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Is There an Asymmetric Effect Between the Exchange Rate and the Gross Domestic Product of Southeastern European Countries?

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Abstract

The main goal of this paper is to examine if there is an asymmetric effect of the exchange rate (ER) on the GDP of the five SEE countries. A nonlinear autoregressive distributed lag (NARDL) model was used, as well as quarterly data from the period 2000Q1 to 2020Q4 across a sample of the five SEE countries (Bulgaria, Croatia, Romania, Serbia and Slovenia). In the long and short run, this study found an asymmetric effect of ER on the GDP of Croatia, Romania and Serbia. In the long run, it was found that appreciation and depreciation have expansionary effect on the GDP of Croatia and Romania. For Croatia, it was found that expansionary appreciation has stronger effect on the GDP, relative to expansionary depreciations, while for Romania expansionary depreciation has stronger effect on the GDP, relative to expansionary appreciation. In the end, for Serbia, it was found that appreciation has an expansionary effect on the GDP, while the depreciation effect is neutral.

1. Introduction

Currency changes receive special attention as they can significantly impact almost every macroeconomic variable (Bahmani-Oskooee and Mohammadian, 2016; Hussain et al., 2019). There are opposing views among economists and policymakers regarding the role of the exchange rate (ER) in terms of economic growth (Zarei, 2019). Policymakers believe that the ER alone can have a positive effect on economic growth, whereas economists believe that a combination of competitive ER and macroeconomic variables can have a positive effect on economic growth (Hussain et al., 2019).

Devaluation or depreciation, and revaluation or appreciation, have different effects on economic growth. Devaluation and revaluation refer to the countries that

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have used a fixed currency system up to 1973, while depreciation and appreciation is used to refer to the countries that after 1973 applied a flexible currency system. In the past, it was considered that devaluation leads to negative effects because it leads to a decrease in output (Alexander, 1952). Furthermore, it has an inflationary character, causes delays when adjusting earnings relative to inflation, leads to changes in distribution of income and wealth, and causes a drop in the aggregate demand (Bahmani-Oskooee and Mohammadian, 2016, 2017a; Edwards, 1986; Lizondo and Montiel, 1989). In the short run, depreciation leads to the worsening of the deficit of current account, an increase in the import prices of goods, and a decrease in manufacturing and growth. All of these factors have a negative impact on the aggregate supply. In the long run, depreciation leads to the growth of exports, growth in domestic manufacturing, the growth of import prices, the decrease of imports, bigger inflation, the balancing of the trade equilibrium, and a positive impact on aggregate demand (Hsing, 2020). Namely, in the long run, if manufacturers are late with decisions regarding an increase in the manufacturing and delivery of goods, the effects of depreciation may be negative. The effects of depreciation makes the growth in aggregate demand larger than the decrease in aggregate supply (Cooper, 1971; Krugman and Taylor, 1978). The increase in net exports lead to the neutralisation of the drop in consumption while also having an expansionary effect on growth.

Also, appreciation has either an expansionary effect or contractionary effect on growth depending on the relationship between the increase in supply (decrease in manufacturing costs) and decrease in demand (competitiveness channels) (Kandil, 2015). When the supply (decrease in manufacturing costs) is larger than the demand (competitiveness channels), an expansionary appreciation effect is found. This effect is typical for developed and emerging economies (Kandil, 2015). An expansionary appreciation of the domestic currency leads to a decrease in prices of intermediate goods, decrease in inflation, growth in foreign investment, growth in real interest rates, etc. In addition, an expansionary appreciation of the domestic currency decrease inflation, as the import of inputs becomes cheaper. In the short run, appreciation leads to decrease in export, while in the long run, due to decrease of the prices of import inputs it ensures an increase in domestic production and growth of export. An appreciation of the domestic currency leads to growth in real interest rates. Higher real interest rates attract foreign investors, which lead to an increase in demand (the possession of domestic currency) and in the value of domestic currency (Kandil, 2015; Lane and Stracca, 2018).

On the other hand, when the demand (competitiveness channels) is larger than the supply (decrease in manufacturing costs), a contractionary appreciation is found. This effect leads to contractions in manufacturing due to the loss of competitiveness. When the exports are decreased in comparison to the imports, the costs of imported intermediate goods are reduced, which lead to a decrease in inflation, the investments decrease, there is a drop in revenue, expenditure, and aggregate demand. Additionally, the foreign investment expenditures increase due to the increase in expenditure in the local currency. The deficit of current account grows, etc., (Kandil, 2015; Lane and Stracca, 2018).

The principal motive behind this study is the fact that no studies have been done so far to examine the asymmetric effect of ER on GDP in the SEE countries

(Bulgaria, Croatia, Romania, Serbia and Slovenia). An additional reason to focus on this group is the fact that these countries have demonstrated the highest GDP growth among the SEE countries. There are certain similarities and differences among these countries. Bulgaria, Croatia, Romania, and Slovenia are in the EU, whereas Serbia is a candidate to becoming an EU member country. Slovenia, Croatia and Romania are categorised as high-income economies, while Bulgaria and Serbia are upper-middle-income economies. Croatia, Romania, and Serbia use a managed floating exchange rate system and inflationary targeting as the nominal anchor for their monetary policy. Bulgaria use a currency board exchange rate regime. In the period from 1992 to 2006, Slovenia has applied the managed floating exchange rate system. After joining the EMU in 2007, it started applying a free-floating system (Kurtović et al., 2021).

In the academic circles of these countries, there are often debates as to whether the ER has been overestimated or underestimated, and about the effect it has on the GDP. In that regard, this study will attempt to ascertain whether the GDP reacts in an asymmetric way to the depreciation and appreciation of the ER. If there is a different response, there is an asymmetric effect due to the ER on GDP. Since it is known that imports and exports respond asymmetrically to changes in ER because there are different trade environments and levels of competitiveness among the countries in the trade process, it is to be expected that the GDP will react in a similar way.

To assess the asymmetry of the ER on the GDP of five SEE countries (Bulgaria, Croatia, Romania, Serbia and Slovenia), we used the nonlinear autoregressive distributed lag model (NARDL) and the quarterly data for the period from 2000 Q1 to 2020 Q4. Shin et al., (2014) proposed the application of a nonlinear ARDL model based on the assessment of the positive and negative partial sum decompositions and the identification of the asymmetric effect in the short and long run. The presence of asymmetry involves different responses following the GDP in relation to depreciation and appreciation.

In the long and short run, this study found an asymmetric effect of ER on the GDP of Croatia, Romania and Serbia. In the long run, it was found that appreciation and depreciation have expansionary effect on the GDP of Croatia and Romania. For Croatia, it was found that expansionary appreciation has stronger effect on the GDP, relative to expansionary depreciations, while for Romania expansionary depreciation has stronger effect on the GDP, relative to expansionary appreciation. In the end, for Serbia, it was found that appreciation has an expansionary effect on the GDP, while the depreciation effect is neutral.

The paper is structured as follows. In section two discusses the literature review. Section three describes the methodology and data sources. Section four discusses the results, and section five presents the conclusions.

2. Literature Review

The period up to the mid-1990s was dominated by linear models that could not ensure a reliable estimation of the ER effect on economic growth. The models demonstrated weakness in areas where the transaction expenditures could not be disregarded and there were also cyclic oscillations among the existing variables (Hussain et al., 2019; Shin et al., 2014). The early studies, such as Edwards (1986)

and Nunnenkamp and Schweickert (1990) used panel cointegration and estimated an ER effect on the economic growth of both developed and developing countries. The results of these studies are identical as devaluation leads to contractionary effects in the GDP in the short run and not in the long run. In contrast, Chou and Chao (2001) and Christopoulos (2004) found there to be mixed results regarding the contractionary effects of depreciation on the GDP in Asian countries in the short and long run. In addition, they found there to be cointegration among the variables. In their view, the pioneering work used non-stationary data which yielded unreliable data. Furthermore, in the cases of non-OECD countries and emerging economies, Bahmani-Oskooee and Miteza (2006) and Miteza (2006) found that depreciation has a long run contractionary effect on the GDP, as well as cointegration among the variables. Contrary to the previous studies, Bussiere et al., (2013) and Levy-Yeyati et al., (2013) found that in the case of developing countries, a strong depreciation has an expansionary effect on GDP in the short run, and a contractionary effect on GDP in the long run. In particular, the study by Levy-Yeyati et al., (2013) stresses that an expansionary effect on the depreciation of GDP occurs as a result of the growth in investment and domestic savings. The mixed results were also found by Rajan and Shen (2006). They compared the impact of the ER on GDP before and after the 2008 financial crisis in the countries of East Asia and Latin America. They used VAR analysis and found that depreciation had an expansionary effect on the GDP prior to the economic crisis and that there was a contractionary effect after the crisis.

The approach that involves an estimate of the symmetric effect related to GDP has dominated over the past two decades. In this regard, Razin and Collins (1999) examined the effect of an overvalued ER related to growth in 93 developed and developing countries. They found that an overvalued ER has an expansionary effect on growth. Contrary to this, Rodrik (2008) estimated the effect of an undervalued ER on the economic growth in 188 countries. He found that an undervalued ER has an expansionary effect on the economic growth of less developed countries. In the long run, depreciation has positively affected traded goods and helped mitigate economic expenditures driven by institutional and market shortcomings. Rapetti et al., (2012) estimated the effect of an undervalued ER on economic growth for the panel of developed and developing countries. This study found that depreciation has an expansionary effect in terms of the economic growth of the developing countries. The linkage between an undervalued ER and economic growth has not been reserved for developed and developing countries alone. On the other hand, Bahmani-Oskooee and Kandil (2009) and Bahmani-Oskooee and Gelan (2013) used the ARDL model to estimate the impact of depreciation on the GDP of MENA countries and 22 African countries. They found that depreciation has an expansionary effect and contractionary effect on the GDP. Mills and Pentecost (2001) found mixed results for four emerging countries in Central Europe. They used the ARDL model and found that depreciation has no long run effects on the GDP of Hungary and the Czech Republic, while depreciation has a contractionary effect in terms of the GDP of Poland and an expansionary effect in terms of the GDP of Slovakia. By using the same sample, Mills and Pentecost (2001) and Miteza (2006) found there to be contractionary effects of devaluation on the GDP. Contrary to the aforementioned studies, Bahmani-Oskooee and Kutan (2008) found that depreciation has no contractionary effects on GDP in the long run for emerging countries in the EU but it

does affect the short term as these countries are dependent on the import inputs. The costs of manufacturing were found to be significantly higher than the GDP increase. Contrary to this, Sencicek and Upadhyaya (2010) examined the effect of a real and nominal ER on GDP in the long run and found that depreciation has a neutral effect on the GDP of Turkey. They found that depreciation has a contractionary effect in the short run. These effects were linked to changes in the nominal ER but not to the changes in the level of price.

Over the past several years, the studies are dominated by estimates of the asymmetric effect of ER on GDP. Bahmani-Oskooee and Mohammadian (2016, 2017a) estimated the asymmetric impact of ER on the GDP of Australia and Japan. They used the NARDL model and found that depreciation does not have long run significant effect on GDP. On the other hand, they found that appreciation has a significant negative effect on the GDP of Australia and Japan. Similarly, Bahmani-Oskooee and Mohammadian (2018) evaluated the effect of an ER change on GDP for seven emerging CEE countries. They applied the NARDL model and annual data for the period between 2004-2015. For the Czech Republic and Hungary, they found that appreciation has a stronger effect on GDP, while depreciation has a neutral effect. On the other hand, in the case of Poland, Latvia, and Russia, they found that depreciation has an expansive impact on GDP. Finally, they found that depreciation has a contractionary effect and appreciation expansionary effect on the GDP of Estonia. Similarly, Bahmani-Oskooee and Mohammadian (2017b) estimated the ER effect on the GDP of 68 countries. They applied the NARDL model and used the quarterly data for the period 1970-2015. They found mixed results for the effects of depreciation and appreciation on the GDP. They found there to be an asymmetric effect for most countries in the short run but an asymmetric effect for only 24 countries in the long run. Unlike the previous studies, Hussain et al., (2019) left out the aggregate supply and estimated aggregate demand through the use of a small series of data and the possible multiple correlations. They applied the NARDL model and annual data for the period between 1972-2014. The results identified the asymmetry and confirmation of the fact that depreciation leads to a decrease in GDP, while appreciation leads to the strengthening of the GDP in Pakistan. They noted that decision-makers should use appreciation more, as it has more of a positive effect on GDP growth.

3. Methodology and Data

3.1 Theoretical Framework

In this study an extension of the Keynesian IS-LM model or the Mundell-Fleming model was employed. The IS-LM model represents a relation among the ER, GDP, and the interest rate. IS, or an aggregate demand, is a sum of personal consumption, government consumption, investments, and net exports, while LM or an aggregate supply representing a combination of an interest rate and manufacturing.

The estimate of the effect of ER on real GDP growth in the long and short run was based on the aggregate demand. The aggregate supply was left out from the model due to the reasoning that we share with Hussain et al., (2019): to avoid possible occurrence of multicollinearities between the explanatory variables of

aggregate supply and demand. A general form of the model is presented in the following manner:

$$lnGDP_t = a + bIR_t + clnGS_t + dlnDI_t + flnREER_t + e_t, \quad (1)$$

where GDP is the gross domestic product per capita; REER is the real effective exchange rate. REER provides relevant information on the competitiveness of a country compared to its main trade partners. It also expresses, in the same currency, the relationship of the changes in price from the domestic country relative to the prices in foreign countries. On the other hand, the nominal effective exchange rate expresses the value of the domestic currency relative to several foreign currencies. IR is the interest rate; GS is the government spending; DI is the domestic investment or gross domestic capital formation (GCF) (see the data source in Appendix, Table A1).

3.2 Empirical Model

Empirical assessment is based on the application of the NARDL model, which is an asymmetric extension of linear ARDL (autoregressive distributed lag) (Shin et al., 2014; Kurtović et al., 2022). Shin et al., (2014) proposed the application of a NARDL model based on the assessment of the positive and negative partial sum decompositions and the identification of the asymmetric effect in the short and long run. The presence of asymmetry involves different responses following the GDP to appreciation and depreciation (Kurtović et al., 2022). Thus, a decomposition of the change in the variable $REER_t$ will occur in relation to its positive change $\Delta\mathrm{REER}_t^+$ and negative change $\Delta\mathrm{REER}_t^-$. These are two time series with the first representing appreciation (REER_t^+) and a partial sum of positive changes, marked as $\Delta\mathrm{REER}_t^+$ while the other represents depreciation (REER_t^-) and a partial sum of negative changes marked as $\Delta\mathrm{REER}_t^-$:

$$REER_t^+ = \sum_{k=1}^{t} \Delta REER_k^+ = \sum_{k=1}^{t} max(\Delta REER_k, 0)\,, \quad (2)$$

$$REER_t^- = \sum_{k=1}^{t} \Delta REER_k^- = \sum_{k=1}^{t} min(\Delta REER_k, 0). \quad (3)$$

In equation (1) we included $REER_t^+$ and $REER_t^-$ and so we get the nonlinear model of ARDL in unrestricted asymmetric error correction model (Kurtović et al., 2022):

$$\Delta y_t = \varphi y_{t-1} + \lambda^+ REER_{t-1}^+ + \lambda^- REER_{t-1}^- + \sum_{k=1}^{z-1} \beta_k \Delta y_{t-k} + \sum_{k=0}^{l-1} (\psi_k^+ \Delta REER_{t-k}^+ + \psi_k^- \Delta REER_{t-k}^-) + \varepsilon_t. \quad (4)$$

The nonlinear model of ARDL in unrestricted asymmetric error correction model will be presented in the following form:

$$\begin{aligned}\Delta lnGDP_t = {} & \varphi_o lnGDP_{t-1} + \varphi_1 IR_{t-1} + \varphi_2 lnGS_{t-1} + \varphi_3 lnDI_{t-1} \\ & + (\alpha_4 lnREER^+_{t-1} + \alpha_5 lnREER^-_{t-1}) \\ & + \beta_0 + \sum_{k=1}^{z} \beta_1 \Delta lnGDP_{t-1} + \sum_{k=0}^{l1} \beta_2 \Delta IR_{t-1} + \sum_{k=0}^{l2} \beta_3 \Delta lnGS_{t-1} \\ & + \sum_{k=0}^{l3} \beta_4 \Delta lnDI_{t-1} \sum_{k=0}^{l4} \psi_5 \Delta lnREER^+_{t-1} \\ & + \sum_{k=0}^{l5} \psi_6 \Delta lnREER^-_{t-1} \\ & + \varepsilon_t,\end{aligned} \tag{5}$$

where $REER_t^+$ and $REER_t^-$ are positive and negative shock in the decomposition of a partial sum of $REER_t$, z and l are lags orders for independent variables and dependent variables, Δ is the first difference operator, while ε_t is the error term in period t.

Lower interest rates have a positive effect on GDP growth, while the larger interest rates have the opposite effect. Therefore, it is expected that φ_1 will have a negative effect on GDP. Larger government spending leads to GDP growth, while lower government spending has the opposite effect. Therefore, it is expected that φ_2 will have a positive effect on GDP. The growth of gross domestic capital investment or domestic investment leads to GDP growth, while a decrease in domestic investment has the opposite effect. Therefore, it is expected that domestic investment φ_3 will have a positive effect on GDP. GDP reacts differently to depreciation and appreciation which is the reason why change $REER_t^+$ may have a different sequence of lags than a change in $REER_t^-$, or if $l4 \neq l5$ in the equation (5). This confirms the asymmetry. If the k coefficient estimate for $REER_t^+$ is different in any of the lag from the $REER_t^-$ coefficient estimate, then the occurrence of an asymmetric effect in the short run is confirmed. The $REER_t^+$ appreciation and $REER_t^-$ depreciation may have an expansionary or contractionary effect on the GDP. Therefore, it is expected that α_4 and α_5 will have an expansionary asymmetric effect or contractionary asymmetric effect on GDP.

The assessment of the NARDL model is a three-stage process. The first stage implies the testing of the long run cointegration by the F-test (Fisher test). The second stage implies testing the short and long run asymmetry using the Wald test. The long run asymmetry test refers to $\lambda^+ = \lambda^- = \lambda$ and the short run asymmetry to $\psi = \psi_k^+ = \psi_k^-$. The Wald test confirmed the validity of our results as well as the fact that different models generate similar results (Kurtović et al., 2021; Kurtović et al., 2022). The third stage implies testing the cumulative dynamic multipliers impact y_t^+ and y_t^- on the dependent variable x_t can be expressed as follows (Kurtović et al., 2022):

$$m_h^+ = \sum_{k=0}^{h} \frac{\partial \mathrm{y}_{t+k}}{\partial \mathrm{x}_{t-1}^+}, m_h^- = \sum_{k=0}^{h} \frac{\partial \mathrm{y}_{t+k}}{\partial \mathrm{x}_{t-1}^-}, h = 0,1,2 \ldots, \tag{6}$$

where m_h^+ is a cumulative dynamic multiplier, $h \to \infty$, then $m_h^+ \to \vartheta^+$ and $m_h^- \to \vartheta^-$. Where $\vartheta^+ = -\lambda^+/\varphi$, and $\vartheta^- = -\lambda^+/\varphi$ are the positive and negative asymmetric long run coefficients (Kurtović et al., 2022).

3.3 Data

We use quarterly data for the period 2000Q1 to 2020Q4. The countries included in our sample are the five SEE countries (Bulgaria, Croatia, Romania, Serbia, and Slovenia). According to studies by Bahmani - Oskooee and Mohammadian (2016, 2017a) and Hussain et al. (2019), we used the real GDP per capita in constant 2010 US dollars in millions. We use the real GDP per capita from the International Financial Statistics of the IMF dataset. As a measure of the exchange rate, we used the REER from Eurostat and National Bank of Serbia dataset. The REERs are expressed in indirect quotation (i.e., an increase in the value of the REER indicates real appreciation) and indexed to 1 for the year 2010 (Fisera and Horvath, 2020). We used the real interest rate (% of GDP) adjusted for the effect of inflation to reflect the real cost of funds to the borrower and the real yield to the lender. We used the interest rate data from the International Financial Statistics of the IMF dataset. As a measure of real government spending, we used the government spending in national currency – in millions. We used the real government spending data from the International Financial Statistics of the IMF dataset. As a measure of domestic investment (DI), we use the real gross domestic capital formation in national currency (in millions) from the International Financial Statistics of the IMF dataset. A somewhat broader description of the variables and data source is presented in Table A1 in the Appendix.

Table A2, in the Appendix, presents the descriptive statistics (mean and standard deviation). Mean value indicates that Slovenia and Croatia are countries with the highest GDP per capita, while Serbia and Bulgaria have the lowest GDP per capita. Measured using standard deviation, Slovenia and Romania have the highest variability in GDP per capita, while Serbia and Croatia have the lowest variability in GDP per capita. During the transition period, the SEE countries implemented the necessary economic reforms that have had a positive effect on the GDP per capita. Also, mean value indicates that Serbia has the highest REER, while Bulgaria has the lowest REER. In terms of competitiveness, high REER (appreciation) for Serbia indicates that this is a case of low external competitiveness of domestic currency, while low REER (depreciation) for Bulgaria indicates that this is a case of high external competitiveness of domestic currency. Also, standard deviation indicates that Serbia and Bulgaria have the highest variability in REER, while Slovenia and Croatia have the lowest. Serbia and Croatia have the highest interest rates, while Slovenia and Bulgaria have the lowest interest rates. In addition, measured by standard deviation, Serbia and Romania have the highest variability in the interest rate, while Slovenia and Bulgaria have the lowest variability in interest rate. The interest rate level in these countries is affected by factors such as low competitiveness of economy, increased inflation and low credit rating. The highest volume of government spending was recorded by Bulgaria and Romania, while the lowest volume of government spending was recorded by Serbia and Croatia. Measured by standard deviation, the highest variability in government spending was recorded by Croatia and Slovenia, while the lowest variability in government

spending was recorded by Serbia and Slovenia. In the end, the highest volume of domestic investment was recorded by Bulgaria and Romania, while the lowest volume of domestic investment was recorded by Serbia and Croatia. Measured by standard deviation, the highest variability in volume of domestic investment was recorded by Bulgaria and Serbia, while the lowest variability in domestic investment was recorded by Romania and Slovenia.

On the other hand, Table A3, in the Appendix, presents correlation among the variables. The results showed that for most countries there is no high correlation among the variables, with the exception of some variables related to Bulgaria, Romania and Serbia. In line with that, sensitive analysis of the variance inflation factors was done for all the countries (see Table A4). The results showed that value of centred VIF is relatively low, which means there is an absence of significant multicollinearity in the current model.

4. Results and Discussion

4.1 Results of the Nonlinear ARDL Model Estimate

The first step in this section, before estimating the asymmetry based on equation (5), is the estimation of the stationarity of the variables using the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests. We started from the null hypothesis (H_0): variables have a unit root or are not stationary and alternative hypothesis (H_1): variables have no unit root or variables are stationary. The results of the ADF and PP unit root tests showed that most of the variables were integrated or stationary at level I (1) following the introduction of the first difference at the 1% and 5% levels of statistical significance, whereby we rejected null hypothesis (H_0) and we accept the alternative hypothesis (H_1). The following step refers to the estimate of the KPSS unit root test. A key difference between the ADF test and PP test is the null hypothesis of the KPSS test and that the series is stationary. So, practically, the interpretation of the p-value is just the opposite to the other. That is, if p-value is < significance level (0.05) then the series is non-stationary, whereas in the ADF test it would mean the tested series is stationary. Hypothesis is reversed in KPSS test compared to the ADF test and PP test. The KPSS test starts from the null hypothesis (H_0): variable has no unit root or the trend is stationary and an alternative hypothesis (H_1): variable has a unit root or the trend is not stationary. The results of the KPSS unit root tests showed that most of the variables were integrated or stationary following the introduction of the first difference at the 1% and 5% levels of statistical significance. For most variables, the p-value is significant at the level of 1% or 5% and therefore fails to reject the null hypothesis (H_0), i.e., time series does not have a unit root, meaning it is trend stationary. Based on the results of the unit root tests, the condition for application of the nonlinear ARDL model was met (Table A5, Appendix).

The next step in this section refers to the disaggregate estimate of asymmetry based on the nonlinear equation (5). Based on the AIC - Akaike criterion, BIC - Schwartz Bayesian criterion, and HQC - Hannan-Quinn criterion, we found the optimal number of lags. The results of the estimate of nonlinear equation (5) are presented in Tables 1, 2, 3, 4 and 5. In the A panels of the tables, based on the

coefficient estimates for appreciation ($REER_t^+$) and depreciation ($REER_t^-$) in the short run, the evidence of an asymmetric effect on the GDP of Croatia, Romania and Serbia in the short run is obvious. The evidence of the asymmetric effect of ER on the GDP in the short run is corroborated based on the sign and size of the appreciation and depreciation coefficients which are different on the same lag length. There is also evidence of an asymmetric effect due to ER on GDP in the short run, since the sum of the estimates of the appreciation coefficients in the short run are different from the sum of estimates of the depreciation coefficient in the short run.

In the short term, appreciation and depreciation have an asymmetric effect on the GDP of Croatia and Romania, while appreciation has an asymmetric effect and depreciation a neutral effect on the GDP of Serbia. Appreciation has a negative sign and significant effect on the GDP of Croatia in the first two lags, while depreciation also has a negative sign and significant effect on GDP in the fourth lag. Appreciation and depreciation have a contractionary effect on GDP, however based on the value of the coefficient, the contractionary effect of appreciation is stronger than the contractionary effect of depreciation on the GDP of Croatia. Also, appreciation has a negative sign and significant effect on the GDP of Romania in the first three lags, while depreciation has a positive sign and significant effect on the GDP in the fourth lag. Based on the value of the coefficient, the contractionary effect of appreciation is stronger than expansionary effect of depreciation on GDP. Finally, contractionary appreciation has a negative sign and significant effect on the GDP of Serbia in the second and fourth lag, while contractionary depreciation has a neutral effect.

Table 1 Estimate of Nonlinear ARDL Model for Bulgaria

Panel A: Short Run Coefficient Estimates					
Lag order	*0*	*1*	*2*	*3*	*4*
ΔlnREER+	0.20 (1.32)	0.18 (1.12)	0.12 (1.08)	0.19 (1.15)	0.14 (1.08)
ΔlnREER-	0.15 (0.63)	-0.17 (-1.45)	-0.09 (-1.63)	-0.13 (-2.67)	-0.16 (-2.87)
ΔIR	-0.02 (-0.70)	0.02 (0.69)	0.07 (2.10) **	0.08 (2.53) **	0.04 (1.51)
ΔlnGS	-0.05 (-1.33)	0.05 (1.31)	0.09 (2.18) **	0.10 (3.18)	0.13 (3.28)
ΔlnDI	-0.02 (-1.74) *	0.03 (1.18)	0.07 (2.66) ***	0.10 (3.66)	0.09 (2.89)
Panel B: Long Run Coefficient Estimates					
	lnREER+	lnREER-	IR	lnGS	lnDI
	-3.50 (-0.32)	-2.57 (-0.35)	1.12 (0.33)	1.83 (0.87)	0.36 (0.56)
Panel C: Diagnostic Statistics					
ECM (-1)	F-test	Adj. R2	Wald	LM x^2_{SC}	RESET	Cusum/ Cusumq
-0.15***	3.22***	0.43	16.47***	1.48***	1.16	S/U
Panel D: Structural Break Tests					
	Chow test	Andrew's test	Multiple test		
	27.59***	31.50***	18.90** Break date 2007Q2		

Notes: The numbers outside the brackets are coefficients, while the numbers within the square brackets are t-statistics. F-test or bound test for cointegration, Error-correction model ECM (-1), Lagrange multiplier test (LM) for autocorrelation, RESET test for misspecification, stability tests Cusum and Cusumq – stable (S) and unstable (U). ***, ** and * indicate "statistical significance" at 1%, 5% and 10% levels, respectively.

Source: Author's compilation

Table 2 Estimate of Nonlinear ARDL Model for Croatia

Panel A: Short Run Coefficient Estimates					
Lag order	*0*	*1*	*2*	*3*	*4*
ΔlnREER+	0.11 (2.53)**	-0.16 (-2.97)***	-0.18 (-2.15)**	-0.13 (-1.26)	-0.14 (-1.07)
ΔlnREER-	0.24 (1.24)	-0.31 (-1.86)	-0.21 (-1.46)	-0.11 (-2.37)**	-0.14 (-1.58)
ΔIR	0.12 (0.29)	0.18 (0.58)	0.16 (2.02)**	0.18 (2.14)**	0.19 (2.54)
ΔlnGS	0.01 (0.29)	-0.01 (-0.58)	0.65 (2.88)***	0.57 (2.37)**	0.53 (2.17)**
ΔlnDI	0.05 (0.84)	0.14 (1.98)*	-0.04 (-0.50)	-0.21 (-2.38)**	-0.11 (-1.39)

Panel B: Long Run Coefficient Estimates					
	lnREER+	lnREER-	IR	lnGS	lnDI
	0.26 (3.09)***	0.09 (2.31)**	0.01 (1.32) **	-0.07 (-0.64)	0.19 (3.80)***

Panel C: Diagnostic Statistics						
ECM (-1)	F-test	Adj. R2	Wald	LM x^2_{SC}	RESET	Cusum/Cusumq
-0.95***	2.97***	0.76	7.07***	0.33***	1.08	S/S

Panel D: Structural Break Tests			
	Chow test	Andrew's test	Multiple test
	2.79**	14.30**	85.83** Break date 2008Q4

Notes: See the notes of Table 1.

Table 3 Estimate of Nonlinear ARDL Model for Romania

Panel A: Short Run Coefficient Estimates					
Lag order	0	1	2	3	4
ΔlnREER+	-0.07 (-0.45)	-0.36 (-2.20)**	-0.30 (-1.85)*	-0.27 (-2.45)	-0.31 (-2.34)
ΔlnREER-	0.14 (0.76)	0.02 (0.11)	0.27 (1.65)	0.18 (1.22)	0.34 (2.49)**
ΔIR	0.06 (2.02)*	0.21 (5.19)***	0.17 (4.33)	0.15 (4.49)	0.18 (5.49)
ΔlnGS	-0.07 (-1.26)	-0.01 (-0.26)	0.10 (2.28)**	0.13 (2.89)**	0.15 (3.01)
ΔlnDI	0.01 (0.07)**	0.29 (4.55)***	0.21 (3.19)***	0.20 (3.39)***	0.10 (1.94)**

Panel B: Long Run Coefficient Estimates					
	lnREER+	lnREER-	IR	lnGS	lnDI
	0.10 (1.90)*	0.32 (2.84)***	0.28 (8.78)***	-0.02 (-0.67)	0.02 (3.73)***

Panel C: Diagnostic Statistics						
ECM (-1)	F-test	Adj. R2	Wald	LM x^2_{SC}	RESET	Cusum/Cusumq
-0.18***	12.83***	0.33	21.66***	0.18***	0.99	S/S

Panel D: Structural Break Tests			
	Chow test	Andrew's test	Multiple test
	20.50***	25.81***	25.81** Break date 2009Q1

Notes: See the notes of Table 1.

The effects of ER in the short run are transmitted into an effect on GDP in the long run in the case of Croatia, Romania and Serbia. In the long run, in the B panels of the given tables, it is visible that appreciation and depreciation have one or more significant coefficients. Due to the decomposition of a partial sum of appreciation and depreciation, it was found that appreciation and depreciation together or

individually have an effect on the GDP of Croatia, Romania and Serbia. Based on the Wald statistics estimate (see the C panels in Tables 2, 3 and 4), the significant asymmetric effect of ER on the GDP of Croatia, Romania and Serbia in the long run was confirmed.

Unlike the short run, in the long run we found the opposite effect. For Croatia and Romania, it was found that appreciation and depreciation have a positive sign of the estimated coefficients. Appreciation and depreciation have an expansionary effect on the GDP of Croatia and Romania. For Serbia, it was found that appreciation has a positive sign or expansionary effect on GDP, while the depreciation effect is neutral. In the case of all three countries, the size of the coefficient is different and significant, indicating the existence of asymmetry in the long term. For Croatia, it was found that an expansionary appreciation has a stronger effect on the GDP relative to expansionary depreciations. An expansionary appreciation of 1% point has led to an increase in the GDP of Croatia by 0.26%, while an expansionary depreciation of 0.09% has led to a decrease in the GDP. In the case of Romania, the effect is different. The expansionary depreciation by a 1% point has led to an increase in the GDP of Romania by 0.32%, while an expansionary appreciation by 0.10% has led to a decrease in the GDP. Finally, an expansionary appreciation of 1% point has led to an increase in Serbia's GDP by 0.25%, while the effect of depreciation is neutral. An expansionary appreciation of the domestic currency leads to lower costs of imported products, increased supply, and GDP growth.

The results of this study are in line with the results of the studies by Kandil (2015), Bahmani-Oskooee and Mohammadian (2016, 2017a, 2018), and Hussain et al. (2019) in that this study has also examined the asymmetric effect of the ER on GDP and applied the NARDL model.

Table 4 Estimate of Nonlinear ARDL Model for Serbia

Panel A: Short Run Coefficient Estimates					
Lag order	*0*	*1*	*2*	*3*	*4*
ΔlnREER+	0.04 (0.39)	-0.06 (-0.56)	-0.19 (-1.81)*	-0.12 (-1.29)	-0.20 (-1.61)**
ΔlnREER-	-0.9 (-0.86)	-0.23 (-0.60)	-0.15 (-0.68)	-0.12 (-1.53)	0.16 (-1.76)
ΔIR	0.01 (1.31)	0.13 (2.79)***	0.11 (2.04)***	0.15 (3.06)***	0.05 (2.03)
ΔlnGS	0.05 (0.77)	0.02 (0.37)	0.17 (2.57)**	0.07 (1.75)*	0.05 (1.89)
ΔlnDI	0.16 (6.19)***	0.06 (2.42)**	0.08 (3.53)***	-0.07 (-2.89)***	-0.07 (-3.02)***

Panel B: Long Run Coefficient Estimates				
lnREER+	lnREER-	IR	lnGS	lnDI
0.25 (2.45)**	0.11 (1.21)	0.01 (2.22)**	-0.19 (-2.97)***	0.28 (9.54)***

Panel C: Diagnostic Statistics						
ECM (-1)	F-test	Adj. R2	Wald	LM x^2_{SC}	RESET	Cusum/Cusumq
-0.65***	6.93***	0.76	1.16***	0.78***	1.15	S/S

Panel D: Structural Break Tests			
Chow test	Andrew's test	Multiple test	
4.53***	6.32***	37.95**	Break date 2009Q2

Notes: See the notes of Table 1.

Table 5 Estimate of Nonlinear ARDL Model for Slovenia

Panel A: Short Run Coefficient Estimates					
Lag order	*0*	*1*	*2*	*3*	*4*
ΔlnREER+	0.25 (1.59)	0.18 (123)	0.27 (1.67)	0.21 (1.62)	0.26 (2.45)
ΔlnREER-	0.20 (0.97)	-0.11 (-1.79)	-0.98 -(0.87)	-0.13 (-1.14)	-0.18 (-2.28)
ΔIR	-0.01 (-1.02)	-0.02 (-2.24)**	-0.01 (-2.44)	-0.03 (2.45)**	-0.01 (2.16)
ΔlnGS	-0.01 (-0.14)	-0.02 (-0.26)	-0.16 (-2.04)	-0.19 (-2.56)	-0.21 (-2.79)
ΔlnDI	0.04 (1.10)	0.23 (5.34)***	0.25 (5.78)***	0.17 (4.24)**	0.05 (3.64)

Panel B: Long Run Coefficient Estimates				
lnREER+	lnREER-	IR	lnGS	lnDI
0.70 (1.59)	0.54 (0.92)	-0.05 (-2.78)***	-0.01 (-0.14)	0.30 (10.20)***

Panel C: Diagnostic Statistics						
ECM (-1)	F-test	Adj. R2	Wald	LM x^2_{SC}	RESET	Cusum/Cusumq
-0.36***	9.96***	0.53	22.7***	0.80***	2.15	S/U

Panel D: Structural Break Tests			
Chow test	Andrew's test	Multiple test	
26.31***	23.56***	54.56**	Break date 2008Q4

Notes: See the notes of Table 1.

Expansionary appreciation effects and contractionary depreciations effects regarding the exchange rate on the GDP will be explained below. An expansionary appreciation effect on GDP depends on the relationship between the decrease in demand (competitiveness channels) and increase in supply (decrease in manufacturing costs) (Lane and Stracca, 2018). For the analysed countries we found that the supply (decrease in manufacturing costs) is larger than the demand (competitiveness channels) leading to an expansionary appreciation effect. An expansionary appreciation of the ER might lead to a decrease in the price of imported intermediate goods, a reduction in inflation, growth in foreign investment and decrease in interest rates in Croatia and Serbia.

Based on the results, in the short run, it is evident that contractionary appreciation and depreciation might lead to the growth of import inputs, which has a negative effect on the growth of GDP. Compared to the short run, in the long run a positive effect on expansionary appreciation and depreciation on the GDP of Croatia and Serbia was found. Results show that an expansionary appreciation might lead to a positive effect so that the price of imported intermediate goods becomes cheaper. In addition to a positive effect on expansionary appreciation of ER on GDP, an expansionary depreciation also might lead to a positive effect on the GDP or production, which explains the positive effect of greater demand for export of products from these countries, since goods produced in these countries become cheaper for foreign importers. Finally, an expansionary appreciation of ER might lead to the higher of real interest rates. Higher real interest rates attract foreign investors to invest, which lead to an increase in demand (the possession of domestic currency) and in the value of domestic currency (Kandil, 2015; Lane and Stracca, 2018).

Thanks to an expansionary appreciation effect of ER in these countries leading to a decrease in import costs, a larger growth in aggregate supply was achieved. This is more than the compensated decrease in aggregate demand or competitiveness channels. As the allocation effect of directing might lead the manufacturing resources changing from traded to non-traded goods, the negative effect on competitiveness was mitigated by strengthening the terms of trade, cheaper imports, a lower share of imports in the exports of goods, a greater disposable income, a growth in consumption, etc.

On the other hand, the expansionary appreciation and depreciation of the ER are both significant and have a positive effect on the GDP of Romania. The expansionary depreciation effect of ER is stronger than the expansionary appreciation effect on the GDP. This effect caused the growth in aggregate demand to be smaller than the reduction in aggregate supply. This might result in the growth of the price of traded goods, a decrease in manufacturing, a negative effect on the deficit of current account, etc.

In terms of the explanatory variables, evidence was found that a decrease in interest rate was significant and had a positive effect on the growth of supply and GDP in three out of five countries. The appreciation of ER lead to an increase in the real interest rates of Croatia, Serbia and Slovenia, while depreciation caused a decrease in real interest rates and had a negative effect on the GDP of Romania. Government spending has a significant effect on the GDP growth of Serbia. The significant effect of the domestic consumption on GDP is a clear indicator of the growth of economic activity. Finally, the gross domestic capital formation and domestic investments are significant and have a positive effect on the GDP growth in four out of five countries. The increase in domestic investment indicates that the supply channels are stronger than the demand channels.

In panel C in the given tables, we present the results of the F-test. The statistics are above the significant upper critical value so we can conclude that there is a long term cointegration between the variables. Also, in panel C, we checked the long term cointegration using the error-correction model ECM (-1) and found that the coefficients are significant and range from -1 to 0, thus confirming the cointegration between the variables. Furthermore, in panel C, we present the results of the diagnostic tests. The Lagrange multiplier test (LM test) shows that our model is free of autocorrelation, while the Ramsey regression equation specification error test (RESET) shows that there is no misspecification. Finally, the Cusum and Cusumq tests show the stability of the model.

Croatia, Romania, and Serbia use a managed floating exchange rate system and inflationary targeting as the nominal anchor of their monetary policy. Bulgaria uses a currency board exchange rate regime. In the period from 1992 to 2006, Slovenia applied the managed floating exchange rate system. After joining the EMU in 2007, it started applying the free-floating system (Kurtović et al., 2021). The managed floating exchange rate system ensures that the domestic currency is not fixed to a certain currency or currency basket and that a relatively stable nominal exchange rate against the euro is maintained. This is freely formed on the market with occasional interventions. On the other hand, when it comes to the currency basket, such as the case with REER, this weighted average exchange rate cannot influence the value of the domestic currency against foreign currencies because its

value is determined by the relations of the euro and other currencies in the international currency market.

During the financial crisis of 2007-2009, these countries noted a drop in GDP. In panel D of the given tables, the results of the Chow test, Andrew test and Multiple test are presented, indicating a structural break for all five countries. The structural breakpoint in GDP occurred for Bulgaria in 2008 Q2, Croatia in 2008 Q4, Romania in 2009 Q1, Serbia in 2009 Q2, and Slovenia 2008 Q4. Prior to the financial crisis, most of these countries used the appreciation of ER, with the exception of Romania. During the financial crisis in the world market, a drop in demand and the decrease of exports occurred. This had a negative effect on the economies of these countries. These countries carried out the depreciation of their national currencies to increase the price of their imports, and to increase their exports and manufacturing. In addition, there was a strong drop in FDI inflow. After the crisis ended, most of these countries appreciated their currencies again, with the exception of Romania, which saw a positive effect on GDP growth.

The third stage implies the application of dynamic multipliers to estimate the transition between the initial equilibrium, the short run imbalance following the change, and the new long run equilibrium. It is useful for the analysis of the asymmetric short run adjustment and asymmetric long run response. The cumulative dynamic multiplier shows that the asymmetric impact of the appreciation is more powerful than the depreciation. It also explains the changes in the output of Croatia and Serbia in both the short and long run. On the other hand, the asymmetric impact of the depreciation is more powerful than the appreciation, and it explains the changes in the output of Romania. For Croatia and Serbia, the output had a more powerful response to the appreciation in the 6th quarter (Figure 1). After the 6th quarter, a new equilibrium state in the output was established. The output had a more powerful response to the depreciation after the 4th quarter for Romania.

Figure 1 The Cumulative Dynamic Multiplier

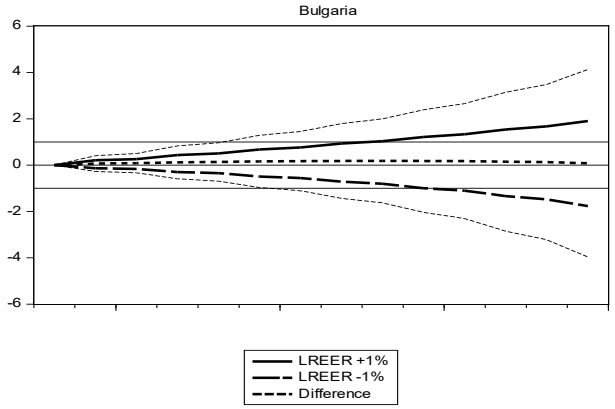


Figure 1 The Cumulative Dynamic Multiplier Continued I.

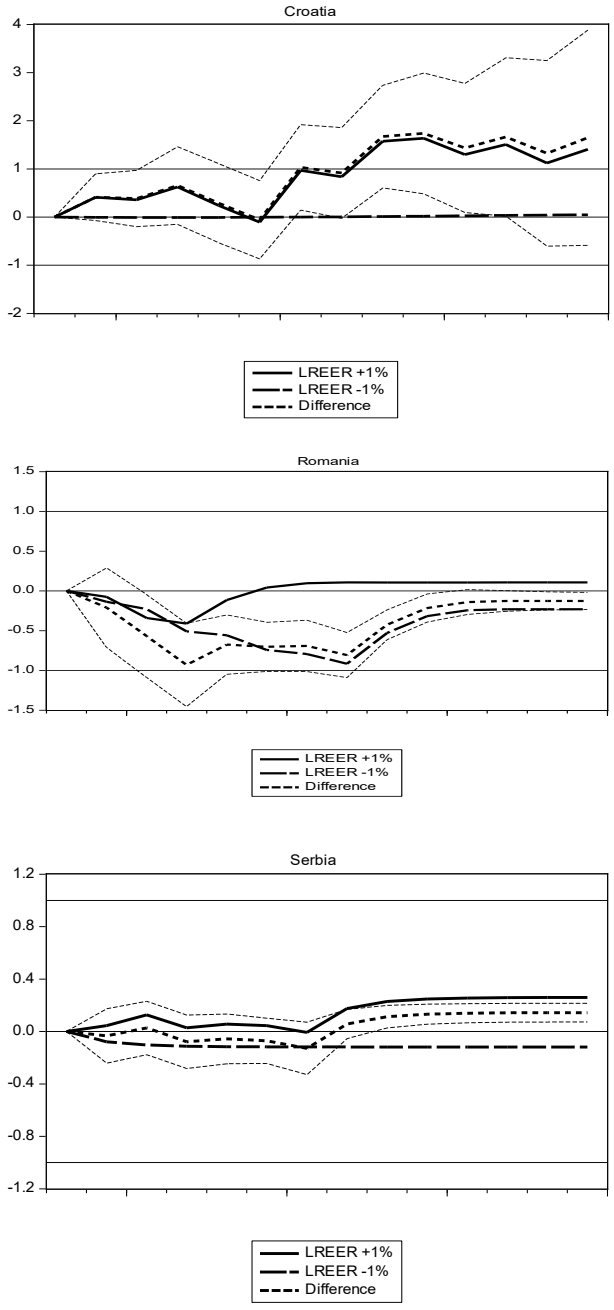
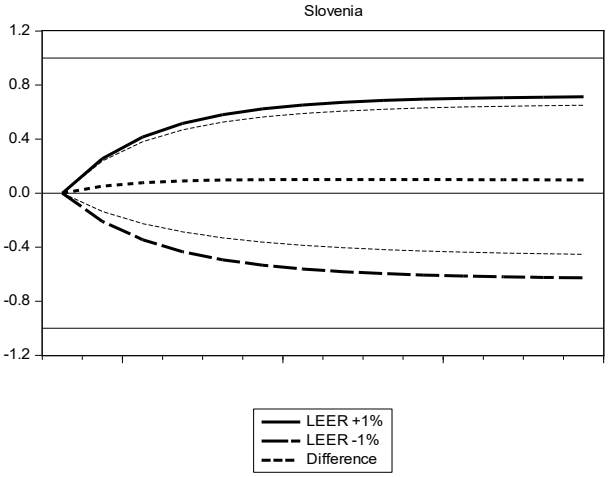


Figure 1 The Cumulative Dynamic Multiplier Continued II.



Notes: The positive shock in REER stock is represented with a bold black line while the negative shock in REER stock is presented with a dotted black line. The central black dotted line denotes the asymmetry and represents a difference between the positive and negative shocks in REER. The two black dotted lines indicate the upper and lower boundaries of statistical significance at the 5% level (Kurtović et al. 2021; Kurtović et al. 2022).
Source: Author's compilation

4.2. Robustness Check

The next step in this section refers to the robustness check of long term cointegration between variables, as well as the control of the Balassa-Samuelson (B-S) effect which can be used to explain the real appreciation of the ER on GDP and the catching-up process. When a catching-up economy is made equal to a developed country in terms of its income level, it is then faced with the real appreciation of the ER (Couharde et al., 2020).

In order to robustness check of long term cointegration between variables, as well as the control of the Balassa-Samuelson (B-S) effect, we used the dynamic ordinary least squares (DOLS) and fully modified OLS (FMOLS) estimator, and the pooled mean group estimator (PMGE). The DOLS and FMOLS provide an estimate of nonlinear cointegration, using expanded linear to quadratic function. These models are more flexible in estimate of the cross-sectional dependencies of structural breaks in economy of transition countries. The pooled mean group estimator (PMGE) is successful in resolving the issue of heterogeneity, since it starts from the assumption that homogeneity of the long run coefficients is present, but at the same time it ensures that error variances and the short run coefficients differ among the variables.

The sample consists of a group of transition countries that behave in a similar manner. The panel approach was selected because based on the initial disaggregate regression it was found that out of the five analysed countries three have an asymmetric expansionary effect of appreciation on GDP. Based on this, it is believed that panel approach will ensure results that reflect results found in disaggregate regression. In that regard, robustness check will help control the B-S effect, i.e., the ER effect on GDP. The following was used as a basic regression equation (5):

$$\Delta lnGDP_{it} = \varphi_o lnGDP_{it-1} + \varphi_1 IR_{it-1} + \varphi_2 lnGS_{it-1} + \varphi_3 lnDI_{it-1} + \varphi_4 lnPR_{it-1} + (\alpha_5 lnREER^{+}_{it-1} + \alpha_6 lnREER^{-}_{it-1}) + \beta_0 + \sum_{k=1}^{z} \beta_1 \Delta lnGDP_{it-1} + \sum_{k=0}^{l1} \beta_2 \Delta IR_{it-1} + \sum_{k=0}^{l2} \beta_3 \Delta lnGS_{it-1} + \sum_{k=0}^{l3} \beta_4 \Delta lnDI_{it-1} + \sum_{k=0}^{l4} \beta_4 \Delta lnPR_{it-1} \sum_{k=0}^{l5} \psi_5 \Delta lnREER^{+}_{it-1} + \sum_{k=0}^{l6} \psi_6 \Delta lnREER^{-}_{it-1} + \varepsilon_t, \quad (7)$$

where $lnPR_{i,t-1}$ is the difference between consumer price index (CPI) and producer price index (PPI). The CPI refers to changes in non-tradable products, while the PPI refers to changes in marketed products. An increase in the price ratio means a higher increase in prices in the non-traded sector compared to the traded sector (Fisera and Horvath, 2020).

Table 6 indicates results of the estimate of two different panel approaches. Results of the estimate, the DOLS and FMOLS estimator and the PMGE, show that coefficients of appreciation and depreciation of the ER are significant at the level of 1% to 5%. Results of the robustness check to indicate that appreciation and depreciation of ER have an expansionary effect on the growth of GDP in the analysed countries. Namely, based on the size of estimated coefficients it is clear that an expansionary effect of appreciation is stronger relative to an expansionary effect of depreciation on the GDP. An expansionary appreciation of ER might lead to a decrease in import prices of inputs. In these countries, a larger growth in aggregate supply, as a result of the decrease in import costs, was achieved. In these countries, there might lead to a larger growth in aggregate supply, as a result of the decrease in import costs, was achieved. Due to the allocation effect of directing the manufacturing resources from traded to non-traded goods, the negative effect on competitiveness might lead to mitigated by strengthening the terms of trade, cheaper imports, a lower share of imports in the exports of goods, a greater disposable income, a growth in consumption, etc.

In the end, for DOLS and PMGE the estimated coefficients of the price ratio are larger than one. This means that the consumer prices are over the manufacturing prices – thus the prices of non-trade goods grow. Their growth leads to the appreciation of the ER and GDP growth. An increase in the price of non-traded goods by a 1% point lead to the appreciation of ER by 1.10% in PMG and 1.05% in the DOLS specification. In the PMGE specification, appreciation has an expansionary effect on GDP which is in line with the findings of this study. In addition, one of the main reasons for application of the real appreciation of the ER is the fact that analysed countries have achieved the growth of real GDP per capita and have come significantly close to the level of income of the developed countries. In particular, this is refers to Slovenia, Romania and Croatia, which are classified as high-income countries, while Bulgaria and Serbia are classified as countries with upper middle income.

Table 6 Panel Cointegration Estimation of Demand Model

Variables	*FMOLS*	*DOLS*	*PMGE*
lnREER+	0.35 (2.97)***	0.28 (2.06) **	0.14 (1.25) **
lnREER-	0.30 (3.61) ***	0.24 (2.54) **	0.31 (2.58) **
IR	0.05 (4.05) ***	0.04 (3.00) **	0.03 (0.27) **
lnGS	0.13 (4.96) ***	0.17 (4.68) ***	0.03 (0.82)
lnDI	0.08 (4.06) ***	0.07 (3.25) ***	0.22 (9.84) ***
LnIR	0.56 (1.92)	1.05 (2.45) ***	1.10 (2.65) ***
Total number of observations	4.19	419	419

Notes: ***, ** and * indicate "statistical significance" at 1%, 5% and 10% levels, respectively.
Source: Author's compilation

The next step in this section refers to robustness check of the results by using the panel NARDL model. This model also ensures the possibility of decomposition of the ER into positive and negative shocks and measurement of the asymmetric effect on the economic growth of SEE countries as a whole. Within the robustness check, the dependent variable of GDP per capita was replaced with the variable GDP growth. Furthermore, two new independent variables, inflation and productivity, were included that to a large extent determine economic growth. The basic regression in equation (5) was used to obtain equation (8) as follows:

$$\begin{aligned}\Delta lnGDPgrowth_{it} = {} & \varphi_o lnGDPgrowth_{it-1} + \varphi_1 IR_{it-1} \\ & + \varphi_2 lnGS_{it-1} + \varphi_3 lnDI_{it-1} + \varphi_4 lnINF_{it-1} + \varphi_5 lnPRO_{it-1} \\ & + (\alpha_6 lnREER^{+}_{it-1} + \alpha_7 lnREER^{-}_{it-1}) + \beta_0 \\ & + \sum_{k=1}^{z} \beta_1 \Delta lnGDPgrowth_{it-1} + \sum_{k=0}^{l1} \beta_2 \Delta IR_{it-1} \\ & + \sum_{k=0}^{l2} \beta_3 \Delta lnGS_{it-1} + \sum_{k=0}^{l3} \beta_4 \Delta lnDI_{it-1} + \sum_{k=0}^{l4} \beta_5 \Delta lnINF_{it-1} \\ & + \sum_{k=0}^{l5} \beta_6 \Delta lnPRO_{it-1} + \sum_{k=0}^{l6} \psi_7 \Delta lnREER^{+}_{it-1} \\ & + \sum_{k=0}^{l7} \psi_8 \Delta lnREER^{-}_{it-1} + \varepsilon_t,\end{aligned} \tag{8}$$

where GDPgrowth is the real gross domestic growth rate, INF_t is the inflation or consumer price index and PRO_t is the productivity. The gross domestic per capita $GDPpc_t$ measures a country's GDP divided by its total population. The inflation or consumer price index (CPI) measures changes in the prices of purchased goods and services. The productivity $PROpc_t$ measures gross domestic product per hour of work.

The results of the estimate of panel nonlinear equation (8) are presented in Table 7. In the A panel, there is also evidence of an asymmetric effect due to ER on GDP growth in the short run, since the sum of the estimates of the appreciation coefficients in the short run are different from the sum of estimates of the depreciation coefficient in the short run. Appreciation has a positive sign and significant effect on the GDP growth of SEE countries in the second lags, while depreciation has a negative sign and significant effect on GDP growth in the fifth lag.

The effects of ER in the short run are transmitted into an effect on GDP growth in the long run in the case of SEE countries. In the long run, in the B panel, due to the decomposition of a partial sum of appreciation and depreciation, it was found that appreciation and depreciation have a significant effect on the GDP growth of SEE countries. Based on the Wald statistics estimate (see the C panel), the significant asymmetric effect of ER on the GDP growth of SEE countries in the long run was confirmed.

Table 7 Estimate of Panel NARDL Model

Panel A: Short Run Coefficient Estimates					
Lag order	*0*	*1*	*2*	*3*	*4*
*Δ*lnREER+	0.19 (1.16)	0.24 (2.14) **	0.15 (1.51)	0.08 (0.64)	0.11 (1.22)
*Δ*lnREER-	0.40 (1.52)	0.25 (1.34)	0.13 (0.55)	0.27 (1.70) *	-0.34 (12.34) **
*Δ*IR	0.01 (0.07)	-0.01 (-0.85)	0.01 (0.23)	0.01 (0.32)	0.02 (4.76) ***
*Δ*lnGS	0.02 (1.02)	0.04 (0.50)	0.03 (1.27)	-0.01 (-0.16)	0.04 (2.35) **
*Δ*lnDI	0.05 (1.75) *	0.07 (2.28)**	0.01 (0.73)	-0.01 (-2.28)	-0.02 (-1.34)
*Δ*INF	-0.01 (-1.26)	0.01 (0.14)	-0.01 (-0.48)	0.01 (1.22)	0.02 (2.45) **
*Δ*PR	0.01 (4.76) ***	0.01 (2.32) **	0.02 (3.02) ***	0.02 (3.62) ***	0.01 (2.56)

Panel B: Long Run Coefficient Estimates						
lnREER+	lnREER-	IR	lnGS	lnDI	INF	PR
2.94 (3.17) **	1.44 (2.06) ***	0.03 (0.48) **	0.20 (2.10) **	0.13 (2.26) **	0.01 (2.25) **	0.02 (2.88) **

Panel C: Diagnostic Statistics		
Wald test	Adj. R2	Number of observations:
77.67***	0.52	399

Notes: ***, ** and * indicate "statistical significance" at 1%, 5% and 10% levels, respectively.

Source: Author's compilation.

Unlike the short run, in the long run we found the opposite effect. For SEE countries, it was found that appreciation and depreciation have a positive sign of the estimated coefficients. For SEE countries, appreciation and depreciation have an expansionary effect on GDP growth. The size of the appreciation and depreciation coefficient is different and significant, indicating the existence of asymmetry in the long term. For SEE countries, it was found that an expansionary appreciation has a stronger effect on the GDP growth relative to expansionary depreciation. An expansionary appreciation of a 1% point has led to an increase in the GDP growth of SEE countries by 2.94%, while an expansionary depreciation of 1.44% has led to a

decrease in the GDP growth. An expansionary appreciation of the domestic currency might reduce the cost of imported intermediate goods with a positive effect on the output supply and real growth (Kandil, 2015).

In the long run, independent variables such as government spending, interest, domestic investment, inflation and productivity have a significant effect on the GDP growth of SEE countries. Results of the estimate of the coefficient of independent variables, such as government spending, interest, and domestic investment, are in line with results of the estimate of our basic model or equation (5). In terms of two additionally included independent variables (inflation and productivity), it was found that low inflation has a positive effect on the GDP growth of SEE countries. Low inflation is in correlation with GDP growth, and vice versa. Low inflation might lead to appreciation of the ER. In addition, productivity has a positive effect on the GDP growth of SEE countries. Positive effects of productivity on economic growth might be the result of the improvement of technological process, development of human capital and growth of domestic investment. In addition to positive effects on economic growth, an increase in productivity might lead to the appreciation of real ER, since productivity is transmitted through the real exchange rate based on tradable prices (Kaplan, 2015).

5. Conclusions

The currency changes receive special attention as they can have a significant effect on macroeconomic variables such as the GDP, net export, current account, inflation, consumption, interest rate, FDI, and domestic investment. The previous studies have mostly examined the symmetric effect of the ER on GDP in the SEE countries and disregarded the asymmetric effect. Therefore, this study is considered to be the first to examine the asymmetric effect of the ER on GDP in SEE countries.

Using the nonlinear ARDL model provided the following results, evidence was found for short term asymmetry in the ER in relation to the GDP of Croatia, Romania and Serbia, but not that of Bulgaria and Slovenia. Secondly, the effects of the ER in the short run are transmitted into long term effects on the GDP of Croatia, Romania and Serbia. An expansionary appreciation and expansionary depreciation both have a long-term effect on the GDP of Croatia and Romania. An expansionary appreciation effect on GDP was found for Serbia, while the contractionary depreciation effect was neutral. Based on the results, an expansionary appreciation of the domestic currency might lead to a decrease in the cost of imported goods, and an increase in the supply and GDP growth of Croatia and Serbia. In addition, expansionary appreciation in these countries might lead to a greater FDI inflow as a result of the decrease in prices of semi-finished goods and better business conditions. Also, an expansionary appreciation of the ER might lead to a decrease in import prices, a decrease in the cost of intermediate imported goods, a strengthening of the purchasing power of consumables, and a decrease in inflation in Croatia and Serbia. Due to an expansionary appreciation, there might be a decrease in the price of intermediate goods and better conditions for doing business as the inflow of FDI increased in these countries. This also might result in the stimulation of exports as a result of reducing the manufacturing costs. Finally, within the defined managed float

system of ER, the expansionary appreciation had a positive effect on economic growth.

On the other hand, an expansionary appreciation and expansionary depreciation of the ER is significant and has a positive effect on the GDP of Romania. The expansionary depreciation effect of the ER is stronger than the expansionary appreciation effect on the GDP. This effect caused the growth in aggregate demand to be smaller than the reduction in aggregate supply. This might lead to an increase of the price of traded goods, a decrease in manufacturing, a negative effect on the deficit of current account, etc. The expansionary depreciations are a possible result of non-elastic demand for the export of goods, intermediate goods, and raw materials from Romania.

The policymakers of these countries may use ER changes as an instrument to increase their economic growth. A leading currency policy, within the managed float system of ER, requires taking into consideration certain specific features of a country such as economic competitiveness and trade terms. It is recommended for policymakers in Croatia, following the strengthening of the competitiveness of their economy and trade terms, to use expansionary appreciation more as it has a stronger effect on the GDP growth. Similarly, it is recommended for policymakers in Serbia to use more expansionary appreciation or a stronger currency that in the long run has a stronger effect on GDP growth relative to depreciation, which has a neutral effect. It is recommended for policymakers in Romania to use expansionary appreciation more and less contractionary depreciation, as it has a negative effect on GDP growth.

However, there are certain limitations reflected in the lack of data for the estimation of the impact of the ER on economic growth by the industrial sectors of SEE countries. Our future paper will focus on examining the asymmetric impact of the ER on the aggregate supply in SEE economies.

APPENDIX

Table A1 Description Variables and Data Source

Variables	*Definition and Measurement*	*Data source*
Gross Domestic Product per capita (GDPpc)	It measures a country's GDP divided by its total population (constant 2010 US dollars).	International Financial Statistics of the IMF https://data.imf.org/regular.aspx?key=61545852
Interest rate (IR)	The real interest rate (% of GDP) is adjusted for the effect of inflation and reflects the real cost of funds to the borrower, and the real yield to the lender - quarterly data.	International Financial Statistics of the IMF https://data.imf.org/regular.aspx?key=61545855
Government spending (GS)	Government spending refers to money spent on education, healthcare, social protection, and defence. Real data in national currency is deflated by GDP deflator – quarterly data in millions.	International Financial Statistics of the IMF https://data.imf.org/regular.aspx?key=61545852
Domestic investment (DI) or Gross domestic capital formation	It measures the outlays of the additions to the fixed assets of the economy plus net changes in the level of inventories. Real data in national currency – quarterly data in millions.	International Financial Statistics of the IMF https://data.imf.org/regular.aspx?key=61545852
Real effective exchange rate (REER)	The REER is the weighted average of a country's real exchange rate in relation to an index or basket of other major real exchange rates.	Eurostat https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ert_eff_ic_q&lang=en National Bank of Serbia https://www.nbs.rs/en/drugi-nivo-navigacije/statistika/ks_stat/
Real Gross domestic growth rate (GDPgrowth)	It measures economic growth, as expressed by gross domestic product (GDP), from one period to another, adjusted for inflation or deflation	International Financial Statistics of the IMF https://data.imf.org/regular.aspx?key=61545852
Inflation (INF)	The Consumer Price Index (CPI) is measured changes in the prices of purchased goods and services and services purchased or otherwise acquired by households, which households use directly, or indirectly, to satisfy their own needs and wants.	International Financial Statistics of the IMF https://data.imf.org/?sk=4FFB52B2-3653-409A-B471-D47B46D904B5&sId=1485878855236
Productivity (PRO)	The productivity is measured as gross domestic product per hour of work. This data is adjusted for inflation and for differences in the cost of living between countries.	Organisation for Economic Co-operation and Development (OECD) https://data.oecd.org/lprdty/gdp-per-hour-worked.htm

Table A2 Descriptive Statistics

Variables	*GDP*				*REER*				*IR*			
	Mean	*Stan. Dev*	*Max.*	*Mini.*	*Mean*	*Stan. Dev*	*Max.*	*Min.*	*Mean*	*Stan. Dev*	*Max.*	*Min.*
BUL	6199	1341	8234	3717	91	10	101	68	3.9	3.2	10.3	-0.9
CRO	11730	1297	11779	8805	96	3	101	87	7.9	3.9	14.0	1
ROM	7838	1987	11221	4548	96	8	114	78	4.9	4.0	12.6	-2.1
SRB	5061	984	6568	3193	114	14	140	82	8.6	5.4	16.3	1
SLN	20372	2151	24071	16241	98	2	101	95	2.5	2.3	8.5	-1.2

Variables	*GS*				*DI*			
	Mean	*Stan. Dev*	*Max.*	*Min.*	*Mean*	*Stan. Dev*	*Max.*	*Min.*
BUL	3109	1153	5724	1345	5347	9875	7239	1062
CRO	1548	3484	2287	9294	1725	3753	2541	8253
ROM	2122	1278	5112	2769	3407	1852	7498	3240
SRB	1465	627	2873	1620	1514	8219	3339	8984
SLN	1774	997	10081	823	2185	2401	2367	1246

Notes: Gross domestic per capita (GDP), Real effective exchange rate (REER), Interest rate (IR), Government spending (GS), Domestic investment (DI).

Source: Author's compilation

Table A3 Correlation between Variables by Country

BUL	***GDP***	***REER***	***IR***	***GS***	***DI***
GDP	1	0.69	-0.62	0.27	0.40
REER	0.69	1	-0.25	0.29	0.23
IR	-0.62	-0.25	1	-0.18	-0.35
GS	0.29	0.34	-0.29	1	0.45
DI	0.40	0.23	-0.35	0.45	1
CRO	***GDP***	***REER***	***IR***	***GS***	***DI***
GDP	1	0.60	-0.56	0.55	0.49
REER	0.60	1	-0.34	0.44	0.53
IR	-0.56	-0.34	1	-0.53	-0.42
GS	0.55	0.44	-0.44	1	0.61
DI	0.49	0.53	-0.42	0.61	1
ROM	***GDP***	***REER***	***IR***	***GS***	***DI***
GDP	1	0.67	-0.49	0.56	0.54
REER	0.67	1	-0.51	0.48	0.47
IR	-0.49	-0.51	1	-0.79	-0.46
GS	0.54	0.48	-0.79	1	0.57
DI	0.54	0.47	-0.46	0.57	1
SRB	***GDP***	***REER***	***IR***	***GS***	***DI***
GDP	1	0.69	-0.55	0.62	0.63
REER	0.69	1	-0.61	0.47	0.59
IR	-0.55	-0.61	1	-0.48	-0.48
GS	0.62	0.47	-0.48	1	0.56
DI	0.63	0.59	-0.48	0.56	1
SLN	***GDP***	***REER***	***IR***	***GS***	***DI***
GDP	1	0.56	-0.58	0.16	0.30
REER	0.56	1	-0.52	0.18	0.56
IR	-0.58	-0.52	1	-0.09	-0.53
GS	0.16	0.18	-0.09	1	0.10
DI	0.30	0.57	-0.52	0.10	1

Notes: Gross domestic per capita (GDP), Real effective exchange rate (REER), Interest rate (IR), Government spending (GS), Domestic investment (DI).

Source: Author's compilation

Table A4 Multicollinearity Test

Country/variables	*REER*	*IR*	*GS*	*DI*
BUL	2.85 (5.58)	3.85 (4.68)	0.04 (1.34)	6.37 (1.39)
CRO	2.35 (3.17)	1.29 (3.02)	0.03 (4.72)	0.01 (2.34)
ROM	1.53 (3.33)	7.43 (3.93)	0.03 (1.61)	0.02 (2.29)
SRB	0.02 (3.79)	0.04 (2.20)	4.26 (2.03)	1.95 (1.58)
SLN	8.10 (4.99)	0.02 (3.77)	1.38 (1.06)	2.47 (2.84)

Notes: The numbers outside the brackets represents the coefficient of variance, while the numbers inside the brackets represents the centred variance inflation factors (VIF).

Source: Author's compilation

Table A5 Unit Root Tests

Variables	***GDP***					
Country	***ADF***		***PP***		***KPSS***	
	Intercept	***Trend & intercept***	***Intercept***	***Trend & intercept***	***Intercept***	***Trend & intercept***
BUL	-4.05**	-4.00*	-14.9**	-14.8*	0.45**	0.17**
	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
CRO	-10.0***	-10.1***	-10.0***	-10.2***	0.64**	0.19**
	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
ROM	-8.98***	-8.91***	-8.98***	-8.91***	0.56***	0.15**
	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
SRB	-11.4***	-11.5***	-12.2***	-12.3***	0.42**	0.21***
	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
SLN	-9.80***	-9.78***	-9.81***	-9.78***	0.73***	0.16**
	I(1)	I(1)	I(1)	I(1)	I(0)	I(I)
Variables	***REER***					
Country	***ADF***		***PP***		***KPSS***	
	Intercept	***Trend & intercept***	***Intercept***	***Trend & intercept***	***Intercept***	***Trend & intercept***
BUL	-15.3***	-15.2***	-9.21***	-10.0***	0.74**	0.22***
	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
CRO	-3.52***	-3.75**	-9.62***	-10.5***	0.47**	0.21***
	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
ROM	8.07***	-8.08***	-8.06***	-8.07***	0.47**	0.25***
	I(0)	I(0)	I(1)	I(1)	I(1)	I(1)
SRB	-7.00***	-7.10***	-6.18***	-6.22***	0.62***	0.19***
	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)
SLN	-14.1***	-14.2***	-14.5***	-15.1***	0.73***	0.17**
	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Table A5 Unit Root Tests Continued

Variables	*IR*					
Country	*ADF*		*PP*		*KPSS*	
	Intercept	*Trend & intercept*	*Intercept*	*Trend & intercept*	*Intercept*	*Trend & intercept*
BUL	-12.7*** I(1)	-12.6*** I(I)	-13.2*** I(1)	-13.1*** I(I)	0.69*** I(1)	0.23*** I(1)
CRO	-10.2*** I(1)	-10.2*** I(1)	-10.2*** I(1)	-10.1*** I(1)	0.73*** I(1)	0.21*** I(1)
ROM	-6.17*** I(0)	-6.64*** I(0)	-6.11*** I(1)	-6.57*** I(1)	0.76*** I(1)	0.24** I(I)
SRB	-4.22*** I(1)	-3.95** I(1)	-7.41*** I(0)	-7.57*** I(1)	0.73*** I(0)	0.22** I(I)
SLN	-9.67*** I(1)	-10.0*** I(1)	-9.67*** I(1)	-10.1*** I(1)	0.87*** I(0)	0.21*** I(1)
Variables	*GS*					
Country	*ADF*		*PP*		*KPSS*	
	Intercept	*Trend & intercept*	*Intercept*	*Trend & intercept*	*Intercept*	*Trend & intercept*
BUL	-14.9*** I(1)	-15.1*** I(1)	-14.9*** I(1)	-15.6*** I(1)	0.89*** I(1)	0.16** I(1)
CRO	-8.88*** I(1)	-8.84*** I(1)	-8.89*** I(1)	-8.85*** I(1)	0.75*** I(1)	0.18** I(1)
ROM	-12.21*** I(1)	-12.57*** I(1)	-12.3*** I(1)	-12.6*** I(1)	0.77*** I(1)	0.19** I(1)
SRB	-9.20*** I(1)	-9.22*** I(1)	-5.97*** I(1)	-5.90*** I(1)	0.79*** I(1)	0.17** I(0)
SLN	-10.8*** I(1)	-10.7*** I(1)	-7.8*** I(1)	-7.9*** I(1)	0.56** I(0)	0.50* I(1)
Variables	*DI*					
Country	*ADF*		*PP*		*KPSS*	
	Intercept	*Trend & intercept*	*Intercept*	*Trend & intercept*	*Intercept*	*Trend & intercept*
BUL	-7.45*** I(1)	-7.72*** I(1)	-7.45*** I(1)	-7.72*** I(1)	0.56** I(1)	0.13** I(1)
CRO	-2.82* I(1)	-3.22** I(1)	-8.68*** I(1)	-8.62*** I(1)	0.55** I(1)	0.16** I(1)
ROM	-6.90*** I(1)	-6.90*** I(1)	-6.91*** I(1)	-6.91*** I(1)	0.71*** I(1)	0.15* I(1)
SRB	-8.25*** I(1)	-8.22*** I(1)	-8.33*** I(1)	-8.32*** I(1)	0.76*** I(1)	0.22** I(I)
SLN	-4.07*** I(1)	-4.00** I(1)	-7.93*** I(1)	-7.87*** I(1)	0.43** I(1)	0.17** I(0)

Notes: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) tests, Kwiatkowski – Phillips – Schmidt – Shin (KPSS). I (0) level, I (1) first difference. Individual lag lengths are based on Akaike Information Criteria (AIC). ***, ** and * indicate "statistical significance" at 1%, 5% and 10% levels, respectively.

Source: Authors' compilation

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