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BEHAVIORAL IMPULSES AND THE TRANSMISSION CHANNELS OF THEIR IMPACT ON MACROECONOMIC STABILITY

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ABSTRACT. This study investigates the impact of behavioral impulses, specifically corruption perception and government effectiveness, on macroeconomic stability through fiscal transmission channels. A Vector Autoregression (VAR) model was used to analyze the impulse responses of key macroeconomic indicators, including tax revenues, state budget expenditures, and GDP per capita, to shocks in corruption perception and governance quality. The findings reveal that improvements in corruption perception initially boost tax revenues and economic growth but have diminishing effects over time, emphasizing the need for sustained policy enforcement. In contrast, government effectiveness has a delayed but more persistent impact on fiscal stability. The study challenges the greasing-the-wheels hypothesis, demonstrating that corruption weakens rather than facilitates economic efficiency. The study contributes to the literature on behavioral economics by demonstrating that public trust, shaped by corruption control and effective governance, plays a more pivotal role in maintaining macroeconomic stability than the previously acknowledged indicators of individual well-being.

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Introduction

The traditional methods employed by governments to assess and predict macroeconomic growth often fall short in adequately accounting for numerous parameters that are inherently weakly formalized. These parameters are influenced by the emotional, volitional, and cognitive factors that drive the behavior of economic agents. Traditional economic models generally operate under the assumption of rational behavior and efficient markets (Friedman, 1953). However, empirical evidence suggests that psychological factors and behavioral impulses significantly shape economic outcomes (Kahneman & Tversky, 1979; Shiller, 2000).

Different types of shocks are used as a background to differentiate channels of the transmission mechanism. However, there is no unanimous agreement in the literature regarding the number and exact functioning of these channels (Shahnazarian & Bjellerup, 2015). While there is some variation in categorizing monetary policy transmission mechanism channels, interest rate, asset price, balance sheet, bank capital, exchange rate, and uncertainty channels are commonly highlighted as the main mechanisms through which financial sector disturbances (shocks) propagate to the broader economy (Mishkin, 1995; Choi et al., 2024). The effectiveness and reliability of each transmission channel can vary significantly across countries, influenced by factors such as the level of financial development, institutional frameworks, and economic structure (Choi et al., 2024; Kuzior et al., 2024).

Fiscal shocks have been extensively studied because of their impact on macroeconomic stability (Ramey, 2016). Specifically, changes in government spending and taxation can influence macroeconomic conditions through various transmission channels, including the direct demand channel, the interest rate channel, the wealth effect, and the expectations channel, among others. These channels affect aggregate demand, interest rates, and private sector behavior, thereby transmitting fiscal shocks to the broader economy. The anticipated effects of fiscal policy on macroeconomic variables are complex and multifaceted. However, the effectiveness and reliability of these fiscal policy transmission channels also vary significantly based on several factors. The size of the government plays a crucial role; larger governments can exert a more substantial influence on aggregate demand through fiscal policy (Romer & Romer, 2010; Auerbach & Gorodnichenko, 2017). Economic openness also affects fiscal policy transmission, with more open economies experiencing greater leakage through trade (Lane & Milesi-Ferretti, 2001; Cerdeiro & Komaromi, 2021). Additionally, the level of financial development determines the efficiency of credit markets in transmitting fiscal policy changes, with well-developed financial systems facilitating better resource allocation and amplifying fiscal multipliers (Banerjee & Zampolli, 2019; Beck et al., 2000).

Although some prior studies examine the connectedness among behavioral indicators, such as uncertainty and sentiment shocks and macroeconomic and financial market fluctuations (Kobiyh et al., 2023; Zhang & Hamori, 2021; Nowzohour & Stracca, 2020; Popp & Zhang, 2016), the direct effects of behavioral impulses on macroeconomic stability and the mechanisms through which these impulses are transmitted, remain underexplored.

The Ukrainian economy is particularly vulnerable to societal attitudes and expectations, which can result in various "contagion effects" (Akerlof & Shiller, 2009). A notable example is the erosion of trust in the financial sector (both in the National Bank of Ukraine and its financial institutions), which has historically triggered depositor panic and bank runs, as seen in Ukraine in 2004, 2008, and 2014, leading many to transfer their savings to the shadow economy. Additionally, the "Credit Maidan" protests of 2014-2015 underscored widespread dissatisfaction with the financial system. Such actions drain the official financial system and pose a direct threat to the country's financial security and macroeconomic stability. Furthermore, the decline in trust in public authorities, combined with their opaque communication, exacerbates this instability. When citizens believe that government actions lack transparency and accountability, it fuels widespread tax avoidance and evasion. This behavior not only undermines the state's fiscal capacity but also intensifies social tension (Feld & Frey, 2007; Vasylieva et al., 2023), as observed in Ukraine during the Revolution of Dignity (February 2014), Euromaidan (November 2013), and the Orange Revolution (22 November 2004 – 23 January 2005), where public trust has declined.

This paper aims to contribute to the identification and a deeper understanding of the role of behavioral impulses and their transmission channels, through which the transfer of behavioral impulses to macroeconomic stability occurs. To achieve this, the study employs a Vector Autoregression (VAR) model, which has been previously utilized in analyzing the transmission mechanisms of monetary and fiscal policy shocks (Ramey, 2016). Different behavioral indicators, based on both qualitative and quantitative data, were tested as proxies for behavioral impulses that play a significant role in macroeconomic stability through various channels, particularly in the context of fiscal rules.

The remaining part of the paper proceeds as follows. The next section will provide an overview of the literature on fiscal policy shocks and their impact on macroeconomic development and growth. This will be followed by the presentation of the theoretical framework that will be tested in this study. The third section will cover the data collection and empirical strategy employed in this study. The fourth section presents the empirical results of each research stage, followed by a discussion and conclusion section.

1. Literature review

The concepts of shocks and impulses have been studied extensively since the early 20th century, although the terms are often used interchangeably and without precise definitions. Economic literature substantially explores the shocks that governments can independently create by adjusting monetary and/or fiscal policy instruments. Researchers often discuss these shocks as a specific form of impulse that can influence, and in some cases, disrupt or exacerbate the mechanisms of economic transmission. It is crucial to differentiate between shocks and impulses: while both can alter economic dynamics, they are not identical. A shock implies a specific reaction to an impulse that may occur under particular conditions. With respect to the primary initiators of change (impulses), one can distinguish between those induced by government interventions and those caused by the behavioral reactions, perceptions, and attitudes of economic agents.

Government interventions can include discretionary changes in tax rates, governmental spending, unexpected shifts in inflation targets, unforeseen alterations in the money supply, or other instruments of economic regulation, as extensively discussed in the literature (Christiano & Eichenbaum, 1992; Mishkin, 1995; Popp & Zhang, 2016; Choi et al., 2024, among others). In contrast, behavioral impulses are not planned interventions but rather arise from various factors that shape the behavior and decision-making of individuals, businesses, and institutions within an economy. These behavioral impulses reflect the responses of economic agents to their perceptions of the economic environment and their expectations about the future. This conceptualization aligns with the idea that behavioral impulses stem from the perceptions and expectations of economic agents, which can significantly influence economic dynamics (Shiller, 2017).

1.1. Fiscal policy shocks and transmission mechanisms

The majority of the literature on fiscal policy shocks discusses the impact of expansionary or contractionary changes in the fiscal policy stance on aggregate demand and economic growth. A large and growing body of literature has investigated this relationship in various countries and historical periods (Romer & Romer, 2010; Auerbach & Gorodnichenko, 2012; Ilzetzki et al., 2013; Jordà & Taylor, 2016), including times of economic crises, growth booms, technological advancements, taking into different economic contexts, and shedding light on the transmission mechanisms through which fiscal policy impacts the broader economy.

Impulses generated by fiscal policy tools impact economic growth and inflation volatility through various transmission channels. The literature clearly shows the direct effects, such as increased government purchases and changes in disposable income (particularly tax cuts or increases in transfer payments), play a significant role in influencing aggregate demand and growth through higher consumption (Mountford & Uhlig, 2009). Auerbach and Gorodnichenko (2012) demonstrated that government spending stimulates additional rounds of economic activity, thereby creating a multiplier effect. Moreover, the multiplier effect is particularly strong when there is slack in the economy and the nominal interest rate is close to zero (Auerbach & Gorodnichenko, 2012; Christiano et al., 2011). The effectiveness of fiscal stimulus and the magnitude of the multiplier hinge on the responsiveness of monetary policy and shifts in interest rates. It has been demonstrated that fiscal expansion has a greater impact when monetary policy does not offset the rise in inflation expectations (Woodford, 2011).

Several studies have begun to examine the expectations and confidence channels of the transmission mechanisms through which fiscal policy shocks can impact aggregate demand and economic growth (Bachmann & Sims, 2012; Romer & Romer, 2010). In a comprehensive study of the role of behavioral link in the transmission channel, Bachmann & Sims (2012) found that consumer and business confidence explains almost all of the output stimulus during uncertain economic times, as fiscal policy can provide a signal of future economic stability, encouraging higher spending and investment. In the same vein, Romer C. & Romer D. (2010) found empirical evidence supporting the positive impact of fiscal policy announcements and actions on economic agents' expectations about future economic conditions, through increasing spending in anticipation of future income growth. However, actual tax cuts have a stronger immediate impact on economic output than announcements, such as presidential speeches and Congressional reports, about future tax changes.

The impact of fiscal shocks can vary significantly across countries. A recent study demonstrated that developing countries, including emerging market economies and low-income countries, often experience larger impacts from fiscal shocks compared to advanced economies (Cevik & Miryugin, 2024). The effectiveness and impact of fiscal policy shocks – whether expansionary or contractionary – are highly dependent on the state of the economy at the time the shock occurs. In economic booms, fiscal stimulus tends to have a smaller effect because the economy is operating near its potential (Ilzetzki et al., 2013) and full employment (Auerbach & Gorodnichenko, 2012) and there is limited room to stimulate further demand. During periods of recession or slack, expansionary fiscal policy is more effective due to increased fiscal multipliers, as there is greater idle capacity and unemployed labor that can be mobilized to meet increased demand (Auerbach & Gorodnichenko, 2012). During periods of slack, expansionary policies can stimulate demand without raising interest rates or inflation, leading to higher multipliers and a more significant impact on output (Christiano et al., 2011; Cevik & Miryugin, 2024).

1.2. Theoretical framework

In contrast to the impulses induced by governmental fiscal policy interventions, behavioral impulses influence the economic behavior of agents, encompassing decisions related to consumption, investment, tax compliance, and indebtedness, among others. These behavioral impulses can have significant impacts on fiscal stability and economic growth, often in ways that differ from traditional fiscal policy interventions.

Much of the literature pays particular attention to the role of behavioral economics in enhancing tax compliance. It highlights how improving tax compliance through behavioral mechanisms can lead to an increase in tax revenues without necessarily increasing tax rates (Castro & Scartascini, 2013; Kleven et al., 2011). Behavioral impulses can create fiscal policy shocks by influencing individuals' willingness to pay taxes, thereby affecting government revenues and, by extension, fiscal stability (*Figure 1*).

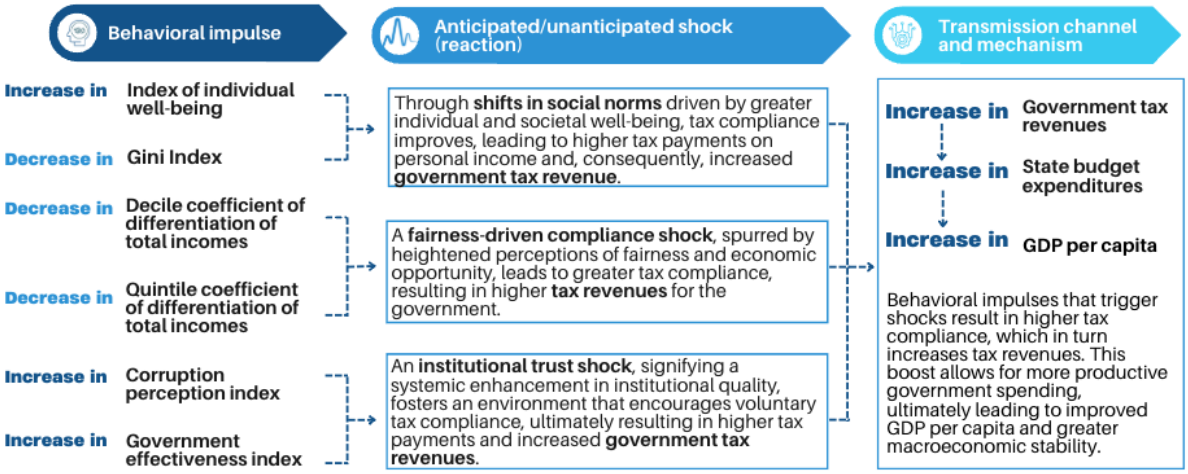

Figure 1. Transmission channels of behavioral impulses shock effects on macroeconomic stability through fiscal stability
Source: *author's own elaboration*

Personal and social well-being, which can be measured by the perception of individual well-being and the Gini index, captures levels of personal satisfaction and income inequality. These factors influence resentment and tax compliance, as paying taxes is seen as contributing to the common good and maintaining public services that enhance well-being, leading to shifts in social norms (Cahyonowati et al., 2023). Perceptions of fairness and anxiety about the wealth gap, reflected in indicators such as the decile and quintile coefficients of differentiation of total incomes, influence the motivation to pay taxes. When income distribution is more equal, people are more likely to perceive the tax system as fair, which in turn increases their willingness to comply. Lower values of these coefficients indicate a more equal distribution of income, leading to higher voluntary compliance rates, reduced attempts at tax evasion, and a greater overall acceptance of tax obligations (Berlingieri et al., 2023). The Corruption Perceptions Index and the Government Effectiveness Index reflect the level of institutional integrity and performance, which are essential for fostering public trust and influencing tax compliance and revenue shortfalls. As public perception of government integrity and effectiveness improves, economic agents are more likely to believe that their tax contributions are being utilized effectively and fairly (Rothstein, 2013).

The aforementioned behavioral impulses lead to higher tax compliance, which directly results in increased tax collection and thereby expands the fiscal capacity of governments. This effect is well-documented in multiple studies, which show that when compliance improves, government revenues benefit significantly (Appiah, 2024; Persian et al., 2023). With more resources available, governments can expand their expenditures on public goods and services, as well as investments in infrastructure, technology development, and education, thereby further stimulating economic activities. This, in turn, stimulates aggregate demand through increased employment, consumption, and investment. The resultant increase in aggregate demand can propel GDP growth and enhance macroeconomic stability.

2. Methodological approach

2.1. Data

Different behavioral indicators, based on both qualitative and quantitative data, were tested as proxies for behavioral impulses that play a significant role in macroeconomic stability through various channels, particularly in the context of fiscal rules. Due to the complex nature of behavioral impulses and macroeconomic stability, multiple data sources were used to generate the initial dataset. The variables employed for the models fall into two categories. The first set of variables includes the behavioral variables proposed in this research, which are supposed to represent the various behavioral impulses that cause shocks to macroeconomic stability. The second category comprises variables that are frequently employed in macroeconomic models, with the majority used in making monetary policy decisions and analyzing financial stability.

To measure the perception of individual well-being (IB), the real wage index relative to the corresponding period of the previous year (%) was used. Additionally, tax revenues (TR), state budget expenditures (SE), and GDP per capita (GDPPC) were collected from the State Statistics Service and the State Treasury Office, as published by the National Bank of Ukraine (2024). Historical data for the Gini index were retrieved from the World Bank's Poverty and Inequality Platform (World Bank, 2024a). The decile coefficient (Dti) and the quintile coefficient (Dti*) of income differentiation were sourced from the Demographic and Social Statistics/Income and Living Conditions data published by the State Statistics Service of Ukraine (2024).

Government Effectiveness (GE) captures perceptions of the quality of public services, the quality of the civil service and its degree of independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. It was sourced from the World Bank's Worldwide Governance Indicators (World Bank, 2024b). The Corruption Perceptions Index (CPI) measures the level of corruption, particularly the misuse of public positions for private gain, such as bribe-taking, among public officials and politicians. The data for this index is sourced from Transparency International (2024).

These behavioural indicators are chosen for their relevance to tax compliance and their potential impact on economic growth. GDP per capita reflects the average level of economic production per person in a country, indicating its economic well-being and standard of living. State budget expenditure reflects the fiscal policy stance and the capacity for public spending, which in turn influences aggregate demand and economic activity. Tax revenues (TR) represent the total amount of revenue generated from taxation, which is the primary source of funding for government spending and programs.

The data was collected annually from 2000 to 2021. Since 2010, data have been presented excluding the temporarily occupied territories, the Autonomous Republic of Crimea, and the city of Sevastopol. Since 2014, it has also excluded a part of the temporarily occupied territories in the Donetsk and Luhansk regions. Between 2017 and 2019, the data are presented considering changes in the balance of payments of the National Bank of Ukraine. CPI data were reduced to a single measurement based on the official calculation methodology for the period 2012-2021. *Table 1* represents the descriptive statistics for the observed variables used in the study.

Table 1. Descriptive statistics of the sample

Variables	Mean	Standard Deviation	Min.	Max.
Behavioural impulses				
Perception of individual well-being (IB)	108.34	11.04	79.60	123.80
Gini index (GI)	26.59	1.98	24.00	30.30
Decile coefficient (Dti)	3.27	0.85	2.30	5.20
Quintile coefficient (Dti*)	2.07	0.20	1.90	2.60
Government Effectiveness (GE)	-0.62	0.15	-0.87	-0.33
Corruption Perceptions Index (CPI)	25.91	4.22	15.00	33.00
Channel indicators				
Tax revenues (TR)	339417.82	306094.47	31317.50	1107090.89
State budget expenditures (SE)	439026.45	439538.30	33946.52	1491206.36
GDP per capita (GDPPC)	38562.41	36339.89	3582.00	131734.00

Source: *own compilation*

The findings presented in *Table 1* illustrate significant developments in Ukraine over the past twenty-two years. The Government Effectiveness (GE) indicator reflects a mean value of -0.62, signifying a stable yet persistently negative perception of government effectiveness during this period. Similarly, the Corruption Perceptions Index (CPI) values, which range from 15 to 33, indicate substantial fluctuations in perceptions of corruption, underscoring the challenges faced by the government in effectively addressing this issue. The minimum and maximum values of GDP per capita and tax revenues, corresponding to the first and last observations in the analyzed sample, suggest that significant economic changes have occurred in the country over an extended period. A similar trend can be seen in state budget expenditures. These changes are not just a response to economic crises but also indicate increased spending on state programs and social initiatives. The mean and standard deviation of the GI indicate stability in the perception of individual well-being. However, fluctuations in the range from 79.60 to 123.80 indicate changes in the perception of well-being among the country's population. The relatively low standard deviation of the GI indicates a moderate level of economic inequality in the country over this period. It is confirmed by the Dti and Dti* statistics, which indicate the presence of fluctuations in income distribution.

2.2. Empirical strategy

Identification of transmission mechanisms through which behavioral impulses are conveyed to macroeconomic stability is achieved using Vector Autoregression (VAR) models as the primary methodological tool. The VAR model is extensively employed in the literature to analyze the transmission of monetary (Shahnazarian & Bjellerup, 2015) and fiscal (Caldara & Kamps, 2008) policy shocks to the financial and real sectors economy. Vector autoregression methodology has proven particularly effective in analyzing complex causal relationships between macroeconomic variables, demonstrating significant interactions between monetary policy variables such as interest rates, inflation, and exchange rates (Aji et al., 2021). Compared to other models, the advantage of using a VAR model is its capacity to simultaneously assess multiple dependencies, which helps identify the dynamic relationship between indicators using current and lagged values.

The empirical strategy was developed following the methodological framework proposed by Ramey (2016). Initially, relationships between two variables were assessed to elucidate their nature and strength within specified channels. The most influential behavioral factors at this stage have been selected for future research. Subsequently, the stationarity of the time series for the indicators was assessed using the Augmented Dickey-Fuller (ADF) Test. Following this, the appropriate lag order of the Vector Autoregression (VAR) model was determined with Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), Hannan-Quinn Criterion (HQ). In the next step, VAR models were built, and tests were conducted to assess their stability (AR Roots Test), determine causal relationships between variables (Granger Causality Test), check residuals for autocorrelation (Portmanteau Autocorrelation Test and Autocorrelation LM Test), and detect heteroskedasticity (variability of residual variance) with or without cross terms (White Heteroskedasticity Test - No Cross Terms / With Cross Terms). Finally, impulse response and variance decomposition analyses were employed to analyze how variables respond to shocks within the system and to discern the relative significance of various shocks in explaining the variance of each variable.

3. Conducting research and results

3.1. Analysis of relationships between variables

Correlation analysis was employed to identify and substantiate the causal relationships within the transmission channels. This was achieved by utilizing the significant coefficients of determination and correlation coefficients along with significant Chi-square tests. Based on the developed theoretical framework (Figure 1), six behavioral impulses were tested through the channels of increased tax revenues (TR), state budget expenditures (SE), and GDP per capita (GDPPC):

$IB\uparrow \rightarrow TR\uparrow \rightarrow SE\uparrow \rightarrow GDPPC\uparrow$
$GI\downarrow \rightarrow TR\uparrow \rightarrow SE\uparrow \rightarrow GDPPC\uparrow$
$Dti\downarrow (Dti^*\downarrow) \rightarrow TR\uparrow \rightarrow SE\uparrow \rightarrow GDPPC\uparrow$
$GE\uparrow \rightarrow TR\uparrow \rightarrow SE\uparrow \rightarrow GDPPC\uparrow$
$CPI\uparrow \rightarrow TR\uparrow \rightarrow SE\uparrow \rightarrow GDPPC\uparrow$

In these visualizations of transmission mechanisms, the symbols "↑" and "↓" indicate an increase or decrease in the indicator (initial impulse direction), while the symbol "→" shows the spread within the channel and the transmission of the impulse. The results of the canonical analysis are presented in *Table 2*.

The analysis results suggest that there is no significant causal relationship between the perception of individual well-being (IB) and tax revenues (TR). The low correlation coefficient (0.2125) and Chi-square (0.9009), nonsignificant p-value (0.3425), and very weak explanation of variation (0.0451) all point towards the absence of a meaningful linear relationship between these variables. Consequently, changes in the perception of individual well-being do not explain changes in tax revenues, and vice versa, both in the current period and considering any potential lagged effects.

Table 2. Relationships analysis summary results

Channels	IB↑ →TR↑	GI ↓ →TR↑	Dti ↓ →TR↑	Dti*↓ →TR↑	GE↑ →TR↑	CPI↑ →TR↑	TR↑ →SE↑	SE↑ → GDPPC↑
Coefficient of determination (R^2)	0.0451	0.3003	0.4204	0.1643	0.4515	0.6690	0.9805	0.9926
Correlation coefficient (R)	0.2125	0.5480	0.6484	0.4054	0.6720	0.8180	0.9902	0.9963
Chi-square	0.9009	6.9645	10.6355	3.5007	11.7119	21.5628	76.7574	95.7465
p-value	0.3425	0.0083	0.0011	0.0613	0.0006	0.0000	0.0000	0.0000

Source: *own compilation*

The correlation coefficient of 0.5480 indicates a moderate linear relationship between the Gini index (GI) and tax revenues (TR). The Chi-square value of 6.9645 with a p-value of 0.0083 indicates that the relationship between GI and TR is statistically significant. The coefficient of determination for GI and TR indicates that only 30.03% of the variation in one variable is explained by the other. These results are not sufficient for further modeling, as this may lead to model instability or the transfer of an endogenous variable to the exogenous category.

The results depicted in Table 2 show a strong (0.6484) and statistically significant (at the 5% level) relationship between the decile coefficient (Dti) and tax revenues (TR) and a moderate (0.4054) and not statistically significant relationship (less than 5% level) between the quintile coefficient (Dti*) and tax revenues (TR). Therefore, for Dti, about 42.04% of the variance is explained by TR, indicating a moderate level of explanatory power, whereas for Dti*, only 16.43% of the variance is explained by TR, indicating very weak explanatory power.

Similar results are observed between the Government Effectiveness (GE) index and tax revenues (TR). The correlation coefficient of 0.6720, combined with a Chi-square value of 11.7119 and a p-value of 0.0006, confirms the significance of this relationship at the 0.05% level. 45.15% of the variation for GE is explained by changes in TR and vice versa. This means that improvements in government performance can have a tangible effect on tax revenue dynamics. On the other hand, changes in tax revenue have a moderate impact on the effectiveness of government policy.

The correlation analysis results indicate a very strong and statistically significant relationship between the Corruption Perceptions Index (CPI) and tax revenues (TR). The correlation coefficient of 0.8180, alongside a Chi-square value of 21.5628 with a p-value of 0.0000, signifies that the association between these variables is significant at the 0.05% level. The coefficient of determination value of 0.6690 for both CPI and TR suggests that approximately 66.90% of the variance in one variable can be explained by the other. This implies that changes in the Corruption Perceptions Index are strongly associated with changes in tax revenues, and vice versa, highlighting the potential impact of corruption measures on tax revenue dynamics.

The correlation analysis results suggest a strong and statistically significant relationship between tax revenues (TR) and state budget expenditures (SE). The correlation coefficient, Chi-square value, and p-value indicate a highly significant connection between these variables. The coefficient of determination for TR and SE demonstrates that a substantial proportion of the variance (98.05%) in one variable can be explained by the other, both in the current period and considering potential lagged effects. Furthermore, the correlation analysis results show that SE explains 99.26% of the volatility in GDPPC, indicating a strong correlation and stable connection between these variables, with Chi-square test results confirming statistical significance (p-value approaching 0).

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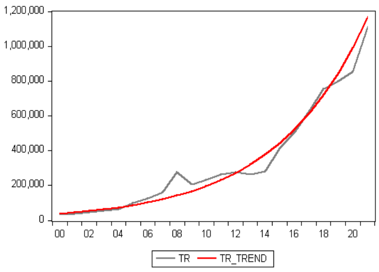
Based on the correlation analysis results, only two behavioral impulses – Corruption Perceptions Index (CPI) and Government Effectiveness (GE) – will be analyzed further within the transmission channels due to their moderate and significant impact on tax compliance, as reflected by the increase in tax revenues. The subsequent effects on state budget expenditures (SE) and GDP per capita (GDPPC) will also be examined to understand the broader macroeconomic implications. It is worth noting that the decile coefficient (Dti) can also be considered, but the experiments conducted with the modeling of this chain allowed us to obtain an unstable and poor-quality model, therefore, in this study, its results are not appropriate to be presented.

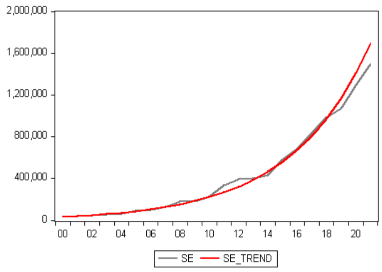
3.2. Data preprocessing and testing

Prior to examining the impact of behavioral impulses on macroeconomic stability, a comprehensive pre-processing and testing of the data was conducted. This process involved an analysis of the characteristics of the time series, an assessment for stationarity, the identification of significant lags, and the execution of cointegration tests.

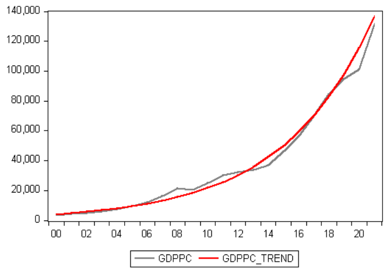
To gain a comprehensive understanding of the series and to identify its underlying trends, a prudent approach is to visualize the data and construct trend analyses. *Figures 2a-e* illustrate graphs representing the following variables: tax revenue, state budget expenditures, GDP per capita, Government Effectiveness, and the Corruption Perceptions Index, along with their respective trends. The data indicates that the variables TR, SE, and GDPPC exhibit exponential growth trends, as evidenced by the identified exponential patterns within the dataset. High values of the coefficients of determination (*Figures 2a-c*) confirm that this type of trend qualitatively describes the variation of the data and is in good agreement with empirical observations. In regard to other variables, GE is characterized by the presence of a polynomial trend. At the same time, it demonstrates an average fit (*Figure 2d*), which indicates the possible influence of other factors on the behaviour of the series. The CPI leans more towards a linear type of development. Its trend shows an average fit with the input data (*Figure 2e*).



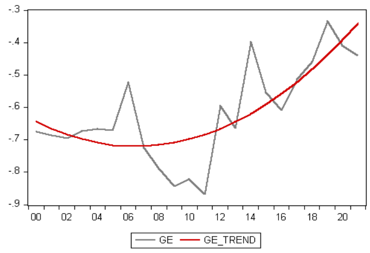
$R^2 = 0.9759$
a)



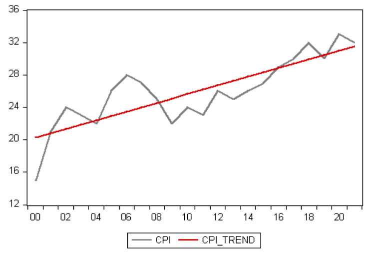
$R^2 = 0.9910$
b)



$R^2 = 0.9917$
c)



$R^2 = 0.585$
d)



$R^2 = 0.6874$
e)

Figure 2. Graphs of variables and their trends: a) TR; b) SE; c) GDPPC; d) GE; e) CPI
Source: *own compilation*

Analysis of the visualization of the dynamics series and their trends leads to the need to perform a logarithmization procedure for the TR, SE, and GDPPC variables. This will help reduce the dispersion and stabilize the variation of the time series, which will facilitate the detection of stationarity and improve the results of stationarity tests.

The next step is to examine the stationary properties of the series, for which the augmented Dickey-Fuller (ADF) test was applied. The results of the stationary tests are presented in *Table 3*, where the ADF results, and the corresponding p-values are given for each variable. These indicators are calculated for the initial series (0 difference), for the first and second differences. The testing is presented for three types of transformations: without intercept and trend, with intercept but without trend, and both with intercept and trend. P-values greater than 0.05 indicate failure to reject the null hypothesis (H0) of non-stationarity. Non-stationary series can lead to erroneous regressions and unreliable forecasts if used directly in modelling. Accordingly, p-values less than 0.05 confirm the stationarity of the series.

Table 3. The Augmented Dickey-Fuller (ADF) Test results

Difference	GE		CPI		TR		LN(TR)	
	ADF	p-value	ADF	p-value	ADF	p-value	ADF	p-value
Type 1: no intercept, no trend $\Delta Y_t = b * Y_{t-1}$								
0	-0.7911	0.3612	1.2010	0.9354	5.2878	1.0000	4.3240	0.9999
1	-6.2965	0.0000	-4.9694	0.0000	-1.1295	0.2261	-2.6012	0.0122
2	-10.6060	0.0001	-7.1902	0.0000	-4.3999	0.0002	-5.5717	0.0000
Type 2: with intercept, no trend $\Delta Y_t = a_0 + b * Y_{t-1}$								
0	-1.6694	0.4314	-2.5796	0.1127	3.1597	1.0000	-1.0316	0.7221
1	-6.2368	0.0001	-5.1019	0.0006	-2.2065	0.2101	-4.5689	0.0020
2	-10.3109	0.0000	-7.0411	0.0000	-4.4550	0.0030	-5.3925	0.0004
Type 3: with intercept and trend $\Delta Y_t = a_0 + a_1 * t + b * Y_{t-1}$								
0	-2.5193	0.3164	-3.3647	0.0834	0.5792	0.9988	-1.9495	0.5937
1	-6.1469	0.0004	-3.4389	0.0775*	-3.5600	0.0598	-4.5749	0.0086
2	-10.0616	0.0000	-6.9003	0.0001	-4.3017	0.0165	-5.1949	0.0032
Difference	**SE**		**LN(SE)**		**GDPPC**		**LN(GDPPC)**	
	ADF	**p-value**	**ADF**	**p-value**	**ADF**	**p-value**	**ADF**	**p-value**
Type 1: no intercept, no trend $\Delta Y_t = b * Y_{t-1}$								
0	11.1963	1.0000	7.5098	1.0000	8.5087	1.0000	8.2861	1.0000
1	2.7118	0.9964	-0.6265	0.4317**	2.2834	0.9915	-1.2263	0.1943***
2	-4.8411	0.0001	-6.8670	0.0000	-3.3766	0.0020	-5.1656	0.0000
Type 2: with intercept, no trend $\Delta Y_t = a_0 + b * Y_{t-1}$								
0	7.0812	1.0000	-1.1414	0.6766	5.5187	1.0000	-0.9460	0.7525
1	1.2620	0.9969	-5.0954	0.0007	-0.4553	0.8810	-3.6909	0.0128
2	-5.3900	0.0004	-6.6492	0.0000	-3.7804	0.0117	-4.9927	0.0010
Type 3: with intercept and trend $\Delta Y_t = a_0 + a_1 * t + b * Y_{t-1}$								
0	2.9224	1.0000	-2.4271	0.3565	2.0348	1.0000	-1.7061	0.7123
1	-3.7020	0.0461	-5.2311	0.0026	-2.6047	0.2818	-3.6311	0.0526****
2	-4.6220	0.0108	-4.2039	0.0224	-3.7944	0.0432	-4.7692	0.0069

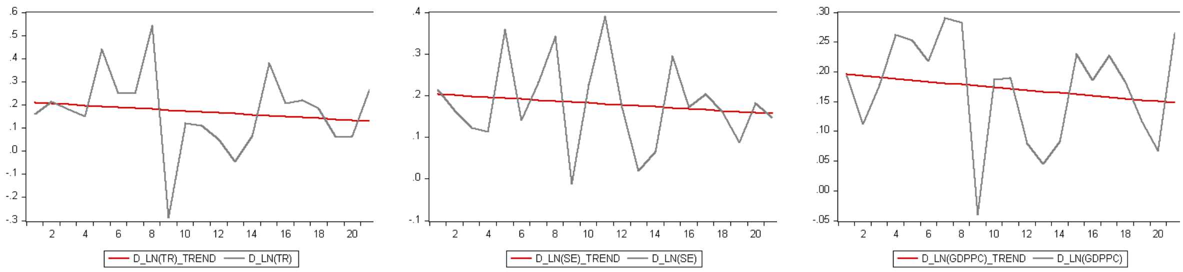
*Notes: * Phillips-Perron Test: ADF = -5.1081, p-value = 0.0030; Elliott-Rothenberg-Stock (DF-GLS) Test: ADF = -4.6051 (ADF critical: -3.7700 (1% level), -3.1900 (5% level), -2.8900 (10% level)); Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test: ADF = 0.1086 (ADF critical: 0.2160 (1% level), 0.1460 (5% level), 0.1190 (10% level)).*
*** Phillips-Perron Test: ADF = -2.0527, p-value = 0.0411.*
**** Phillips-Perron Test: ADF = -1.0565, p-value = 0.2523.*
***** Phillips-Perron Test: ADF = -3.5449, p-value = 0.0615; Elliott-Rothenberg-Stock (DF-GLS) Test: ADF = -3.8689 (ADF critical: -3.7700 (1% level), -3.1900 (5% level), -2.8900 (10% level)); Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test: ADF = 0.0848 (ADF critical: 0.2160 (1% level), 0.1460 (5% level), 0.1190 (10% level)). The grey colour confirms the level of differentiation when the series becomes stationary.*

Source: *own compilation*

Based on the analysis of the results of the extended Dickey-Fuller Test (Table 3), the obtained values for different time series can be interpreted as follows. Upon examining the Augmented Dickey-Fuller (ADF) Test results and the associated p-values at the zero level, it is evident that the initial time series exhibit non-stationarity. Taking the first differences for the variables GE and CPI, the ADF Test results confirm their stationarity under three types of transformations. For the CPI and the third type, additional tests were conducted since the ADF Test showed non-stationarity with a p-value very close to 0.05. The Phillips-Perron Test, the Elliott-Rothenberg-Stock (DF-GLS) Test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test confirmed the stationarity of the CPI for the third type of transformation (see footnotes under Table 3).

Since the tax revenues, state budget expenditures and GDP per capita variables were subjected to logarithmization, Table 3 contains the results of the tests for the original and transformed variables. The ADF and p-value calculations confirm that the initial series becomes stationary when taking the second difference. As for the logarithmic series, they become stationary when taking the first differences. This conclusion for the first types of transformations was confirmed by additional tests (see footnotes under Table 3). Thus, the Phillips-Perron Test confirmed the stationarity of the logarithmic State budget expenditures variable under its first difference. In the case of the logarithmic GDP per capita variable, the tests turned out to be contradictory. For the first type of transformation, even with the additional test, the logarithmic GDP per capita variable becomes stationary at second differences. For the third type of transformation of this variable, the p-value turned out to be very close to 0.05. The Elliott-Rothenberg-Stock (DF-GLS) Test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test confirmed the stationarity of the series for the third type of transformations, but the Phillips-Perron Test did not.

To conclude the stationarity of the logarithmic series, plots of their first differences and corresponding trends were constructed (Figures 3a-c). The graphs show a weak relationship between the trend and the time series, which confirms the values of the coefficients of determination, which approach zero. That is, the first differences of the logarithmic variables are stationary.



$R^2 = 0.0206$ a) $R^2 = 0.0194$ b) $R^2 = 0.0281$ c)

Figure 3. Graphs of first differences of logarithmic variables and their trends: a) TR; b) SE; c) GDPPC
Source: *own compilation*

Based on the results of the stationarity tests and the accompanying visualization analysis, it can be concluded that the variables achieve stationarity upon taking their first differences. In this study, the Government Effectiveness and Corruption Perceptions Index are utilized in their original form, while tax revenues, state budget expenditures, and GDP per Capita are presented in logarithmic form.

The subsequent step involves justifying the number of lags necessary for detecting cointegration. To achieve this, the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ) metrics will be calculated. The results pertaining to the two behavioral models are presented in *Table 4*.

Table 4. Lag order selection criteria

Lag	LR	FPE	AIC	SC	HQ
		Model 1: GE↑ →TR↑ →SE↑→GDPPC↑			
0	NA	1.26e-06	-2.2359	-2.0371	-2.2023
1	111.1732*	2.53e-09*	-8.4926**	-7.4985*	-8.3244**
2	13.2808	4.78e-09	-8.1365	-6.3471	-7.8337
3	17.2486	3.55e-09	-9.3271*	-6.7423	-8.8896*
		Model 2: CPI↑ →TR↑ →SE↑→GDPPC↑			
0	NA	0.0004	3.4840	3.6828	3.5176
1	114.1290*	6.25e-07**	-2.9840**	-1.9898**	-2.8157**
2	9.4977	1.72e-06	-2.2495	-0.4601	-1.9467
3	34.5945	7.10e-08*	-6.3311*	-3.7463*	-5.8936*

Notes:
** Lag selected based on the critical value of the corresponding criterion.*
*** Lag selected based on the next critical value of the corresponding criterion.*
Source: *own compilation*

The results of the lag selection analysis indicate that, according to the majority of criteria, a lag of one is statistically significant for Model 1. Consequently, this lag has been selected for use in the subsequent steps of the analysis. For Model 2, a lag of three is deemed significant; however, subsequent calculations and modeling efforts revealed that the empirical data set lacks a sufficient number of observations to support the construction of a model that incorporates three lags. Therefore, it has been determined that a lag of one will also be utilized for Model 2, as the computed information criteria suggest it is the next most appropriate option following the critical value.

In the final step of data pre-processing and testing, the Johansen Cointegration Test is conducted to verify the presence of cointegration relationships. The results for both behavioural impulse models are presented in *Table 5*. Since the study only needs to prove the presence of these relationships, only the Trace Test metric was used, which tests the hypothesis that the number of cointegration vectors is less than or equal to a certain value.

Analysis of the Trace Test statistics for Model 1 indicates the presence of 0 to 2 cointegration vectors, depending on the trend model. The best estimate of the information criteria corresponds to the model with Intercept and Linear Trend and shows that the minimum value of AIC and SC is achieved at one cointegration ratio, which indicates a long-term relationship between the variables. The results of the Cointegration Test for Model 2 show that the number of cointegration vectors also depends on the trend specification. In particular, the Trace metric indicates the presence of one cointegration ratio for most trend models and, in the case of a quadratic trend, four cointegration vectors. From a statistical fit perspective, the information criteria indicate that the best forecasting models have both a constant and a trend in the cointegration equations and also exhibit a constant and a trend in the data, where there are no cointegration relationships. But in general, the lowest AIC values are achieved with a single cointegration vector, which is consistent with the results of the Trace Test. Thus, in this model, cointegration relationships between variables are also identified, indicating the existence of a long-run equilibrium between them.

Table 5. Johansen Cointegration Test results

	None No Intercept No Trend	**None Intercept No Trend**	**Linear Intercept No Trend**	**Linear Intercept Trend**	**Quadratic Intercept Trend**
Model 1: GE↑ →TR↑ →SE↑→GDPPC↑					
Selected (0.05 level) Number of Cointegrating Relations by Model					
Trace Test	1	1	0	1	2
Information Criteria by Rank and Model					
Rank	Akaike Information Criteria by Rank and Models				
0	-7.0717	-7.0717	-7.3227	-7.3227	-6.9367
1	-7.1535**	-7.4071**	-7.6040	-7.9750	-7.6874
2	-7.1235	-7.3876	-7.6635**	-8.1461*/**	-7.9573**
3	-6.7116	-6.9725	-7.2358	-7.8040	-7.7043
4	-5.9231	-6.4405	-6.4405	-7.2391	-7.2391
Rank	Schwarz Criteria by Rank and Models				
0	-6.2751**	-6.2751**	-6.3270**	-6.3270	-5.7418
1	-5.9586	-6.1624	-6.2100	-6.5312*	-6.0942**
2	-5.5303	-5.6949	-5.8712	-6.2542	-5.9659
3	-4.7246	-4.8317	-5.0452	-5.4641	-5.3145
4	-3.5334	-3.8516	-3.8516	-4.4510	-4.4510
Model 2: CPI↑ →TR↑ →SE↑→GDPPC↑					
Selected (0.05 level) Number of Cointegrating Relations by Model					
Trace Test	1	1	0	0	4
Information Criteria by Rank and Model					
Rank	Akaike Information Criteria by Rank and Models				
0	-1.2848	-1.2848	-1.5387	-1.5387	-1.1440
1	-1.5978**	-1.7375**	-1.8878*/**	-1.8656**	-1.5699**
2	-1.5803	-1.6815	-1.8163	-1.7639	-1.5662
3	-1.0379	-1.2591	-1.4020	-1.5515	-1.4518
4	-0.2434	-0.6102	-0.6102	-1.0372	-1.0372
Rank	Schwarz Criteria by Rank and Models				
0	-0.4882**	-0.4882	-0.5429*/**	-0.5429*/**	0.0509
1	-0.4029	-0.4929**	-0.4938	-0.4218	0.0233**
2	0.0128	0.0113	-0.0240	0.1280	0.4253
3	0.9536	0.8817	0.7887	0.7884	0.9380
4	2.1464	1.9787	1.9787	1.7509	1.7509

*Notes: * The best result of the information criterion among all models and ranks.*
*** The best result of the information criterion for each model among all ranks.*
Source: *own compilation*

Thus, the result of the preliminary processing and testing of the data is the detection of an exponential trend for the variables, which confirms the need for their logarithmization. The assessment of stationarity confirmed the non-stationarity of the analysed time series. However, by computing their first differences, it is possible to obtain stationary variables, which are essential for the development of a Vector Autoregression (VAR) model. The presence of cointegration relationships at the levels of the series was also confirmed. According to the research conducted by Fanchon and Wendel (1992), the findings obtained in this study reaffirm that, in this particular instance, it is unnecessary to differentiate the time series to construct behavioural impulses. Consequently, the Vector Autoregression (VAR) model will be developed using the levels of the series rather than their differences. This phenomenon is also discussed in Enders (2008, p. 301) and Brooks (2008, pp. 292-293). Moreover, Luetkepohl

(2011) addresses this issue extensively. Therefore, the subsequent development of the VAR model will proceed at the levels of the series, omitting the need for differencing, which will facilitate the acquisition of a stable and high-quality model with consistent parameter estimates.

3.3. VAR model order determination and adequacy assessment

Using the results of Section 4.2, two Vector Autoregression (VAR) models were constructed. The first model reflects the behavioural impulse GE↑ → TR↑ → SE↑ → GDPPC↑ (Formulas 1-3), and the second – CPI↑ → TR↑ → SE↑ → GDPPC↑ (Formulas 4-7). As a result of the modelling, it turned out that GDP per capita for the first model is an exogenous variable. Therefore, the final version of the resulting equations considers it exogenous.

$$GE_t = -0.778 + 0.381 \cdot GE_{t-1} - 0.240 \cdot LN(TR)_{t-1} + 0.345 \cdot LN(SE)_{t-1} - 0.091 \cdot LN(GDPPC)_t + \varepsilon_{1t}, \quad (1)$$

$$LN(TR)_t = 2.730 + 0.073 \cdot GE_{t-1} + 0.226 \cdot LN(TR)_{t-1} - 0.552 \cdot LN(SE)_{t-1} + 1.352 \cdot LN(GDPPC)_t + \varepsilon_{2t}, \quad (2)$$

$$LN(SE)_t = 1.2241 = -0.197 \cdot GE_{t-1} - 0.373 \cdot LN(TR)_{t-1} + 0.593 \cdot LN(SE)_{t-1} + 0.827 \cdot LN(GDPPC)_t + \varepsilon_{3t}, \quad (3)$$

where GE_t, $LN(TR)_t$, $LN(SE)_t$ are endogenous model variables at the time t; GE_{t-1}, $LN(TR)_{t-1}$, $LN(SE)_{t-1}$ are endogenous model variables at the time $t-1$; $LN(GDPPC)_t$ is an exogenous variable; ε_{it} are random errors (shocks).

$$CPI_t = 27.712 + 0.576 \cdot CPI_{t-1} - 9.230 \cdot LN(TR)_{t-1} - 1.304 \cdot LN(SE)_{t-1} + 11.274 \cdot LN(GDPPC)_{t-1} + \varepsilon_{1t}, \quad (4)$$

$$LN(TR)_t = 5.473 + 0.034 \cdot CPI_{t-1} - 0.432 \cdot LN(TR)_{t-1} - 0.978 \cdot LN(SE)_{t-1} + 2.338 \cdot LN(GDPPC)_{t-1} + \varepsilon_{2t}, \quad (5)$$

$$LN(SE)_t = 3.400 + 4.63E-05 \cdot CPI_{t-1} - 0.778 \cdot LN(TR)_{t-1} + 0.114 \cdot LN(SE)_{t-1} + 1.720 \cdot LN(GDPPC)_{t-1} + \varepsilon_{3t}, \quad (6)$$

$$LN(GDPPC)_t = 1.970 + 0.017 \cdot CPI_{t-1} - 0.442 \cdot LN(TR)_{t-1} - 0.330 \cdot LN(SE)_{t-1} + 1.722 \cdot LN(GDPPC)_{t-1} + \varepsilon_{4t} \quad (7)$$

where CPI_t, $LN(TR)_t$, $LN(SE)_t$, $LN(GDPPC)_t$ are endogenous model variables at the time t; CPI_{t-1}, $LN(TR)_{t-1}$, $LN(SE)_{t-1}$, $LN(GDPPC)_{t-1}$ are endogenous model variables at the time $t-1$; ε_{it} are random errors (shocks).

The quality assessment of the Vector Autoregression models to determine how well the model fits the data and the reliability of the results was based on several key statistical indicators, including Multiple R-squared, Adjusted R-squared, F-statistic, Standard Error of the Equation, presented in *Table 6.*

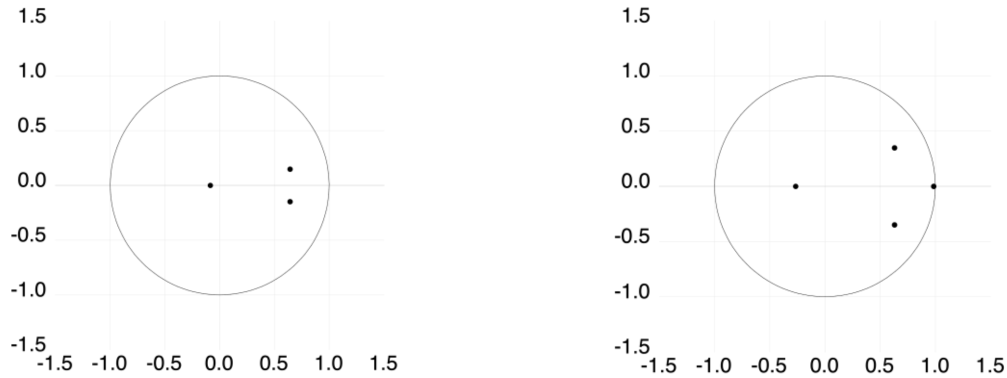
The evaluation shows that the models for most economic variables are accurate. In both scenarios, when the Corruption Perceptions Index (CPI) and Governmental Effectiveness (GE) were used as initial impulses, the VAR models generally performed well. They have strong and moderate high R-squared and adjusted R-squared values, significant F-statistics, and very low Standard Error of the Equation. The TR, SE and GDPPC models are extremely strong in both scenarios, explaining a significant portion of the variation and being highly statistically significant. Although the models for GE and GDPPC show lower explanatory power, they are still significant and provide valuable insights into governance quality and its impact on macroeconomic variables.

Table 6. The adequacy assessment of the Vector Autoregression (VAR) models

Criteria	**Model 1: GE↑ → TR↑ →SE↑ → GDPPC↑**			
	GE	**LN(TR)**	**LN(SE)**	**X**
Multiple R-Squared	0.6798	0.9953	0.9976	X
Adjusted R-squared	0.5997	0.9941	0.9971	X
F-statistic	8.4918	838.7023	1697.2200	X
S.E. equation	0.0968	0.0774	0.0621	X
Criteria	**Model 2: CPI↑ → TR↑ →SE↑ → GDPPC↑**			
	CPI	**LN(TR)**	**LN(SE)**	**LN(GDPPC)**
Multiple R-Squared	0.7896	0.9883	0.9965	0.9954
Adjusted R-squared	0.7370	0.9853	0.9957	0.9943
F-statistic	15.0126	336.9590	1154.3410	869.9860
S.E. equation	1.8100	0.1217	0.0753	0.0782

Source: *own compilation*

To assess the stability of the constructed VAR models, graphs of the roots of the characteristic polynomial were constructed (*Figures 4a-b*).



a) b)

Figure 4. Graphs of the roots of the characteristic polynomial for: a) the first VAR model; b) the second VAR model
Source: *own compilation*

The plot of the first model (Figure 4a) shows the location of all eigenvalues (roots) inside the unit circle indicating the stability of the VAR model. This means that the estimated model is stable and can be used for analysis and forecasting without the risk of exponential growth of errors. The plot of the second model (Figure 4b) shows that one of the roots is very close to the boundary of the unit circle but does not cross it. This means that the model is formally stable but may be sensitive to changes in parameters or specifications.

A series of diagnostic tests were conducted to verify the constructed VAR models' adequacy and compliance with key assumptions. In particular, the Granger Causality Test was performed to determine the interdependencies between variables, the Jarque-Bera Test for the normality of residuals, heteroscedasticity tests to check the stability of the variance of residuals, as well as autocorrelation tests (Portmanteau and LM Tests) that assess the independence of residuals in time. The tests conducted allow us to conclude the correctness of the model specification and its suitability for further economic analysis and impulse detection. The test results are given in *Table 7*.

Table 7. Tests to verify the quality of VAR models.

Criteria	VAR1	VAR2
VAR Granger Causality Test		
LN(SE), p-value	0.0014	0.0001
LN(TR), p-value	0.0000	0.0001
LN(GDPPC), p-value	X	0.0425
GE, p-value	0.0267	X
CPI, p-value	X	0.0412
VAR Residual Normality Test		
Joint Skewness, p-value	0.9405	0.7775
Joint Kurtosis, p-value	0.9615	0.2532
Joint Jarque-Bera, p-value	0.9947	0.5234
VAR Residual Heteroskedasticity Test (Levels and Squares)		
Joint Chi-square, p-value	0.7067	0.6653
VAR Residual Heteroskedasticity Test (Includes Cross Terms)		
Joint Chi-square, p-value	0.4485	0.2744
VAR Residual Serial Correlation LM Tests		
Null hypothesis: No serial correlation at lag h		
LRE statistics Lag 1, p-value	0.2442	0.9290
LRE statistics Lag 2, p-value	0.6304	0.2444
Rao F statistics Lag 1, p-value	0.2494	0.9329
Rao F statistics Lag 2, p-value	0.6346	0.2616
Null hypothesis: No serial correlation at lags 1 to h		
LRE statistics Lag 1, p-value	0.2442	0.9290
LRE statistics Lag 2, p-value	0.4995	0.5787
Rao F statistics Lag 1, p-value	0.2494	0.9329
Rao F statistics Lag 2, p-value	0.5303	0.6788

Source: *own compilation*

The Granger Causality Test confirmed that GE, LN(TR) and LN(SE) in the first VAR model are causal for the other variables at the 5% significance level. At the same time, the second VAR model has CPI, LN(TR), LN(SE) and LN(GDPPC) as the causal variables. Both models passed the Residual Normality Test, as the p-values for Joint Skewness, Joint Kurtosis and Jarque-Bera are significantly higher than 0.05. This means that the model residuals have a distribution that does not differ from normality. The VAR Residual Heteroskedasticity Test (Levels and Squares) and VAR Residual Heteroskedasticity Test (Includes Cross Terms) are generalized versions of the heteroskedasticity tests based on the Breusch-Pagan and White approaches, adapted for VAR models. For both models, the p-values of the tests are significantly higher than 0.05 (0.7067 for VAR1 and 0.6653 for VAR2 in the levels and squares test; 0.4485 for VAR1 and 0.2744 for VAR2 in the cross-term test). It means that there is no statistically significant evidence of heteroscedasticity, i.e., the variance of the residuals is stable. Both tests for the components also confirmed the absence of heteroscedasticity for all components (Table A.1). The LM Test for serial correlation confirms the absence of autocorrelation in the residuals, as all p-values exceed 0.05 for both models. Both VAR models are well-specified. The residuals are normally distributed, and there is no heteroscedasticity and autocorrelation. Also, VAR1 is stable, and VAR2 is formally stable. The obtained results allow us to obtain impulses and perform their analysis for both scenarios.

3.4. Impulse response analysis

Impulse response analysis was executed to assess the transmission channels of behavioural impulses on macroeconomic stability. This section examines how behavioural impulses, specifically the Corruption Perceptions Index (*Figure 5*) and Government Effectiveness (*Figure 6*), create shocks that impact key macroeconomic variables, such as tax revenues (TR), state budget expenditures (SE), and GDP per capita (GDPPC), over time. The analysis employs the Vector Autoregression (VAR) model developed in the previous section to evaluate the dynamic response of these variables to behavioural impulses.

The impulse response function of the Corruption Perceptions Index (CPI) to CPI exhibits a sharp initial increase, indicating that corruption perception reacts strongly to new corruption-related information, such as corruption scandals or significant anti-corruption reforms. This effect, however, declines steadily over the next five periods, suggesting that while corruption-related events have an immediate and substantial influence on public perception, the impact diminishes over time. After period five, the response stabilizes and shows a slight upward adjustment, implying that corruption perception eventually normalizes unless reinforced by additional shocks.

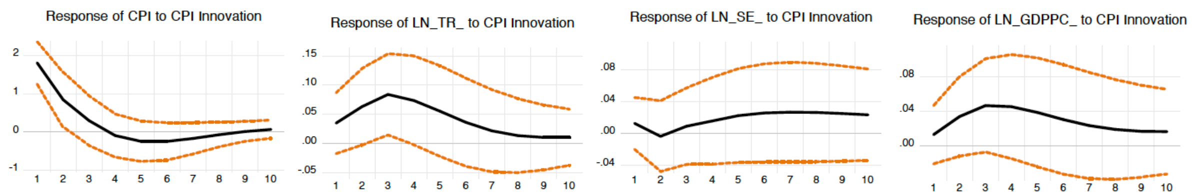


Figure 5. Impulse response functions illustrating the transmission channels of the Corruption Perceptions Index (CPI) impulse on macroeconomic stability, depicting the responses of tax revenues (LN_TR_), state budget expenditures (LN_SE_), and GDP per capita (LN_GDPPC_) over a ten-period period
Source: *own compilation*

Figure 5 shows that the initial response of tax revenues (TR) to the Corruption Perceptions Index (CPI) impulse is observed immediately, with a peak response occurring within three years, during which the increase in tax revenues is most significant. This suggests that an improvement in control of corruption led to a significant rise in tax revenues shortly after the shock. This could be due to improved tax compliance, reduced tax evasion, or increased taxable income as corruption diminishes. After reaching its peak, the response starts to decline gradually, but tax revenues remain above zero until approximately the seventh period. This implies that while improved corruption perception initially boosts tax revenues, the effect diminishes over time.

An impulse response function depicts a short-term decline in government spending (SE) in the initial periods. However, from the third period onward, the response turns positive, peaking around period 6 and stabilizing at a higher level, suggesting that improved corruption perception enhances public sector efficiency, fiscal space, and confidence in budgetary allocations. Unlike tax revenues, which decline in later periods, government expenditures remain elevated over the long term, indicating that corruption reduction leads to sustained fiscal improvements, potentially through increased investments in infrastructure, social programs, or policy-driven spending.

The impulse response analysis of GDP per capita to a change in CPI (*Figure 5*) demonstrates a positive and sustained impact of improvements in corruption perception on economic growth. The response initially rises sharply, peaking around periods 3-4, indicating that reducing corruption fosters short-term economic gains, likely by enhancing business confidence, institutional efficiency, and investment flows. After reaching its peak, the response gradually declines but remains positive throughout the 10-year horizon, suggesting that while the initial economic boost from lower corruption perception is strong, its long-term effects depend on continued structural reforms.

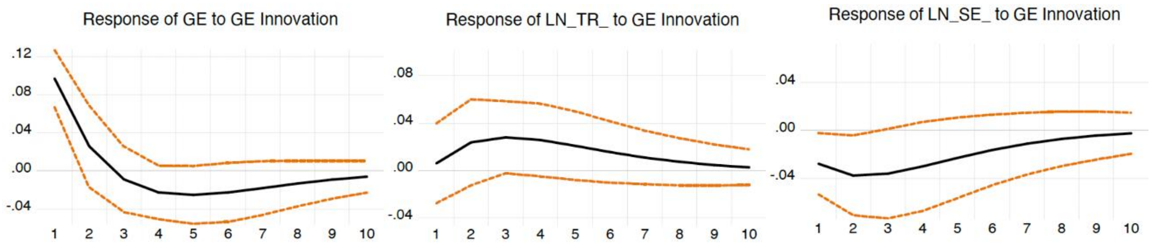


Figure 6. Impulse response functions illustrating the transmission channels of Government Effectiveness (GE) impulse on macroeconomic stability, depicting the responses of tax revenues (LN_TR_) and state budget expenditures (LN_SE_) over ten periods.
Source: *own compilation*

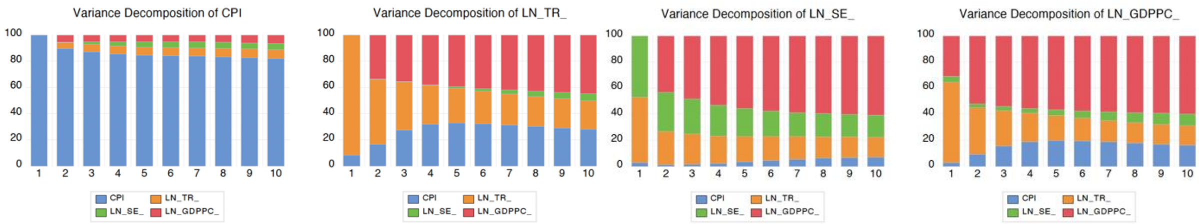
According to the results depicted in *Figure 6*, governance quality (GE) initially reacts sharply and positively, peaking in the first year before declining into negative territory around years 3-4. This suggests that improvements in governance may initially trigger short-term instability due to adjustments or resistance to change. However, from the sixth year onward, the response gradually recovers, indicating a potential self-correcting mechanism or policy adaptation process.

The impulse response of tax revenues to Government Effectiveness (GE) demonstrates that improvements in governance quality lead to an increase in tax revenues, but the effect is moderate and short-lived. The response starts slightly positive in the first year, reaching its peak around years 3-4, suggesting that enhanced governance (e.g., better public service delivery, reduced bureaucratic inefficiencies, and improved institutional efficiency) contributes to higher tax compliance and collection. When government services improve in quality and responsiveness, businesses and individuals are more likely to comply with tax obligations due to reduced administrative burdens and lower transaction costs. Additionally, more efficient tax administration reduces the time required for tax processing, thereby increasing the effectiveness of revenue collection. However, the response gradually declines after the peak, approaching zero by years 8-10.

The response of state budget expenditures (SE) to Government Effectiveness (GE) reveals a delayed and gradual positive relationship, suggesting that improvements in governance influence fiscal policy over time. Initially, state expenditures decrease in the first three years. After the third year, the response begins to recover gradually, turning positive by the sixth year and continuing to increase until year 10, indicating that improved governance leads to more effective allocation of public spending. This effect is closely linked to the positive response of tax revenues (TR) to the GE impulse. The increase in tax revenues following governance improvements suggests that higher government effectiveness enhances tax compliance and collection efficiency, which, in turn, creates additional fiscal space for state expenditures. As a result, the delayed rise in SE can be interpreted as the government leveraging increased revenues to fund public services and infrastructure projects more effectively.

3.5. Variance decomposition analysis

The variance decomposition of CPI shows that its fluctuations are overwhelmingly explained by its own past values (Figure 7a), with limited influence from other macroeconomic variables. This suggests that corruption perception is primarily shaped by historical trends, institutional changes, and external shocks (such as media coverage, anti-corruption policies, or scandals) rather than immediate economic factors.

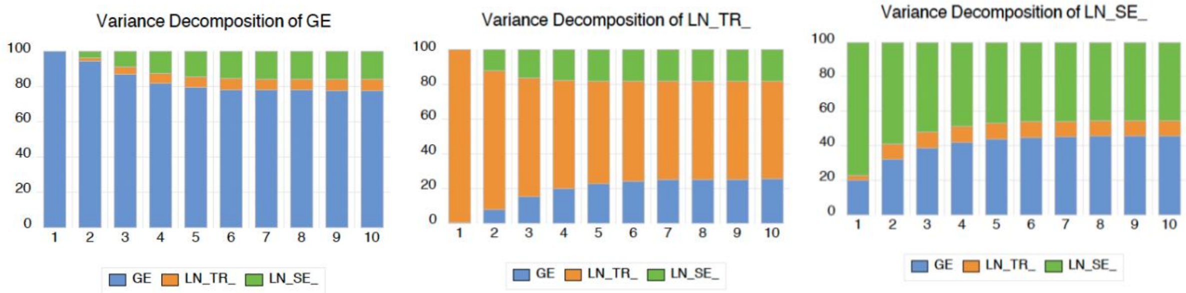


(a) (b) (c) (d)

Figure 7. Variance decomposition of Corruption Perceptions Index (a), tax revenues (b), state budget expenditures (c), and GDP per capita (d) over ten periods.
Source: *own compilation*

CPI impact on tax revenues (*Figure 7b*) and GDP per capita (*Figure 7d*) increases over time, suggesting that reducing corruption enhances fiscal performance and economic growth. Initially, tax revenues are primarily self-driven, but from the fourth year onward, CPI plays a more significant role (30% of fluctuations), demonstrating that anti-corruption measures have a delayed yet substantial impact on fiscal performance. Similarly, as corruption declines, investment confidence strengthens, institutions become more efficient, and businesses operate in a more stable environment, fostering sustained economic expansion and improved governance-driven growth. The fluctuations in GDP per capita due to an impulse in corruption perception are 20% in years 5 and 6.

The variance decomposition analysis presented in *Figure 8a* indicates that GE fluctuations are largely self-driven, meaning that improvements in governance tend to reinforce themselves over time through institutional reforms, policy stability, and public sector efficiency.



(a) (b) (c)

Figure 8. Variance decomposition of Government Effectiveness (a), tax revenues (b), and state budget expenditures (c) over ten periods.
Source: *own compilation*

However, as governance quality improves, its influence on tax revenues (*Figure 8b*) and public expenditures (*Figure 8c*) grows, highlighting its role as a fundamental driver of fiscal performance. Figures 8b and 8c show that an impulse in governmental efficiency can, respectively, cause fluctuations of up to 23% and 43% in tax revenues and state budget expenditures. While its impact on tax revenues is more immediate but short-lived, its influence on public expenditures grows gradually and sustains over a longer horizon.

Conclusion

The findings of this study challenge the conventional wisdom that the perception of individual well-being, level of income inequality, and income distribution (specifically the differentiation between rich and poor groups), which are often driven by macroeconomic development and growth, are key determinants of tax compliance and overall economic behavior. Contrary to expectations, these factors were found to have a negligible impact on macroeconomic fluctuations.

Instead, based on a 22-year period, the study underscores the pivotal role of the Corruption Perceptions Index (CPI) and the Government Effectiveness Index (GE) as significant behavioral drivers that create shocks. When transmitted through fiscal policy channels, these shocks contribute to macroeconomic stability. These outcomes align with other research indicating that good governance, through efficient delivery of public services, creating a stable and predictable economic framework, resource allocation, and infrastructure development, positively impacts innovation, economic growth, and welfare (Van Erkel & Van Der Meer, 2016; Khyareh & Amini, 2021, among others).

Considering the behavioral aspect of the research, these outcomes can be largely explained by the trust effect (shock). Corruption, whether real or perceived, leads to a reduction in trust in governments and an increase in cynicism (Park & Blenkinsopp, 2011). Conversely, when the public observes effective anti-corruption measures and government actions that align with the public interest, it enhances the trustworthiness of the state and its capacity to generate public trust (Vasylieva et al., 2023; Richey, 2010; Levi & Stoker, 2000; Levi, 1988). Increased trust in government fosters greater compliance and economic participation, ultimately promoting sustained economic growth and stability. These results further support the idea that trust in the government is a critical factor in tax compliance, complementing traditional enforcement tools (Kirchler et al., 2008; Batrancea et al., 2019).

The results of this study reveal that corruption perception is highly sensitive to shocks, with a strong initial reaction followed by a gradual decline. This suggests that while corruption-related events have an immediate impact, their influence weakens over time unless reinforced by new developments. This aligns with existing literature indicating that corruption perception is cyclical and often driven by external triggers rather than sustained structural changes (Charron, 2015). However, this study does not explicitly account for the role of media as a key transmission mechanism despite growing evidence that media coverage significantly shapes public attitudes toward corruption (Nguyen, 2017; Rizzica & Tonello, 2015). Media narratives can amplify corruption scandals, prolong negative sentiment, or alternatively, highlight anti-corruption measures, improving institutional trust over time. Future research should incorporate media-driven sentiment analysis to explore the extent to which traditional and social media influence perceptions of corruption and their macroeconomic effects.

The immediate and significant rise in tax revenues following the improvements in the perception of corruption aligns with previous studies that highlight the role of trust in government institutions in enhancing tax compliance. Research has demonstrated that when corruption decreases, taxpayers perceive the tax system as fairer and more transparent, leading to greater voluntary compliance (Farrar et al., 2020; Rothstein, 2013). However, the gradual decline after the peak indicates that while corruption control can boost tax revenues in the short term, its long-term sustainability may require broader structural reforms. This consists of the findings that demonstrate that tax reforms enhance fiscal space only when paired with strong corruption control mechanisms (Yohou, 2023).

Similarly, the sustained positive response of GDP per capita to improvements in corruption perception is consistent with the work of Shleifer and Vishny (1993). The study's findings challenge the greasing-the-wheels hypothesis, which suggests that corruption may sometimes facilitate economic activity by enabling businesses to bypass bureaucratic inefficiencies (Leff, 1964; Acemoglu & Verdier, 1998). The sustained positive impact of improvements in corruption perception on GDP per capita contradicts studies such as Acemoglu & Verdier (2000) and Krammer (2014), which argue that a moderate level of corruption can stimulate growth under weak and underdeveloped institutions.

The analysis also suggests that government effectiveness leads to increased fiscal space and more effective public spending over time. However, a surprising result is the delayed response of government expenditures to governance improvements. While previous research, such as Mauro (1998), suggests that stronger governance should lead to immediate fiscal efficiency, the findings of this study indicate an initial decline in government spending during the first three years, followed by a gradual increase from year six onwards. This pattern suggests that fiscal restructuring occurs before the benefits of governance reforms materialize, potentially due to the initial elimination of inefficient expenditures, followed by the reallocation of funds toward more productive investments.

The main contribution of this paper is twofold. First, this study expands the list of impulses and their transmission channels through which the transfer to macroeconomic stability occurs. By doing so, the research encourages reevaluating the factors traditionally considered most influential (perception of individual well-being and fairness) in shaping economic outcomes. Instead, this study showed that when corruption is effectively controlled and government operations are perceived as efficient and fair, macroeconomic stability is reached by the shock of public trust in governmental institutions. By linking public trust in government to economic participation and compliance, the research provides a behavioral perspective that complements traditional economic theories.

These insights suggest that prioritizing governmental integrity and institutional performance may be more effective in ensuring macroeconomic stability than focusing exclusively on redistributive policies aimed at individual well-being or income inequality. While addressing social disparities remains essential for social cohesion, this study underscores that fiscal and economic stability depends on the sustained credibility of government institutions. However, the findings also reveal that governance improvements, particularly in tax compliance, may be temporary if not reinforced by long-term structural reforms. The observed decline in tax revenues after the initial governance improvements suggests that institutional credibility must be continuously reinforced through consistent policy enforcement, transparency, and legal frameworks that deter regression into corrupt practices.

Second, this paper contributes methodologically by testing and quantifying the theoretical framework for behavioral impulse shocks on macroeconomic stability using a Vector Autoregression (VAR) model. By applying impulse response analysis, the study provides empirical evidence on the time-lagged effects of governance and anti-corruption reforms, demonstrating that while these reforms enhance macroeconomic stability, their effects take time to materialize and require sustained commitment. The findings align with the notion that significant governmental reforms, such as those aimed at combating corruption and enhancing effectiveness, often require time to yield stable, positive macroeconomic outcomes.

By situating the findings within the broader governance literature, this study contributes to the ongoing debate on the long-term impacts of anti-corruption policies and institutional reforms. The results support the sanding-the-wheels hypothesis, which posits that corruption weakens economic stability rather than facilitating efficiency, contradicting the alternative view that corruption serves as a functional workaround for bureaucratic inefficiencies.

These insights contribute to a more comprehensive understanding of the interplay between governance, economic stability, and behavioral responses, particularly in politically volatile contexts such as Ukraine. Future research should further explore the mechanisms through which public trust in institutions influences economic decisions at the micro-level, as well as extend the analysis to other economies with varying degrees of institutional maturity. A comparative cross-country analysis could provide deeper insights into whether these findings hold across different governance structures.

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Appendix A

Table A.1 Residual Heteroskedasticity Tests for individual components of VAR models

Dependent	R-squared	F(8,12)	Probability	Chi-sq(8)	Probability
VAR 1: VAR Residual Heteroskedasticity Test (Levels and Squares)					
res1*res1	0.1952	0.3638	0.9206	4.0993	0.8481
res2*res2	0.4449	1.2021	0.3733	9.3422	0.3143
res3*res3	0.3044	0.6563	0.7196	6.3919	0.6034
res2*res1	0.2174	0.4167	0.8896	4.5652	0.8029
res3*res1	0.2070	0.3915	0.9049	4.3463	0.8246
res3*res2	0.2403	0.4744	0.8520	6.0458	0.7527
Dependent	**R-squared**	**F(14,6)**	**Probability**	**Chi-sq(14)**	**Probability**
VAR 1: VAR Residual Heteroskedasticity Test (Includes Cross Terms)					
res1*res1	0.5247	0.4730	0.8834	11.0177	0.6846
res2*res2	0..6623	0.8404	0.6336	13.9074	0.4566
res3*res3	0.5380	0.4990	0.8668	11.2976	0.6625
res2*res1	0.5084	0.4432	0.9016	10.6760	0.7113
res3*res1	0.6206	0.7009	0.7276	13.0318	0.5240
res3*res2	0.6778	0.9013	0.5952	14.2322	0.4326
Dependent	**R-squared**	**F(8,12)**	**Probability**	**Chi-sq(8)**	**Probability**
VAR 2: VAR Residual Heteroskedasticity Test (Levels and Squares)					
res1*res1	0.1416	0.2475	0.9720	2.9746	0.9359
res2*res2	0.4141	1.0603	0.4474	8.6968	0.3685
res3*res3	0.3909	0.9627	0.5055	8.2090	0.4133
res4*res4	0.2139	0.4081	0.8949	4.4910	0.8103
res2*res1	0.7840	5.4440	0.0046	16.4637	0.0362
res3*res1	0.5403	1.7631	0.1812	11.3467	0.1828
res3*res2	0.4432	1.1939	0.3773	9.3067	0.3171
res4*res1	0.6461	2.7387	0.0565	13.5685	0.0937
res4*res2	0.4171	1.0732	0.4402	8.7584	0.3631
res4*res3	0.4300	1.1315	0.4087	9.0296	0.3398
Dependent	**R-squared**	**F(14,6)**	**Probability**	**Chi-sq(14)**	**Probability**
VAR 2: VAR Residual Heteroskedasticity Test (Includes Cross Terms)					
res1*res1	0.7203	1.1034	0.4822	15.1253	0.3696
res2*res2	0.7375	1.2042	0.4343	15.4880	0.3456
res3*res3	0.7574	1.3382	0.3785	15.9061	0.3191
res4*res4	0.8318	2.1200	0.1818	17.4686	0.2321
res2*res1	0.8747	2.9916	0.0924	18.3686	0.1905
res3*res1	0.6239	0.7111	0.7205	13.1026	0.5185
res3*res2	0.7915	1.6268	0.2845	16.6211	0.2769
res4*res1	0.8571	2.5699	0.1261	17.9985	0.2069
res4*res2	0.7208	1.1062	0.4808	15.1361	0.3689
res4*res3	0.7307	1.1629	0.4533	15.3448	0.3550

Source: *own compilation*