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Article

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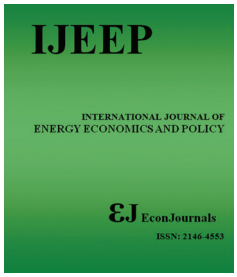

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The impact of Russian Energy Resources on the Economic Growth of the EU: Using Computational Intelligence Algorithms

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ABSTRACT

This study explores the impact of Russian oil and natural gas on the economic growth of the European Union. The Gradient boosting algorithm was relied on to determine this effect because of its high prediction metrics (MSE: 0.002, RMSE: 0.040, MAE: 0.034, R2: 99.9). The study depended on three scenarios. The first scenario is that Russia's exports of both products decline to half the year 2022, then to the quarter of 2023, and this second scenario, then the worst scenario, is to prevent its exports of both products in 2024. But the result is a decline in the European Union's economic growth in 2022 to (−2.15%), then it turns to 2.85% in 2023, and then to 3.86% in 2024, i.e., in the worst scenario year. The evidence for this is that the economies of these countries reduced their growth rates in 2020 (the COVID-19 crisis) to −5.96%, which turned to positive growth in 2021, amounting to 5.38%. This indicates these economies' ability to adapt quickly by providing alternatives to the crisis.

Keywords: Gradient Boosting, Russia-Ukraine War, European Union Growth, Crude Oil, Natural Gas
JEL Classifications: C80, C81, C87

1. INTRODUCTION

The Ukraine conflict casts doubt on the recovery of the world economy from the COVID-19 virus. Due to Russia's position as the world's third-largest producer of crude oil, the second-largest supplier of natural gas, and one of the top five suppliers of steel, nickel, and aluminum, and a massive reduction in energy and metal supplies are highly likely to cause the global prices of these goods to soar. As a result, when the invasion started, worldwide financial markets experienced a dramatic decrease, and the cost of metals, cereals, and other foods rose. Due to the deepening conflict between Russia and Ukraine, commodity prices are expected to remain elevated for an extended period, even though this was already a risk identified as potentially detrimental to the world economy. This, in turn, increases the chance of chronically rising inflation that affects more than essentials, increasing the likelihood of civil discontent in industrialized and developing countries. Particularly vulnerable are the vehicles, transportation, chemicals, and, most generally, all other industries reliant on the above inputs (United Nations, 2022).

The world economy, expected to grow by 4.1% and 3.2% in 2022 and 2023, respectively, is at grave risk due to the war. If the fluctuations in commodity prices and financial markets that have arisen since the war started continue, they might lower this year's global Growth rate by more than 1% and increase inflation by almost 2.5%. The war and the rise in oil prices since September 2021 will reduce the growth of emerging nations by approximately 1% in 2022 and 1% in 2023, or 4.6% and 4.5%, respectively (OECD, Economic Outlook). The Russian economy will experience a severe recession in 2022 due to the severity of the sanctions imposed by Western nations and their allies and the potential of currency warfare. Due to its reliance on Russian oil and natural gas, Europe seems most susceptible to the war's effects. While it is virtually difficult to replace the whole of the Russian natural gas supply to Europe (nearly 40% of total

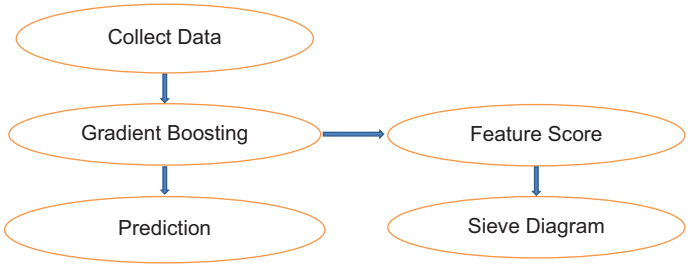
European consumption of natural gas) in the short term, the current price levels, if controlled through the end of the year, will have a major impact on inflation in the Eurozone, reducing household consumption and gross domestic product (GDP) growth by at least 1.5% points. Some Eurozone countries, like Germany and Italy, rely on Russian natural gas more than others. The impact on external trade and corporate investment is expected to lower the trade dependency of Eurozone states by approximately 1% point in 2022, from 4.2% to 3.2%. If the Russian gas supply were fully cut off, costs would rise by at least 4% points, cutting 2022 annual GDP growth to 0.2%. (Open knowledge, World Bank).

Finally, as a result of wars, everyone loses, whether the conflicting parties directly or third parties that are indirectly affected, whether by relying on one of the conflicting parties to supply them with goods or as a result of the high prices of goods as a result of problems in supply chains. Prediction, classification, and clustering are the key areas of concentration in machine learning (ML), which creates algorithms for use with datasets (Malladi, R.K. 2022). The gradient boosting algorithm (GB) is used because of its great accuracy in exploring the impact of Russian oil and natural gas on the economic growth of the European Union countries (EU). Figure 1 shows a description of the work's steps.

2. LITERATURE REVIEW

Mbah and Wasum (2022). This study examined, in a theoretical framework, the impact of the Russian-Ukrainian war on the United States of America (US), Britain (UK), Canada, and Europe, and the study concluded that there would be severe inflation in crude oil, natural gas, and food prices as a result of disruptions in supply chains, which will negatively affect the global economy. Prohorovs (2022), this study relied on the same methodology as the previous study and examined the effect of the Russian-Ukrainian war on the EU countries. The study concluded that the war led to an increase in inflation and exacerbated economic problems, which led to a long-term negative impact on EU economies. Guenette et al. (2022). This study examined in a theoretical framework the effect of the Russian-Ukrainian war on the global economy, and the study relied on experts' estimates in its results [that the war will lead to the displacement of about 12 million people and more than 13 million need humanitarian assistance. The study also concluded that the war would result in a rise in food and energy prices, exacerbating poverty and harming foreign investments, eventually leading to a decline in the global economy. Tank and Ospanova (2022), the study expects Russia's GDP (relative to base) to shrink by 1.5 % in 2022 and 2.6% by the end of 2023. Russian inflation is predicted to reach 20% this year because of rising import prices following the rouble's depreciation and higher inflation predictions, resulting in reduced confidence, lower real incomes, and interrupted trade. We anticipate that sanctions against Russia will restrict foreign direct investment, resulting in capital outflows and lowering Russia's long-term prospective growth rate.

Figure 1: A description of the work's steps



UNDP (2022) The study identified some of the effects of the Russian-Ukrainian war on South Africa, which were represented in: The war enhances supply chain obstacles and inflationary pressures through higher energy and food costs, which will almost certainly result in a more rapid hardening of monetary policy and further budgetary constraints. Rising interest rates and rising inflationary pressures will reduce discretionary income and have a negative impact on consumer expenditure, economic growth, employment, poverty, and food security Celi et al. (2022). To measure the relative vulnerability of European economies to energy shocks, the paper calculated the weighted value of energy-intensive firms and the proportion of workers employed in them for each EU country. Other things being equal, member states with an extremely high proportion of employment in energy-intensive sectors are more vulnerable to unemployment and recession. While Czechia and Slovenia have the greatest shares, at 15.7% and 13.7%, respectively, employment in energy-intensive sectors accounts for more than 11.5% of total employment in Germany (equivalent to 5.3 million employees) and 9.5% in Italy (2.3 million workers).

Glauben et al. (2022), the conflict in Ukraine has exacerbated already-existing tensions on the agricultural goods market. Prices for commodities such as cereals and vegetable oils have hit historic highs since late 2021, surpassing even the levels seen during the world food price dilemma of more than a decade earlier. The entry of Russian military in Ukraine has pushed prices further higher. This has primarily impacted import-reliant countries of the Middle East and North Africa, as well as Sub-Saharan Africa, which rely significantly on Russian and Ukrainian wheat. The article suggested that global food institutions are essential for managing crises and reducing the likelihood of food shortages. In this manner, exports from one location can make up for export-related disruptions in another. To do this, though, there must be more cooperation in global trade. It is strongly cautioned against making any proposals for a move toward a centrally-planned economy or autarky, as this would only harm food security in the Third World. van Bergeijk (2022), This working paper examines four significant and well-documented historical sanction episodes: (a) the anti-Apartheid sanctions of the 1980s; (b) the sanctions against the Iraqi occupation of Kuwait in 1990; (c) the sanctions against Iranian nuclear capabilities; and (d) the US and EU sanctions against the Russian annexation of Crimea. The case for sanctions against the Russian war with the Ukraine in 2022 is studied against the background of these four major and well-documented historical sanction episodes. The 2014 sanctions on Russia serve as an example of how weak and relatively vulnerable European democracies are when it comes to putting together effective, all-encompassing penalties. Smart and targeted sanctions are unlikely to have an impact on the Kremlin's decision-making given the enhanced Russian resilience, the increasingly authoritarian nature of President Putin's government, the legitimacy of his 2014 tit-for-tat strategy, and the weakness of European democracies to

implement the necessary strong and broad-based measures. Only by regaining its credibility as a legitimate proponent of tough measures, such as a ban on capital goods and a restriction of Russian energy, could the European Union have any impact on that calculation. Alam et al. (2022), the goal of this study is to examine how the Russian invasion issue has affected the dynamic interconnectedness of five commodities, the G7, and the BRIC (leading stock) economies. The results demonstrate that during this invasion crisis, the the Us, Canada, China, and Brazil stock markets, as well as gold and silver (commodities), are the shocks' receivers from the other commodities and markets.

WTO (2022) Due to the fluidity of the conflict, the WTO currently anticipates 3.0% increase in 2022 (down from its earlier expectation of 4.7%) and 3.4% growth in 2023 for the number of goods traded, but these projections are less definite than usual. In 2022, the global GDP is projected to increase by 2.8% at market exchange rates, down 1.3% from the prior prediction of 4.1%. In 2023, growth should accelerate to 3.2%, which is close to the 3.0% average rate during 2010 and 2019. Mustafa (2022). The situation in Ukraine is intensifying, raising questions as to whether crops will be produced and goods exported. Ports have already been closed as a result of the war, oil seed crushing processes have been halted, and some items now need export licences. In the upcoming months, all of these can have an impact on the nation's exports of cereals and vegetable oils. Given potential sales challenges brought on by the economic sanctions imposed on the nation, there is also a great deal of uncertainty about Russian export prospects. According to FAO's simulations assessing the potential effects of a sudden and significant decrease in the exports of grain and sunflower seeds by the two nations, these shortages may only be partially made up for during the 2022-2023 marketing season by alternative sources. High manufacturing and input costs may restrict many exporting nations' ability to increase output and shipments. Concerningly, the resulting worldwide supply deficit may cause global food and feed prices to increase by 8-22% over their baseline values, which are already high.

3. METHODOLOGY

The GB model is a supervised machine learning model which builds a function to generate predictions based on fresh data and performs analysis based on training data. Simple is the concept of discarding data instances with minor gradients (Rahmani and Hosseini Mirmahaleh, 2022). The sample weight in AdaBoost provides a reliable indication of the significance of data occurrences. However, as the GB model lacks native sample weights, it cannot directly apply the sampling strategies suggested for Ada-Boost. Fortunately, we observe that the Gradient for each data instance in the GB model provides useful information for data sampling. If an instance is connected with a small gradient, it has minimal training error and is already well-trained. However, doing so will modify the data distribution, lowering the trained model's accuracy. To circumvent this difficulty, we propose a unique GB algorithm method (Abd El-Aal, 2023).

The GB model keeps examples with massive gradients while randomly sampling cases with modest gradients. To account for the influence of the data distribution, GB algorithms utilize a constant multiplier when calculating the information gain for data instances with modest gradients. GB algorithm finds the top a*% instances by sorting the data instances according to the absolute value of their gradients. The remaining data is then chosen by randomly selecting one hundred percent of the remaining cases (Chu and Qureshi, 2022). To calculate the information gain, the GB algorithm multiplies the sampled data with gentle gradients by the constant (1-a/b). The algorithm could be designed with the following mathematical rules to increase the focus on the under-trained situations without materially altering the original data distribution:

1. Model initialization using a constant value:

$$F_0(x) = \underset{\gamma}{\operatorname{argmin}} \sum_{i=1}^{n} L\left(y_i, \gamma\right)$$

2. For m=1 to m:

2.1. Compute residuals $r_{im} = -\left[\frac{\partial L\left(y_i, F\left(x_i\right)\right)}{\partial F\left(x_i\right)}\right]_{F(x)=F_{m-1}(x)}$

for i= 1,….,n

2.2. Create terminal node reasons by training a regression tree with x characteristics against r.

R_{jm} for j= 1,…., J_m

2.3. Measure

$$\gamma_{jm} = \underset{\gamma}{\operatorname{argmin}} \sum x_i \in R_{jm} L\left(y_i, F_{m-1}\left(x_i\right) + \gamma\right) for\ j = 1, \ldots, J_m$$

2.4. Improve the model $F_m(x) = F_{m-1}(x) + v\sum_{j=1}^{J_m} \gamma_{jm} 1\left(x \in R_{jm}\right)$

Data were collected from the World Bank database for the EU countries' imports value of Russian crude oil and natural gas from 2000 to 2021 and the EU countries' economic growth rate during the same period (https://databank.worldbank.org/source/world-development-indicators).

4. RESULTS

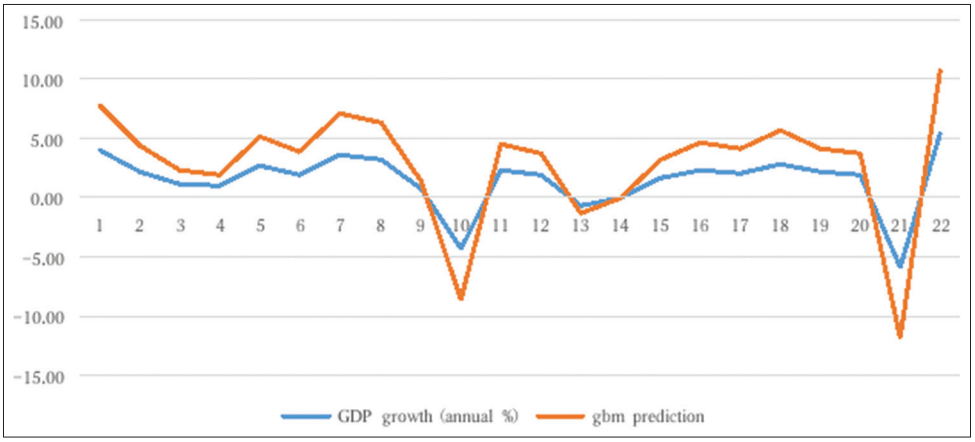
The GB algorithm was used for its high accuracy, as shown in (Table 1). As a result of this accuracy, the results of forecasting the economic growth of the EU countries were almost identical to the actual data, as shown in Figure 2 and Table 2.

Table 1: GB algorithm's performance (data from 2000 to 2021)

Model	MSE	RMSE	MAE	R^2
GB model	0.002	0.040	0.034	99.9

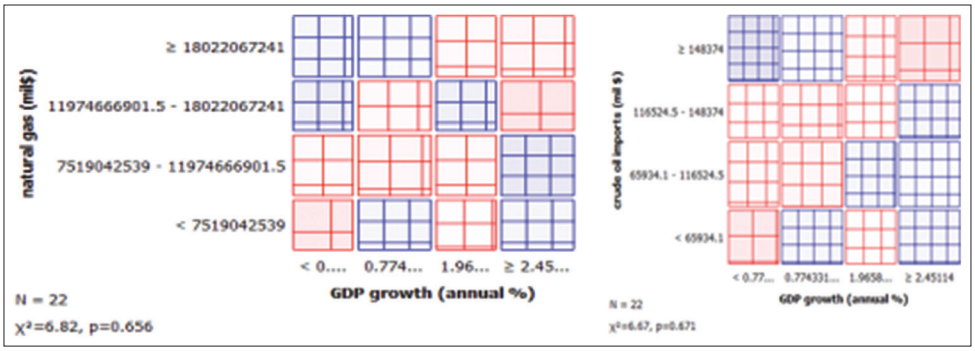
Source: Compiled by the author. GB: Gradient boosting, RMSE: Root mean squared error, MSE: Mean squared error, MAE: Mean absolute error

Figure 2: Actual and prediction values of EU country's gross domestic product growth



Source: Made by the author

Figure 3: Sieve diagram for Russian natural gas and crude oil effect on EU country's gross domestic product growth



Source: Made by the author

Table 2: Actual EU countrie's GDP forecast based on a GB model

Year	EU countrie's GDP growth (annual %)	GB prediction
2000	3.90	3.86
2001	2.18	2.17
2002	1.11	1.159
2003	0.91	0.913
2004	2.59	2.539
2005	1.92	1.9
2006	3.49	3.51
2007	3.15	3.092
2008	0.64	0.678
2009	−4.35	−4.257
2010	2.25	2.238
2011	1.86	1.825
2012	−0.71	−0.656
2013	−0.03	−0.026
2014	1.58	1.546
2015	2.31	2.293
2016	2.01	2.025
2017	2.82	2.792
2018	2.07	2.036
2019	1.83	1.863
2020	−5.96	−5.895
2021	5.38	5.327

Source: Compiled by the author. GDP: Gross domestic product, EU: European Union, GB: Gradient boosting

4.1. Predictions

To predict the impact of Russian oil and natural gas on economic growth, the paper assumed three scenarios resulting from Russia and Ukraine conflict. The first scenario is that Russia's exports of both products decline to half the year 2022, then to the quarter of 2023, and this second scenario, then the worst scenario, is to prevent its exports from both products in 2024. But the results were a decline in the economic growth of the EU countries to (−2.15%), then it turns to 2.85% in 2023, and then to 3.86% in 2024, i.e., in the worst scenario. The evidence for this is that the economies of these countries decreased their growth rates in 2020 (the Covid-19 crisis) to (−5.96%) to a positive growth in 2021 that amounted to 5.38% (World Bank), indicates the ability of these economies to adapt in the short term by providing alternatives to the crisis, this as the (Table 3) shows.

4.2. Metrics

Mean Squared Error (MSE), mean absolute error (MAE), Root Mean Squared Error (RMSE), and Coefficient of determination (R^2) are the most common metrics employed in regression analysis to evaluate forecast error rates and highest accuracy.

The MAE reflects the difference between actual and expected values, as determined by averaging the absolute difference throughout the full data set; it is computed using the following formula (1):

$$MAE = \frac{1}{n}\sum_{1}^{n}|y_i - \hat{y}_i| \quad (1)$$

The MSE represents the difference between actual and predicted values and is derived by quadrupling the average difference

Table 3: GB algorithms prediction for EU country's GDP (2022-2024)

Year	EU country's GDP growth (actual)	Crude oil (mil$) (actual)	Natural gas (mil$) (actual)
2021 (actual)	5.38022	117199	21,116,410,885
Year	**GBM prediction**	**Crude oil (mil$) (assumption)**	**Natural gas (mil$) (assumption)**
2022	−2.15854	58,599.5	10,558,205,443
2023	2.85191	29,299.75	5,279,102,721
2024	3.86888	0	0

Source: Compiled by the author. GDP: Gross domestic product, EU: European Union, GB: Gradient boosting

Table 4: Feature importance score

Feature groups	Feature weight
Natural gas	51.7
Crude oil	48.3

Source: Compiled by the author

across the full data set. It is computed using the following formula (2):

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y})^2 \quad (2)$$

The RMSE is the error rate multiplied by the square root of the MSE. It is calculated using the following formula (3):

$$RMSE = \sqrt{MSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}|y_i - \hat{y}_i|^2} \quad (3)$$

The R^2 measures how well the values fit relative to the initial values. The greater the value, the better the model (The proportion of values between zero and one). It is calculated using the following formula (4):

$$R^2 = 1 - \frac{\sum(y_i - \hat{y})^2}{\sum(y_i - \bar{y})^2} \quad (4)$$

4.3. The GB Model and Feature Assessment

To find out which is of greater relative importance to the economic growth of the EU countries, oil or Russian gas? The paper used the feature's importance, and it was found that Russian gas is more important than oil in influencing the economic growth of the EU countries, as we can see from (Table 4); this can be clear from the following sieve diagram Figure 3.

5. CONCLUSION

The bilateral conflict between two countries does not affect their economies only but includes its impact on all countries of the world economies (the world is one village with intertwined relations). On the one hand, the conflicting countries have demand and supply, and thus affect the volume of aggregate demand and global aggregate supply. This effect results in a rise in the general level of prices due to the problems facing supply chains. On the other hand, the lack of optimal exploitation of resources, as the conflicting countries and the countries supporting them increase their military spending at the expense of their spending on production, and thus a negative transformation of resources. Also, the human damage and damage to the infrastructure of these countries.

The countries of the Union represent a large part of global demand and supply. The decline in their growth rates will cause serious harm to their trading partners. Hence, measuring the impact of Russian oil and natural gas on economic growth rates in the EU countries was necessary. Then, the GB algorithm was used to predict this effect and show the high ability of these countries to adapt to crises and find alternative solutions.

6. ACKNOWLEDGMENT

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REFERENCES

Abd El-Aal, M.F. (2023), Analysis factors affecting Egyptian inflation based on machine learning algorithms. Data Science in Finance and Economics, 3(3), 285-304.

Alam, M.K., Tabash, M.I., Billah, M., Kumar, S., Anagreh, S. (2022), The impacts of the Russia-Ukraine invasion on global markets and commodities: A dynamic connectedness among G7 and BRIC markets. Journal of Risk and Financial Management, 15(8), 352. Available from: https://openknowledge.worldbank.org/bitstream/handle/10986/36519/9781464817601.pdf?sequence=10&isAllowed=y Available from: https://www.oecd.org/economy/Interim-economic-outlook-report-march-2022.pdf

Celi, G., Guarascio, D., Reljic, J., Simonazzi, A., Zezza, F. (2022), The asymmetric impact of war: Resilience, vulnerability and implications for EU Policy. Intereconomics, 57(3), 141-147.

Chu, B., Qureshi, S. (2022), Comparing out-of-sample performance of machine learning methods to forecast U.S. GDP growth. Computational Economics, 1-43. https://doi.org/10.1007/s10614-022-10312-z

Glauben, T., Svanidze, M., Götz, L., Prehn, S., Jamali Jaghdani, T., Đurić, I., Kuhn, L. (2022), The war in Ukraine, agricultural trade and risks to global food security. Intereconomics, 57(3), 157-163.

Guenette, J.D., Kenworthy, P.G., Wheeler, C.M. (2022), Implications of the War in Ukraine for the Global Economy. Washington, D.C.: World Bank Group.

Malladi, R.K. (2022), Application of supervised machine learning techniques to forecast the COVID-19 U.S. Recession and stock market crash. Computational Economics, 1-25.

Mbah, R.E., Wasum, D.F. (2022), Russian-Ukraine 2022 war: A review of the economic impact of Russian-Ukraine crisis on the USA, UK, Canada, and Europe. Advances in Social Sciences Research Journal, 9(3), 144-153.

Mustafa, S.E. (2022), The Importance of Ukraine and the Russian Federation for Global Agricultural Markets and the Risks Associated

with the Current Conflict. Rome, Italy: FAO.
Prohorovs, A. (2022), Russia's war in Ukraine: Consequences for European countries' businesses and economies. Journal of Risk and Financial Management, 15(7), 295.
Rahmani, A.M., Hosseini Mirmahaleh, S.Y. (2022), An intelligent algorithm to predict GDP rate and find a relationship between COVID-19 outbreak and economic downturn. Computational Economics, 1-20. https://doi.org/10.1007/s10614-022-10332-9
Tank, A., Ospanova, A. (2022), Economic impact of Russia-Ukraine war. International Journal of Innovative Research in Science Engineering and Technology, 11, 3345-3349.
UNDP. (2022), The Impact of the Ukraine War on the South African Economy, Policy Brief. New York: United Nations.
United Nations. (2022), Global Impact of War in Ukraine on Food, Energy and Finance Systems. Brief No. 1. New York: United Nations.
Van Bergeijk, P.A. (2022), Economic Sanctions and the Russian war on Ukraine: A Critical Comparative Appraisal. International Institute of Social Studies. Available: https://www.iss.nl/en/news/economic-sanctions-and-russian-war-ukraine-critical-comparative-appraisal-peter-ag-van-bergeijk [Last accessed on 2022 Dec 12].
World Bank Dataset, World Development Indicators. Available from: https://databank.globalbank.org/source/global-development-indicators
WTO. (2022), Russia-Ukraine Conflict Puts Fragile Global Trade Recovery at Risk. Geneva, Switzerland: World Trade Organization.