BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

Lyubomir Todorov (Bulgaria)

COVID-19 AND DOMESTIC TRADE IN BULGARIA

Abstract

Domestic trade is an essential contributor to economic growth and an indicator of the people's welfare. It is vulnerable to the COVID-19 crisis due to the pandemic itself and the government's measures against it. An accurate estimation of the pandemic influence on domestic trade is needed for effective economic intervention in support of the economic recovery and improvement of the well-being of the population. The aim of this paper is to estimate the magnitude and timing of the COVID-19 impact on domestic trade in Bulgaria. The data used in the study covered the period 2000–2020 with monthly data for the indicator "Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria." This paper employed unit root tests, autocorrelation function analysis, building, estimating, forecasting ARIMA and ARCH models, and intervention analysis. The results revealed that Bulgarian domestic trade followed the difference-stationary process as unit root tests failed to reject the random walk hypothesis. The COVID-19 impact on domestic trade proved to be long-lasting and has permanently decreased its level since March 2020. The timing of the impact coincided with the government's measures against the pandemic. The drop in the volume of domestic trade was substantial and estimated at 19.3%. Following the nature of domestic trade, determined and decisive intervention is necessary if the Bulgarian government seeks to expand domestic demand and successfully procure economic recovery.

Received on: 14th of July, 2022
Accepted on: 7th of October, 2022
Published on: 26th of October, 2022

Lyubomir Todorov, Ph.D., Associate Professor, D. A. Tsenov Academy of Economics, Bulgaria.

Keywords COVID-19 impact, domestic trade, intervention analysis, unit roots

JEL Classification C12, C22, C51

Conflict of interest statement:
Author(s) reported no conflict of interest

INTRODUCTION

COVID-19 had profound effects on both economic development and society. The pandemic led to a reduction in the labor force, production, and export potential in various industries (Borojo et al., 2021; Hayakawa & Mukunoki, 2021a, 2021b, 2021c). Many governments implemented strict measures against the virus, including lockdowns, restrictions on travel and tourism, and social distance requirements. The trade relations suffered both internationally (due to disruptions of supply chains) and inside the counties (because of restrictions and lockdowns). COVID-19 affected international and domestic trade (Vidya & Prabheesh, 2020; Cao et al., 2021; Milea, 2020).

While suffering from the pandemic and the restrictions, some supply chains remained robust (Ando et al., 2021; Chenarides et al., 2021). E-commerce and m-commerce grew (Dumanska et al., 2021), enterprises proved to be flexible in the crisis (Deconinck et al., 2020), and exports rose (Rose et al., 2021; Jomthanachai et al., 2022), all suggesting the heterogeneity in the pandemic impact on trade (Zhang et al., 2022; Ngatno & Prihatiningsih, 2021). Nevertheless, restrictive measures curtailed the competition and contributed to a temporary rise in the market power of retailers (Ihle et al., 2020).

The varying COVID-19 influence made it vital to assess trade reduction as an essential task when developing plans for economic recovery, setting priorities in critical areas with high public importance, and encouraging transformation in response to the challenges of the post-COVID economy. The existing empirical research on the pandemic's impact on domestic trade indicated the expansion of online trade in Germany (Dannenberg et al., 2020) and the considerable initial reduction in China (Aohan, 2020). However, no studies were performed for Bulgaria, leaving the question about the magnitude of the COVID-19 impact on domestic trade.

1. LITERATURE REVIEW

COVID-19 and its effects on the world economy received serious attention despite the short time since the pandemic's start and data availability problems. The studies concerning international and domestic trade could be summarized in several key areas.

The first area covered conceptual aspects of the COVID-19 crisis, its immediate and long-term effects, the propagation mechanism of the economic downturn, and the future of the world economy. Bekkers and Koopman (2022) predicted the impact of the pandemic and analyzed the consequent recovery by developing three scenarios (V, U, and L-shaped). They expected the drop in the GDP to vary between 5% and 11% worldwide, while the reduction in international trade to be between 8% and 20%. Vidya and Prabheesh (2020) studied the interconnections among the trade participants. They found that the structure of trade relations was changing, with some countries becoming less dependent on international sources. Zagashvili (2021) summarized factors influencing international trade in relation to COVID-19: contracting demand, disruption of global supply chains, restrictions on export, rising cost of production, implementation of sanitary measures, and restrictions on tourism and business travel.

Li and Lin (2021) studied the hypothesis that the pandemic would increase the cost of trade transactions and decrease labor supply, thus leading to a drop in international and domestic trade. Bonadio et al. (2021) assessed the connection between COVID-19 and the global supply chains. They considered the governments' restrictive measures and the jobs available for homeworking and estimated that the GDP decline only partially contributed to factors linked with supply chains. Ihle et al. (2020) analyzed the households' access to food during the COVID-19 crisis. They provided evidence of growing price margins at the expense of consumers and farmers because the implemented mobility constraints reduced competition and raised the market power of retailers.

The second area covered the measures against the pandemic and in support of economic development. Stojanov (2021) analyzed the activities of Bulgarian companies in the retail sector in response to the challenges of COVID-19, the emergency state imposed in Bulgaria in March 2020, and the implemented measures against the pandemic. Milea (2020) studied the impact of both the pandemic and the measures against it and found that COVID-19 influenced the trade in goods more than services. Finally, Evenett et al. (2020) summarized the different instruments of the trade policy applied by the governments in response to COVID-19. They marked the heterogeneity in the governments' response via implemented measures.

The third research area focused on the demand for industrial goods, foodstuff trade, and the corresponding supply chains. Ongan and Gocer (2022) studied the connection between the COVID-19 pandemic and the Japan-USA trade about the production of 60 industrial branches. The study applied an autoregressive distributed lags model to analyze the effect of the economic measures through the Trade Policy Uncertainty (TPU) index and found that its influence was country-dependent – more substantial in the USA than in Japan. Even with the increased uncertainty in both countries, consumer demand remained stable. Hayakawa and Mukunoki (2021a) analyzed the global trade in machinery and equipment for the first half of 2019 and 2020 to assess the influence of the global pandemic on demand, production, and supply chains. They found that the effects of COVID-19 were negative – stronger for supply chains, weaker for production, and not sig-

http://dx.doi.org/10.21511/ppm.20(4).2022.09

nificant for demand. The biggest drops were recorded in May 2020, when trade in finished machinery goods fell by 30%, and trade in machinery parts was down by 20%.

Ando et al. (2021) studied the Japanese trade in machinery and equipment concerning COVID-19-induced shocks. They used detailed data for 2020 and found that the trade in parts and components was stable even at the pandemic's peak, and the international supply chains were unaffected. They were able to distinguish between the negative and positive impacts of COVID-19. The study also indicated the increased demand for some products, machinery and equipment, which partially explained the heterogeneous effects in the sector. Deconinck et al. (2020) studied the relationship between COVID-19 and global food supply chains. They found that government measures for reducing border waiting times, streamlining certification procedures, and relaxing food trade regulations led to the remarkable resilience of food supply chains. Thus, consumers' loss of income was a significant risk to food security.

Mallory (2021) considered the changes in the dynamics of the agricultural exports of the USA and Brazil concerning the first wave of COVID-19 (April-May 2020). He established that the export of cereals and oil seeds was not affected seriously, while the export of pork and beef suffered due to the closure of many processing facilities. Chenarides et al. (2021) analyzed the production of fresh fruits and vegetables in Canada during the COVID-19 pandemic and found that the supply chains for fresh fruits and vegetables remained robust. Finally, Cao et al. (2021) considered the influence of the pandemic on Chinese trade in agricultural products. They found a negative impact both in the short and long term. The problems in international trade and the disruption of the supply chains contributed to the short-term decrease.

In contrast, the implementation of trade barriers reinforced the overall effects of the pandemic. Wittwer and Anderson (2021) studied the specialized wine market in relation to COVID-19. They found that the pandemic caused a decrease in the international wine trade and domestic consumption (worldwide domestic consumption of wine fell by 11%) due to social distancing, isolation, lockdowns of restaurants, bars, and clubs, reduction in travel and tourism. While there was some increase in e-trade in wine, it could not compensate for the decline in direct sales and consumption.

The fourth area described the notable effects of COVID-19 related to the substantial decrease in macroeconomic activities – production, employment, income, and trade. Đukić et al. (2021) pointed out that the COVID-19 pandemic decreased all major economic indicators of the European Union member states. They stated that there were many global factors for reduced growth before the outbreak of the pandemic: difficulties in USA-China trade relations; confrontation between Russia and the West (primarily the USA and European Union); the UK leaving the European Union (Brexit); and economic migration from Africa and Asia toward Europe. The study applied regression and correlation analysis and established that COVID-19 significantly affected GDP, income, unemployment, and public debt.

Borojo et al. (2021) studied the influence of COVID-19 on trade, production, and the environment. They used panel data and the gravity model of trade to estimate that the pandemic had a negative impact on trade and production but a positive effect on the environment's quality (decreased carbon dioxide emissions). Hayakawa and Mukunoki (2021b) analyzed the changes in international trade due to the implemented policies against COVID-19. They found that the adverse effects of the pandemic led to an overall decrease in the trade volume that was particularly significant for the industries producing durable goods. In their other work, Hayakawa and Mukunoki (2021c) used data for export (34 countries) and import (173 countries) to assess the impact of the pandemic on international trade. They found that the effects were adverse concerning both imports and exports but diminished as early as July 2020 with the end of the first wave of COVID-19.

Espitia et al. (2021) used the sector gravity model for 28 countries. They estimated regression coefficients that indicated the negative effect of COVID-19 on trade, but the impact varied across the sectors. Sectors were less influenced when they had more possibilities for work at home. Participation in international trade had mixed

http://dx.doi.org/10.21511/ppm.20(4).2022.09

effects – it increased dependency on external shocks in trade partners but decreased susceptibility to internal shocks. Zhang et al. (2022) applied the Fourier test with monthly data for China and USA to investigate the impact of COVID-19 on international trade. They found that China's trade depended on the number of deaths but not on the number of infected. The situation was different for the USA, where the exports and imports were related to both the number of deaths and the number of infected.

Obayelu et al. (2021) examined the influence of COVID-19 on African trade. They recorded a substantial decrease in the trade among the regions in Africa and the international trade of African countries. Duan et al. (2021) used quarterly data for China and the general equilibrium model to evaluate the impact of COVID-19. According to their estimates, the growth reduction for 2020 was 3.5%, while the final consumption dropped by 4.4%. The service industry suffered the most, with a decrease of 14.6% for some sectors. Du and Shepotylo (2021) analyzed the United Kingdom exports and found that it fell for the first nine months of 2020 compared to 2019 by 17.0%, while the import decreased by 14.3%.

Fifth, despite some results demonstrating the negative impact of the global pandemic on the economy, some studies showed ambiguous results, as the effects of COVID-19 vary across producers, industries, goods, and destinations. Dumanska et al. (2021) examined the COVID-19 impact on international trade and found an ongoing increase in the share of mobile transactions and a slow transition from e-commerce to m-commerce. Ngatno and Prihatiningsih (2021) analyzed the import and export of Indonesia and found that the trade relations between Indonesia and Asian countries were influenced in diverse ways by COVID-19. The study assumed that it was connected to the severity of the pandemic and the export structure. Jomthanachai et al. (2021) compared the effects of the pandemic on international trade for six ASEAN members (Vietnam, Indonesia, Malaysia, Philippines, Singapore, and Thailand). They found that the Thailand trade suffered the most due to severe supply chain and logistics problems. Conversely, Vietnam had a very efficient export sector and was the least impacted by the pandemic. Michail and Melas (2022) used cointegration analysis to study the impact of COVID-19 on the freight rates for tankers carrying refined petroleum products and crude oil. They found that the global pandemic's influence varied by routes and products. Ferrari et al. (2022) analyzed the relationship between COVID-19 and the international trade of Italy using detailed data since 2012. They modeled the existing patterns, compared them with the first six months of 2020, and found that COVID-19 impact was asymmetric in relation to regions and goods. The import was influenced in February 2020, while the export reacted to the pandemic with some delay in March-April 2020.

Rose et al. (2021) developed an equilibrium model to study the propagation of restrictive measures' effects. They found that the impact on the US GDP was negative (the USA trade suffered at different degrees depending on the trade partners), while China was able to increase export. Xu et al. (2021) studied the trade relation between China and three trade regions – European Union, North America, and South-East Asia, concerning pandemic and seaborne trade. They used a dynamic model with panel data for the first nine months of 2020 and established that implemented measures for control of the pandemic led to a decrease in export volume, but imports increased. Dannenberg et al. (2020) studied the impact of COVID-19 on online grocery retail in Germany. They found a disproportionately high increase in the online grocery trade but little transition from grocery to e-grocery. Aohan (2020) examined retail sales in China in 2020 using the Holt-Winters multiplicative model. The results showed that the total retail sales of consumer goods dropped by 16.2% due to COVID-19.

The established results led to the conclusion that the pandemic's effects on trade were mainly adverse, but their scope (countries, regions, industries, and products), amplitude, and duration varied. While the impact was documented for international trade, it had severe implications on the income, employment, production, and availability of foreign goods, thus influencing also domestic trade both through the demand and supply side. The diversity, complexity, and prolongation of pandemic effects on trade made it difficult to presume its impact in Bulgaria, thus raising the ques-

http://dx.doi.org/10.21511/ppm.20(4).2022.09

tion of proper evaluation of COVID-19 influence. In that regard, the aim of this study was to assess the timing and magnitude of COVID-19 impact on Bulgarian domestic trade.

2. METHODOLOGY

The analyzed time series was "Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (Indices, 2015 = 100%)." The series characterized the main economic results and short-term trends in the development of the enterprises from the group "G" in the statistical classification of economic activities (NACE Rev. 2/2008). The indices reflected the changes in the demand and supply of goods and services via the turnover ratio between the two compared periods. The data sources were official and available at the internet site of the National Statistical Institute via the INFOSTAT (n.d.) system in the section "Business Statistics/Short-term Business Statistics/Trade." They were compiled under the Eurostat standards (Regulation EU 1158/2005 and Regulation EU 1893/2006). The measurement unit was a percentage at constant prices (2015 = 100%). Due to the way of indices construction, the values for the separate periods were multiplicatively linked.

The study covered 2000–2020, ensuring a long enough time series to identify the main patterns. However, the time before 2000 was avoided as it was connected with some radical changes in the structure of the Bulgarian economy – implementation of the Currency Board (1997), denomination of currency (1998), the transformation of ownership of the enterprises from public to private and transfer of large part of the labor force into the services sector.

The estimation of COVID-19 impact on the dynamics of particular indicators could be done in different ways. It can use the multiplicative Holt-Winters model (Aohan, 2020); comparative analysis (Dannenberg et al., 2020; Ihle et al., 2020); equilibrium model (Duan et al., 2021); scenario analysis (Cao et al., 2021) and Global Trade Model (Bekkers & Koopman, 2022); gravity model (Espitia et al., 2021; Hayakawa & Mukunoki, 2021c); and Fourier causality test (Zhang et al., 2022). However, some methods require panel data for several countries, and others – micro-level data for sectors of the economy or individual enterprises. Other instruments cannot distinguish between short and long-run effects. Therefore, the intervention analysis was used in the study, a convenient tool for estimating the impact of external shocks assuming the timing of their occurrence was known (Box et al., 2016).

To assess the influence of external shock, a two-component model presented the series:

$$y_t = \frac{\theta(B)}{\phi(B)}\varepsilon_t + \frac{\alpha}{\delta(B)}D_t, \qquad (1)$$

where: y_t was the time series;

$\frac{\theta(B)}{\phi(B)}\varepsilon_t$ – the first component that characterized the patterns in series dynamics. The component was assumed to follow the autoregression and moving averages (ARMA) model or, in case of non-stationarity – autoregression and integrated moving averages model (ARIMA).

$\frac{\alpha}{\delta(B)}D_t$ – the second component that characterized the influence of the external shock. The functional form of the lag operator polynomial δ(B) allowed the response to be either permanent or transitory, instant, cumulative, or diminishing. D_t – deterministic indicator variable that could be pulse (P_t), step (S_t), or trend (T_t), evaluating one-time transitory change in the level of the series, permanent change in the level, and permanent change in the slope. ε_t – random component or random variable following identical and independent normal distribution (white noise); ϕ(B), θ(B), and δ(B) – polynomials of the lag operator; α – parameter(s) that estimated the impact of the external shock.

When time series y_t was non-stationary, the estimation process required transformation: $\Delta = (1 - B)$ – if unit root was present; $\Delta_s = (1 - B^S)$ – when there was seasonal unit root (unit roots); $\Delta\Delta_s = (1 - B)(1 - B^S)$ – when both unit root and seasonal unit root were observed in the series.

The choice of transformation had a profound impact on the intervention analysis. It was stated that the mechanical application of seasonal differences could lead to incorrect specification of the model (Beaulieu & Miron, 1992, p. 19), thus making statistical tests for the presence of unit roots at seasonal frequencies a critical initial step in the analysis. Therefore, instead of the classical tests (ADF, PP, and KPSS), the paper used the methodology proposed by Hylleberg et al. (1990) in the variant for monthly data developed by Beaulieu and Miron (1992). The testing involved the construction of 12 auxiliary variables (10 of them forming conjugate pairs). After the testing equation was evaluated, the null hypothesis of the unit root could be assessed. If all testing statistics (t_2 and all $F_{i,i+1}$) are statistically different from zero, the null hypothesis has to be rejected. Otherwise, the series contained unit roots and required transformation.

The main patterns in the data were identified with the classical tools of autocorrelation function analysis for the transformed series. The timing of the COVID-19 impact and other structural breaks was analyzed in two ways. First, a deduction was used for the possible critical moments in the development of Bulgarian domestic trade when there was strong, reliable evidence from earlier studies, and information for the government's actions. When there were doubts about possible lags in the response, the empirical evidence was derived from the available data by ARIMA modeling in two steps:

1. Building and estimating auxiliary ARIMA model for 2000–2019 and creating a forecast for 2020.

2. Comparing the real data and the forecasted values and computing the forecast errors.

The ARIMA models were used both for the first component in the intervention model and for the auxiliary model. They were built with the homoscedasticity assumption. When this assumption was violated, the conditional autoregressive heteroscedasticity (ARCH) model was used instead. In ARCH models, the variance was not supposed to be constant but was allowed to develop as an autoregressive process.

Estimation of all models was performed in EViews software by the method of nonlinear least squares (when possible) and by the method of maximum likelihood in other cases. In addition, the stepwise procedure of removing insignificant variables was used to increase the precision of the parameter estimates. At each step, only one variable was removed, and the choice was based on the Akaike information criteria.

3. RESULTS

The domestic trade dynamics are presented in Figure A1. For the period under study, there was an increase in the trade volume together with a clear seasonal component. The amplitude of the seasonal fluctuations grew with the level of the series. Such behavior was expected for this indicator due to the multiplicative nature of the series; thus, logarithmic transformation was applied to achieve linearity. As seen in Figure A2, the transition to logarithms stabilized the fluctuation of the seasonal component while retaining all other features of the series.

The autoregressive structure of the transformed series is presented in Figure A3. The first-order autocorrelation coefficient had a value of $r_1 = 0.96$, and the coefficients of higher order decreased slowly. Such a pattern was typical for non-stationary series that contained unit roots. The first differences of the series (Figure A4) did not show any movement up or down, but the seasonal fluctuations remained clearly visible, and their corresponding autocorrelation coefficients (Figure A5) were significant. They declined slowly ($r_{12} = 0.84$; $r_{24} = 0.75$; $r_{36} = 0.68$) suggesting seasonal unit roots.

When only seasonal differences were used, the series was cleansed from the repeating seasonal fluctuations, but its pattern still exhibited serious deviation from stationarity (Figure A6). Moreover, the series did not return to its mean value; on the contrary – for prolonged periods, deviations were observed with substantial amplitude. This pattern was distinctive for processes with unit roots, and the shape of the autocorrelation function (Figure A7) gave even more support to the non-stationarity hypothesis. The first-order autocorrelation coefficient was $r_1 = 0.89$, and while the values of

http://dx.doi.org/10.21511/ppm.20(4).2022.09

higher-order coefficients decreased faster than in Figure A3, they remained significant up to lag 20.

Only when both first and seasonal differences were used, the transformed series showed homogeneity and stationarity (Figure A8). The series fluctuated around zero with varying intensity. In the second half of the series, there were several peaks in a negative direction. Autocorrelation coefficients (Figure A9) were in the range of their respective confidence intervals with only 3 being significantly different from zero at 5% ($r_{12} = -0.24$; $r_{12} = -0.18$; $r_{35} = 0.16$), while only 2 were significant at 1% (r_1 and и r_{12}). All of the significant coefficient values were in the (–0.5; 0.5) interval suggesting moving average process (Durbin & Koopman, 2001, p. 51).

The unit-roots testing results are shown in Table A1. The unit root hypothesis could not be rejected at 5% for neither of the variants. Only in some of the variants could it be rejected at frequencies π/3 ($F_{7,8}$ was significant for models A and B) and 5π/6 ($F_{9,10}$ was significant for models A, C, and E). Besides, in no variant, the first testing characteristic t_1 was significant at 5%, indicating that the unit root hypothesis at zero frequency could not be rejected.

The data did not show enough evidence against unit root neither at zero nor at seasonal frequencies, and – following visual patterns and autocorrelation functions – the series had to be transformed with both first and seasonal differences. Based on these results, the first component of the candidate model was:

$$\Delta\Delta_{12} y_t = \left(1-\theta_1 B\right)\left(1-\theta_{12} B^{12}\right)\varepsilon_t, \qquad (2)$$

known as *airline model* of Box and Jenkins: $ARIMA(0,1,1) \times SARIMA(0,1,1)$.

Another essential feature of the series was linked to the possibility of a structural break around the third or fourth quarter of 2008. It was noticeable in both the initial data and the transformed series. Such change in the behavior of the series could be attributed to the global financial crisis that started in the United States in 2006 with the mortgage market's collapse. It reached Bulgaria two years later via international trade and investments (Zlatinov, 2018). The crisis expressed itself in slow growth, depreciation of industrial activity, decline in export, decrease in the banking sector liquidity and simultaneous increase of interest rates, rise of unemployment, and constriction of private consumption. All those factors naturally influenced the domestic trade in Bulgaria, and the recovery to the pre-crisis level was achieved after almost six years. A similar decrease in the series level was observed during 2020, with expected timing around the first quarter. It gave some evidence to assume that both the implementation of the government's measures against the pandemic and the spread of COVID-19 in the country led to substantial changes in domestic trade.

The visual inspection of the time series suggested choosing indicator functions that could estimate possible changes both in the level of the series and in the growth rates in 2008 and 2020. Furthermore, the studies about the influence of the 2008 economic crisis allowed identifying the third quarter of 2008, specifically October, as a critical moment of structural change (Zlatinov, 2018, pp. 118, 120). Regarding the structural break in 2020, there were some expectations for it to be in March. The government implemented measures to contain the pandemic (Decision of the Council of Ministers of the Republic of Bulgaria №159/8.03.2020).

The timing of the COVID-19 impact was established by using an auxiliary model estimated with the method of Maximum Likelihood for the 2000–2019 subset. The diagnostic checking of the residuals detected the presence of conditional autoregressive heteroscedasticity (*ARCH*). The Engle test statistics for conditional heteroscedasticity of first-order $ARCH(1) = 10.476$ surpassed the critical value of $\chi_T^2 = 3.84$ at 5%. Thus, the auxiliary model was specified as $ARCH(1)$, and the estimation led to the following results:

$$\Delta\Delta_{12} y_t = \left(1-0.2537B\right)\left(1-0.3638B^{12}\right)\varepsilon_t, \qquad (3)$$

$$\sigma_t^2 = 0.0009 + 0.1967\varepsilon_{t-1}^2. \qquad (4)$$

The diagnostic check established that residuals could be treated as independent while the heteroscedasticity problem was solved. The only distortion was due to the deviation from the normal distribution – the Jarque-Bera test had a value $JB = 15.968$, which was significant at 5% (critical value is $\chi_T^2 = 5.99$). However, the deviation from normality could not cause serious problems, as the series length (more than 200 observations) was enough for the asymptotic normality of the parameters' estimates.

The deviations of the forecasted values for 2020 from the real data are presented in Figure A10. For the first two months of 2020, only marginal deviations did not rise above the confidence limits of ($\pm 3\sigma_\varepsilon$). In March 2020, though, the observed forecast error exceeded the boundaries and remained outside during the rest of the year. These findings coincided with the implementation of measures by the Bulgarian government and gave enough reason to accept March 2020 as a critical moment for the second structural break.

Consequently, the second part of the general intervention model included 6 indicator functions in total – 3 of them describing the possible changes in October 2008, and the other 3 – possible changes in March 2020. The relatively short period after March 2020 and the simple form of the autocorrelation function of the transformed series (Figure A9) suggested fixing lag operator polynomial as $\delta(B) = 1$.

The estimation of the model was again performed as *ARCH*(1), and the results are summarized in Table A2. The diagnostic check of the residuals showed that they could be treated as independent variables. The values of their autocorrelation coefficients (Table A3) were not significant up to lag 24. The autocorrelation function of the squared residuals from the model did not show significant values. Thus, no heteroscedasticity problem remained (Table A4). The model was adequate and explained around 25% of the series dynamics ($R^2 = 0.245$).

Only one of the indicator functions had a significant parameter – α_3, corresponding to the permanent change in the growth rate in 2008. All other α_i parameters were not significant. Therefore, the model was improved by stepwise removal of those indicator functions that did not contribute to the explained variation.

The final model included only two indicator functions, representing a change in the rate of growth in 2008 and a change in the level of the series in 2020. The parameter estimates for those two indicator variables were significant at 5% (Table A5). The diagnostic check of the final model revealed that the residuals were independent because there were no significant autocorrelation coefficients (Table A6). In addition, there was no autoregressive conditional heteroscedasticity, as no coefficients were significant in the autocorrelation function of the squared residuals (Table A7).

Based on the parameter estimates, the impact of the 2008 economic crisis on Bulgarian domestic trade was:

$$e^{\alpha_3} = e^{-0.0149} = 0.985, \quad (5)$$

corresponding to a decrease in the rate of growth with 1.5%. The change was significant, with the 95% confidence interval being [–2.5%; –0.5%]. Thus, the global financial crisis of 2008 led to a permanent decrease in the growth of Bulgarian domestic trade.

The impact of COVID-19 on trade in March 2020 was represented in parameter α_5:

$$e^{\alpha_5} = e^{-0.2140} = 0.807, \quad (6)$$

corresponding to a decrease in the trade volume of about 19.3%. The 95% confidence interval was [–29.0%; –8.2%]; thus, the impact of COVID-19 on Bulgarian domestic trade was a permanent decrease between 8.2 and 29.0%.

4. DISCUSSION

The results of unit root testing and modeling of the series allowed estimating the impact of the pandemic and the measures implemented by the Bulgarian government on domestic trade. The impact was a significant decrease in domestic trade by 19.3% in March 2020. This substantial drop could be attributed to the changes in both supply and demand side of the consumer goods market. On the supply side, the key factors were the difficulties with the imports, as fewer goods were available due to the disruption of global supply chains and the reduced capacity of the retailers due to the implemented measures and lockdowns. On-demand side, the job losses led to a reduction in income and changes in consumer behavior, as many people restricted their shopping.

http://dx.doi.org/10.21511/ppm.20(4).2022.09

The negative impact of COVID-19 on domestic trade reinforced the results of the majority of the studies mentioned above about international and domestic trade. The shared key feature was a sharp decrease in trade. The differences were in the scope and amplitude of the reduction, which should be considered in connection with the peculiarities of countries and products. While Bulgarian GDP fell by 0.3% in the first quarter of 2020, private consumption rose by 1.5%. The decrease in Bulgarian domestic trade was disproportionately more considerable than these figures. However, the Bulgarian economy was much more dependent on imports and thus susceptible to supply chain disruption. The country had a much smaller consumption base making it more prone to sudden shocks.

On the demand side, the fluctuations in the labor market also contributed to the decrease. While in 2020, the unemployed decreased by 16.4 thousand, the labor force decreased by 57.0 thousand, and the number of employed people dropped by 40.6 thousand showing a shrinking labor supply. On the supply side, the effect of supply chain disruption was shown in the minor increase of imports in Bulgaria – only by 1.2%, which could not compensate for the loss of domestic production. The import of goods grew in the first quarter of 2020 by 2.4%, while the import of services dropped by 2.5% for the same period. The higher vulnerability of imported services contradicted the results of Milea (2020).

The market power of retailers in Bulgaria grew during the lockdowns. They took advantage of reduced competition and increased their profits by 10.7%. However, in the situation with decreasing demand, they could not influence prices – CPI in Bulgaria rose by 1.7% in 2020 compared with 3.1% in 2019, and retailers' revenues dropped by 1.4% in 2020. The decrease in retailers' expenses by 1.9% in 2020 showed that they were increasing pressure against their suppliers instead.

The online trade in Bulgaria showed signs of rapid growth. The share of people that made purchases online grew from 21.7% in 2019 to 30.9% in 2020, or by 42.4%. However, the volume of online trade in Bulgaria remained relatively small, thus limiting its influence on domestic trade.

The different confidence intervals were related to the accuracy of the estimated parameters corresponding to structural breaks. The first change was estimated with higher precision because more observations were available before and after October 2008 than before and after March 2020. The estimation of the COVID-19 impact could be done with better precision when more data is accumulated after the breaking point in March 2020.

The results were based on two major assumptions:

a) the deviation of the model residuals from the normal distribution did not influence the accuracy of the estimation process due to the length of the series; and

b) the timings of structural breaks were correctly identified in October 2008 and March 2020. The acquired parameter estimates were conditional estimates – their correctness and precision were linked to the validity of the assumptions.

As an added finding, the analysis established first-order autoregressive conditional heteroscedasticity in all models' residuals. Such heteroscedasticity was an essential feature of the series. It is beyond the scope of this study to figure out the reason for this behavior, but the fact must be considered in future analyses of domestic trade.

CONCLUSION

The aim of this paper was to assess the timing and magnitude of COVID-19 impact on Bulgarian domestic trade. Performed statistical tests showed that the unit root hypothesis could not be rejected for the series, neither at zero, nor at the seasonal frequencies. Thus, the series exhibited difference-stationary behavior and would not return to its long-term trend but instead would be permanently affected by external shocks, including the COVID-19 pandemic. The establishment of the patterns in the series prior to 2020 and comparison between forecasts and real data revealed that the moment of structural change in Bulgarian domestic trade was in March 2020, coinciding with the implementation of government measures against the virus. The intervention model results proved that the domestic trade volume was significantly affected in March 2020, and its level decreased by 19.3%.

The substantial drop in Bulgarian domestic trade could be attributed more to the government response to the pandemic than to the infections themselves. The timing of the drop in March 2020 corresponded with the implementation of an emergency state in Bulgaria. Its consequences were lockdowns, restrictions on movement, reduced retailers' capacity, and consumer behavior changes. The reduction in consumption by about one-fifth inevitably led to the worsening of the population's well-being, which would be long-lasting. The consequent trade development would not naturally compensate for the loss. Thus, a proactive policy of government intervention is required to stabilize domestic trade, stimulate consumption, and further expand domestic demand.

AUTHOR CONTRIBUTIONS

Conceptualization: Lyubomir Todorov.
Data curation: Lyubomir Todorov.
Formal analysis: Lyubomir Todorov.
Funding acquisition: Lyubomir Todorov.
Investigation: Lyubomir Todorov.
Methodology: Lyubomir Todorov.
Project administration: Lyubomir Todorov.
Resources: Lyubomir Todorov.
Software: Lyubomir Todorov.
Supervision: Lyubomir Todorov.
Validation: Lyubomir Todorov.
Visualization: Lyubomir Todorov.
Writing – original draft: Lyubomir Todorov.
Writing – review & editing: Lyubomir Todorov.

REFERENCES

1. Ando, M., Kimura, F., & Obashi, A. (2021). International production networks are overcoming covid-19 shocks: Evidence from Japan's machinery trade. *Asian Economic Papers, 20*(3), 40-72. https://doi.org/10.1162/asep_a_00835
2. Aohan, L. (2020). An Empirical Analysis of Total Retail Sales of Consumer Goods Based on Holt-winters. *ACM International Conference Proceeding Series* (pp. 54-57).
3. Beaulieu, J., & Miron, J. (1992). *Seasonal Unit Roots in Aggregate U.S. Data* (NBER Working Paper No. t0126). Retrieved from https://www.nber.org/system/files/working_papers/t0126/t0126.pdf
4. Bekkers, E., & Koopman, R. B. (2022). Simulating the trade effects of the COVID-19 pandemic: Scenario analysis based on quantitative trade modelling. *The World Economy, 45*(2), 445-467. https://doi.org/10.1111/twec.13063
5. Bonadio, B., Huo, Z., Levchenko, A. A., & Pandalai-Nayar, N. (2021). Global supply chains in the pandemic. *Journal of International Economics, 133,* 103534. https://doi.org/10.1016/j.jinteco.2021.103534
6. Borojo, D. G., Yushi, J., & Miao, M. (2021). The effects of COVID-19 on trade, production, environmental quality and its implications for green economy. *Journal of Economic Studies*. https://doi.org/10.1108/JES-06-2021-0307
7. Box, G. E. P., Jenkins, G., Reinsel, G., & Ljung, G. (2016). *Time Series Analysis: Forecasting and Control* (5th ed.). Hoboken, NJ: Wiley.
8. Cao, L., Li, T., Wang, R., & Zhu, J. (2021). Impact of COVID-19 on China's agricultural trade. *China Agricultural Economic Review, 13*(1), 1-21. https://doi.org/10.1108/CAER-05-2020-0079
9. Chenarides, L., Richards, T. J., & Rickard, B. (2021). COVID-19 impact on fruit and vegetable markets: One year later. *Canadian Journal of Agricultural Economics, 69*(2), 203-214. https://doi.org/10.1111/cjag.12272
10. Dannenberg, P., Fuchs, M., Riedler, T., & Wiedemann, C. (2020). Digital Transition by COVID-19

http://dx.doi.org/10.21511/ppm.20(4).2022.09

Pandemic? The German Food Online Retail. *Tijdschrift voor Economische en Sociale Geografie, 111*(3), 543-560. https://doi.org/10.1111/tesg.12453

11. Deconinck, K., Avery, E., & Jackson, L. A. (2020). Food Supply Chains and Covid-19: Impacts and Policy Lessons. *EuroChoices, 19*(3), 34-39. https://doi.org/10.1111/1746-692X.12297
12. Du, J., & Shepotylo, O. (2021). UK trade in the time of COVID-19: A review. *The World Economy, 45*(5), 1409-1446. https://doi.org/10.1111/twec.13220
13. Duan, H., Bao, Q., Tian, K., Wang, S., Yang, C., & Cai, Z. (2021). The hit of the novel coronavirus outbreak to China's economy. *China Economic Review, 67,* 101606. https://doi.org/10.1016/j.chieco.2021.101606
14. Đukić, A., Štaka, M., & Drašković, D. (2021). The impact of the COVID-19 pandemic on the macroeconomic aggregates of the European Union. *Economics, 9*(2), 91-108. https://doi.org/10.2478/eoik-2021-0023
15. Dumanska, I., Hrytsyna, L., Kharun, O., & Matviiets, O. (2021). E-commerce and m-commerce as global trends of international trade caused by the covid-19 pandemic. *WSEAS Transactions on Environment and Development, 17,* 386-397. Retrieved from https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/pt/covidwho-1248604
16. Durbin, J., & Koopman, S. J. (2001). *Time Series Analysis by State Space Methods*. Oxford: Oxford University Press.
17. Espitia, A., Mattoo, A., Rocha, N., & Winkler, D. (2021). *Pandemic trade: COVID-19, remote work and global value chains* (Policy Research Working Paper No. 9508). World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/35023
18. Evenett, S., Fiorini, M., Fritz, J., Hoekman, B., Lukaszuk, P., Rocha, N., Ruta, M., Santi, F., & Shingal, A. (2020). *Trade policy responses to the COVID-19 pandemic crisis: Evidence from a new data set* (Policy Research Working Paper No. 9498). World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/34942
19. Ferrari, C., Persico, L., & Tei, A. (2022). Covid-19 and seaborne trade: The Italian perspective. *Research in Transportation Economics, 93,* 101162. https://doi.org/10.1016/j.retrec.2021.101162
20. Hayakawa, K., & Mukunoki, H. (2021a). Impacts of COVID-19 on global value chains. *Developing Economies, 59*(2), 154-177. https://doi.org/10.1111/deve.12275
21. Hayakawa, K., & Mukunoki, H. (2021b). Impacts of lockdown policies on international trade. *Asian Economic Papers, 20*(2), 124-141. https://doi.org/10.1162/asep_a_00804
22. Hayakawa, K., & Mukunoki, H. (2021c). The impact of COVID-19 on international trade: Evidence from the first shock. *Journal of the Japanese and International Economies, 60,* 101135. https://doi.org/10.1016/j.jjie.2021.101135
23. Hylleberg, S., Engle, R., Granger, C., & Yoo, B. (1990). Seasonal integration and cointegration. *Journal of Econometrics, 44*(1-2), 215-238. https://doi.org/10.1016/0304-4076(90)90080-D
24. Ihle, R., Rubin, O. D., Bar-Nahum, Z., & Jongeneel, R. (2020). Imperfect food markets in times of crisis: economic consequences of supply chain disruptions and fragmentation for local market power and urban vulnerability. *Food Security, 12*(4), 727-734. https://doi.org/10.1007/s12571-020-01084-1
25. INFOSTAT. (n.d.). *Main Page*. Retrieved from https://infostat.nsi.bg
26. Jomthanachai, S., Wong, W., Soh, K., & Lim, C. (2022). A global trade supply chain vulnerability in COVID-19 pandemic: An assessment metric of risk and resilience-based efficiency of CoDEA method. *Research in Transportation Economics, 93,* 101166. https://doi.org/10.1016/j.retrec.2021.101166
27. Li, C., & Lin, X. (2021). COVID-19 and trade: Simulated asymmetric loss. *Journal of Asian Economics, 75,* 101327. https://doi.org/10.1016/j.asieco.2021.101327
28. Mallory, M. L. (2021). Impact of COVID-19 on medium-term export prospects for soybeans, corn, beef, pork, and poultry. *Applied Economic Perspectives and Policy, 43*(1), 292-303. https://doi.org/10.1002/aepp.13113
29. Michail, N. A., & Melas, K. D. (2022). Covid-19 and the energy trade: Evidence from tanker trade routes. *Asian Journal of Shipping and Logistics, 38*(2), 51-60. https://doi.org/10.1016/j.ajsl.2021.12.001
30. Milea, C. (2020). Consequences of COVID-19 on the International Trade in Goods and Services: Forecasts, Developments, Restrictions. *Financial Studies, 4,* 29-40. Retrieved from http://hdl.handle.net/10419/231708
31. Ngatno, & Prihatiningsih, A. E. (2021). Analysis of Indonesia's Exports & Imports in the Asian Region: Before and During the Covid-19 Pandemic. *Asian Economic and Financial Review, 11*(11), 923-937. https://doi.org/10.18488/journal.aefr.2021.1111.923.937
32. Obayelu, A. E., Edewor, S. E., & Ogbe, A. O. (2021). Trade effects, policy responses and opportunities of COVID-19 outbreak in Africa. *Journal of Chinese Economic and Foreign Trade Studies, 14*(1), 44-59. https://doi.org/10.1108/JCEFTS-08-2020-0050
33. Ongan, S., & Gocer, I. (2022). Japan-US bilateral commodity-level trade and trade policy-related uncertainty under the COVID-19 pandemic: The nonlinear ARDL model. *Economic Change and Restructuring, 55*, 1397-1418. https://doi.org/10.1007/s10644-021-09351-7
34. Rose, A., Walmsley, T., & Wei, D. (2021). Spatial transmission of the economic impacts of COVID-19 through international trade. *Letters in Spatial and Resource Sciences, 14*(2), 169-196. https://doi.org/10.1007/s12076-021-00271-8

35. Stojanov, M. (2021). Impact of the COVID-10 Pandemic on the Retail Trade in Bulgaria. *E-Journal Dialog, 1,* 36-49.

36. Vidya, C. T., & Prabheesh, K. P. (2020). Implications of COVID-19 Pandemic on the Global Trade Networks. *Emerging Markets, Finance and Trade, 56*(10), 2408-2421. https://doi.org/10.1080/1540496X.2020.1785426

37. Wittwer, G., & Anderson, K. (2021). Covid-19 and global beverage markets: Implications for wine. *Journal of Wine Economics, 16*(2), 117-130. https://doi/org/10.1017/jwe.2021.13

38. Xu, L., Shi, J., Chen, J., & Li, L. (2021). Estimating the effect of COVID-19 epidemic on shipping trade: An empirical analysis using panel data. *Marine Policy, 133,* 104768. https://doi.org/10.1016/j.marpol.2021.104768

39. Zagashvili, V. S. (2021). International Trade in the Aftermath of the COVID-19 Pandemic. *World Economy and International Relations, 65*(10), 15-23. https://doi.org/10.20542/0131-2227-2021-65-10-15-23

40. Zhang, W., Dawei, W., Majeed, M. T., & Sohail, S. (2022). COVID-19 and international trade: insights and policy challenges in China and USA. *Economic Research-Ekonomska Istrazivanja, 35*(1), 1991-2002. https://doi.org/10.1080/1331677X.2021.1930091

41. Zlatinov, D. (2018). Tema na fokus: Deset godini ot nachaloto na finansovo-ikinomicheskata kriza – pouki i neobhodimi reformi. In V. Jotsov (Ed.), *Ikonomichesko Razvitie i Politiki v Bulgaria: Ocenki i Ochakvania* (pp. 115-150). Sofia: Goreks Pres. (In Bulgarian).

http://dx.doi.org/10.21511/ppm.20(4).2022.09

APPENDIX A

Table A1. Seasonal unit root test

Regression type	Test Statistics						
	t_1	t_2	$F_{3,4}$	$F_{5,6}$	$F_{7,8}$	$F_{9,10}$	$F_{11,12}$
A	2.720	–1.507	1.208	2.615	5.104	3.692	0.178
B	–0.988	–1.488	0.286	2.842	3.362	2.088	0.292
C	–1.091	–2.469	5.900	5.789	3.455	7.641	3.364
D	–0.986	–1.489	0.306	2.811	1.617	2.063	0.239
E	–1.031	–2.465	5.874	5.719	3.327	7.598	3.184
Regression type	**Critical Values (5%)**						
	t_1	t_2	$F_{3,4}$	$F_{5,6}$	$F_{7,8}$	$F_{9,10}$	$F_{11,12}$
A	–1.89	–1.87	3.03				
B	–2.80	–1.89	3.01				
C	–2.76	–2.76	6.26				
D	–3.32	–1.88	2.97				
E	–3.28	–2.75	6.23				

Note: 1. All equations were estimated via OLS. Two lags were included to eliminate the autocorrelation in the residuals. 2. Variants of the regression equation were: A – no intercept, no seasonal dummies, no trend; B – intercept, no seasonal dummies, no trend; C – intercept, seasonal dummies, no trend; D – intercept, no seasonal dummies, trend; E – intercept, seasonal dummies, trend. 3. Values were bold and italic when significant at 5%. 4. Critical Values were from Beaulieu and Miron (1992) for series length of 240. Series in equations were all with length of 238 observations after the adjustments.

Table A2. Estimation results for (5-6) model

Parameter	Estimate	Std. Error	t–Statistic	Prob.
θ_1	–0.2921	0.0642	–4.5535	0.0000
θ_{12}	–0.3799	0.0518	–7.3327	0.0000
α_1	0.0416	0.0270	1.5402	0.1235
α_2	–0.0476	0.0410	–1.1616	0.2454
α_3	–0.0146	0.0053	–2.7297	0.0063
α_4	0.0198	2.4600	0.0080	0.9936
α_5	–0.2268	5.9489	–0.0381	0.9696
α_6	–0.0017	0.0077	–0.2183	0.8272
Variance Equation				
b_0	0.0010	0.0003	3.0669	0.0022
b_1	0.2882	0.1877	1.5356	0.1246

Note: The model was estimated via ML-ARCH (Marquardt). Convergence was achieved after 208 iterations.

Table A3. Residuals' ACF for (5-6) model

Lag	ACF	PACF	Q–Stat	Prob.	Lag	ACF	PACF	Q–Stat	Prob.
1	–0.011	–0.011	0.032	–	13	–0.049	–0.059	13.593	0.256
2	0.007	0.007	0.044	–	14	0.054	0.037	14.342	0.279
3	–0.009	–0.009	0.063	0.803	15	–0.107	–0.109	17.313	0.185
4	–0.140	–0.140	4.848	0.089	16	–0.057	–0.047	18.164	0.199
5	–0.088	–0.093	6.750	0.080	17	–0.087	–0.117	20.120	0.167
6	0.051	0.051	7.404	0.116	18	0.059	0.057	21.031	0.177
7	–0.095	–0.097	9.661	0.085	19	0.065	0.066	22.125	0.180
8	–0.048	–0.077	10.241	0.115	20	0.076	0.033	23.631	0.167
9	–0.003	–0.029	10.243	0.175	21	0.061	0.051	24.606	0.174
10	–0.047	–0.046	10.797	0.213	22	0.123	0.127	28.613	0.096
11	0.073	0.052	12.160	0.204	23	0.103	0.135	31.469	0.066
12	0.057	0.023	12.994	0.224	24	–0.057	–0.047	32.332	0.072

Note: Q-statistic probabilities adjusted for 2 ARMA term(s).

Table A4. Squared residuals' ACF for (5-6) model

Lag	ACF	PACF	Q–Stat	Prob.	Lag	ACF	PACF	Q–Stat	Prob.
1	0.017	0.017	0.069	–	13	0.014	0.006	8.423	0.675
2	0.015	0.015	0.125	–	14	–0.006	–0.012	8.432	0.751
3	0.013	0.012	0.166	0.684	15	–0.011	–0.011	8.466	0.812
4	0.064	0.063	1.159	0.560	16	0.072	0.074	9.806	0.776
5	0.030	0.027	1.377	0.711	17	–0.077	–0.097	11.339	0.728
6	0.060	0.057	2.253	0.689	18	–0.031	–0.046	11.591	0.772
7	0.103	0.100	4.886	0.430	19	–0.041	–0.022	12.021	0.799
8	–0.044	–0.053	5.372	0.497	20	–0.064	–0.071	13.114	0.785
9	–0.020	–0.026	5.468	0.603	21	–0.038	–0.030	13.500	0.812
10	0.018	0.010	5.551	0.697	22	–0.055	–0.062	14.301	0.815
11	0.102	0.089	8.179	0.516	23	–0.051	–0.046	15.002	0.823
12	–0.028	–0.034	8.375	0.592	24	–0.049	–0.013	15.642	0.833

Note: Q-statistic probabilities adjusted for 2 ARMA term(s).

Table A5. Estimation results for (5-6) final model

Parameter	Estimate	Std. Error	t–Statistic	Prob.
θ_1	–0.2907	0.0638	–4.5537	0.0000
θ_{12}	–0.3749	0.0525	–7.1413	0.0000
α_3	–0.0149	0.0052	–2.8455	0.0044
A_5	–0.2140	0.0658	–3.2539	0.0011
Variance Equation				
b_0	0.0010	0.0003	3.1764	0.0015
b_1	0.2897	0.1838	1.5764	0.1149

Note: The model was estimated via ML-ARCH (Marquardt). Convergence was achieved after 41 iterations.

Table A6. Residuals' ACF for (5-6) final model

Lag	ACF	PACF	Q–Stat	Prob.	Lag	ACF	PACF	Q–Stat	Prob.
1	–0.005	–0.005	0.0052	–	13	–0.044	–0.048	12.059	0.359
2	–0.002	–0.002	0.0059	–	14	0.059	0.046	12.949	0.373
3	0.005	0.005	0.0133	0.908	15	–0.100	–0.097	15.511	0.277
4	–0.128	–0.128	4.0437	0.132	16	–0.048	–0.028	16.114	0.306
5	–0.087	–0.089	5.8962	0.117	17	–0.083	–0.108	17.893	0.268
6	0.070	0.070	7.1166	0.130	18	0.053	0.059	18.622	0.289
7	–0.081	–0.081	8.7527	0.119	19	0.057	0.062	19.466	0.302
8	–0.031	–0.049	8.9862	0.174	20	0.053	0.018	20.201	0.322
9	–0.009	–0.034	9.0084	0.252	21	0.057	0.056	21.060	0.334
10	–0.045	–0.037	9.5261	0.300	22	0.133	0.134	25.750	0.174
11	0.068	0.060	10.681	0.298	23	0.098	0.130	28.334	0.131
12	0.059	0.032	11.563	0.315	24	–0.072	–0.075	29.740	0.125

Note: Q-statistic probabilities adjusted for 2 ARMA term(s).

Table A7. Squared residuals' ACF for (5-6) final model

Lag	ACF	PACF	Q–Stat	Prob.	Lag	ACF	PACF	Q–Stat	Prob.
1	0.016	0.016	0.0593	–	13	0.008	0.001	8.2101	0.694
2	0.020	0.020	0.1602	–	14	–0.005	–0.010	8.2177	0.768
3	0.012	0.011	0.1951	0.659	15	–0.021	–0.021	8.3365	0.821
4	0.071	0.070	1.4257	0.490	16	0.081	0.083	10.031	0.760
5	0.028	0.026	1.6177	0.655	17	–0.088	–0.104	12.023	0.677
6	0.051	0.048	2.2628	0.688	18	–0.034	–0.047	12.325	0.721
7	0.099	0.097	4.7178	0.451	19	–0.042	–0.019	12.794	0.750
8	–0.057	–0.067	5.5147	0.480	20	–0.048	–0.059	13.413	0.766

http://dx.doi.org/10.21511/ppm.20(4).2022.09

Table A7 (cont.). Squared residuals' ACF for (5-6) final model

Lag	ACF	PACF	Q–Stat	Prob.	Lag	ACF	PACF	Q–Stat	Prob.
9	–0.009	–0.016	5.5371	0.595	21	–0.043	–0.030	13.907	0.789
10	0.012	0.006	5.5747	0.695	22	–0.049	–0.052	14.556	0.801
11	0.095	0.082	7.8700	0.547	23	–0.056	–0.052	15.379	0.803
12	–0.036	–0.038	8.1936	0.610	24	–0.046	–0.007	15.951	0.818

Note: Q-statistic probabilities adjusted for 2 ARMA term(s).

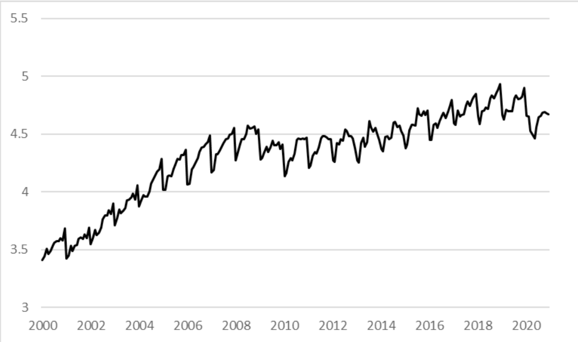

Figure A1. Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (Indices, 2015 = 100%)

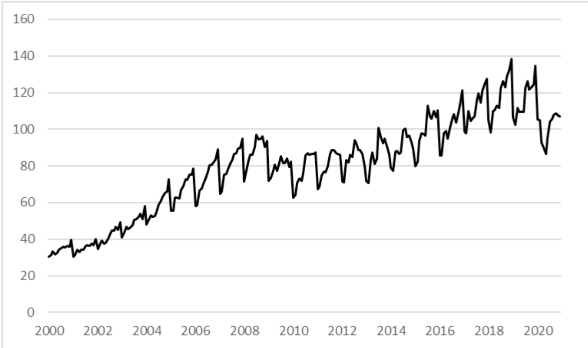

Figure A2. Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs)

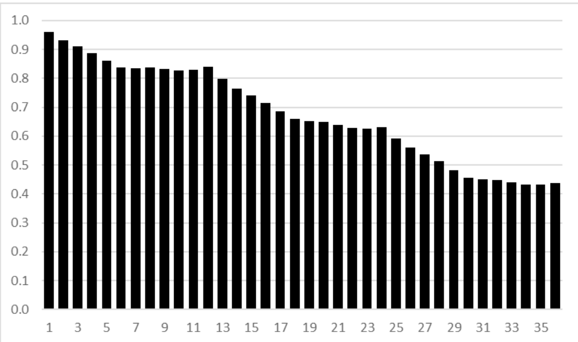

Figure A3. ACF for the turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs)

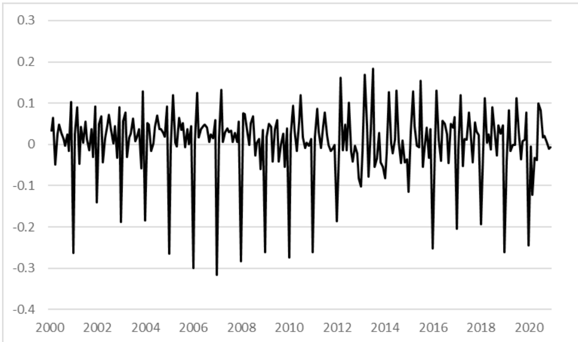

Figure A4. Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, first differences)

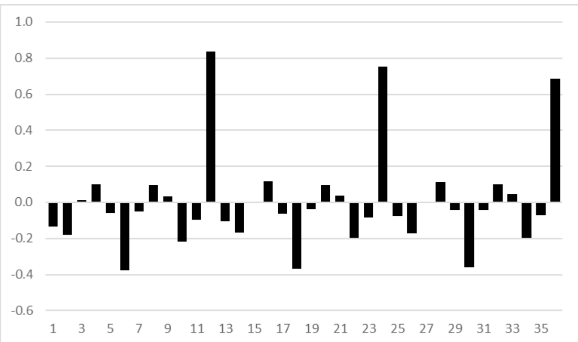

Figure A5. ACF for the turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, first differences)

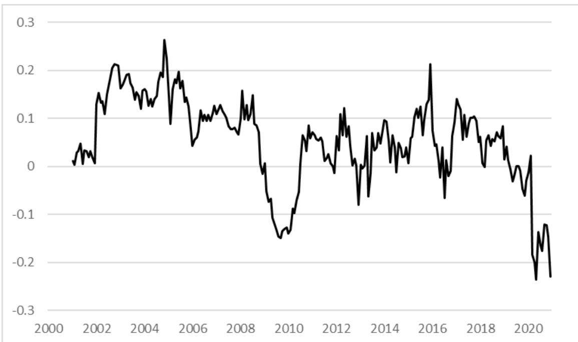

Figure A6. Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, seasonal differences)

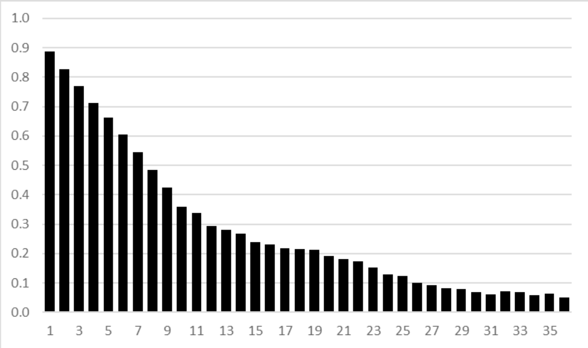

Figure A7. ACF for the turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, seasonal differences)

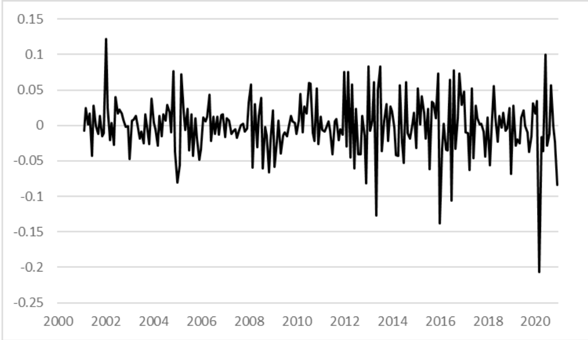

Figure A8. Turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, first, and seasonal differences)

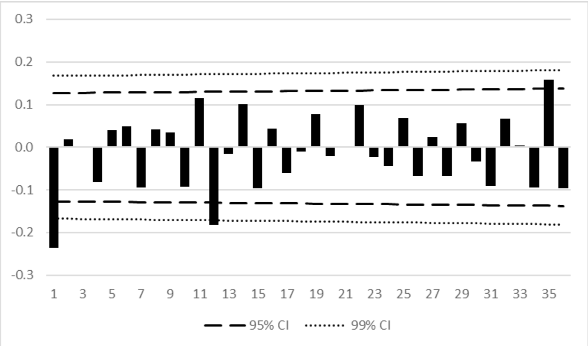

Figure A9. ACF for the turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, first, and seasonal differences)

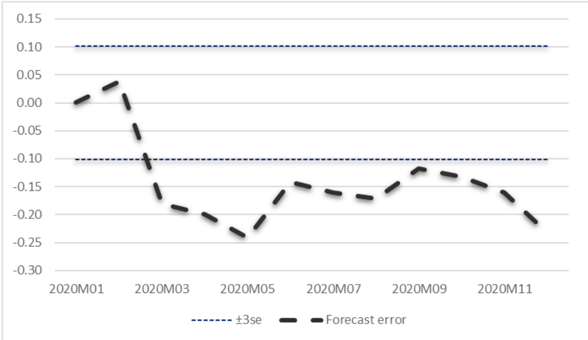

Figure A10. Observed forecast error for the turnover for wholesale and retail trade and repair of motor vehicles and motorcycles in Bulgaria (logs, first, and seasonal differences)

http://dx.doi.org/10.21511/ppm.20(4).2022.09