SERBIA'S FOREIGN EXCHANGE RESERVE ADEQUACY AND THE FACTORS INFLUENCING THEIR ACCUMULATION

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In this paper, the adequacy of foreign exchange reserves in the Republic of Serbia (RS) and the factors that influence their accumulation is analyzed by means of an econometric model. The relevant variables, such as the Gross Domestic Product (GDP), the Real Effective Exchange Rate (REER) and monetary aggregate M2/GDP are included in the analysis. The unit root tests applied in the research led to the conclusion that the timeseries were integrated of the order I(1). The cointegration test revealed that there was one cointegration equation. The regression model was estimated using the quarterly data for the period from 2002q1 to 2020q3. The estimated cointegration coefficients showed that the economic activity approximated in terms of the GDP had a significant influence on foreign exchange reserves accumulation, which is only followed by appreciation pressure on the dinar (approximated by the REER index) and money supply growth (estimated through the monetary aggregate M2/GDP). In addition to conventional factors, the analysis also points out specific factors and their impact on foreign exchange reserve accumulation in RS. The results of the research study show that foreign exchange reserves in RS are greater than the levels suggested by standard optimality criteria. The findings also suggest that it is necessary to take into account the dividends realized by foreign investors, as well as some segments of portfolio investment in assessing the specific indicator of the adequate level of foreign exchange reserves.

Keywords: foreign exchange reserves, gross domestic product, real effective exchange rate, money supply M$_2$, external debt, cointegration

INTRODUCTION

Globalization and liberalization in the world economy have led to growing involvement in world trade and international financial flows for the largest number of countries. In itself, this imposed a need for countries to have an adequate amount of foreign exchange reserves, which has only been reinforced by disruptions in the international flows of goods, services and capital in recent decades. The greater openness of a country also carries a higher risk of external disturbances. In order to dampen and soften

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said disruption, larger foreign exchange reserves are needed. In international finance, the "international reserves" term includes monetary gold, Special Drawing Rights (SDR), cash and deposits abroad, securities in foreign currencies and a country's reserves position with the International Monetary Fund (IMF). Considering that the National Bank of Serbia (NBS) uses the term "foreign exchange reserves" instead of the term "international reserves" in the same scope as the term "international reserves" (NBS, 2020, 110), the term "foreign exchange reserves" is used in this paper as in the NBS as a synonym for "international reserves". The question of the optimal level of every country's foreign exchange reserves has been attracting economists' attention for a long time. Many research papers and empirical research studies are dedicated to this topic. They can generally be divided into two groups. The first group contains the papers that investigate the optimal level of foreign exchange reserves (Frenkel & Jovanovic, 1981; Jeanne & Rancière, 2011; Aizenman & Sun, 2012; IMF, 2015). The second group includes the papers that investigate the factors influencing foreign exchange reserve accumulation (Bahmani-Oskooee & Brown, 2002; Rogoff, Hussain, Mody, Brooks & Oomes, 2004; Sula, 2011; Bruno & Shin, 2015; Bošnjak, Bilas & Kordić, 2020).

The subject matter of the research study conducted in this paper implies considering the adequacy of foreign exchange reserves in the Republic of Serbia (RS), taking into account the usual criteria from the literature on international economics. The motivation for this research stems from the fact that, in recent decades, Emerging Market Economies (EMEs) have shown a tendency to increase their foreign exchange reserves. The empirical research shows that the countries with larger amounts of foreign exchange reserves have found it easier to deal with external shocks due to financial crises (Davis, Cowley & Morris, 2018). Bearing in mind the impact of the 2008-2009 global economic and financial crisis on the world economy, as well as the effects of the COVID-19 pandemic on world trade and international capital flows, it is necessary to review and analyze the current level of foreign exchange reserves in RS.

The aim of this paper is to assess the extent to which Serbia's foreign exchange reserves meet international standards, taking into account relevant criteria. In addition to that, the research study is aimed at assessing the impact of those relevant factors on the accumulation of foreign exchange reserves in RS by applying an appropriate econometric model. The findings should serve as recommendations in the implementation of an adequate foreign exchange reserve policy in the future.

Starting from the research subject and goal, the research hypotheses are as follows:

H1: The GDP, the appreciation of the REER of the dinar and Serbia's money supply significantly affect the volume of foreign exchange reserves.

H2: The current level of Serbia's foreign exchange reserves is adequate according to the relevant indicators.

H3: The level of the openness of the economy and the foreign capital stock in the Republic of Serbia suggest a need for strengthening foreign exchange reserves in the future.

In accordance with the objectives of the research study, the basic indicators for the assessment of the adequacy of the current level of foreign exchange reserves in RS are analyzed in this paper. Bearing in mind the openness of the Serbian economy and the accumulated net-debt external position, as well as the cyclical trends of the world economy and the occurrence of crises, the emphasis is put on considering the impact of precautionary motives in creating foreign exchange reserves. Although these are traditional motives, international financial fluctuations (as a side effect of economic and financial crises) reaffirm the attractiveness of these reasons for the creation of an adequate level of foreign exchange reserves. Hereinafter, an econometric model is used as a satisfactory framework in order to analyze the impact of the selected variables on the accumulation of foreign exchange reserves in RS. The cointegrating equation is estimated by using the said model.

In addition to the Introduction, the paper is organized into three parts and the Conclusion. The first part is

a review of the empirical literature. The second part refers to the stylized facts about the accumulation of foreign exchange reserves in RS. In the third part, the data and methodology of the research study are described and the results of the applied econometric model are presented and discussed. In the Conclusion, the main findings of the research study and the implications for the future accumulation of foreign exchange reserves in RS are presented together with the limitations and directions for future research in this area.

LITERATURE REVIEW

The literature on the optimal level of foreign exchange reserves and the reasons for their growth in EMEs since the 1990s is quite extensive. Recently, the drivers of foreign exchange reserve accumulation and the indicators used to determine foreign exchange reserve adequacy have been reexamined. Foreign exchange reserves are mainly accumulated as a result of a country's certain goals, which include economic growth, the price stability, financial fluctuations prevention, export competitiveness protection (central bank interventions on the foreign-exchange market so as to prevent the appreciation of the national currency), foreign exchange management, and so on (Ho & McCauley, 2003; Aizenman & Lee, 2007; Magud & Sosa, 2010; Aizenman, Yin-Wong & Ito, 2014; Ghosh, Ostry & Qureshi, 2017; Jones, 2018; Arslan & Cantú, 2019; Hofmann, Song Shin & Villamizar-Villegas, 2019).

Although foreign exchange reserves bring significant benefits to a country, there is a substantial cost associated with a large amount of such reserves. D. Rodrik (2006) points out the fact that these costs arise because interest rates on foreign exchange reserves are lower than interest rates on foreign borrowings. Based on this difference, he finds that the cost of foreign exchange reserves in EMEs is close to 1% of their GDP (Arslan & Cantú, 2019, 11). However, E. Levy-Yeyati (2008) argues that the previous calculation does not take into account the fact that a smaller amount of foreign exchange reserves would raise interest rates

on foreign loans, so that actual costs are lower than D. Rodrik's (2006) estimate. In addition to that, the foreign exchange reserves of EME central banks have significantly been diversified in recent years, aimed at increasing yields. In any case, the costs of insufficient foreign exchange reserves to defend a country's financial system affected by an external shock may be higher and more painful than the costs incurred due to the accumulation of foreign exchange reserves. Of course, it is necessary to determine the optimal level of foreign exchange reserves, taking into account a number of factors. O. Blanchard and G. Adler (2015) prove that central bank interventions on the foreign exchange market may help to mitigate the shocks in capital flows to the exchange rate and capital account.

M. Fratzscher, O. Gloede, L. Menkhoff, L. Sarno and T. Stöhr (2019) confirmed the effectiveness of central bank interventions in mitigating the exchange rate volatility although they do not provide convincing evidence of the impact of interventions on the exchange rate itself. New country-specific analyses are less convincing in proving the effectiveness of interventions. Using data on daily interventions in Brazil between 2011 and 2015, M. Janot and L. Macedo (2016) point out the fact that an unexpected intervention affects the exchange rate level to some extent, but it does not affect the exchange rate volatility. P. Agenor and L. Pereira da Silva (2018) emphasize the fact that, in countries with high financial dollarization, interventions on the foreign exchange market are motivated by financial stability. Therefore, they believe that interventions on the foreign exchange market can be understood as a part of the macroprudential package. J-P. Allegret and A. Allegret (2018) point out the fact that the accumulation of foreign exchange reserves increases the macroeconomic resilience of the domestic economy to external shocks. S. Davis, M. B. Devereux and C. Yu (2020) argue that intervention on the foreign exchange market can be used to avoid sudden stoppages in capital inflows in a small open economy with emerging markets. N. Popovska-Kamnar, M. Nikolov and A. Sulejmani (2016) analyzed the determinants of foreign exchange reserves in the Republic of Macedonia using the quarterly data for the period from 2004 to 2016. The empirical evidence in that paper of theirs, including

an ordinary least squares estimation, showed that there was a significant relationship between foreign exchange reserves, as the dependent variable, and reference interest rates, the unit value of imports, the nominal GDP and the exchange rate (euro/denar), as the independent variables. The authors concluded that the exchange rate had the greatest impact on the level of foreign exchange reserves.

M. Bošnjak *et al* (2020) applied quantile regression in doing research into the determinants of foreign exchange reserves in RS and Northern Macedonia. Based on the quarterly data for the period from 2005q1 to 2019q1, the authors showed that the appreciation of the REER of the dinar supported the increase in Serbian foreign exchange reserves, the relationship being significant in all the observed quintiles. They also found that the monetary aggregate M2/GDP had an impact on the growth of foreign exchange reserves in RS, whereas the impact the GDP exerted on the growth of foreign exchange reserves was not significant. Unlike RS, the empirical evidence for Northern Macedonia showed that the GDP level was a significant determinant of the level of foreign exchange reserves, whereas the impact of REER was mixed, individually by quantiles. The same methodology was applied by Bošnjak *et al* (2019) in their research into the factors that affected the accumulation of foreign exchange reserves in Croatia. The results showed that the GDP (at constant prices) and the nominal exchange rate against the euro (daily, at the end of the period) were the significant factors of international foreign exchange reserves in the Republic of Croatia. At higher levels of foreign exchange reserves, their elasticity increased. The authors found that the elasticity of Croatia's foreign exchange reserves to changes in the exchange rate lost its statistical significance at a level above the seventh decile.

STYLIZED FACTS

EMEs' foreign exchange reserves have been growing since the early 1990s. Their average level increased from 5% of the GDP in 1990 to 30% of the GDP in 2018

(Arslan & Cantú, 2019, 2). Central banks accumulate foreign exchange reserves for various reasons. As a rule, the crises of the 1980s to date have carried the risk of a sudden interruption of capital flows, which might cause disturbances in the financial system and significantly disrupt economic growth. During the 2008-2009 global financial crisis, the EMEs that held a relatively higher amount of foreign exchange reserves experienced a lesser depreciation of the national currency (Davis *et al*, 2018). The central banks that hold large foreign exchange reserves can efficiently use them in the times of stress so as to provide foreign exchange liquidity to domestic financial institutions and nonfinancial companies, all in order to alleviate the consequences of the reduced lending activity. Small open economies are particularly exposed to disturbances in foreign trade (Ghosh, Ostry & Tsangarides, 2014) and their capital account is sensitive to interruptions in the foreign fund inflow (Obstfeld, Shambaugh & Taylor, 2010; Borio & Disyatat, 2015; Alberola, Erce & Serena, 2016). Accompanied by the growth of capital flows over the past few decades, financial globalization has created a satisfactory framework for the rapid transmission of external shocks. Therefore, cautionary motives for increasing foreign exchange reserves have strengthened in EMEs, serving as a shock absorber which should absorb transient shocks to the balance of payments. A higher amount of foreign exchange reserves also acts as a deterrent to currency speculation.

L. Cabezas and J. De Gregorio (2019) point out the fact that speculation prevention was a strong motive for the increase in foreign exchange reserves during the 2000s. The reserves can discourage speculators even when they are not being used. An increase in foreign exchange reserves can also be seen as a strategy to prevent the appreciation of the national currency, thus preserving export competitiveness (Aizenman & Lee, 2007; Rodrik, 2008). This is especially important for countries with a trade deficit and a current account deficit. In doing so, each country defines the appropriate level of foreign exchange reserves based on several indicators. Numerous indicators of the adequate level of foreign exchange reserves are given in the literature. Each one of them starts from protection against individual risks. Foreign exchange reserves have the task to enable a country

to achieve satisfactory external liquidity and prevent disturbances in the domestic financial system in the cases of external or internal shocks. Using foreign exchange reserves to maintain financial stability, countries protect their banking sectors. This role of foreign exchange reserves is especially noticeable in the countries where foreign-owned banks play the dominant role in the banking system.

In this paper, several selected indicators are used to assess the adequate level of foreign exchange reserves in RS. Unless otherwise indicated, foreign exchange reserves in RS mean the net foreign exchange reserves of the NBS (the foreign exchange reserves of the NBS not including the foreign exchange reserves of commercial banks). If banks' foreign exchange reserves are included, then they are gross foreign exchange reserves. The dynamics of foreign exchange reserves and their relationship to the short-term debt and GDP of RS are shown in Figure 1.

The accumulation of Serbia's foreign exchange reserves is taking place in parallel with the growth of the GDP and an increase in the country's openness. At the end of September 2020, the NBS's foreign exchange reserves reached the equivalent of 13

billion euros (28.2% of the GDP in the third quarter of 2020, Figure 1; data are given in the Annex, Table A), which is almost three times greater than it was in 2005. The quantity of foreign exchange reserves is typically related to the value of the imports of goods and services, where the amount that covers the quarterly value of the imports of goods and services is the reference value. The value of this indicator for RS exceeds the usual reference value, with oscillations from 9.7 months in 2009 to 5.4 months in 2018 (this indicator focuses on the current account and is especially important in the countries with limited access to the international capital market). Although this indicator belongs to traditional foreign exchange reserve adequacy measures, it is still used by international financial institutions. The important indicator of foreign exchange reserve adequacy is their ratio to the GDP. In recent years, this indicator in Serbia has been around 30%, which coincides with the average realized value for EMEs (Arslan & Cantü, 2019, 2).

The ratio of foreign exchange reserves to the short-term external debt with remaining maturity is also one of the most broadly used indicators of foreign exchange reserve adequacy, being the measure
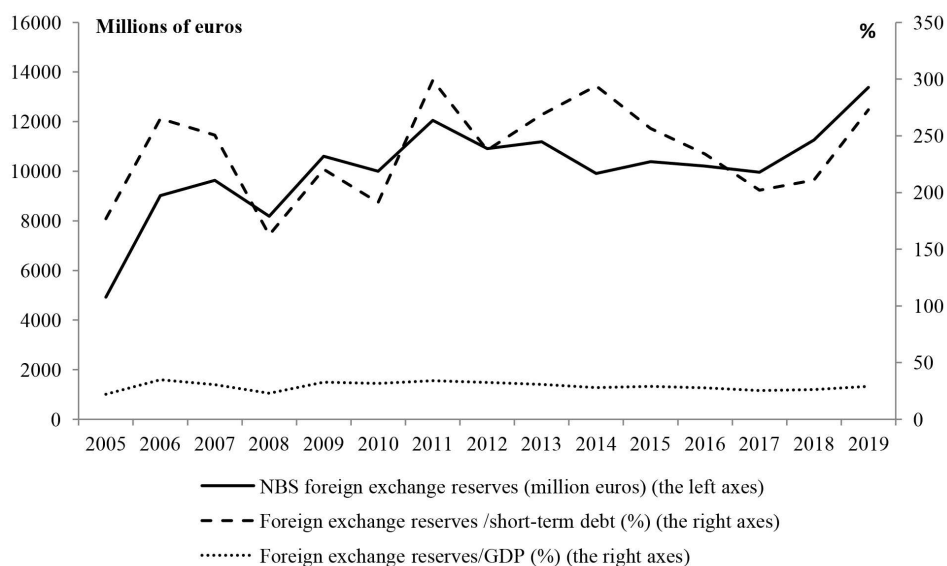

Figure 1 Serbia's foreign exchange reserves

Source: Author, based on: Table A (in Appendix)

of potential demand for foreign exchange on the foreign exchange market needed to repay a short-term external debt. The coverage ratio of 100% is considered as desirable. (Jeanne & Rancière, 2011, estimate that the optimal ratio of foreign exchange reserves to a short-term debt ranges from 90 to 100% if a sudden break in capital inflows is greater than 10% of the GDP.) This indicator of Serbia's external liquidity was around 270% in 2019, with a tendency to decrease in 2020. Its value indicates that Serbia's external liquidity is satisfactory, which facilitated the strike of the 2008-2009 crisis, certainly contributing to internal macroeconomic stability during the crisis caused by the COVID-19 coronavirus pandemic. In the cases of shocks abroad or disturbances in the country, a short-term debt may quickly 'leave' the country instead of the revolving in a usual manner, thus exerting pressure on the domestic currency. Therefore, keeping a short-term debt under control is an important prerequisite for external liquidity maintenance.

In relation to the money supply M_1, the NBS level of foreign exchange reserves has been providing coverage for money supply over 160% in recent years (in 2015, the coverage was 250%, only to decrease and fall to 136% in the third quarter of 2020) (see the Annex, Table A). The downward trend in this indicator in 2020 is a consequence of the stronger growth of M_1, which can turn into increased demand for foreign exchange on the foreign exchange market. In the literature, the ratio of foreign exchange reserves and a broader money supply aggregate, M_2, is used as a measure of the adequate level of foreign exchange reserves. This indicator is the measure of potential demand for foreign exchange from domestic sources. It is considered as relevant for the countries with developed financial markets and open capital accounts. The optimal benchmark is usually 20% (Arslan & Cantú, 2019, 5).

At the end of 2019, foreign exchange reserves in Serbia provided coverage for the M_3 money supply with 55.7% (according to the NBS, foreign exchange reserves in the amount of 20% of the M_3 money supply are considered as optimal; NBS, 2019, 25). The maintenance of the current level of external liquidity is particularly important if the fact that the NBS sold

1450 million euros net on the foreign exchange market in 2020 in order to maintain its relative stability is appreciated. The role of foreign exchange reserves in the context of a flexible exchange rate is to maintain the country's financial credibility by reducing the costs of excessive dinar exchange rate volatility and mitigate the risk of a sudden capital outflow from the country, too. In order to preserve the value of foreign exchange reserves, the NBS increased the share of gold in foreign exchange reserves to about 13% at the end of November 2020 in addition to the diversification by currencies and instruments.

In order to more accurately assess foreign exchange reserve adequacy, the NBS has constructed the indicator called "the right measure for Serbia", the concept of which is a modification of the Greenspan-Guidotti indicator (Guidotti, Sturzenegger & Villar, 2004) and whose task is to take into account the specifics of the Serbian economy. According to this indicator, the level of foreign exchange that provides coverage for several potential sources of demand for a foreign currency (the short-term debt by remaining maturity, the current account deficit adjusted for net FDIs, 15% foreign currency and foreign exchange indexed and 5% dinar corporate and household deposits) is accepted as an adequate level of foreign exchange reserves (NBS, 2011, 17). At the end of 2019, this composite indicator amounted to 187.7%, which means that the level of Serbia's foreign exchange reserves was 87.7% higher than the required amount according to this indicator. Although this indicator is adjusted for the Serbian economy, it starts from the assumption that the net inflow of FDIs is a stable source of financing, because the amount of the current account deficit is adjusted by the amount of the net inflow of FDIs.

In our opinion, it would be more expedient to increase foreign exchange reserve adequacy by the amount of foreign investors' dividends instead of the corrected current account deficit with a net FDI inflow, because they can be repatriated quickly (for the time being, they are mostly reinvested in RS). There are also convincing reasons for the inclusion of a part of foreign portfolio investments in this indicator. Namely, in the case of an internal or external shock, a part of the total portfolio investments may be converted into

short-term capital to flee the country. These reasons justify the inclusion of these two aggregates together with the other above-mentioned components in the specific indicator of Serbia's foreign exchange reserve adequacy. The fact that, according to the O. Jeane and R. Ranciere (2011) model, the optimal level of Serbia's foreign exchange reserves at the end of 2019 was confirmed by all the five stress scenarios should also be noted. The optimal level of foreign exchange reserves in this model includes the size and probability of sudden stagnation in capital inflows, a potential loss of production and consumption, the opportunity cost of holding reserves and a risk aversion degree. Stress scenarios involve different sizes of shocks (NBS, 2011, 18). As a small open economy, Serbia is characterized by the existence of a current account deficit, which is primarily generated by a trade deficit (Figure 2). Given the structural nature of the trade deficit, it is not surprising that there is a correlation between economic growth and an increase in Serbia's trade deficit. Therefore, economic growth and the GDP affect foreign exchange reserves.

The Serbian economy has experienced growth in 'openness' since 2001, which coincides with the higher rates of economic growth and the increase

in the trade deficit and the current account deficit until 2008. The growth of the economy based on the existing economic structure led to the broadening of the current account deficit, which had to lead to an increase in the foreign debt, with the dynamic inflow of Foreign Direct Investment (FDI). The underlying cause for the current account deficit is the trade deficit. These developments suggested an increase in foreign exchange reserves. Since the outbreak of the global economic and financial crisis of 2008-2009, Serbia's slow economic growth has led to a reduction in the current account deficit, while the economic openness has increased. The rest of the current account deficit is covered by borrowing from abroad, and nearly by net FDI inflows (Figure 3).

After rescheduling and the write-off with the Paris and London Clubs, Serbia's external debt began to increase in 2004. The growing trend of the external debt did not even stop in 2009, the economy having fallen into recession. The debt-to-GDP ratio also grew. The additional effect was an increase in the debt repayment as a percentage of the GDP. This fact will likely become more pronounced with the expected post-crisis increase in interest rates on the international capital market. An increase in foreign
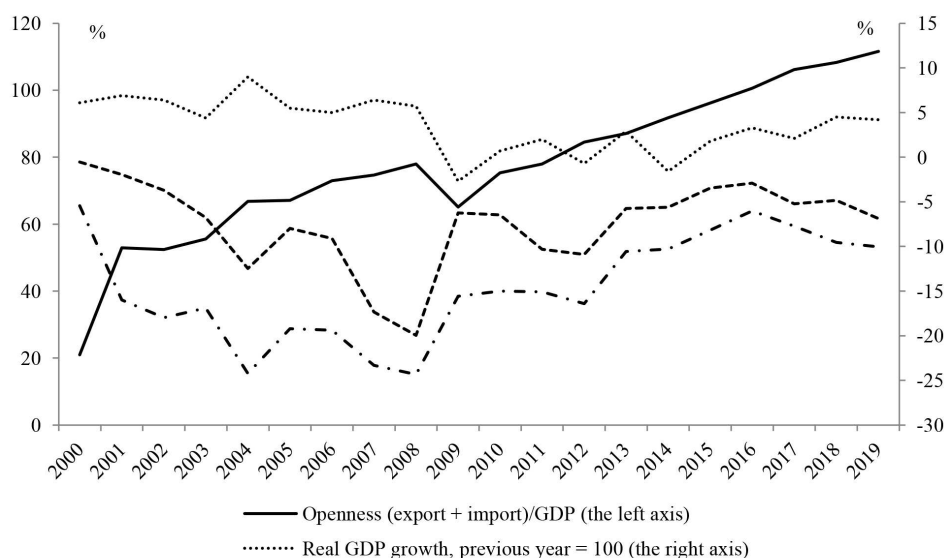

Figure 2 Serbia's current account balance and trade balance

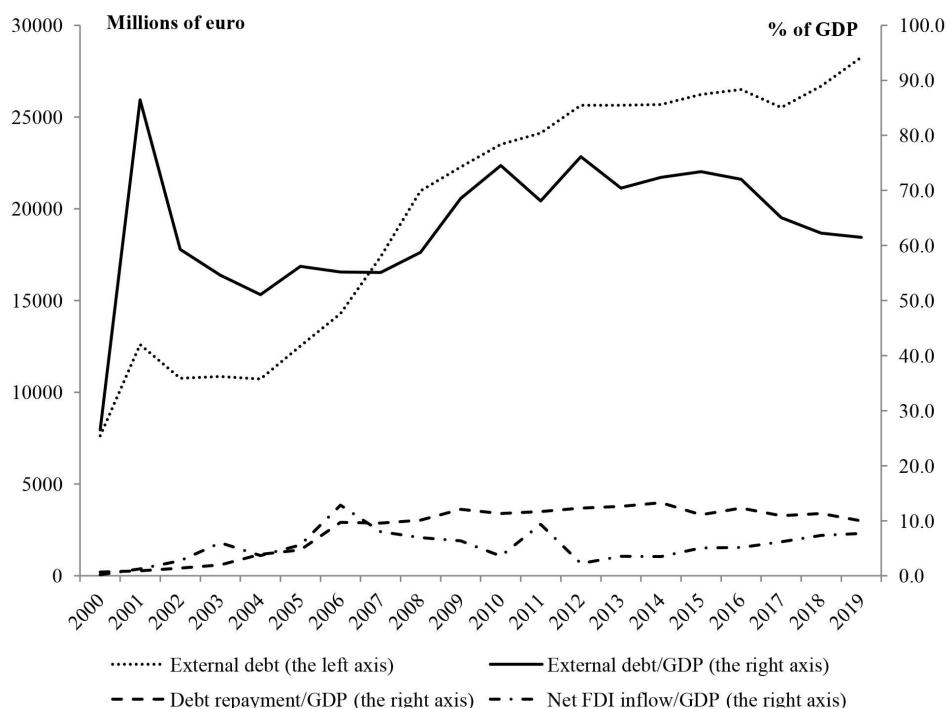*Source*: Author, based on: Table B (in Appendix)

Figure 3 Serbia's external debt

Source: Author, based on: Table C (in Appendix)

debt servicing means higher demand on the foreign exchange market and increases in foreign exchange expenditures. Therefore, foreign exchange reserves should be sufficient to ensure the repayment of the external debt according to maturity.

FDI is a significant channel, through which capital comes into RS. The FDI net inflow is uneven with occasional jumps (Figure 3). Since 2012, there has been a growing relationship between the net FDI inflows and the GDP. The total net inflow of financial resources from abroad has enabled coverage for the current account deficit and the growth of foreign exchange reserves. Over time, the total amount of the external debt has increased, so that it is necessary to provide a satisfactory level of foreign exchange reserves to debt service payment in the future. In addition to that, the greater openness and liberalization of capital accounts increase sensitivity to sudden reversals in capital flows. Given the fact that foreign exchange reserves are expected to amortize sudden external shocks, their level should be harmonized with the

scale of the potential capital withdrawal from RS. In crisis circumstances, foreign exchange reserves are responsible for financing the current account deficit, the orderly servicing of the public external debt to foreign creditors and preserving the stability of the financial sector. These tasks should be taken into account when assessing foreign exchange reserve adequacy. In the literature, the P. Guidotti *et al* (2004) rule is applied in order to assess foreign exchange reserve adequacy from the point of view of a country's ability to regularly service its external debt during the year.

Foreign exchange reserve adequacy should also be considered in the environment of possible future outflows conditioned upon the state of liabilities to foreign residents. Serbia's international investment position can be the starting point for assessing the level of its foreign exchange reserve adequacy. The data show that Serbia's net international investment position amounted to EUR -42.3 billion on 30th September 2020. The FDI stock in the country was EUR

40.9 billion (equity capital being about EUR 30 billion, which included EUR 7.2 billion of the reinvested profit) and the debt instruments of EUR 10.9 billion. The foreign resident's investment portfolio amounted to EUR 6.5 billion. Government loans were EUR 10.1 billion and government securities (bonds) amounted to EUR 6.5 billion.

The gross external debt stock in EUR was 30.7 billion as of 30th September 2020, the total external public debt stock in EUR was 15.1 billion (which is the general level of the Government, whereas the central government debt was EUR 14.9 billion), and the private sector's debt (the banks, companies and other sectors for which no guarantee was granted by the Government) was EUR 15.6 billion (the medium and long-term debts were EUR 13.1 billion, of which the banks accounted for EUR 2.3 billion and the companies accounted for EUR 10.8 billion, and the short-term debt was EUR 2.5 billion (the banks accounted for EUR 1.5 billion and the companies accounted for EUR 895 million). According to the FDI stock, it is noted that their net inflow generates additional potential outflows in the primary income account of the balance of payments, with possible increasing pressure on capital outflows. In this case, the NBS interventions on the foreign exchange market would lead to a decrease in foreign exchange reserves. This happened to EMEs before the outbreak of the global economic and financial crises of 2008-2009 (Menciger, 2009, 15). This is important for RS, keeping in mind the FDI stock in the country, as well as the volume of the portfolio investments that can be withdrawn from the domestic financial market in a short time.

EMPIRICAL ANALYSIS

Data description and the research methodology

The data about the dinar REER (consumer prices), foreign exchange reserves and the money supply aggregate M_2 were taken from the NBS website, whereas the data about the GDP at constant prices (chained values 2015) were taken from the website of the Statistical Office of the Republic of Serbia (SORS). The timeseries representing the relationship between M_2 and the GDP was calculated based on the chain values of the GDP, where the reference year was 2015. The analysis is based on the quarterly data for the period from 2002q1 to 2020q3. The data of the timeseries are logarithmic (natural logarithms), so that the estimated cointegration equation coefficients are elasticity coefficients. Following the studies (Obstfeld *et al*, 2010; Ghosh *et al*, 2014; Aizenman *et al*, 2014), regression analysis was applied in order to assess how precautionary motives and exchange rates affect Serbia's foreign exchange reserves.

The applied empirical model can be presented as follows:

$$ln(DRNBS) = \beta_0 + \beta_1 \, ln(BDP) + \beta_2 \, ln(REDK) + \beta_3 \, ln(M_2/BDP) + \varepsilon \tag{1}$$

where the *FERNBS* dependent variable represents the NBS net foreign exchange reserves (excluding the banks' foreign exchange reserves), the GDP is the GDP at constant prices (the chained volume measures, reference 2015), and REER is the real effective exchange rate (calculated by using consumer prices). An index above 100 shows the appreciation of the dinar, and that below 100 shows the depreciation of the dinar. M_2/GDP is the ratio between the aggregate of the money supply M_2 and the GDP, and ε is a random error. The indicator M_2/GDP measures potential demand for foreign assets from domestic sources and is becoming increasingly important along with the development of the domestic financial market and the opening of capital accounts (Obstfeld *et al*, 2010).

Before the previous model was estimated (the model was estimated by using the EViews 12 statistical-econometric software package), the stationarity of the timeseries was checked. The following standard tests are used to check timeseries stationarity: the Augmented Dickey-Fuller (ADF) test (Dickey-Fuller, 1979), the PP (Phillips & Perron, 1988) test, the ERS (Elliott, Rothenberg, & Stock, 1996) test, and the KPSS (Kwiatkowski, Phillips, Schmidt & Shin, 1992) test. Since the majority of the unit root tests (the results are given in the Appendix, Table D) showed

that the series was integrated of order I(1), so we proceeded to doing the cointegration test using the S. Johansen (1991) test. The results are given in the Appendix, Table E. Based on the trace statistics and the maximum eigenvalue statistics, it was concluded that there was one cointegration regression equation. The cointegrating equation (1) was then estimated by using the two estimators: the Fully Modified Least Squares (FMOLS) (Philips & Hansen, 1990) and the Dynamic Least Squares (DOLS) (Saikkoken, 1992) estimators. The intercept and the trend are the deterministic components in the cointegration equation. A long-run covariance (Bartlett kernel, Newey-West fixed bandwidth 4.0000) was estimated. The estimated cointegration parameters of the regression equation are statistically significant. Autocorrelation in the residuals of the estimated equation is negligible, and the residuals do not have a unit root and are normally distributed. The B. E. Hansen (1992) parameter instability test showed that the estimated parameters were stable. Thus, the estimated model has satisfactory statistical properties.

Empirical results and discussion

In this section, the obtained empirical research results are presented. Table 1 provides the descriptive statistics of the variables used in this study.

Table 1 shows that the mean value of the observed variables is positive, except for the M_2/GDP ratio. The foreign exchange reserves and the M_2/GDP ratio have the largest standard deviation (0.26), which shows the dispersion of the timeseries. Based on the Jarque-Bera test statistics for the FERNBS and GDP series, the hypothesis of normal distribution at the 1% level, as well as for the REER series at the 5% level (but not at the 1% significance level) is rejected, whereas the M_2/GDP series is normally distributed at the 1% significance level. The skewness coefficients for all the four timeseries are less than zero, which indicates the fact that their empirical distribution is asymmetric to the left. The value coefficient of the kurtosis for the FERNBS and GDP series is greater than 3, suggesting that the tails of the empirical distribution of these series are heavier than the tails of the normal distribution. This is a consequence of the sharp increase in foreign exchange reserves until 2008

Table 1 The descriptive statistics of the observed variables

	FERNBS	GDP	REER	M_2/BDP
Mean	3.878965	6.003333	2.064133	-0.407600
Median	3.993701	6.020000	2.072985	-0.380000
Maximum	4.144761	6.120000	2.148603	0.090000
Minimum	3.050380	5.780000	1.948413	-0.900000
Std. Dev.	0.264920	0.071723	0.042059	0.256930
Skewness	-1.509808	-1.119420	-0.783465	-0.303860
Kurtosis	3.996558	4.014990	2.850156	2.176581
Jarque-Bera	31.59754	18.88314	7.742891	3.272949
Probability	0.000000*	0.000079*	0.020828**	0.194665
Sum	290.9224	450.2500	154.8100	-30.57000
Sum Sq. Dev.	5.193523	0.380667	0.130903	4.884968
Observations	75	75	75	75

Note: *$p < 1\%$; ** $p < 5\%$.

Source: Author

and subsequent slower growth. However, the value coefficient of the kurtosis for the timeseries REER and M_2/GDP is less than 3, which means that the tails are lighter than those of the normal distribution. The results of the estimation according to the equation (1) are given in Table 2.

According to both estimators, the estimates of the cointegrating parameters show that there is a positive relationship between foreign exchange reserves and the observed determinants. The estimated coefficients are statistically significant at the 1% level, except for the REER coefficient, which indicates it is statistically significant at the 0.10% level. The positive value of the GDP coefficient confirms that the GDP and foreign exchange reserves simultaneously grow (the finding differs from the assessment presented in the paper by M. Bošnjak *et al*, 2020). This relationship is expected because an increase in the GDP in an open economy leads to an increase in imports and exports, which requires an increase in foreign exchange reserves as a

guarantee of ordinary foreign payments in the event of the balance of payments strike.

The GDP coefficient obtained according to the FMOLS model shows that 1% of the GDP growth leads to an increase in foreign exchange reserves by 2.1%. This finding coincides with the theoretical assumptions, also indicating the need to increase Serbia's foreign exchange reserves in line with the expected economic growth. The GDP growth also means residents' income growth, so that the growth of their demand for imports can be expected, as well as the growth of foreign exchange demand for tourist trips abroad and other reasons for staying abroad. Therefore, the GDP is an important factor for foreign exchange reserves accumulation.

The estimated REER coefficients also confirm the theoretical expectation that real appreciation leads to an increase in foreign exchange reserves. Real appreciation pressure on the dinar stemmed from

Table 2 The determinants of foreign exchange reserves in Serbia for the period 2002Q2-2020Q3

	FMOLS		DOLS	
Constant	Coeff. (Std. Error)	-10.70778 (2.694493)	Coeff. (Std. Error)	-9.216314 (2.643371)
	Prob. (p)	0.0002	Prob. (p)	0.0008
GDP	Coeff. (Std. Error)	2.094727 (0.508849)	Coeff. (Std. Error)	1.870496 (0.509928)
	Prob. (p)	0.0001	Prob. (p)	0.0005
REER	Coeff. (Std. Error)	1.316221 (0.720574)	Coeff. (Std. Error)	1.306247
	Prob. (p)	0.0721	Prob. (p)	0.0882
M_2/GDP	Coeff. (Std. Error)	0.913378 (0.354560)	Coeff. (Std. Error)	1.117044 (9.371815)
	Prob. (p)	0.0121	Prob. (p)	0.0037
Trend	Coeff. (Std. Error)	-0.008860 (0.003829)	Coeff. (Std. Error)	-0.010132 (0.004012)
	Prob. (p)	0.0237	Prob. (p)	0.0138
R^2	0.913966		0.927170	
Adjusted R^2	0.908979		0.923009	
S.E. of regression	0.074887		0.073508	
DW stat.	0.675840		0.544003	
S.D. dependent var.	0.248218		0.264920	
Long-run variance	0.014007		0.015417	
Observations (after adjustment)	74		75	

Source: Author

the foreign capital inflow through borrowing, portfolio investment and FDIs. The net capital inflows from all the sources larger than the negative current account balance put pressure on the foreign exchange market towards the appreciation of the dinar. The NBS interventions on the foreign exchange market amortized the surplus of foreign exchange supply, having converted it into foreign exchange reserves, thus preventing the excessive appreciation of the domestic currency. The estimates given in Table 1 show that the monetary aggregate M_2/GDP is also a significant determinant of Serbia's foreign exchange reserves. An increase in this aggregate is a precondition for an increase in demand for foreign exchange on the foreign exchange market, so that an increase in foreign exchange reserves (as a shock absorber) is expected to meet this potential growing demand. Therefore, all the three variables in the cointegrating regression equation affect the growth of Serbia's foreign exchange reserves. The regression coefficient estimates in Table 1 also represent the elasticity coefficients, testifying to the strength of the influence of individual factors on foreign exchange reserve accumulation. The elasticity coefficient for the GDP had the highest value, whereas the monetary aggregate M_2/GDP had the lowest. The coefficient estimates suggest that the accumulation of foreign exchange reserves was strongly affected by the level of the economic activity in the country.

CONCLUSION

Based on the findings, a conclusion can be drawn that the current level of Serbia's foreign exchange reserves is higher than their optimal amount defined according to the common indicators. The Johansen cointegration test shows that the GDP, REER and M_2/GDP variables are cointegrated with foreign exchange reserves. Therefore, these variables have a long-term impact on the accumulation of foreign exchange reserves. Based on the empirical research study carried out in this paper, several conclusions can be drawn.

First, the findings confirm that the GDP, REER and the monetary aggregate M_2/GDP are the important

determinants of Serbia's foreign exchange reserves. In the estimated model, foreign exchange reserves show the greatest elasticity to changes in the GDP. Thus, the obtained empirical results confirm the fact that the GDP growth significantly affects an increase in foreign exchange reserves. The expected revival of the world economic growth in the period after the COVID-19 pandemic calming down could stimulate the growth of exports and the GDP in Serbia. However, domestic economic growth is generally associated with an increase in the trade deficit and the current account deficit. Such a scenario would require an increase in foreign exchange reserves as a guarantee for the smooth flow of current payments towards foreign countries. A possible increase in the current account deficit would require an increase in foreign exchange reserves to the level that would compensate for the absence of autonomous net capital inflows.

The empirical findings also confirm the fact that the influence of the appreciation of the REER of the dinar on the increase in foreign exchange reserves is significant, which actually means that the NBS intervention on the foreign exchange market was aimed at buying foreign exchange in order to prevent an excessive appreciation of the dinar as it might undermine the competitiveness of the country's export prices. The pressure exerted by the exchange market is derived from a net capital inflow. This finding confirms the importance of the NBS intervention on the foreign exchange market intended to prevent the appreciation of the dinar. Although these interventions represent but one channel for the implementation of an inflation-targeting regime, they do have an impact on foreign exchange reserves. Their accumulation facilitates potential interventions in the opposite direction in the event of an increased outflow of capital from the country due to some external shock. The net sale of the NBS foreign exchange on the foreign exchange market in 2020 confirmed the fact that an increase in the capital outflow and a decline in foreign exchange reserves was a possible option for the future.

The relationship between the M_2/GDP growth rates and foreign exchange reserves suggests that

the growth of this indicator creates satisfactory conditions for an increase in imports, and thus an increase in foreign exchange demand in order to pay for imports. Also, the growth of this indicator indicates the growing power of companies and individuals to buy foreign assets when confidence in the domestic economy is weakening. As this would lead to an outflow of capital from the country, a larger amount of foreign exchange reserves is needed to meet increased demand for foreign exchange, thus simultaneously preventing an excessive depreciation of the domestic currency. Avoiding an extreme currency depreciation can be a strong motivating factor for maintaining an adequate level of foreign exchange reserves. If a possible increase in domestic residents' investment in foreign assets is added to the said, their demand for foreign exchange may be even greater than that potentially caused by a sudden stop in capital inflows. Therefore, it can be said that the empirical research conducted in this paper has confirmed the first research hypothesis, according to which the GDP, REER and the monetary aggregate M_2/GDP are the significant determinants of foreign exchange reserves in Serbia.

Second, the fact that the existing amount of foreign exchange reserves in Serbia can be considered as satisfactory because it is even higher than the estimated adequate level according to the standard indicators of individual risks has already been pointed out. One of the most frequently used indicators for assessing the adequacy of foreign exchange reserves (monthly imports of goods and services coverage) is almost twice as big as the standardized quarterly amount. The other indicators also have the values greater than the usual thresholds, which has confirmed the second starting hypothesis of the presented research study. The current fulfillment of the optimality criteria, however, should not deceive monetary policymakers. Namely, the expected revival of economic growth has a potential to increase the imports of goods and services (the increase in the M_2/GDP ratio in 2020 also contributes to this), which may increase the trade balance deficit and thus the current account deficit as well, which would require an increase in foreign exchange reserves for prudent reasons compared to their current level.

Third, Serbia's external debt significantly increased in 2020 compared to the end of 2019. It is still, however, below 80% of the GDP, which can be considered as a high level of the external debt, which increases the annual debt repayment-to-GDP ratio. An additional cost of increasing the external debt is the mismatch between higher interest rates on the external debt and the lower rates of return on foreign exchange reserves. A potential rise in interest rates on the international capital market would increase the amount of servicing the external debt, which might exert additional pressure on an increase in foreign exchange reserves.

Fourth, the FDI stock in RS generates dividends greatly exceeding one billion euros annually. These amounts are being reinvested for the time being, but potential major disturbances on the world market or a disruption of internal stability might redirect dividends to repatriation, in which case there would be an increase in demand for foreign exchange on the foreign exchange market, which would require the NBS interventions in order to prevent excessive daily fluctuations of the exchange rate and enable normal cross-border capital flows. This means that this potential impact should also be taken into account in determining the optimal level of foreign exchange reserves. A possible further FDI net inflow into the Serbian economy would increase the foreign capital stock, with a tendency to increase the future outflow of dividends. The share of intercompany loans as a short-term source of capital in total capital flows is increasing, which is also a foreign exchange outflow at the time of repayment. Certainly, these capital flows should be taken into consideration when designing the optimal amount of foreign exchange reserves in RS. On the other hand, an adequate level of foreign exchange reserves that takes into account these capital flows can strengthen investors' confidence and increase investment and economic growth. The construction of the specific indicator of the optimality of foreign exchange reserves in RS, which would take into account a possible outflow of dividends some types of portfolio capital as well, is proposed in this paper.

The identified tendencies and factors of foreign exchange reserve accumulation suggest that it should

also be kept in mind that there are limitations of further borrowing abroad as a source to cover the current account deficit. However, if the net capital inflow is smaller than the current account deficit, then the difference must be covered from foreign exchange reserves, which would mean their rapid reduction. The question of what amount of foreign exchange reserves is available for interventions on the foreign exchange market also arises. Although it is not possible to precisely answer this question, it should be remembered that the assessment of foreign exchange reserve adequacy made in this paper is based on the NBS net foreign exchange reserves (excluding the banks' foreign exchange reserves). However, it is useful to keep in mind the fact that, according to the IMF criteria, a certain amount of the NBS foreign exchange reserves are the so-called permanent foreign exchange reserves, which may only be spent in an extremely critical situation, which fact actually means that the amount available for interventions on the foreign exchange market is equal to the difference between the NBS net foreign exchange reserves and the level of the permanent foreign exchange reserves. Increasing the exports of goods and services is a way to achieve a moderate trade deficit and Serbia's current account deficit, which, with a low level of short-term external indebtedness, can significantly reduce the pressure on increasing foreign exchange reserves for prudent reasons. However, the growing stock of total foreign capital in the Republic of Serbia is putting pressure on increasing foreign exchange reserves only for prudential reasons. The effects of these factors are intertwined and require the accumulation of foreign exchange reserves at an adequate level in changing circumstances. We should always bear in mind the fact that foreign exchange reserves are accumulated at a favorable time and allow the NBS to spend them when bad times have come, thus increasing economic resilience.

The fact that the results of the empirical research study conducted in this paper agree with similar analyses available in the literature (Magud & Sosa, 2010; Sula, 2011; Bruno & Shin, 2015; partly Bošnjak *et al*, 2020) and that they confirm the initial hypotheses can be highlighted. The findings have both theoretical and practical implications. The theoretical contribution is contained in the recommendations

for assessing the level of foreign exchange reserve adequacy in Serbia, taking into consideration foreign investors' dividends and a part of foreign portfolio investments, in which way another specific sensitivity indicator derived from the stock of foreign capital in the Serbian economy would be constructed. The empirical findings also have a practical dimension. Namely, they send messages to policymakers that additional borrowing from abroad should be handled with caution, because the repayment-to-GDP ratio increases, demand for an increase in prudent foreign exchange reserves increasing as well. Given the fact that holding reserves generates high opportunity costs, it is necessary that specific economic policy measures should be implemented in order to increase exports and reduce the trade deficit and the current account deficit.

The paper also has several limitations. First of all, this research study is limited in that the structure of foreign portfolio investments in the domestic economy is not included in the analysis. Namely, it is known that, in the case of a crisis, a significant amount of these investments can be converted into short-term capital with a tendency to leave the country. It is not necessary to particularly prove how big pressure this would be on foreign exchange reserves, so their adequacy should be assessed taking into account this factor as well. In addition to the said, the cointegration equation does not directly include the variable representing the openness of the economy, so it can be assumed that the inclusion of this variable would affect the estimates of the other parameters, which could be addressed in future research by including a larger number of variables in the econometric model. Also, future research should take into consideration a potential outflow of dividends when assessing foreign exchange reserve adequacy. The limitation of this paper reflects in the fact that the structural analysis of foreign exchange reserves is not taken into account, which could indicate potential weaknesses due to excessive reliance on a single currency or certain instruments in the allocation of foreign exchange reserves. Therefore, future research should assess the effects of Serbia's foreign exchange reserve management on the level of foreign exchange reserves.

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APPENDIX

Table A Serbia's foreign exchange reserves

	NBS foreign exchange reserves (EUR million)[1]	Foreign exchange reserves - months of the imports of goods and services	Foreign exchange reserves/GDP (%)	Foreign exchange reserves/short-term debt (%)	Foreign exchange reserves/M$_1$ [2] (%)
2005	4922	6.1	22.1	177.0	290.3
2006	9020	9.0	34.8	265.1	356.1
2007	9634	7.5	30.5	250.6	306.7
2008	8182	5.4	22.9	162.6	300.4
2009	10602	9.7	32.6	220.6	393.4
2010	10002	8.4	31.7	191.2	416.6
2011	12056	8.8	34	299.0	429.6
2012	10915	7.7	32.4	237.3	402.1
2013	11189	7.6	30.7	268.6	330.4
2014	9907	6.6	27.9	294.0	278.1
2015	10387	6.7	29.1	256.4	250.2
2016	10205	6.2	27.8	234.0	207.3
2017	9962	5.4	25.4	202.1	176.2
2018	11262	5.4	26.3	210.9	168.0
2019	13378	5.7	29.1	272.9	174.1
2020 Quarter 1	13115	5.5	28.1	249.4	165.3
2020 Quarter 2	13956	6.2	30.2	259.6	147.1
2020 Quarter 3	13030	5.9	28.2	205.2	136.2

Note: [1]The cash equivalent of all the categories that fall into the NBS foreign exchange reserves (gold, special drawing rights, cash and deposits abroad, securities). A broader category of foreign exchange reserves (gross foreign exchange reserves) also includes the foreign exchange assets of banks on the basis of required reserves and on other bases in addition to the NBS foreign exchange reserves; [2]Money supply M1 includes cash in circulation and demand deposits. Foreign exchange reserves/M1 -the ratio of foreign exchange reserves and money supply at the end of the observed period; Foreign exchange reserves/imports of goods and services (in months) - the ratio of foreign exchange reserves at the end of the observed period and the average monthly import of goods and services during the last 12 months; Foreign exchange reserves/short-term debt - the ratio of foreign exchange reserves and the short-term debt as per remaining maturity at the end of the observed period.

Source: NBS

Table B Serbia's foreign trade in the Balance of Payments and the real GDP

	Real GDP growth rate, the previous year = 100 (%)	Openness (exports + imports of goods and services/GDP) x 100 (%)	Goods and services (balance) / GDP (%)	Current account (balance) / GDP (%)
2000	6.1	21.0	-5.4	-0.5
2001	6.9	52.9	-16.0	-1.9
2002	6.4	52.4	-18.0	-3.7
2003	4.4	55.6	-16.9	-6.8
2004	9.0	66.8	-24.2	-12.5
2005	5.5	67.1	-19.2	-8.0

2006	5.0	73.0	-19.4	-9.1
2007	6.4	74.7	-23.3	-17.3
2008	5.7	78.0	-24.3	-20.0
2009	-2.7	65.1	-15.6	-6.3
2010	0.7	75.3	-15.0	-6.5
2011	2.0	78.0	-15.1	-10.3
2012	-0.7	84.5	-16.4	-10.9
2013	2.9	87.1	-10.6	-5.8
2014	-1.6	91.8	-10.3	-5.6
2015	1.8	96.2	-8.2	-3.5
2016	3.3	100.6	-6.0	-2.9
2017	2.1	106.2	-7.7	-5.2
2018	4.5	108.3	-9.5	-4.8
2019	4.2	111.6	-10.0	-6.9

Source: NBS

Table C Serbia's external debt

	External debt (EUR million)	External debt/GDP (%)	External Debt/Exports of goods and services (%)	Debt service/GDP (%)
2000	7626	26.5	341.7	0.7
2001	12609	86.4	468.2	0.9
2002	10768	59.3	344.7	1.4
2003	10857	54.6	282.2	2.0
2004	10720	51.1	239.6	3.9
2005	12520	56.2	234.9	4.7
2006	14291	55.2	205.7	9.7
2007	17382	55.1	214.3	9.6
2008	20982	58.8	218.9	10.1
2009	22272	68.6	276.9	12.1
2010	23509	74.5	247.1	11.3
2011	24123	68.1	216.5	11.7
2012	25645	76.1	223.6	12.3
2013	25644	70.4	184.0	12.6
2014	25679	72.4	177.7	13.3
2015	26234	73.4	166.8	11.1
2016	26494	72	152.4	12.3
2017	25526	65.1	132.2	10.9
2018	26682	62.2	126.0	11.3
2019	28254	61.5	121	10.0
2020 I quarter	28738	61.4	121.6	7.5
2020 II quarter	31024	67.0	138.1	6.2

Note: The external debt/exports of goods and services - the ratio of the stock of the external debt at the end of the observed period and the value of the annual exports of goods and services; External debt/GDP - the ratio of the debt at the end of the observed period and the GDP.

Source: NBS

Table D The unit root tests

Variable	Test		Determinis. component	Statistics	Prob. (p)	Included observation	Nonstat. (NS), Stationary (S)
LnFERNBS	ADF	Level	Constant	-4.502589	0.0005	74	S
			Con.& trend	-3.217764	0.0890	74	NS
		1st dif.	Constant	-7.844045	0.0000	73	S
			Con.& trend	-8.220783	0.0000	73	S
	PP	Level	Constant	-4.582933	0.0000	73	S
			Con.& trend	-3.219582	0.0886	74	NS
		1st dif.	Constant	-7.844957	0.0000	73	S
			Con.& trend	-8.287871	0.0000	73	S
	KPSS	Level	Constant	0.842104		75	NS
			Con.& trend	0.532519		75	NS
		1st dif.	Constant	0.948597		74	NS
			Con.& trend	0.150959		74	S
	ERS	Level	Constant	250.0618		75	NS
			Con.& trend	106.4255		75	NS
		1st dif.	Constant	9.307744		74	NS
			Con.& trend	8.256552		74	NS
LnGDP	ADF	Level	Constant	-2.758031	0.0697	70	NS
			Con.& trend	-3.697111	0.0290	70	S
		1st dif.	Constant	-3.244606	0.0215	70	S
			Con.& trend	-3.446021	0.0536	70	S
	PP	Level	Constant	-3.125008	0.0290	74	S
			Con.& trend	-5.171691	0.0003	73	S
		1st dif.	Constant	-17.25767	0.0001	73	S
			Con.& trend	-15.73426	0.0001	73	S
	KPSS	Level	Constant	1.007101		75	NS
			Con.& trend	0.236531		75	NS
		1st dif.	Constant	0.307597		74	S
			Con.& trend	0.134366		74	S
	ERS	Level	Constant	410.8190		75	NS
			Con.& trend	156.7380		75	NS
		1st dif.	Constant	42.85301		74	NS
			Con.& trend	102.9402		74	NS
LnREER	ADF	Level	Constant	-2.190552	0.2115	72	NS
			Con.& trend	-2.189091	0.4881	72	NS
		1st dif.	Constant	-7.151703	0.0000	72	S
			Con.& trend	-7.162933	0.0000	72	S
	PP	Level	Constant	-2.747717	0.0710	74	NS
			Con.& trend	-2.720853	0.2316	74	NS
		1st dif.	Constant	-6.239871	0.0000	73	S
			Con.& trend	-6.235144	0.0000	73	S
	KPSS	Level	Constant	0.662136		75	NS
			Con.& trend	0.204765		75	NS
		1st dif.	Constant	0.179422		74	S
			Con.& trend	0.067781		74	S
	ERS	Level	Constant	41.85519		75	NS
			Con.& trend	22.92765		75	NS
		1st dif.	Constant	0.536310		74	S
			Con.& trend	1.463019		74	S

LnM$_2$/GDP	ADF	Level	Constant	-0.650387	0.8519	74	NS
			Con.& trend	-2.183604	0.4913	74	NS
		1st dif.	Constant	-3.208590	0.0235	70	S
			Con.& trend	-3.183164	0.0962	70	NS
	PP	Level	Constant	-0.609668	0.8614	74	NS
			Con.& trend	-2.285391	0.4363	74	NS
		1st dif.	Constant	-10.17816	0.0001	73	S
			Con.& trend	-10.03011	0.0000	73	S
	KPSS	Level	Constant	1.133599		75	NS
			Con.& trend	0.165305		75	NS
		1st dif.	Constant	0.162970		74	S
			Con.& trend	0.158353		74	S
	ERS	Level	Constant	275.2033		75	NS
			Con.& trend	14.10366		75	NS
		1st dif.	Constant	6.474479		74	NS
			Con.& trend	13.18598		74	NS

Source: Author

Table E The Johansen cointegration test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.425922	78.98528	63.87610	0.0016
At most 1	0.273011	39.02594	42.91525	0.1161
At most 2	0.156901	16.06921	25.87211	0.4870
At most 3	0.051158	3.780916	12.51798	0.7736
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Characteristic value	Trace statistics	Critical value 0.5	Probability**
None*	0.425922	39.95933	32.11832	0.0045
At most 1	0.273011	22.95673	25.82321	0.1143
At most 2	0.156901	12.28830	19.38704	0.3888
At most 3	0.051158	3.780916	12.51798	0.7736

Note: Both tests indicate 1 cointegrating eq(s) at the 0.05 level; *denotes the rejection of the hypothesis at the 0.05 level; **the MacKinnon-Haug-Michelis (1999) p-values.

Source: Author