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THE IDENTIFICATION OF THE BUSINESS CYCLE CHARACTERISTICS IN THE EUROPEAN UNION WITH REFERENCE TO THE REPUBLIC OF SERBIA

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A large number of papers indicate stylized facts related to the business cycles of different countries. However, the business cycle is a very complex phenomenon, which is not easy to measure and interpret. Therefore, in addition to the gross domestic product (GDP) as a standard measure of the business cycle, it is useful to analyze the cyclical behavior of the GDP components, the labor market variables, as well as nominal variables. This paper attempts to identify patterns in their movements during the period from the first quarter of 2009 to the third quarter of 2023. The goal is to provide a general overview of business cycles in contemporary developments within the European Union as a whole, Germany being the most developed EU country, with reference to the Republic of Serbia. Detailed statistical time series analysis was used to examine stylized facts, as well as the volatility of these variables, their correlation with the GDP, and their persistence. The general conclusion implies that the business cycle of Serbia does not lag behind more developed countries. Some observations were also made of the common tendencies that could be valid in most cases.

Keywords: volatility, correlation, persistence, business cycle, stylized facts

JEL Classification: E31, E32, F44

INTRODUCTION

Economic systems continuously experience various cyclical fluctuations with recognizable patterns and diverse origins. Characterized by the alternating periods of expansion and contraction, these fluctuations are influenced by many factors, such as technological progress, government policies and global economic conditions. Understanding the complexities and dynamics of these economic cycles is essential for policymakers, businesses and individuals to effectively navigate through varying economic conditions and uncertainties. The subject of this paper precisely implies a study of the stylized facts related to business cycles and the identification of their characteristics through the analysis of the

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cyclical components of the key macroeconomic variables on the example of the European Union, Germany and Serbia.

The aim of the research is to document the nature of these variables in the period after the global financial crisis and to examine whether the business cycle patterns that were established in the pre-crisis period are still valid in the changed economic context and modern crises. For this purpose, the cyclical behavior of the components of the gross domestic product (GDP) (personal consumption, government consumption, investments, exports and imports), the labor market variables (employment, unemployment and real wages) and the nominal variables (inflation, interest rates and the exchange rate) are examined. Identifying the characteristics of the cycle of these variables involves the examination of whether they are procyclical or countercyclical or not, whether they lead, coincide or lag behind the GDP or not, as well as to what extent they are persistent due to unforeseen shocks. The question is whether a group of developed and developing countries, such as the European Union, a developed country (such as Germany), and a developing country (such as Serbia), demonstrate similar cycle patterns or not, despite their differences. What they undoubtedly have in common is that the period following the global economic crisis has witnessed a sustained economic growth trend, especially after 2015 (Trpeski, Kozheski & Merdzan, 2024).

This paper relies on the idea that the phenomenon of the business cycle is not a simple fluctuation of the aggregate output, but rather a complex phenomenon which also includes different patterns of correlations between different time series. A common theme in this line of research implies that the business cycle phenomenon does not only consist of fluctuations in outputs, but it also comprises common patterns of the correlation between different aggregate time series (Backus & Kehoe, 1992). Therefore, the volatility of these time series, their correlation with the GDP and their persistence are examined, which enables the measurement of economic stability and exposure to risks, the identification of the leading indicators of the economic activity and the factors of economic growth, as well as the identification of the areas in which policy interventions or additional research are needed. The applied methodology first includes the extracting of the cyclical component from the observed time series using the HP filter, the checking of the stationarity of this cyclical component around zero using unit root tests, and finally the calculation of volatility, correlation and persistence using standard deviations, the correlation coefficients of the observed variables with the GDP and autocorrelation coefficients, respectively. The mentioned methodology is in accordance with the study by R. Fiorito and T. Kollintzas (1994) and R. Jovančević and V. Arčabić (2011). The data in this paper do not fully match the aforementioned papers bearing in mind the fact that a later period of time is covered in relation to them. The time series used are adapted to the available data for Serbia, which is why the results may differ.

Therefore, in accordance with the subject matter and goal of the research study, the following hypotheses are set:

H1: Serbia's business cycles do not lag behind the business cycles of the European Union and Germany.

H2: The GDP components are procyclical and coinciding in nature, investments are more volatile compared to consumption, and the movement of government spending is stable.

H3: Employment is procyclical, and real wages are a countercyclical variable.

H4: Inflation and interest rates show a procyclical and lagged effect with the highest persistence of inflation.

The paper is structured into a few sections. First, the previous literature related to the presented problem and the stylized pertaining to business cycles are presented. This is followed by the section describing the research data, based on which the results for further discussion are obtained. The final section summarizes and offers possible conclusions.

LITERATURE REVIEW

The recognition of stylized facts about the entire set of time series is considered to be the key step in macroeconomic research (Harvey & Jaeger, 1993). The importance of monitoring them is reflected in considering the possibilities for the country's preventive action in order to eliminate the negative effects of the cycle. However, it is very often the case that these stylized facts ignore certain exceptions, which is the reason why it is important to pay attention to each individual case. Regarding business cycles, stylized facts originate from the famous paper written by A. F. Burns and W. C. Mitchell (1946), who are credited with interpreting the behavior of macroeconomic variables without a model.

The papers by F. E. Kydland and E. C. Prescott (1982, 1988, 1990, 1991) inspired many other authors to examine the stylized facts of business cycles. Namely, they tried to explain the basic characteristics of business cycles in the USA using the stochastic dynamic general equilibrium models that are able to generate artificial data. These are the models that were later modified or continued by numerous authors in their respective papers. Among others, their followers are also R. Fiorito and T. Kollintzas (1994), who rely on the Real Business Cycle Theory (the RBC theory), which points to the stylized facts that include the procyclicality of labor productivity, the volatility of hours worked, the correlation between consumption and leisure, the persistence of business cycles, and the neutral impact of the monetary policy. According to the RBC theory, business cycle fluctuations as such are the result of real shocks to the economy, not of changes in the monetary policy or other nominal factors. R. Fiorito and T. Kollintzas (1994) single out only the most controversial stylized facts of the RBC theory, and group them into the three types, namely (1) the consumption, income, and output components, (2) the price and monetary variables, and (3) the production factors. Using the example of developed countries, the authors conclude that the GDP and its components are procyclical, and that consumption generally fluctuates less (with the exception of the United Kingdom), on the one hand, whereas on the other, investments generally fluctuate more in relation to the real GDP. They confirm the finding by F. E. Kydland and E. C. Prescott for the US that prices are countercyclical in all countries, whereas money supply does not indicate a uniform pattern, but rather differs between countries and depends on the definition of money supply. They also conclude that fixed investments are about three to four times more volatile than consumption, and that both variables are coincident. These results are valid in most of the countries observed by the authors, whereas there are exceptions for some countries.

As far as the government spending is concerned, the results vary from one country to another. The same is in the case of money supply, which does not show a unique behavior pattern, nor does it show a strong correlation with the GDP at any lag, either. The authors also provide the evidence of the countercyclical and leading nature of real interest rates, with greater volatility relative to the GDP. In most cases, the consumer price index is a countercyclical and leading indicator. The countercyclicality of prices and the weak correlation between money supply and the output are consistent with the RBC theory. Regarding the production factors, the labor input is considered to be procyclical and less volatile than the output, whereas employment lags behind the output. The relationship between real wages and the output varies by country. Specifically in Germany, no correlation was perceived between these two variables.

When speaking about the financial variables, the literature usually emphasizes the lagged effect of interest rates. This means that, even when a recession begins, it is possible that interest rates will continue to rise, additionally affecting consumers and the economy which are already affected by the decline in the economic activity (Praščević, 2008).

In the existing literature, there are papers that deal with the nature of such variables in developing countries as well. For example, S. Zarić (2018) examines the key characteristics of the cycle of the macroeconomic variables in Serbia, namely volatility, synchronization, time coincidence and persistence. The research concludes that, according to these characteristics of the cycle, Serbia does not

significantly differ from the European developing countries. C. Ghate, R. Pandey and I. Patnaik (2013) provide the stylized facts pertaining to the business cycles of transition countries, only to conclude that, with the flow of the business cycle, investments and imports showed a procyclical character, whereas the nature of the net exports and the nominal exchange rate was countercyclical. When Serbia in the period from 2015 to 2019 is concerned, E. Jakopin (2020) finds that the largest contributions to the GDP growth were being made by the macroeconomic aggregates of investment and personal consumption. The conclusion about the positive impact of investments on the GDP per capita for the European Union is reached by O. Schneider (2022), who indicates that a more efficient allocation of labor to highly productive regions should raise the overall growth rate in the EU and limit wage increases. Regarding persistence in the European developing countries, the results obtained by Z. Mladenović, K. Josifidis and S. Srdić (2013) suggest the persistence of real exchange rates due to accumulated unexpected random shocks. Additional stylized facts also indicate the procyclicality of the monetary policy. E. C. Prescott (2016) provides an overview of all the papers that illustrate the RBC theory from the methodological point of view or extend the applicability of neoclassical growth theory.

The topic similar to the topic of this paper has been dealt with in the recent literature by M. Orellana, R. Mendieta, S. P. Rodríguez, S. Vanegas and J. Segovia (2023), who analyze a set of the macroeconomic variables for Ecuador related to the demand side, the labor market, the nominal variables, as well as the variables related to the openness of the economy. The above-mentioned study provides an assessment of the co-movements, persistence and volatility of each of these macroeconomic variables. The authors find that the cyclical behavior of these variables changed after the dollarization process. M. M. H. I. Elwia (2024) examines the characteristics and dynamics of the economic fluctuations in Egypt. The author concludes that population consumption, total investment and the unemployment rate are the coincident variables followed by import, the nominal exchange rate, openness, the stock market indicator and the interest rate as the leading variables, on the one hand, and ultimately government consumption, export, exchange, net export, the real exchange rate, the real effective exchange rate, prices, the nominal indicators of the banking sector, real earnings and money supply M0 and M2 are the lagged variables. M. Spychała and J. Spychała (2024) analyzed the most important characteristics of the cyclical fluctuations in the European Union, and they isolated the business cycle fluctuations based on the indicators of the dynamics of the gross domestic product. The authors' findings suggest that the business cycle fluctuations were synchronized until the financial crisis of 2008 and the debt crisis that followed, and that the COVID-19 pandemic then prompted a record synchronization of the business cycle. Nevertheless, one of the main conclusions of this paper implies the differences in business cycles and that they largely depend on the development of the observed region.

DATA

The analysis carried out in this paper starts with the description of the data used in the research study. In accordance with the previously elaborated literature, the components of the GDP representing the measure of the business cycle are important. Then, the labor market variables are analyzed, bearing in mind the fact that it was also affected during the 2008 crisis, especially those lower-income individuals. The unexpected onset of the COVID-19 pandemic also led to a global economic crisis, which severely destabilized labor markets and disrupted their previous equilibrium (Trpeski *et al*, 2024). Therefore, employment, unemployment and real wages are analyzed. In this way, various aspects of the real economy are covered. In addition to the real variables, the nominal variables implying inflation, interest rates and the exchange rate are also included. Thus, a set of variables is chosen as in the paper by R. Jovančević and V. Arčabić (2010), except for the data on the stock prices, which are not available for Serbia. Within the observation units, the European Union is selected as a whole, providing a combination of the developed and developing countries that operate within the common institutional framework and reduced economic and trade barriers, following Germany as a developed country, i.e. the most developed country in the EU,

and the Republic of Serbia, as a developing country. The time period after the financial crisis of 2008 is observed, namely the period from the first quarter of 2009 to the third quarter of 2023. For Serbia, the time series are somewhat shorter, due to the limited time coverage for the labor market variables. Namely, these time series for Serbia are available from 2010 with the exception of the real wages which are available from 2011. So, an assessment is made for the year 2010. Table 1 summarizes the variables, the observed time period and the data description. The observed time series are seasonally adjusted, then expressed through logarithms (except for the indices and the percentages), where necessary.

The data were taken from the publicly available statistical databases of Eurostat, IMF IFS, the Bundesbank, and the National Bank of Serbia, so the results can easily be replicated.

METHODOLOGY

In the literature, ensuring stationary stochastic processes is mentioned as the first step in such an analysis (Leitner, 2007), which is achieved in this paper by detrending the time series. There are a lot of ways to smooth a time series and thereby extract a trend. In this paper, the decomposition of the seasonally adjusted time series into the trend and the cycle is carried out using the Hodrick Prescott (HP) filter, which is a linear filter very popular in macroeconomic research. Although there are the papers that highlight the disadvantages of this filter (King & Rebelo, 1993; Cogley & Nason, 1995), the great advantage of this method is its ability to make the data stationary, and also the fact that it is not necessary to model time series, as is the case with other filters (Marczak & Beissinger, 2013).

The general framework for the decomposition of each time series into the trend and the cycle is:

$$y_t = y^g_t + y^c_t + \varepsilon_t, \; t = 1, 2, ..., T \tag{1}$$

where t denotes the time and y_t the natural logarithm of the observed time series. The time series y_t is broken down into the trend y^g_t, the cycle y^c_t and the irregular component ε_t. With the HP filter, the irregular component is zero, thus any disturbance left in the data after detrending is attributed to the cycle component. As suggested by R. J. Hodrick and E. C. Prescott (1997), the smoothing parameter of 1600 is used for the quarterly data.

Table 1 The database

Variables	Observed time period			Data description
	EU27	Germany	Serbia	
GDP	09:1-23:3	09:1-23:3	10:1-23:3	In millions of euros (2010=100)
Private consumption	09:1-23:3	09:1-23:3	10:1-23:3	In millions of euros (2010=100)
Government spending	09:1-23:3	09:1-23:3	10:1-23:3	In millions of euros (2010=100)
Investments	09:1-23:3	09:1-23:3	10:1-23:3	In millions of euros (2010=100)
Export	09:1-23:3	09:1-23:3	10:1-23:3	In millions of euros (2010=100)
Import	09:1-23:3	09:1-23:3	10:1-23:3	In millions of euros (2010=100)
Employment	09:1-23:3	09:1-23:3	10:1-23:3	Survey data, in thousands
Unemployment	09:1-23:3	09:1-23:3	10:1-23:3	Survey data, in thousands
Real wages	09:1-23:3	09:1-23:3	10:1-23:3	Nominal Wage Index/HICP
Inflation	09:1-23:3	09:1-23:3	10:1-23:3	Harmonized index of consumer prices
Interest rates	09:1-23:3	09:1-23:3	10:1-23:3	Short-term interest rates - money market (instead of EU27 data for the Eurozone)
Exchange rate	09:1-23:3	09:1-23:3	10:1-23:3	Real effective exchange rate

Source: Author

To measure the volatility of a particular variable, the standard deviation of that variable is first used. Additionally, the ratio of the standard deviations of the observed variables and the standard deviation of the GDP is calculated, showing how many times the given variable is more volatile than the GDP. The variables with a ratio greater than one are considered as more volatile than the GDP, whereas those with a ratio less than one are considered as less volatile.

The ratio between the standard deviation of the variable *X* and the standard deviation of the GDP is the measure of the relative volatility or variability of that variable compared to the total economic activity represented by the GDP. Multiplying this ratio by 100 yields the percentage that provides the standardized measure of the dispersion of the variable *X* in relation to variability in the GDP. A higher coefficient indicates a greater relative volatility of the variable *X* compared to the GDP, whereas a lower coefficient suggests that *X* is less volatile relative to the overall economic activity. This measure is particularly useful when comparing the variability of the different variables that may have different measurement units or scales. Also, relative volatility is one of the measures used by R. Fiorito and T. Kollintzas (1994) to check the sensitivity of the results to the choice of the detrending method, taking into consideration the fact that there are authors who indicated that the HP filter could affect those measurements.

Observing correlation, i.e. the time co-movement of the macroeconomic variables with the GDP, is important because it enables the identification of the causal links and changes in the economy. The analysis enables the understanding of the behavior of various variables in relation to economic cycles, which contributes to a better forecasting of the economic activity and the formulation of effective economic policies. This co-movement is measured by the correlation coefficient between the observed cycles and the GDP. In addition to the analysis for the current period, the correlation is also calculated for the previous two and the next two periods for the selected variables, which is done because, for the analysis of cyclical movements, it is important to observe what happens both in the previous period and in the following period, in which way it is also possible to see whether the variable leads or lags in relation to the GDP.

For the given variable *X* and the GDP as the measure of the output *Y*, the measure of correlation reads as follows:

$\rho(j)$, where $j \in \{0, \pm1, \pm2, ...\}$ and where

$\rho(j)$ is correlation coefficient between Y_t and $X_{t \pm j}$,

where *X* is
- the leading variable, if $|\rho(j)|$ is maximum for the negative *j*
- coincident variable, if $|\rho(j)|$ is maximum for the zero *j*
- lagging variable, if $|\rho(j)|$ is maximum for the positive *j*
- procyclical variable, if $\rho(j)>0$
- The countercyclical variable, if $\rho(j)<0$

In other words, the highest correlation coefficient is used for interpretation. The positive sign indicates that the variable is procyclical, and the negative sign indicates that it is countercyclical, whereas the coefficient height indicates the strength of the relationship with the GDP. The coefficients ϱ(j) from 0.5 to 1 are said to be highly correlated, whereas for the coefficient values from 0.2 to 0.5 are said to demonstrate the weaker relationship. The ϱ(j) values below 0.2 indicate a very low correlation or no correlation at all. The threshold 0.2 is chosen because it is an approximate value at which the null hypothesis regarding the significance of the correlation coefficient is rejected at the 5% significance level.

Persistence indicates the sustainability i.e. durability of a certain variable due to unforeseen random shocks. In other words, persistence indicates how long a variable stays in a certain phase of the cycle. If the variable is persistent, it means that, due to a temporary shock, there is longer lasting change in the observed variable as an effect, which means change that does not immediately disappear. Thus, a more persistent variable indicates greater stability. Persistence analysis is important for identifying trends, guiding strategies, managing risks, understanding cyclical patterns, and improving economic modeling. Persistence is measured by the autocorrelation coefficient of each

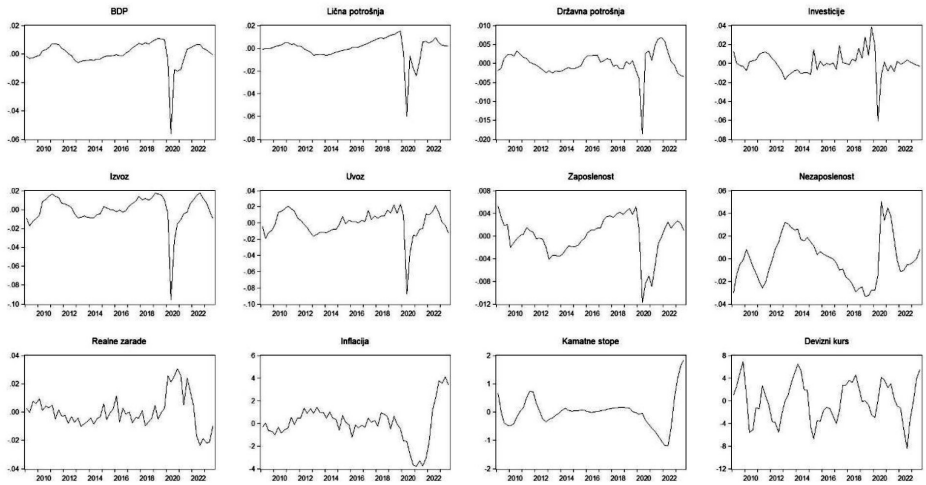

Figure 1 The cyclical components of the key macroeconomic variables in the European Union

Source: Author

observed variable three quarters ahead, in which way it is possible to observe the delayed effects and align with the dynamics of the business cycle.

For the given variable X, the persistence measure is:

$\phi(j)$, where $j \in \{0, +1, +2, ...\}$, where

$\phi(j)$ is the autocorrelation coefficient between X_t and X_{t+j},

when $\phi(j)$ is significant for the larger j, the more persistent X is.

RESEARCH RESULTS AND DISCUSSIONS

The detrending method applies to the data described above, which separate the cycles of the observed time series. In Figures 1, 2 and 3 these cycles are presented for the EU, Germany and Serbia, respectively.

As is already mentioned, it is important that the obtained cycles represent stationary time series, which is first checked using the ADF (Augmented Dickey-Fuller) and the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) unit root tests.

Table 2 shows the results of the unit root tests applied to the data (in level) on the previously obtained cyclic components of all the variables using the HP filter. As the calculated values of the ADF test statistics are less than the critical value at the significance level 5%, the null hypothesis of the presence of the unit root is rejected as such and a conclusion is made that the cycles of the observed variables are stationary time series, i.e. I(0) processes. Also, all the calculated values of the KPSS test statistics are less than the critical values at the significance level 5%, so the null hypothesis is not rejected as such, and it is concluded that the observed cycles are stationary, i.e. I(0) processes. According to the ADF test, certain variables (the real wages in Germany and the inflation in Serbia) indicate the presence of the unit root. However, the reason for this lies in the presence of breaks in the series which the ADF test is sensitive to. The KPSS test then has better performance and shows that the series are stationary, as well as the graphical representation of the correlogram which indicates that there is no unit root.

Volatility

The volatility indicators were calculated in accordance with the previously described methodology. According to the results shown in Table 3, the most volatile in the set of the observed variables are the

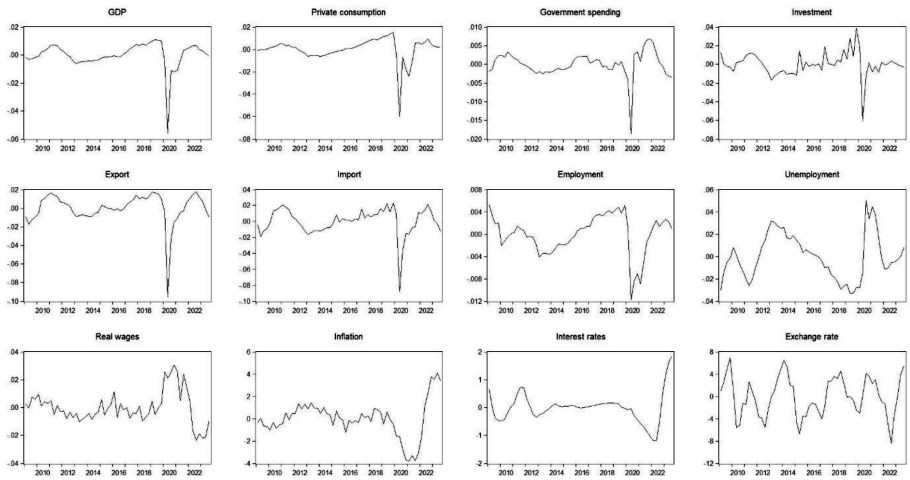

Figure 2 The cyclical components of the key macroeconomic variables in Germany

Source: Author

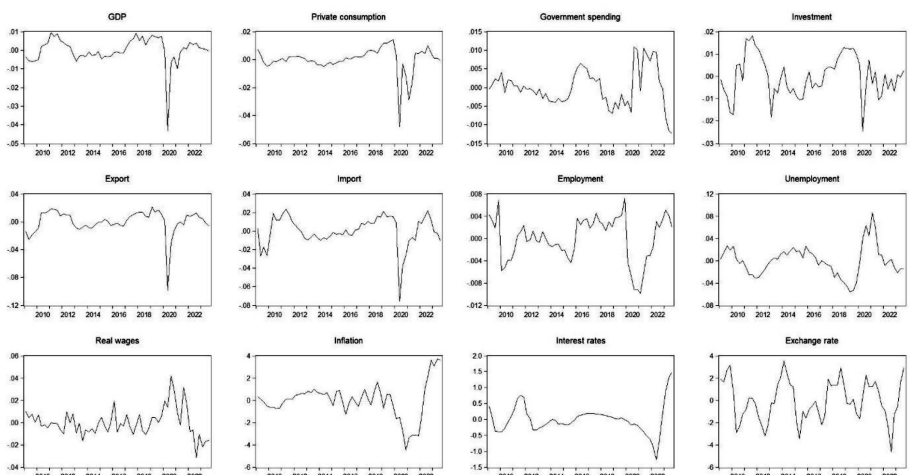

Figure 3 The cyclical components of the key macroeconomic variables in Serbia

Source: Author

inflation, interest rates and exchange rate variables, which together belong to the set of the nominal variables, among which the most oscillations were recorded within the exchange rate, only to be followed by the inflation variable. The exchange rate volatility is undesirable, taking into account the fact that it causes panic in the forex market because the forex traders and users are unclear about what to envisage in the market on a daily basis (Osazevbaru, 2021). In the set of the remaining, real variables, unemployment stands out as the most volatile, which is also the case at the level of the European Union, in Germany and in Serbia as well. Then there are imports in the EU, exports in Germany and investments in Serbia. The least volatile, i.e. the most stable variable in the EU in the observed period was government spending, which is also the case in Serbia. Government spending is considered as the most stable variable, which is

Table 2 The unit root tests for the cyclical components obtained using the HP filter

Variables	ADF (*k*)			KPSS		
	EU	Germany	Serbia	EU	Germany	Serbia
GDP	-4.41 (0)	-4.81 (0)	-4.97 (0)	0.05	0.05	0.06
Private consumption	-4.59 (0)	-5.00 (0)	-4.85 (0)	0.05	0.05	0.05
Government spending	-4.63 (0)	-5.54 (9)	-3.94 (0)	0.05	0.05	0.09
Investments	-5.89 (0)	-3.77 (0)	-3.06 (0)	0.07	0.06	0.08
Export	-4.02 (0)	-4.36 (0)	-3.92 (0)	0.04	0.05	0.05
Import	-4.02 (0)	-3.75 (0)	-4.72 (0)	0.05	0.04	0.04
Employment	-3.70 (3)	-3.11 (0)	-3.65 (4)	0.07	0.05	0.07
Unemployment	-3.05 (2)	-4.10 (3)	-4.74 (2)	0.09	0.05	0.07
Real wages	-4.08 (4)	-1.66 (3)	-3.90 (0)	0.07	0.08	0.09
Inflation	-6.25 (4)	-3.99 (7)	-2.44 (1)	0.07	0.07	0.09
Interest rates	-4.80 (1)	-4.34 (1)	-3.66 (10)	0.05	0.05	0.07
Exchange rate	-4.56 (1)	-4.10 (1)	-3.12 (3)	0.04	0.04	0.06

Note: When modeling time series, the Stock-Watson test showed that the relevant test statistic is τ_{μ} which applies to the model with only one constant. The critical values are available from the *EViews* output and for the significance level 5% they are -2.92 and 0.46 for the ADF and the KPSS tests, respectively. The notation *k* in the ADF test refers to the number of the correction factors that need to be added in order to eliminate autocorrelation.

Source: Author

Table 3 The volatility of the observed variables in the European Union, Germany and Serbia

Variable	Standard deviation (σ_x)			Relative volatility (σ_x/σ_{BDP})		
	EU	Germany	Serbia	EU	Germany	Serbia
GDP	0.009	0.007	0.007	1.000	1.000	1.000
Private consumption	0.011	0.009	0.009	1.222	1.286	1.286
Government spending	0.003	0.005	0.008	0.333	0.714	1.143
Investments	0.013	0.009	0.026	1.444	1.286	3.714
Export	0.016	0.017	0.023	1.778	2.429	3.286
Import	0.017	0.016	0.023	1.889	2.286	3.286
Employment	0.004	0.004	0.009	0.444	0.571	1.286
Unemployment	0.020	0.027	0.035	2.222	3.857	5.000
Real wages	0.012	0.012	0.025	1.333	1.714	3.571
Inflation	1.650	1.593	2.945	183.333	227.571	420.714
Interest rates	0.540	0.446	1.183	60.000	63.714	169.000
Exchange rate	3.554	1.840	3.785	394.889	262.857	540.714

Source: Author

attributed to the factors such as tight budget controls, economic cooperation and policy harmonization. The stable movement mentioned confirms the part of the hypothesis H2 that relates to government spending. The most stable variable in Germany is employment, due to the factors such as strong labor market policies, a strong focus on vocational training and close cooperation between employers and trade unions. In Germany, too, government spending is quite stable and less volatile than the output.

The results reveal that investments fluctuate more than consumption in the EU and Serbia, while in Germany they fluctuate equally. Thus, the hypothesis H2 is accepted in this aspect for the EU and Serbia, whereas it is rejected for Germany. This instability often arises from the larger waves of optimism and pessimism that cause cyclical fluctuations, i.e. they

arise from the "animal spirit" of investors, as described by J. M. Keynes, where instinct and social psychology can cause fluctuations in investments. It forms a part of the broadly held belief that investment shocks set off business cycles. The "animal spirit", i.e. investing based on instinct, is less pronounced in Germany, bearing in mind the fact that, in this country, the volatility of investments and consumption is equal, which can be attributed to stricter regulations that can limit speculative activities and reduce irrational investor behavior. The high volatility of investments and short-term interest rates reported in the literature (Praščević, 2008) is most pronounced in Serbia, where employment is also found to be more volatile than the GDP, whereas this is not the case in the EU and Germany. It is interesting that the literature (Male, 2010) states that the output volatility in developing countries is higher than that in developed countries, which is not the case here. More precisely, the volatility of Serbia's output is identical to the volatility of Germany's output, i.e. it is slightly lower than the volatility of the EU output.

Correlation

Based on the methodology for presenting the correlation of the observed variables with the GDP that has been described above, the ordinary correlation coefficients (Table 4) were calculated, and their statistical significance was tested (the *p*-values are presented in brackets).

The results show that, in the observed time period, the GDP components are mostly procyclical and coincide with the GDP, which partially confirms the initial hypothesis H2. The exception is government spending in Serbia, which is a procyclical but lagging variable. This means that the GDP growth leads to an increase in government spending with a lag of one quarter. The same finding of the lagging nature of government spending is also obtained for Croatia in the paper by R. Jovančević and V. Arčabić (2010). The lag of government spending in relation to the GDP is noticeable in Germany as well, but in the opposite direction. The reason for this countercyclicality lies in the possibility that, in more developed countries, the private sector can use resources more efficiently, and excessive government spending can lead to inefficiency. On the other hand, in less developed countries where the private sector may be less developed or limited, an increase in government spending may have a stronger impact on stimulating economic growth, as the government is often the key driver of development.

Employment is a procyclical variable, which corresponds to the usual findings. In the EU, employment is coinciding, which is in line with the RBC theory, whereas in Germany it is lagging, as in R. Fiorito and T. Kollintzas (1994). These authors believe that the lagged effect in employment exists due to the belief that labor institutions in Europe create higher adjustment costs and barriers to the flow of information. Unemployment in Serbia turned out to be a procyclical variable, leading one quarter in relation to the GDP, which is contrary to the results obtained in the previous literature, which suggest the countercyclicality of this variable and its lagging character, as is shown by the results for the EU and Germany. The reason for this may be the probability that economic growth in Serbia does not follow increased demand for labor quickly enough, bearing in mind the fact that it is a good (negative) sign in moments t+1 and t+2, but statistical significance is not ensured. On the other hand, there are reports saying that the time at which unemployment reaches the turning point is unclassified (Praščević, 2008), which indicates the possibility of its leading character. Furthermore, when the labor market is concerned, real earnings show countercyclical behavior, which is in line with the previous research. They lag behind in the EU and Germany, whereas they are the leading variable in Serbia. The conclusion that in Serbia first there are changes in wages, then in the business cycle, may be a consequence of the less bargaining power of employees in relation to their wages than it is the case in more developed countries. This confirms the hypothesis H3 that employment is a procyclical variable, whereas real wages are a countercyclical variable for all the units of observation.

Inflation and interest rates prove to be the procyclical and lagging variables in the EU, which is expected

Table 4 Correlation of observed variables with GDP in the European Union, Germany and Serbia

Variable	European Union				
	t-2	t-1	t	t+1	t+2
GDP	0.268 (0.048)	0.484 (0.000)	1.000	0.483 (0.000)	0.266 (0.05)
Private consumption	0.192 (0.159)	0.443 (0.001)	0.971 (0.000)	0.46 (0.000)	0.341 (0.011)
Government spending	0.363 (0.006)	0.364 (0.006)	0.643 (0.000)	-0.07 (0.612)	-0.319 (0.018)
Investments	-0.064 (0.644)	0.148 (0.28)	0.795 (0.000)	0.456 (0.001)	0.202 (0.139)
Export	0.312 (0.02)	0.457 (0.000)	0.970 (0.000)	0.553 (0.000)	0.228 (0.094)
Import	0.24 (0.078)	0.379 (0.004)	0.930 (0.000)	0.613 (0.000)	0.274 (0.043)
Employment	0.17 (0.216)	0.39 (0.003)	0.821 (0.000)	0.725 (0.000)	0.552 (0.000)
Unemployment	-0.123 (0.371)	-0.268 (0.048)	-0.435 (0.001)	-0.772 (0.000)	-0.655 (0.000)
Real wages	-0.147 (0.286)	-0.422 (0.001)	-0.421 (0.001)	-0.416 (0.002)	-0.431 (0.001)
Inflation	0.013 (0.925)	0.189 (0.168)	0.278 (0.04)	0.39 (0.003)	0.469 (0.000)
Interest rates	-0.039 (0.777)	0.055 (0.689)	0.127 (0.356)	0.241 (0.076)	0.311 (0.021)
Exchange rate	0.07 (0.614)	0.013 (0.927)	-0.139 (0.312)	-0.265 (0.051)	-0.219 (0.108)
Variable	Germany				
	t-2	t-1	t	t+1	t+2
GDP	0.218 (0.11)	0.415 (0.002)	1.000	0.408 (0.002)	0.203 (0.138)
Private consumption	0.005 (0.972)	0.256 (0.059)	0.857 (0.000)	0.343 (0.01)	0.295 (0.029)
Government spending	0.136 (0.321)	0.053 (0.699)	0.047 (0.732)	-0.399 (0.003)	-0.422 (0.001)
Investments	0.152 (0.267)	0.306 (0.023)	0.721 (0.000)	0.44 (0.001)	0.25 (0.065)
Export	0.258 (0.057)	0.401 (0.002)	0.948 (0.000)	0.48 (0.000)	0.193 (0.159)
Import	0.26 (0.055)	0.409 (0.002)	0.889 (0.000)	0.591 (0.000)	0.331 (0.014)
Employment	-0.07 (0.614)	0.297 (0.028)	0.458 (0.000)	0.519 (0.000)	0.506 (0.000)
Unemployment	-0.13 (0.345)	-0.37 (0.006)	-0.628 (0.000)	-0.713 (0.000)	-0.572 (0.000)
Real wages	-0.208 (0.128)	-0.317 (0.019)	-0.257 (0.058)	-0.409 (0.002)	-0.342 (0.011)
Inflation	0.053 (0.699)	0.211 (0.122)	0.245 (0.071)	0.354 (0.008)	0.462 (0.000)
Interest rates	0.118 (0.39)	0.201 (0.141)	0.26 (0.055)	0.245 (0.071)	0.231 (0.089)
Exchange rate	0.015 (0.913)	0.013 (0.923)	-0.142 (0.302)	-0.22 (0.106)	-0.127 (0.354)
Variable	Serbia				
	t-2	t-1	t	t+1	t+2
GDP	0.062 (0.659)	0.356 (0.009)	1.000	0.357 (0.009)	0.062 (0.659)
Private consumption	0.051 (0.716)	0.231 (0.096)	0.823 (0.000)	0.32 (0.019)	0.094 (0.501)
Government spending	-0.086 (0.538)	-0.045 (0.746)	0.243 (0.079)	0.465 (0.001)	0.398 (0.003)
Investments	-0.046 (0.743)	0.258 (0.062)	0.535 (0.000)	0.198 (0.155)	0.021 (0.881)
Export	0.027 (0.846)	0.305 (0.026)	0.714 (0.000)	0.233 (0.093)	-0.058 (0.679)
Import	-0.03 (0.833)	0.309 (0.025)	0.763 (0.000)	0.261 (0.06)	0.067 (0.632)
Employment	-0.053 (0.704)	0.007 (0.961)	0.188 (0.178)	0.107 (0.444)	0.061 (0.664)
Unemployment	0.356 (0.009)	0.379 (0.005)	0.347 (0.011)	-0.031 (0.824)	-0.218 (0.117)
Real wages	-0.167 (0.233)	-0.283 (0.04)	-0.125 (0.374)	0.188 (0.177)	0.14 (0.317)
Inflation	-0.09 (0.521)	-0.11 (0.433)	-0.078 (0.578)	0.013 (0.925)	0.108 (0.443)
Interest rates	0.021 (0.881)	-0.009 (0.947)	0.01 (0.944)	0.044 (0.753)	0.05 (0.725)
Exchange rate	0.136 (0.331)	0.123 (0.382)	0.131 (0.349)	0.096 (0.495)	0.091 (0.518)

Note: The values in the tables are the ordinary correlation coefficients, and the *p*-values are in parentheses.

Source: Author

Table 5 The persistence of the observed variables in the European Union, Germany and Serbia

Variable	European Union		
	t+1	t+2	t+3
GDP	0.484 (0.000)	0.268 (0.046)	0.147 (0.278)
Private consumption	0.452 (0.001)	0.264 (0.050)	0.238 (0.077)
Government spending	0.419 (0.001)	0.229 (0.09)	0.134 (0.323)
Investments	0.244 (0.070)	0.053 (0.700)	0.115 (0.399)
Export	0.555 (0.000)	0.282 (0.035)	0.097 (0.478)
Import	0.546 (0.000)	0.263 (0.051)	0.146 (0.284)
Employment	0.799 (0.000)	0.57 (0.000)	0.397 (0.003)
Unemployment	0.845 (0.000)	0.652 (0.000)	0.416 (0.001)
Real wages	0.728 (0.000)	0.633 (0.000)	0.437 (0.001)
Inflation	0.861 (0.000)	0.738 (0.000)	0.509 (0.000)
Interest rates	0.822 (0.000)	0.475 (0.000)	0.135 (0.320)
Exchange rate	0.717 (0.000)	0.275 (0.04)	-0.109 (0.424)
Variable	Germany		
	t+1	t+2	t+3
GDP	0.419 (0.001)	0.218 (0.107)	0.21 (0.12)
Private consumption	0.39 (0.003)	0.176 (0.195)	0.245 (0.069)
Government spending	0.627 (0.000)	0.458 (0.000)	0.349 (0.008)
Investments	0.595 (0.000)	0.371 (0.005)	0.267 (0.046)
Export	0.500 (0.000)	0.246 (0.068)	0.047 (0.729)
Import	0.594 (0.000)	0.345 (0.009)	0.101 (0.46)
Employment	0.712 (0.000)	0.507 (0.000)	0.292 (0.029)
Unemployment	0.841 (0.000)	0.641 (0.000)	0.408 (0.002)
Real wages	0.468 (0.000)	0.341 (0.01)	0.248 (0.065)
Inflation	0.839 (0.000)	0.63 (0.000)	0.505 (0.000)
Interest rates	0.789 (0.000)	0.39 (0.003)	0.021 (0.877)
Exchange rate	0.691 (0.000)	0.286 (0.032)	-0.039 (0.774)
Variable	Serbia		
	t+1	t+2	t+3
GDP	0.355 (0.010)	0.062 (0.665)	-0.23 (0.100)
Private consumption	0.376 (0.006)	0.130 (0.360)	-0.012 (0.933)
Government spending	0.524 (0.000)	0.304 (0.028)	0.156 (0.270)
Investments	0.684 (0.000)	0.285 (0.040)	0.077 (0.587)
Export	0.543 (0.000)	0.155 (0.271)	-0.025 (0.858)
Import	0.372 (0.007)	0.037 (0.792)	0.088 (0.536)
Employment	0.875 (0.000)	0.650 (0.000)	0.368 (0.007)
Unemployment	0.795 (0.000)	0.499 (0.000)	0.107 (0.450)
Real wages	0.603 (0.000)	0.236 (0.092)	-0.007 (0.959)
Inflation	0.895 (0.000)	0.705 (0.000)	0.49 (0.000)
Interest rates	0.797 (0.000)	0.405 (0.003)	0.054 (0.706)
Exchange rate	0.711 (0.000)	0.215 (0.126)	-0.235 (0.093)

Note: The values in the tables are the autocorrelation coefficients, and the *p*-values are given in parentheses.

Source: Author

and identical to the findings in the paper by R. Jovančević and V. Arčabić (2010). In the case of Germany, inflation is also procyclical and lagging, whereas interest rates are not significant. In the case of Serbia, the nominal variables are not significant at all for the observed lags, as well as the exchange rate in the EU and in Germany. In the case of inflation and interest rates, the reason for this may lie in the fact that these variables become significant at later lags due to the nature of higher delays in these variables. On the other hand, the insignificance of the exchange rate is expected, bearing in mind the fact that real exchange rates are affected not only by domestic macroeconomic conditions but also by conditions in other countries, which is the reason why relative, rather than domestic, measures of the business cycle and other macroeconomic conditions are relevant for determining the exchange rate (Prasad & Chadha, 1997). Theory envisages that the cyclical movements of the real exchange rate during the business cycle depend on the relative importance of the various shocks that drive the cycle (Prasad & Chadha, 1997). Regarding the nominal variables, however, the hypothesis H4 pertaining to the procyclical and lagging nature of inflation and interest rates can be accepted.

Persistence

In accordance with the presented methodological framework for measuring the persistence of the observed variables, the autocorrelation coefficients (Table 5) were calculated, and their statistical significance was tested (the *p*-values are presented in parentheses).

The results show the statistical significance of all the variables in $t+1$, whereas in $t+2$ and $t+3$ only certain variables remain significant. Those variables are more persistent compared to the variables whose significance ceases in the next two quarters. The most persistent variable in all the observed countries is inflation, which completes the validity of the hypothesis H4. After three quarters, it is perceived that inflation retains almost or over 50% of its initial value, which is quite high and indicates stable inflation in the observed period. In addition to inflation, employment is also very persistent in Serbia. The high persistence of this variable is seen both in the EU countries and in Germany, where a greater number of the variables show persistence than it is the case in Serbia. It is interesting that investments have shown greater persistence in Serbia compared to the countries of the European Union. As is shown by E. Jakopin and A. Gračanac (2023), investments in the period from 2015 to 2021 were the key driver of economic growth in Serbia. Real exchange rates also exhibit the characteristic of persistence, bearing in mind the fact that the autocorrelation coefficient for this variable is significant in $t+2$ for the EU and Germany, as well as in $t+1$ for Serbia.

The results obtained for the volatility, correlation and persistence of the observed variables confirm the initial hypothesis H1, i.e. that the business cycles of Serbia do not lag behind the business cycles of the European Union and Germany. Advanced econometric techniques evaluate the ARMA models and impulse response functions that refer to persistence. However, these advanced techniques are not the subject matter of this paper, bearing in mind the fact that the aim is to provide a general picture of business cycles by studying the stylized facts about the cycles in terms of their volatility, correlation and persistence. The approach is based on the idea of A. F. Burns and W. C. Mitchell (1946), who seek to interpret the behavior of macroeconomic variables without a model.

CONCLUSION

The existing literature has highlighted the stylized facts pertaining to the business cycles of different countries. However, the business cycle is a highly complex phenomenon which is not easy to measure and interpret. This paper examines the stylized facts concerning the cyclical movement of the key macroeconomic variables in the period following the 2008 crisis, using detailed statistical analysis. By analyzing the European Union as a whole, Germany as the most developed economy in the EU, and the

Republic of Serbia as a diverse set of observation units it investigates the volatility, correlation with the GDP, and the persistence of the GDP components, the selected labor market variables, and the nominal variables. The contribution of this paper lies in the identification of the cyclical movement characteristics not only of the gross domestic product as the standard measure of the business cycle, but also of the other mentioned macroeconomic variables. The paper has managed to reveal certain regularities in their movement in the period after the global financial crisis, thus providing a general overview of business cycles. There are very few papers addressing this topic in the case of Serbia, which is yet another contribution of this study.

The research results indicate that the cycles in the observed period were mainly characterized by the following: higher investment volatility compared to consumption and the stability of government spending; the procyclical and coincident nature of the GDP components; procyclical employment and countercyclical real wages; the procyclical and lagging effects of inflation and interest rates; the insignificance of the exchange rate; and the highest persistence of inflation, which retains about 50% of its initial value after three quarters, indicating stable inflation during the observed period. It is important to note that the results for Serbia do not significantly differ from those for the EU and Germany, in which sense Serbia's business cycle can be said to be similar to those of more developed countries. The standard finding in the literature that the output in developing countries is more volatile than that in developed countries does not apply to Serbia, since its output is equally volatile as that of Germany.

In addition to these general conclusions, individual exceptions have also been found. For example, the high volatility of investments and short-term interest rates is perceived in Serbia. The reason for that lies in the fact that developing countries are generally more vulnerable to external economic shocks, such as financial crises or geopolitical tensions, or changes in global interest rates, prices and capital flows. These external factors can spill over to domestic financial markets and lead to increased volatility in short-term interest rates. Consequently, the aforementioned shocks could have led to greater volatility in investments in the observed period. In the EU and Germany, there is no case showing that the volatility of employment is higher in relation to the GDP, either. However, the findings concerning the correlation of these variables with the GDP are mostly confirmed in the EU, whereas there are exceptions when Germany or Serbia are concerned. In particular, government spending has proven to be lagging behind and to have different signs. Therefore, it can be concluded that the character of the spending of the state is largely influenced by the country's development level. The exceptions that occur in Serbia also concern unemployment and real wages, which relates to the nature of the still developing labor market.

The persistence analysis indicated stable inflation during the observed period in the EU and in Germany and Serbia well. In this regard, the recorded stability of interest rates in Serbia indicates the effective monetary policy that maintains stable inflation and supports growth and employment, which is the second most stable variable according to the results.

The analysis could be improved by expanding the set of the observed variables (for example the inclusion of additional labor market variables, such as average labor productivity and hours per worker), or by breaking down the already observed variables into subcategories (for example the division of investments into the fixed investments of the economy, resident investments and investments in stocks). Based on the other empirical research studies, it is possible to divide the observed time period into sub-periods. The results obtained by carrying out statistical analysis could further be examined by forming an adequate model and conducting advanced econometric analyses. For example, a conclusion with respect to persistence can be made on the basis of the impulse response functions obtained from the VAR model.

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