertainty on investor and business confidence, consumer spending and overall economic activity. The negative impact of uncertainty underscores the importance of stability and clarity in the market environment for fostering sustainable economic growth. Policymakers should prioritise measures aimed at reducing uncertainty and enhancing investor confidence to mitigate the detrimental effects of volatility on GDP dynamics.

Conversely, the positive impact of interest rates, loan rates and lagged values of GDP and oil prices on GDP highlights the role of these variables as drivers of economic expansion and prosperity. Higher interest rates signal a commitment to price stability and sound monetary policy, attracting foreign investment and promoting domestic saving and investment. Similarly, rising oil prices stimulate economic activity and consumer demand, driving growth across various sectors of the economy, which is ambiguous and requires careful consideration.

However, our analysis also reveals the negative effects of inflation and GDP values with three-period lags on current GDP, underscoring the challenges posed by inflationary pressures and historical economic performance. Addressing these challenges requires proactive measures to maintain price stability, promote fiscal discipline and enhance economic resilience in the face of limitations of the study.

In conclusion, our study contributes to a deeper understanding of the dynamics between uncertainty shocks, macroeconomic variables and GDP in North Macedonia. By elucidating the mechanisms through which economic agents respond to uncertainty, policymakers can formulate effective strategies to promote sustainable economic growth and stability. Moving forward, further research is needed to explore additional factors influencing economic dynamics and to refine policy interventions aimed at mitigating the adverse effects of uncertainty on GDP and overall economic performance.

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