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The COVID-19 Pandemic, Government Response, and Serbian Stock Market: Evidence from ARDL Cointegration Model

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Abstract: *The existence of a real possibility that the current health crisis could lead to an economic crisis has prompted governments worldwide to make great efforts to sustain their markets. This paper explores the impact of COVID-19 and Serbian government anti-Covid activities on the domestic stock market using the Autoregressive Distributed Lag (ARDL) Cointegration model. In its research, the paper considers the impact of the number of newly infected and the number of deaths from coronavirus daily, as well as measures taken by governments to combat viruses on the representative Belgrade stock exchange index BELEX15. The results showed a significant long-term negative impact on the number of deaths per day and international travel control on the BELEX15 index. In terms of reducing the negative consequences of the crisis caused by the global pandemic, these results could be a good guideline for effective management of government measures.*

1. INTRODUCTION

The SARS-CoV-2 virus, or the COVID-19, surprised the whole world, causing a significant measure of fear and uncertainty, primarily due to rapid contamination and high mortality rates. At the same time, there have been significant disruptions in the international market and relations between national economies. The coronavirus was initially considered a Chinese problem, then a problem of Southeast Asia, but a combination of various factors, natural, political, and regulatory, led to the rapid global spread of the epidemic, which is why it was recognized as a pandemic by the World Health Organization (WHO), on 11 March 2020. At the very beginning, coronavirus was treated as a public health problem, but, over time, its impact on overall life, and thus on the economy and capital markets, became more and more pronounced. A significant number of economic experts and international institutions monitor and predict the impact of the pandemic on the global economy, which is now known as the common term "global recession" (Karajović et al., 2021).

This global recession differs from all previous ones, primarily due to the inclusion of multiple uncertain socio-economic connections. Such relation is largely a result of concerns about the spread of the virus but also about government interventions in terms of limiting contact between people. All this has led to a reduction in the inflow of money into companies and an increase in the number of unemployed (Gravelle and Marples, 2021). Governments have taken unprecedented measures to protect the health of the population and businesses. For example, European countries have provided significant funds to support struggling companies and postpone interest-free and late tax payments, temporarily reduced taxes, implemented measures for the most vulnerable sectors, such as paid leave due to unemployment, etc. The introduction of the state of emergency on March 15, 2020, due to the pandemic of the COVID-19 virus, the extensive curfew, the closing of borders, and the ban on social contacts have caused restrictions or complete work suspension in

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many economic entities in Serbia. Some sectors, such as catering, tourism, air transport, and other services, completely stopped working almost overnight to avoid the circulation of citizens and reduce the spread of the virus. State support for the economy began with the decision of the National Bank of Serbia (NBS) in mid-March to decrease the reference interest rate to 1.75 percent, followed by another additional reduction to 1.5 percent in April. In March, the NBS decided on a three-month moratorium on loan repayments for both the economy and citizens to mitigate obligations to banks during the expected duration of the epidemic. Following these initial measures, the Serbian government has provided a series of individual actions as part of an economic package to lessen the effects of the COVID-19 crisis (Đaković, 2020).

The latest pandemic is also affecting stock markets. According to Azimli (2020), for example, the COVID-19 pandemic affects the stock market in two ways. First, the high level of economic policy uncertainty resulting from the pandemic spread and the unknown future of the virus led to low expectations of cash flow, leading to a depreciation of the stock market. Second, stopping the industrial, tourism, transport, and other sectors directly affect stock indices by depressing related stocks.

Minding the topic, the subject of this paper is the relationship between the COVID-19 pandemic and government response and the Serbian stock market by implementing the ARDL cointegration model. This paper deals with the impact of the number of coronavirus infections and deaths per day, as well as the effect of Restrictions on internal movement (RIM) and International travel controls (ITC) during the COVID-19 pandemic on the representative index of the Belgrade Stock Exchange - BELEX15 (B15). The paper consists of five parts. After the introductory discussion, the second part gives a brief overview of the relevant literature and previous research. The third part contains the research methodology, with hypotheses, research data, and econometric methods. The results of hypothesis testing are presented in part four. The final part holds the conclusions of the conducted research with recommendations for future researchers.

2. LITERATURE REVIEW

The coronavirus caused massive instability in world stock markets, with the sharpest daily decline in stock market indices in history (Fernandes, 2020; Vasiu, 2020; Hatmanu and Cautisanu, 2021). Based on the results of many studies, coronavirus, in terms of new cases and the number of deaths from its consequences, has a negative impact on stock markets (Gherghina et al., 2020; Al-Awadhi et al., 2020; Hatmanu and Cautisanu, 2021).

Zaren and Hizarci (2020) analyze the possible effects of the COVID-19 on stock markets, using stock indices daily data. The cointegration test using COVID-19 daily infections and deaths was used to question possible outcomes on the stock markets. The SSE, KOSPI, and IBEX35 indices have a cointegration relationship with the number of infections, while FTSE MIB, CAC40, DAX30 indices don't.

Wardani and Lahuddin (2021) analyze COVID-19 in response to the Indonesian stock market applying the ARDL cointegration method. In this study, the authors examine the relationship between the natural logarithm of the daily trading volume of the Indonesia Stock Exchange and the natural logarithm of daily COVID-19 confirmed cases both in the short run and the long run. The findings show that in the short-run, Indonesia's stock market is only influenced by its lag, but not in the long run.

The impact of social distancing policies on the stock market, which governments have taken to curb the spread of the pandemic, has been studied by Ozili and Arun (2020). The research results showed that the number of isolation days and international travels had a negative impact on the stock market, while restrictions on internal movement had a positive one.

Eleftheriou and Patsoulis (2020) analyze the impact and effects of government measures due to the COVID-19 pandemic on 45 stock market indices worldwide. Authors find evidence of negative direct and indirect (spillover) effects for the initial period of containment measures (lockdown).

Zaremba et al. (2020) explore the policy responses to the COVID-19 pandemic in 67 countries. Authors demonstrate that non-pharmaceutical interventions significantly increase equity market volatility. Furthermore, two types of actions usually applied chronologically, particularly early—information campaigns and public event cancellations—are the major contributors to the growth of volatility.

Baber and Tripati (2021) look at the effect of lock-in and social distancing policies in light of stock prices, business activity indices, and exchange rates in India. Confirmed cases of COVID-19 and confirmed deaths associated with the disease are used as independent variables. The obtained results reveal a significant negative impact of social distancing policies on economic activity and business, the stock market, and the exchange rate. The authors conclude that the economic stimulus of the Government of India could not have a positive effect on the stock market.

Zoungrana et al. (2021) examined the effect that government measures against coronavirus had at the company level and in the industry, finance, and distribution sectors. The obtained results show that, at the company level, social distancing and government measures had a positive impact on the market, while restrictions movements and isolation measures led to a decline in the value of shares. At the sector level, according to the survey results, restrictions on movement had a significant negative impact on the returns of companies from all three sectors, while isolation measures affected the industrial and financial sectors more than the distribution sector.

3. RESEARCH METHODOLOGY

3.1. Research Hypothesis

Based on the review of the literature, and to meet the objectives of the research presented in the introductory part, the following research hypotheses were set:

Hypothesis One: The B15 index has been affected by the number of new cases due to the coronavirus.

Hypothesis Two: The B15 index has been affected by the number of new deaths due to the coronavirus.

Hypothesis Three: The B15 index is significantly affected by measures adopted by the national authorities.

Hypothesis Four: The B15 index has been negatively affected by restrictions on domestic movements and international travel control.

3.2. Data Set and Description

The analysis used the number of daily infections and deaths in the Republic of Serbia, starting with the appearance of the first case of coronavirus, from March 6, 2020, to March 7, 2022, which is a total of 504 trading days. The B15 index was used to determine the impact of the coronavirus on the Serbian stock market. The variables used in the study as stock market variables (B15), COVID-19 variables (number of COVID-19 infections and deaths per day), and variables related to measures taken by the authorities against the infection (Restrictions on internal movement - RIM, and International Travel control - ITC), as well as data sources, are shown in *Table 1.*

Table 1. Research variables description

Abbreviation	Description	Source
B15	Representative index of the Belgrade Stock Exchange.	Belgrade Stock Exchange
NDC	The number of new cases of coronavirus per day.	Ministry of Health of the Republic of Serbia
NDD	The number of new coronavirus deaths per day.	Ministry of Health of the Republic of Serbia
RIM	Restrictions on internal movement during the COVID-19 pandemic. Ordinal variable (0 - No measures; 1 - Recommend movement restriction; 2 - Restrict movement).	Our World in Data
ITC	International travel controls during the COVID-19 pandemic. Ordinal variable (0 - No measures; 1 - Screening; 2 - Quarantine from high-risk regions; 3 - Ban on high-risk regions; 4 - Total border closure).	Our World in Data

Movements of selected variables from 6 March 2020 to 7 March 2022, which is 504 trading days, are shown in Figure 1. Namely, for the evolution of the local capital market, but global markets also, 2020 was atypical, bearing in mind that the COVID-19 pandemic led to one of the most severe health crises in recent human history (Hatmanu and Cautisanu, 2021). The first signs of a pandemic in the Serbian capital market appeared in mid-March. The period of decline, which followed the trend in the European and international markets, was fueled by the coronavirus-caused panic. The value of the B15 index declines after the appearance of the first case of coronavirus (mid-March), then there is a change in trend and growth so that after the initial shock caused by the COVID -19 pandemic, similar to other stock exchanges, the Serbian capital market slowly recovers from the shock. The pandemic variables in the Republic of Serbia have shown a growth trend, with the number of newly infected growing in four waves, reaching the highest values in January 2022, and the number of deaths in six waves gaining peak values in March 2021. The pandemic variables in the Republic of Serbia have shown a growth trend, with the number of new cases growing in four waves, reaching the highest values in January 2022, and the number of deaths in six waves hitting peak values in March 2021. Governments undertook a wide range of combating COVID-19, and some of these measures are Restrictions on internal movement (RIM) and International travel controls (ITC). When it comes to RIM, the Restrict movement was valid in Serbia from the beginning of March to the middle of May. After that, the periods with the recommended movement restriction and no measures changed. In regards to ITC in Serbia, in the period from March to mid-May 2020, measures included a travel ban in all regions or complete closure of the border, while in late May and early April 2021, as well as between October and December 2021, all people coming from a high-risk region were quarantined.

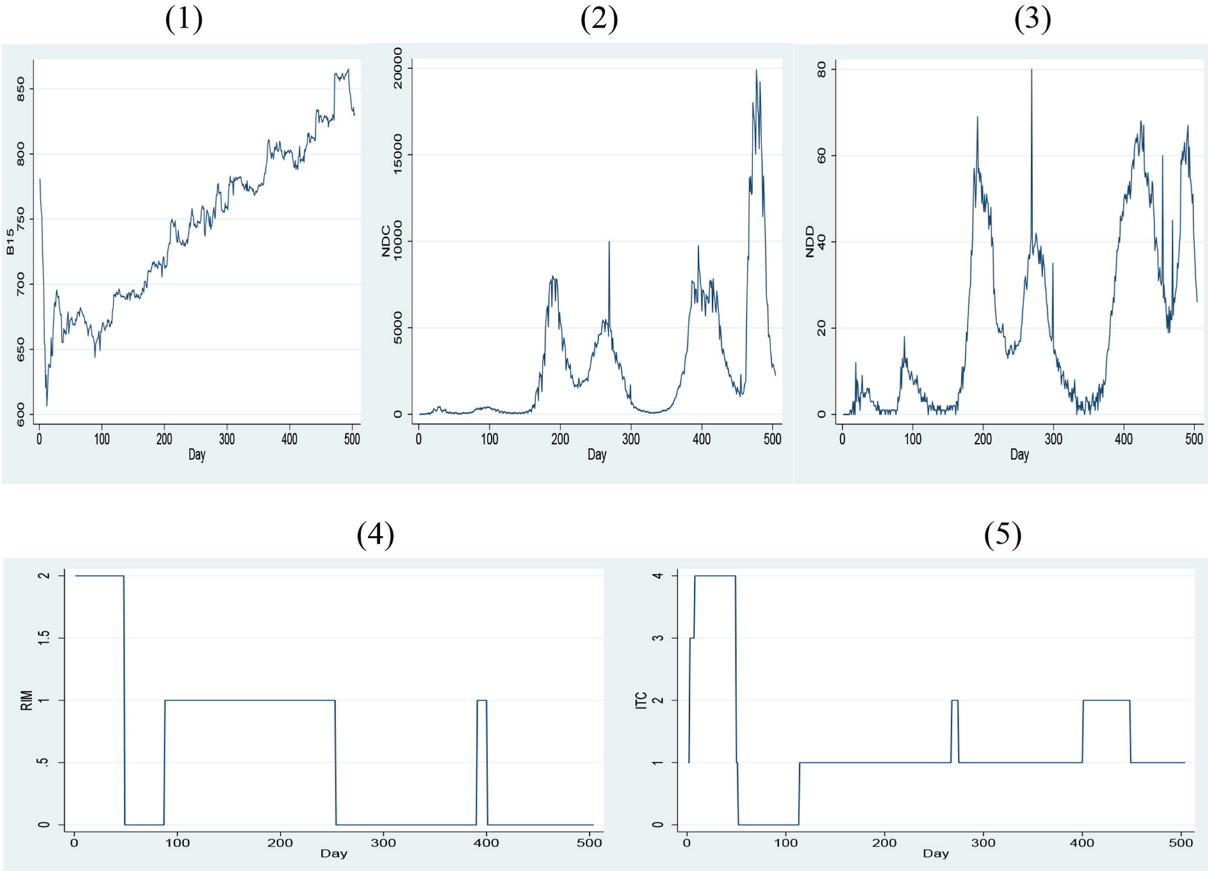

Figure 1. The value of the B15 index at the daily level (1), the number of newly coronavirus infected per day (2), the number of deaths from the consequences of the coronavirus per day (3), Restrictions on internal movement during the COVID-19 pandemic (4) and International travel controls during the COVID-19 pandemic (5)

Source: Authors

3.3. Research Methods

The equation of the influence of COVID-19 variables and variables related to measures taken by the authorities to control the infection on the representative index of the Belgrade Stock Exchange B15 is estimated using the ARDL modeling approach according to Pesaran and Shin (1999), and Pesaran, Shin, and Smith (2001). The ultimate advantage of this approach is its applicability in cases when the variables are I(0) or I(1), which avoids the problem of determining the order of integration of time series that commonly occurs in standard cointegration analyses. In this research, the ARDL methodology involves two steps. The first step begins with conducting tests to probe the existence of cointegration. In the second step, after cointegration is confirmed, the long-term relationship and the associated error correction model are estimated. The ARDL model is a least-squares regression model that contains dependent and explanatory variables (Ganić, 2021, p. 96). It is usually denoted as ARDL (*p, q1,..., qk*), where *p* is the number of lags of the dependent variable, *q1* is the number of lags of the first explanatory variable, *qk* is the number of lags of the *k*-th explanatory variable. The ARDL Bound test, in this work, is given as:

$$\Delta Y_t = \sum_{i=1}^{p-1} \beta_i \Delta Y_{t-1} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j-1} \delta_{j,lj} \Delta X_{j,t-l_j} + \gamma Y_{t-1} + \sum_{j=1}^{k} \Phi_j X_{j,t-1} + u_t \quad (1)$$

Where is:
Y_t – the dependent variable (B15),
$X_{(j,t)}$ – independent variables (NDC, NDD, RIM, ITC),
k – number of independent variables,
Δ – the first difference operator,
u_t – error term, β_i, and
$\delta_{(j,lj)}$ – coefficients that indicate shot-run relationships,
γ and Φ_j – coefficients that indicate long-run relationships,
p and q_j – optimal lags.

The Bounds test examines the null hypothesis about the non-existence of a long-run relationship between the considered variants based on Fisher's statistics. The calculated F-statistic is compared with the critical limit values found in Pesaran, Shin, & Smith (2001). Two sets of asymptotic critical values are available: the first set assuming that all variables are in model I(1), and the second set assuming that all variables are in model I(0). If the calculated value of the F-statistic is higher than the upper limit, the null hypothesis of no long-term relationship can be rejected, whether the variables are I(0), I(1), or fractionally integrated. If the calculated value is lower than the lower bound, the null hypothesis of no long-term relationship can be accepted, whether the variables are I(0), I(1), or fractionally integrated. Finally, if the calculated value is between these two bounds, a single conclusion cannot be made, but it depends on whether the variables are I(0) or I(1), so tests for the unit root existence are necessary.

If the results of the cointegration test indicate long-term relationships between the variables under consideration, the error correction model (ECM) is applied, which can be represented by the following equation:

$$\Delta Y_t = \sum_{i=1}^{p-1} \beta_i' \Delta Y_{t-1} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j-1} \delta_{j,lj}' \Delta X_{j,t-l_j} + \theta ECT_{t-1} + u_t' \quad (2)$$

Where θ is the coefficient of error correction term (ECT), which must be statistically significant, negative, and subunit, showing the rate at which the dependent variable, after the shock produced in the system, restores equilibrium.

The stability of the model coefficient and the residual component was verified to confirm the previously estimated model, while the robustness of the results obtained in the ARDL model was verified using VAR Granger causality.

4. EMPIRICAL RESULTS AND DISCUSSION

Before testing critical values, it is necessary to examine the properties of variables, that is, the degree of their integration. It is of essence to determine whether the variables are integrated of order n = 0, 1, 2 to avoid apparent regression, meaning evident results (Benazić and Mašić, 2016). In the presence of variable I(2), the calculated F-statistic is not valid because the critical value test is based on the assumption that the variables are I(0) or I(1). For this purpose, the extended Dickey-Fuller – ADF (Dickey and Fuller, 1979) and Phillips Perron - PP (Phillips and Perron, 1988) tests can be used. The results of unit-root tests are shown in Table 2. The test results indicate that variables of order I(1) are integrated, that is, they are stationary in the first difference, and for that reason, the ARDL Bounds cointegration approach can be applied.

The first step of the ARDL approach begins with critical values testing to determine the existence of cointegration, a long-term connection. The maximum number of lags in the ARDL model is four and is designed based on the AIC criteria. The chosen model is ARDL (2, 1, 2, 0, 2). The results of long-term relationship testing are given in Table 3. The obtained value of F-statistics is higher than the critical value of I (0) and I (1) regressors, so the null hypothesis about the non-existence of a level relationship is rejected.

The long-run relationship, i.e., the selected long-run ARDL (2, 1, 2, 0, 2) equation of the B15 index value is shown in Table 4. It is clear that the increase in International travel controls during the COVID-19 pandemic caused a decrease in the value of the representative index of the Belgrade Stock Exchange B15 at a statistically significant level and, also, the ADJ coefficient of the B15 index value in the first lag is negative at a statistically significant level and indicates a high rate of convergence towards long-term equilibrium. In the short run, it is evident that the positive changes in the current and first lag of International travel controls during the COVID-19 pandemic (ITC), as well as the positive changes in the first lag of the number of new coronavirus deaths (NDD) are statistically significant and have positive effects on change the value of the index B15 (B15).

Diagnostic and model stability tests indicate that the proposed model has been adequately evaluated, and conclusions based on such a model are acceptable (Table 5 and Figure 2).

Table 2. Unit root test results

Variable and test	Level			First difference			Order of integration
	Φ	Constant	Trend	*Φ*	Constant	Trend	
ADF test							
B15	-8.46***	8.38***	8.62***	-21.67***	-0.95	1.39	I(1)
NDC	-2.68***	-0.01	1.24	-27.36***	0.43	-0.41	I(1)
NDD	-3.25***	0.29	1.79	-33.94***	0.52	-0.38	I(1)
RIM	-3.15***	2.09**	-1.80	-22.38***	-0.84	0.57	I(1)
ITC	-2.35**	1.60	-0.58	-22.34***	0.17	-0.20	I(1)
PP test							
B15	64.21***	8.38***	8.62***	0.86	-0.95	1.39	I(1)
NDC	86.54***	-0.01	1.24	-4.56***	0.43	-0.41	I(1)
NDD	73.44***	0.29**	1.79	-9.62***	0.52	-0.38	I(1)
RIM	81.54***	2.09	-1.80	-0.04	-0.84	0.57	I(1)
ITC	-0.58***	1.60	-0.58	-0.00	0.17	-0.20	I(1)

Note: *, **, and *** - the statistical significance at the 10%, 5%, and 1% level, respectively.

Source: Authors

Table 3. Testing the long-term relationship between variables in the ARDL model

Model	ARDL	F-Statistic
B15\NDC, NDD, RIM, ITC	(2, 1, 2, 0, 2)	35.488
Significance	**Critical values**	
	I(0)	**I(1)**
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Source: Authors

Table 4. ARDL error correction model (2, 1, 2, 0, 2)

D.B15		Coefficient	Std. Err.	t
ADJ	D.B15			
	L1.	-0.7952459	0.0606964	-13.10***
LR	NDC	0.0008438	0.0006506	1.30
	NDD	-0.0870685	0.1647486	-0.53
	RIM	-3.527265	2.468095	-1.43
	ITC	-6.99486	2.636204	-2.65***
SR	B15			
	LD.	-0.1838255	0.0435894	-4.22***
	NDC			
	D1.	-0.0001997	0.000335	-0.60
	NDD			
	D1.	0.1000999	0.1009543	0.99
	LD.	0.1225523	0.0568297	2.16**
	ITC			
	D1	3.964907	1.763985	2.25**
	LD.	3.755436	1.250628	3.00***
	Constant	0.1084512	0.2436009	0.45
R^2		0.5258		
Adj R^2		0.5152		

Note: *, **, and *** - the statistical significance at the 10%, 5%, and 1% level, respectively.

Source: Authors

Table 5. Diagnostic tests

Serial correlation	
Breusch-Godfrey LM test	$\chi2$ = 0.423; Prob > $\chi2$ = 0.5156
Functional form	
Ramsey RESET test	F(3, 495) = 1.23; Prob > F = 0.2989
Heteroskedasticity	
Breusch-Pagan/Cook-Weisberg test	F(4 , 498) = 1.92; Prob > F = 0.0938
ARCH test	$\chi2$ (1) = 2.266; Prob > $\chi2$ = 0.0817

Source: Authors

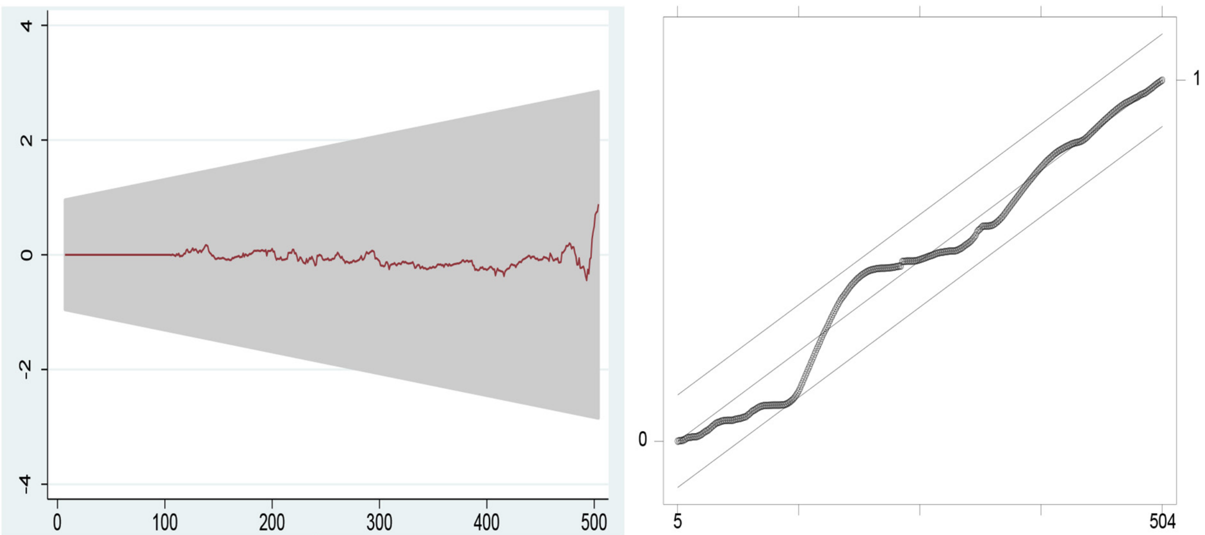

Figure 2. CUSUM and CUSUM of squared plots

Source: Authors

The VAR Granger causality model was used to verify the robustness of the results from the validated model. The results of the VAR Granger causality test (Table 6) also indicate two causal links, suggesting that changes in International travel controls during the COVID-19 pandemic, as well as changes in the number of new coronavirus deaths, cause changes in the values of the B15 index.

Table 6. Granger causality test results

H_0	χ^2	p
NDD does not cause B15	7.1191	0.028
ITC does not cause B15	11.111	0.004

Source: Authors

5. CONCLUSION

The COVID-19 pandemic is one of the latest, but also the most significant phenomena, which has seriously affected stock markets. In that sense, this paper focuses on determining the relationship between the pandemic and the Serbian stock market (measured by the B15 index) in the period from the first case of coronavirus in Serbia, March 6, 2020, to March 7, 2022, which is a total of 504 trading days. We used two categories of variables: 1) pandemic variables (number of new cases and new deaths due to coronavirus per day), and 2) variables that reflect measures taken by the authorities to control the infection (restrictions on internal movement, international travel controls).

The results of the conducted empirical analysis indicate a statistically significant and negative long-term relationship between the number of deaths from the consequences of the coronavirus on the daily level of the B15 index. The obtained results are in accordance with the results of studies by other authors (Hatmanu and Cautisanu, 2021; Gherghina et al., 2020; Al-Awadhi et al., 2020). Also, according to the obtained results, international travel control is statistically significantly and negatively related to the B15 index in the long run. The results of previous studies point to similar conclusions (Chowdhury et al., 2021; Zoungrana et al., 2021; Hatmanu and Cautisanu, 2021).

This paper provides a better insight into the impact of the current pandemic on the Serbian stock market in two years. The results could be a guideline to national authorities to effectively manage the measures adopted to fight the pandemic. The work also has certain limitations. First of all, it is focused only on the analysis of the Serbian context. In addition, the paper did not take into account economic variables such as, for example, inflation, monetary policy, fiscal policy, etc. In this regard, to obtain as accurate results as possible, future research could include these variables and additional pandemic variables, such as the number of tested and vaccinated, and use different methodological approaches, such as panel regression analysis, by including several countries.

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