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# Economic activities' response to the COVID-19 pandemic in developing countries

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ABSTRACT

Since the occurrence of the COVID-19 pandemic, many governments around the world have instituted several economic policy responses to swathe the real sectors of their economies from the ramifications of the pandemic. However, most economies still remain vulnerable to the pandemic. In this paper, we evaluate and quantify the potential short-run impact of the COVID-19 pandemic on economic activities in eighteen (18) developing countries using monthly time series data on Industrial Production Index and Composite Index of Economic Activity from January 2010 to December 2020. In addition, we employ a state-space model (a Bayesian structural time series model) to estimate the absolute and relative effects of the COVID-19 pandemic on economic activities in those countries. The results of our Bayesian posterior estimate show that, in relative terms, economic activities of six countries have significantly reduced during the occurrence of the COVID-19 pandemic, usually between -4.4% and -16%. Our Bayesian posterior distribution graphs show that the significant negative impacts of the COVID-19 pandemic on economic activities of most of the countries are rather short-lived. This finding suggests that the real sectors of those countries have seen a recovery after being adversely affected by the COVID-19 pandemic. We recommend a continuation of the policy tools introduced by the central banks and the international organizations with a key focus on sectors of that economy that involves significant human interactions such as the hospitality and tourism as well as the aviation industry which was hugely hit by the pandemic.

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## Introduction

The outbreak of the Coronavirus (COVID-19) pandemic in the latter parts of 2019 suddenly brought the global economy to its knees in the first quarter of 2020. Countries in an attempt to protect their citizens from the deadly disease initiated restrictive measures including national lockdown to reduce human interactions in order to slow down the spread of the virus

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and prevent further staggering figures of deaths. Though these policies were health related, they had a devastating effect on economic activities of the global economy in several ways. For instance, according to the International Labour Organization [ILO] [28], the national lockdown led to about 319 million people losing their jobs worldwide leading to a reduction in labor participation, productivity, utilization of capital and stunted growth in the global economy. This has significant demand and supply implications in the global economy. The pandemic also put most governments in a stressful situation as they tried to strike a balance between resuscitating their economies, reducing unemployment, poverty but at the same time addressing public health issues [17]. Further, the restrictive policies reduced household income leading to a decrease in consumption and rising inequalities and poverty in both relative and absolute terms, decrease international trade flows and aid [10,15].

Even though governments and civil society were swift in their response to curb the spread of the pandemic, it has had a wide-reaching effect on the world economy. Global Gross Domestic Product (GDP) plummeted by 3.3 percent in 2020 and analysts have indicated that the 6 percent growth projection of 2021 GDP will significantly depend on the extent of the distribution of vaccines across the world [23]. Failure to distribute the vaccines equitably across the world can cost the global economy a colossal amount of US$9 trillion which is likely to be borne equally between the advanced and the developing economies [23].

In terms of regional assessment, the World Bank indicates that the pandemic plunged sub-Saharan Africa into a recession for the first time after 25 years as economic activities of the sub-region declined by 2.0 percent in 2020 [23]. The decline in growth has a strong potential to drive a significant number of people into poverty. In East Asia, economic growth plummeted leading to an insignificant growth of about 1.2 percent in 2020 with the potential of plunging about 19 million people into poverty [23]. Similarly, the economies of Latin America and the Caribbean suffered a decline of 6.7 percent in 2020 and this is believed to be the most excruciating economic contraction in the history of the region [23]. Also, the World Bank reports that an economic recession of this magnitude has the potential to push about 13.5 percent of the population into unemployment and 28 million into extreme poverty [23].

According to the Ghana Statistical Service [GSS] [29] the economy of Ghana contracted by 3.2 percent in the second quarter of 2020 relative to growth of 5.7 percent in the same period in 2019. Similarly, Mauritius and Mali were projected to experience a decline in GDP by 10.2 and 3.3 percent respectively in 2020 [26]. In terms of international economic transactions, foreign direct investment (FDI), a critical source of finance for a greater percentage of developing countries, declined by a staggering amount, ranging between 35.1 percent and 72.5 percent in developing countries, with the hardest hit being oil producing-nations [26]. Oil producing-countries such as Nigeria, Angola and Chad experienced a decline in oil exports ranging from 5.2 percent to 17.8 percent compared to non-COVID-19 years [26]. Island economies such as Cape Verde and Mauritius were among the hardest hit with trade openness falling by 7.4 and 8.4 percent respectively relative to no-COVID-19 era [26]. Expectations of FDI inflow are likely to remain weak because of uncertainty caused by the pandemic.

The objective of this study is to estimate the response of economic activity to COVID-19 in developing countries through the lens of macroeconomics. Precisely, we evaluate and quantify the impact of the COVID-19 pandemic on economic activities in developing countries. In addition, we conduct a comparative analysis of the COVID-19 pandemic effects in developing countries. We focus on developing countries because of multifaceted reasons. First, even though the number of infections and fatalities are extensively different across regions, the highest number of cases came from developing countries such as those in the Latin America, Caribbeans, followed by those in South East Asia, Europe and Central Asia [6]. As a result, developing economies were the hardest hit as they lost about $220 billion in income (United Nations Development program [27], 2020). Second, the World Bank supported 100 countries with financial facilities to respond to the pandemic and out of this number 39 are in sub-Saharan Africa and a significant number of countries in Latin American and Caribbean and East Asia equally benefited from the facilities [25]. Third, the IMF sanctioned an instant debt relief to 29 low-income economies amounting to US$500 million and also offered emergency funding to 85 countries both developed and developing countries. These colossal financial supports are provided to developing countries because they suffered harshly due to the disruption in global trade by the pandemic than the developed countries [25]. For instance, the exports of most developing countries plummeted abruptly in the months of April and May 2020 and have since not been fully out of the woods [24]. Fourth, the central banks and governments of developing countries initiated swift fiscal and monetary policy measures to mitigate the harmful effects of the pandemic on both businesses and individuals. Finally, since the impact of the pandemic on various economies varies depending on the degree of restrictive measures imposed due to the magnitude of infections and deaths, an examination of extensive spatial granularity across developing countries is required. For instance, Angola was severely affected since the pandemic as prices of petroleum experienced a sharp downward trajectory by about 38 percent in the first three quarters of 2020 [25]. On the other hand, Lao People's Democratic Republic experienced an insignificant negative impact of the pandemic as its economy grew by 1 percent within the same period [25]. Similarly, the United Nations' Committee for Development Policy right from the outbreak of the pandemic was deeply worried about the negative effects on developing countries since it has the potential of eroding the gains chalked by these countries in meeting the Sustainable Development Goals [SDGs] [24]. Introduction of mitigation policy responses to moderate the negative effects of the pandemic needs an evaluation of the extent of response of relevant macroeconomic variables to the pandemic in near real-time.

Since the outbreak of the pandemic, a plethora of studies have been conducted on its economic impacts. For instance, Beyer et al. [3] apply daily electricity use and nighttime light intensity to stand for economic activity. The authors unravel that electricity use declined from the month of March to April 2020, when a national lockdown was imposed in India. In addition, the authors disclose that the decline in electricity use varies among the states; while some states experienced about

50 percent decline others experienced very little decrease. This was attributed to the degree of infections and deaths in the various states. Similarly, Sheridan et al. [21] use actual transaction data from banks in Scandinavia to evaluate the impact of social distancing laws on spending behavior of consumers. The study reveals that total consumer spending declined by 25 and 29 percent in Sweden and Denmark respectively. Cox et al. [9] in a similar study using household-level bank data from the U.S. find a significant decline in spending from March to April.

However, spending among low-income households renounced in mid-April while high-income households remained low. Elgin et al. [13] undertake an extensive review of various economic policy responses to COVID-19 by 166 countries. This permits them to construct a huge database to include fiscal and monetary policy, exchange rates and apply principal component analysis (PCA) to create a COVID-19 Economic Stimulus Index (CESI). Using the database created, they conducted a cross-country regression analysis and the results indicate per capita GDP, median age of the population, the total number of infections recorded as well as number of hospital beds per capita possess weighty relationships with the degree of a country's mitigating economic policies. Further Dzansi et al. [12] apply weekly urban employment data and monthly electricity consumption to estimate the economic impact of COVID-19 in Ghana. The authors unravel that while employment rates dropped by 25 percent, residential electricity consumption rose by 10.4 percent, but non-residential electricity usage on the other hand decreased by 12.7 percent. Finally, Asante and Mills [2], Aduhene and Osei-Assibey [1] and Bukari et al. [5] examine the socioeconomic impact of the COVID-19 in Ghana and reveal the presence of significant increases in prices of food, loss of 42,000 jobs, a rise in poverty and reduction in living standards of households in Ghana. The above studies used consumer spending, employment, electricity usage and nighttime light intensity data to estimate the effect of COVID-19. Second, the studies on Ghana used micro-level data to analyze the socioeconomic impact of COVID-19.

The insight from the above studies provides us the latitude to contribute to the literature by applying the Composite Index of Leading Indicators, Composite Index of Economic Activity, or Industrial Production Index published monthly by the various central banks of selected developing countries to estimate the economic activity impact of the COVID-19 pandemic. The index predicts the path and movements of economic activity. It comprises ten economic indicators whose growth and variations tend to influence and lead the economic changes in the macroeconomy. Investors and businesses apply this index to plan their activity and forecast anticipated performance of the whole economy so as to take advantage of economic expansion and avoid recessions. In addition, we apply the Bayesian structural time series approach which possesses both a structural time series component with a target series and a regression part to capture the impacts of the correlation for the target time series. This approach exhibits significant flexibility in the selection of the various components and predictors available for each target series. The cyclical section in the model can deal with huge changes in the short term which can be attributed to exogenous shocks [18] such as the COVID-19 pandemic. Therefore, we contribute to the existing literature not only in terms of estimating the effect of the severity of the pandemic on economic activities at a single point but by evaluating the time-dependent relative effects of the pandemic.

As reported in detail later, we find that the COVID-19 pandemic has had significant negative impacts on economic activities (the real sector) of six (6) developing economies. However, although the impacts of COVID-19 on the real sectors of the remaining twelve (12) developing economies within our sample are found to be negative, these impacts are not statistically significant. At the disaggregated level we, we find that Romania has its real sector being largely affected by the COVID-19 pandemic (about 16% reduction in economic activities in relative terms), followed by Bulgaria (−7.1%), Costa Rica (−6.8%), Ecuador (−6.2%), Brazil (−6.1%), with the least affected country being Russia (−4.4%). In addition, we find that there is almost zero probability that the COVID-19 pandemic would have positively impacted the economic activities in all the countries considered in this study.

The remainder of the study is arranged as follows. In section two, we rely on the objectives of the study to review the relevant literature. Based on the literature review we apply the relevant economic indicator and estimation technique to analyze the data in section three. Discussion of the estimated results are presented in section four, while section five concludes.

## Literature review

The literature on economic activity of COVID-19 effect is greatly concentrated on both micro and macro-level analysis as well as on the policy responses initiated by countries to mitigate the harmful impact and stabilize economies. On the micro-level analysis, Horvath et al. [14] apply credit card data to estimate shocks from COVID-19 on the utilization and consumer credit availability across different types of borrowers from March to August 2020. The study discloses a significant negative impact of the COVID-19 severity on credit card utilization but this tended to decay over time. In addition, most banks raised their interest rates as a way to tighten credit supply and ensured that their funds are placed in safe hands. Even though Costa Rica and South Korea equally raised their policy rates from 0.75 percent to 9 percent and from 0.5% to 0.75%, a greater percentage of the countries in this study cut their policy rates to induce a fast-economic recovery. For instance, Ghana reduced its policy rate by 150 basis points in March 2020; Brazil reduced lending rate from 42.2% in 2019 to 33.2% in 2021; Romania cut their policy rate by 25 basis points to 1.5% in 2020; Russia decreased its policy rate to an unprecedented record low level of 4.25% in 2020; India reduced its policy repo rate by 115 basis points in 2020 and Mongolia Central Bank cut its policy from 10% to 9% in 2020 [25].

Similarly, Cox et al. [9], Kantur and Ozcan [16] and Sheridan et al. [21] using similar household-level bank account data examine the heterogeneous impact of COVID-19 on savings and spending in the U.S., Turkey and Scandinavia. Cox et al.

[9] unravels a significant reduction of spending by all households across different income groups from March to April 2020; however, low-income households experienced a faster rebound of their spending by Mid-April 2020. Kantur and Ozcan [16] also detect that overall usage of credit cards declined. The authors attributed this finding to mitigating initiatives, fear of job loss and social distancing restrictions in Turkey. Further, Sheridan et al. [21] indicate that total consumer spending plummeted by 25 and 29 percent for Sweden and Denmark respectively. In a similar manner, Chetty et al. [7] created a database that traces economic activity characterized by a high level of granularity applying unidentified information from private corporations. The authors reveal that high-income persons decreased spending significantly in the middle of March 2020, particularly in areas that experienced a high rate of infections and sectors of the U.S. economy that needed physical human interaction. The decline in consumer spending substantially reduced the earnings of businesses in the highly affected areas, leading to a massive layoff of labor.

With respect to Ghana, Asante and Mills [2], Aduhene and Osei-Assibey [1] and Bukari et al. [5] explore the socioeconomic impact of COVID-19 using micro-level data. Overall, the authors disclose that the pandemic exerted a negative effect on socioeconomic activities in Ghana as 42,000 jobs were lost in the first quarter of the pandemic and an astronomical rise in prices of food in the marketplace. The studies further reveal a rise in poverty and a reduction in living standards with the rural dwellers being the hard hit. Similarly, Mensah and Boakye [17] investigate the effect of national lockdown measures on tourism and the response of the government of Ghana to COVID-19. The authors reveal a strong correlation between the tourism industry and the pandemic. Further, the study indicates that though government responses in the form of tax reliefs were timeous and important, the implementation was rather fraught with difficulties.

At the macro-level, studies such as Roberts [19], Dzansi, et al. [12] and Beyer et al. [3] employed electricity usage and nighttime lights as proxies of economic performance to study the economic activity impact of COVID-19 in Morocco, Ghana and India. The authors indicate the existence of a significant and weighty correlation between light intensity and variation in economic activity. Specifically, there was a significant decline in light intensity after national lockdown measures were initiated in March by the various countries. A disaggregation of the data into sectoral analysis reveals that the manufacturing sector recorded the highest losses relative to agricultural and services sectors.

Another strand of the literature focuses on responses introduced by governments to mitigate the negative effects of the pandemic and stabilize the macroeconomy. For instance, Elgin et al. [13] reviewed policy responses introduced by 166 countries to mitigate the negative impact of COVID-19 and created COVID-19 Economic Stimulus Index (CESI) applying the principal component analysis (PCA). Relying on a basic cross-country regression analysis based on the PCA, the study discloses that per capita GDP, total number of infections, median age of the population and the number of hospital beds per capita have weighty correlation with the degree of policy responses introduced by the countries. Chudik et al. [8] estimate the effect of COVID-19 pandemic for several countries using many dimensions to show that global economic downturn will be devastating and long. Thus, despite the number of policy interventions undertaken, no economies can overcome the negative impact of COVID-19 easily. The authors suggested the need for a coordinated multi-country introduction of mitigation measures.

The above literature review reveals that a majority of the studies are conducted on advanced economies and the studies on developing countries extensively focused on micro-level analysis. Again, consumer spending, electricity usage and nighttime light intensity, employment and prices of food are the indicators greatly used to proxy economic impact of COVID-19. There are limited studies using Composite Index of Economic Activity (CIEA) or Industrial Production Index which encapsulates all the above variables in estimating the economic activity impact of COVID-19. In addition, there are limited studies on a comparative analysis of the COVID-19 pandemic effects in developing countries using a novel approach such as the Bayesian structural time series technique which is capable of tracing the economic effects of short-term shocks such as the COVID-19 pandemic.

## Data and methodology

### *Data*

This study uses historical monthly Industrial Production Index (IPI) data and Composite Index of Economic Activity (CIEA) (time series data) from January 2010 to December 2020 on 18 (eighteen) developing countries.[1] These eighteen countries are chosen based on data availability. They include: Bosnia and Herzegovina, Brazil, Bulgaria, Costa Rica, Ecuador, Ghana, India, South Korea, Mongolia, Montenegro, Paraguay, Romania, Russia, Serbia, Turkey, Ukraine, and Uzbekistan. The data for the IPI and CIEA are used to measure the overall economic activities in each country. The data for all the countries were collected from the International Monetary Fund's (IMF's) Financial Statistics database except that for Ghana which was collected from the database of Bank of Ghana. It is to be noted that we use the IPI to measure economic activities for all the country except Ghana, where we used the CIEA to measure economic activities. The use of CIEA for Ghana instead of IPI is due to unavailability of IPI data on Ghana at the IMF's financial statistics database.

It is to be noted that we create pre-COVID-19 and post-COVID-19 periods for each of the countries using the first month in which the countries recorded their first coronavirus infection(s) or case(s). We present the pre-COVID-19 and post-COVID-

[1] We use the IMF's classification of developing countries to select these countries.

**Table 1**
Pre- and Post-COVID-19 periods.

| Country | First confirmed case | pre-COVID-19 | post-COVID-19 |
|---|---|---|---|
| Bosnia and Herzegovina | March 2020 | Jan. 2010 to Feb. 2020 | March 2020 to Dec. 2020 |
| Brazil | February 2020 | Jan. 2010 to Jan. 2020 | Feb. 2020 to Dec. 2020 |
| Bulgaria | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Costa Rica | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Sept. 2020 |
| Ecuador | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Oct. 2020 |
| Ghana | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| India | January 2020 | Jan. 2010 to Dec. 2019 | Jan. 2020 to Dec. 2020 |
| South Korea | January 2020 | Jan. 2010 to Dec. 2019 | Jan. 2020 to Dec. 2020 |
| Mongolia | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Montenegro | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Aug. 2020 |
| Paraguay | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Romania | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Russia | February 2020 | Jan. 2010 to Jan. 2020 | Feb. 2020 to Dec. 2020 |
| Serbia | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Turkey | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Ukraine | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |
| Uzbekistan | March 2020 | Jan. 2010 to Feb. 2020 | March. 2020 to Dec. 2020 |

Source: Authors' construction.

19 periods for all the countries in Table 1. For example, Brazil recorded its coronavirus infection in February 2020. Therefore, Brazil's pre-COVID-19 period starts from January 2010 to January 2020, while the post-COVID-19 period is from February 2020 to December 2020. In a similar manner, Ghana recorded its first Covid-19 case in March 2020, and so January 2010 to February 2020 represents the pre-COVID-9 period whereas March 2020 to December 2020 represents the post-COVID-19 periods for Ghana. Again, the first case of COVID-19 was identified in India in January 2020. This means that from January 2010 to December 2019 form its pre-COVID-19 period, whereas from January 2020 to Dec. 2020 form the post-COVID-19 period for India. In addition, the first coronavirus case was recorded in Costa Rica in March 2020. Therefore, in Costa Rica the pre-COVID-19 period starts from January 2010 to February 2020, whereas the post-COVID-19 period starts from March 2020 to September 2020. It can be seen, for example, that the end month for the post-COVID-19 period for Costa Rica is September 2020, due mainly to data unavailability for October, November and December 2020.

*Empirical econometric model*

To identify the potential causal impact of the COVID-19 pandemic in economic activities in all the eighteen countries, we employ a Bayesian structural time series model. This model has recently gained attention in the policy evaluation literature. In particular, we follow Brodersen et al. [4]; Scott and Varian [20], Droste et al. [11] and Takyi and Bentum-Ennin [22]. The following simplified local level model with seasonality is estimated:

$$EA_t = \mu_t + \tau_t + \epsilon_t \tag{1}$$

$$\mu_{t+1} = \mu_t + w_t \tag{2}$$

$$\tau_{t+1} = -\sum_{s=0}^{S-2} \tau_{t-s} + \nu_t \tag{3}$$

where $EA_t$ is economic activity, proxied with IPI or CIEA, of each country $t$; $\epsilon_t \sim N(0, \sigma_\epsilon^2)$, $w_t \sim N(0, \sigma_w^2)$, and $\nu_t \sim N(0, \sigma_\nu^2)$ are *iid* normal errors. Also, $\mu_t$ is the level or the mean which changes with time and $\tau_t$ is the seasonal component with $S$ being the number of seasons.

The above three equations estimate the causal impact[2] of the COVID-19 pandemic on economic activities. Specifically, they estimate the post- COVID-19 difference between the actual monthly time series of the economic activity variable and a simulated (synthetic or forecasted) time series data of the same variable that would have been recorded without the occurrence of the COVID-19 pandemic. Here, the posterior causal inference works in the following way: First, the model is estimated[3] using only the pre-COVID-19 period economic activity monthly data.[4] Second, using the estimated model, the forecasts (predictions) of the economic activity data for the post-COVID-19 period are calculated or obtained. Finally, the difference between the forecasted (predicted) values and the actual data (observed values) of economic activity monthly data during the post-COVID-19 period is interpreted as the causal impact of the COVID-19 pandemic on economic activities.

[2] We use the Causal Impact package within R software for the estimation.

[3] In this case, the model is estimated using 15,000 Markov Chain Monte Carlo (MCMC) samples with $S = 30$.

[4] We estimate a 10-year monthly data (i.e., from January 2010 to say February 2020 for Ghana) to forecast the post-COVID-19 periods data. We believe that a decade of monthly data is long enough to predict the actual trend of the out-of-sample data.

**Table 2**
Results of posterior estimates (inference) of the causal impact of COVID-19 on economic activities.

| | Average | | | | |
|---|---|---|---|---|---|
| | Actual (1) | Prediction (2) | Absolute Effect (3) | Relative Effect (4) | Posterior tail-area probability (5) |
| Brazil | 82 | 88 (2.4) [83, 92] | −5.4 (2.4) [−10, −0.59] | −6.1%** (2.8%) [−12%, −0.67%] | 0.0145 |
| Bulgaria | 111 | 119 (3.1) [113, 125] | −8.4 (3.1) [−15, −2.4] | −7.1%** (2.6%) [−12%, −2.1%] | 0.0050 |
| Costa Rica | 177 | 190 (6.3) [178, 202] | [178, 202] [−25, −0.45] | −6.8%** (3.3%) [−13%, −0.24%] | 0.0231 |
| Ecuador | 112 | 119 (2.7) [114, 125] | −7.4 (2.7) [−13, −2] | −6.2% **(2.3%) [−11%, −1.7%] | 0.0032 |
| Romania | 147 | 175 (5.7) [164, 186] | −28 (5.7) [−39, −17] | −16%** (3.2%) [−22%, −9.6%] | 0.0000 |
| Russia | 132 | 138 (2.5) [133, 143] | −6.1 (2.5) [−11, −1.1] | −4.4%** (1.8%) [−7.9%, −0.81%] | 0.0081 |

Note: The values in the brackets show 95% confidence interval, while those in the parentheses are standard deviations and ** represent 5% significance level.

**Table 3**
Results of posterior estimates (inference) of the causal impact of COVID-19 on economic activities.

| | Average | | | | |
|---|---|---|---|---|---|
| | Actual (1) | Prediction (2) | Absolute Effect (3) | Relative Effect (4) | Posterior tail-area probability (5) |
| Bosnia and Herzegovina | 92 | 110 (44) [23, 195] | −17 (44) [−103, 70] | −16% (40%) [−94%, 64%] | 0.3433 |
| Ghana | 642 | 644 (32) [582, 706] | −2.7 (32) [−64, 60] | −0.42% (4.9%) [−9.9%, 9.3%] | 0.4647 |
| India | 120 | 118 (2.8) [113, 124] | 1.5 (2.8) [−4.3, 6.9] | 1.3% (2.4%) [−3.6%, 5.8%] | 0.2937 |
| South Korea | 115 | 117 (2.4) [112, 122] | −1.7 (2.4) [−6.6, 2.9] | −1.4% (2.1%) −1.4% (2.1%) | 0.2397 |
| Mongolia | 80 | 77 (11) [55, 99] | 2.8 (11) [−19, 25] | 3.6% (14%) [−24%, 33%] | 0.4039 |
| Montenegro | 84 | 96 (9.3) [78, 115] | −13 (9.3) [−31, 5.9] | −13% (9.6%) [−32%, 6.1%] | 0.0801 |
| Paraguay | 144 | 153 (4.7) [143, 162] | −9.1 (4.7) [−18, 0.28] | −6% (3.1%) [−12%, 0.18%] | 0.0305 |
| Serbia | 118 | 125 (4.3) [117, 134] | −6.9 (4.3) [−15, 1.6] | −5.5% (3.4%) [−12%, 1.2%] | 0.0536 |
| Turkey | 169 | 175 (5.6) [164, 186] | −6.1 (5.6) [−17, 4.9] | −3.5% (3.2%) [−9.9%, 2.8%] | 0.1425 |
| Ukraine | 76 | 83 (3.9) [75, 91 | −6.8 (3.9) [−15, 0.92] | −8.2% (4.7%) [−18%, 1.1%] | 0.0419 |
| Uzbekistan | 173 | 180 (7.1) [165, 193] | −6.7 (7.1) [−21, 7.5] | −3.7% (4%) [−11%, 4.2%] | 0.1689 |

Note: The values in the brackets show 95% confidence interval, while those in the parentheses are standard deviations.

## Results and discussion

In this section, we discuss the results of both the Bayesian posterior estimates and the Bayesian posterior distribution graphs for the causal impact of the COVID-19 pandemic on economic activities for each of the eighteen (18) countries.

### *Bayesian posterior estimates*

The results obtained for the posterior estimates of the impact of the COVID-19 pandemic on economic activities for each country are shown in Tables 2 and 3. Each column of Tables 2 and 3 shows the average values. Thus, column 1 of each Table indicates the average value of the actual series of economic activities, column 2 indicates the mean value of the forecasted (predicted) series, column 3 indicates the absolute effect, and column 4 shows the relative impact of the pandemic. In what follows, we first discuss in detail the results for each country in Tables 2.

During the post-COVID-19 period, economic activities had an average value of 82 in Brazil. On the other hand, without the occurrence of the pandemic, an average value of 88 would have been recorded with a 2.4 standard deviation. The 95% confidence interval associated with this counterfactual prediction is [83, 92]. When the predicted average value is subtracted

from the observed average value, an estimate for the impact of the COVID-9 pandemic on economic activities in Brazil is obtained. In absolute terms, the impact is −5.4 with as standard deviation of 2.4 and a 95% confidence interval of [−10, −0.59]. In relative terms, economic activities in Brazil registered a decrease of about 6%. The standard deviation associated with this decrease is 2.8% with the 95% confidence interval of that relative percentage decrease being [−12%, −0.67%]. This implies that the negative effect observed during the COVID-19 period is statistically significant at 5 percent level of significance since the −6.1% is within the 95% confidence band. In addition, the posterior tail-area probability value of 0.0145 show that there is only 1.45% likelihood that the COVID-19 pandemic would have a positive effect on economic activities in Brazil. This re-enforces the earlier statistically significant negative causal effect of the pandemic.

Also, in Bulgaria, during the post-COVID-19 period, economic activities had a mean value of 111. However, in the absence of the occurrence of the COVID-19 pandemic, we would have expected a mean value of 119 with a standard deviation of 3.1 and a 95% confidence interval associated with this counterfactual prediction being [113, 125]. The difference between those two mean values indicates that, in absolute terms, the COVID-19 pandemic has led to a reduction in economic activities in Bulgaria by about 8.4. It can be seen that this reduction is statistically significant. In relative terms, the reduction is about 7.1% with the 95% confidence interval associated with this effect being [−12%, −2.1%] and the standard deviation being 2.6%. This suggests that the negative impact of the COVID-19 pandemic on economic activities in Bulgaria is statistically significant at 5 percent level of significance. Again, the posterior tail-area probability value is 0.0050 which indicate that there is only 0.5% chance that the COVID-19 pandemic would have affected economic activities in Bulgaria positively.

Additionally, in Costa Rica, the mean values of the actual and predicted economic activities during the post-COVID-19 periods registered values of 177 and 190, respectively. This means that, in absolute terms, the occurrence of the COVID-19 pandemic caused economic activities in Costa Rica to shrunk by about 13 with a standard deviation value of 6.3 and a 95% confidence interval values of [−25, −0.45]. By quantifying this reduction in relative terms, it can be seen that economic activities in Costa Rica have significantly reduced by 6.8%. This is because the −6.8% is within the 95% confidence interval of [−13%, −0.24%]. Also, the posterior tail-area probability value of 0.0231 indicate that there is only about 2.3% probability that the COVID-19 pandemic would positively impact economic activities in the country.

Furthermore, economic activities in Ecuador recorded an average value of 112 during the post-COVID-19 periods. On the contrarily, without the occurrence of the COVID-19 pandemic, the average value and the standard deviation of economic activities in Ecuador would have been 119 and 2.7, respectively. The 95% confidence interval of associated with this counterfactual prediction is [114, 125], suggesting a significant mean prediction. Performing mathematical operation by subtracting the predicted average value of economic activities from the actual mean value of economic activities leads to a significant reduction in economic activities by 7.4, in absolute term. Relatively, economic activities in Ecuador saw a decrease of 6.2% with the 95% confidence interval of this percentage decrease being [−11%, −1.7%] and the standard deviation being 2.3%. This indicates that the reduction in economic activities is statistically significant at 5 percent level of significance. Evidently, the posterior tail-area probability value of 0.0032 suggest that there is only about 0.3% likelihood of economic activities responding positively to the COVID-19 pandemic in Ecuador.

Moreover, during the post-COVID-19 periods, economic activities in Romania had an average value of 147. On the other hand, an average value of 175 and a standard deviation value of 5.7 would have been recorded without the COVID-19 pandemic. In absolute terms, therefore, the occurrence of the COVID-19 pandemic has caused economic activities in Romania to see a reduction of 28 (the largest among all the countries). In relative terms and with a 95% confidence interval of [−22%, −9.6%], this negative impact approximates 16%. It can be seen that the negative impact statistically significant at 5 percent level of significance since the −16% is within the 95% confidence band. Again, with a posterior tail-area probability value of 0.0000, there is absolutely no chance that the COVID-19 pandemic would impact economic activities positively in Romania.

With regards to Russia, economic activities in the country also had its share of the adverse effect of the COVID-19 pandemic. It can be seen that the actual and predicted economic activities during the post-COVID-19 periods averaged 132 and 138, respectively, suggesting a significant reduction in economic activities in Russia. Quantitatively, the reduction is about 6.1 with the 95% confidence interval being [−11, −1.1]. In relative terms, Russia saw a significant reduction in her economic activities by 4.4% (the smallest among all the countries). Again, as with the other countries, the posterior tail-area probability value of 0.0081 show the COVID-19 could barely have a positive impact on economic activities in the country.

However, the results in Table 3 show that eleven (11) countries within our sample did not experience a significant reduction in their economic activities although both the absolute and the relative effects of the COVID-19 pandemic are negative in all of those countries. These countries include Ghana, Bosnia and Herzegovina, India, South Korea, Mongolia, Montenegro, Paraguay, Serbia, Turkey, Ukraine, and Uzbekistan. The implication of the above finding is that, although the occurrence of the COVID-19 pandemic reduced economic activities in these countries when we consider the post-COVID-19 periods as a whole, the reductions in economic activities are not statistically significant, and therefore cannot be meaningfully interpreted. One of the reasons for these statistically insignificant COVID-19 effects could be attributed to the resilience of the real sector of those countries which could partly be attributed to the COVID-19 economic policy responses introduced by policy makers in those countries.

By comparing the impact of the COVID-19 pandemic across countries under study, Romania has its real sector largely affected by the COVID-19 pandemic, about 16% reduction in economic activities in relative terms, followed by Bulgaria (−7.1%), Costa Rica (−6.8%), Ecuador (−6.2%), Brazil (−6.1%), with the least affected country being Russia (−4.4%). However, the real sectors in Ghana, Bosnia and Herzegovina, India, South Korea, Mongolia, Montenegro, Paraguay, Serbia, Turkey, Ukraine, and Uzbekistan were not significantly affected by the COVID-19 pandemic within our sample period.

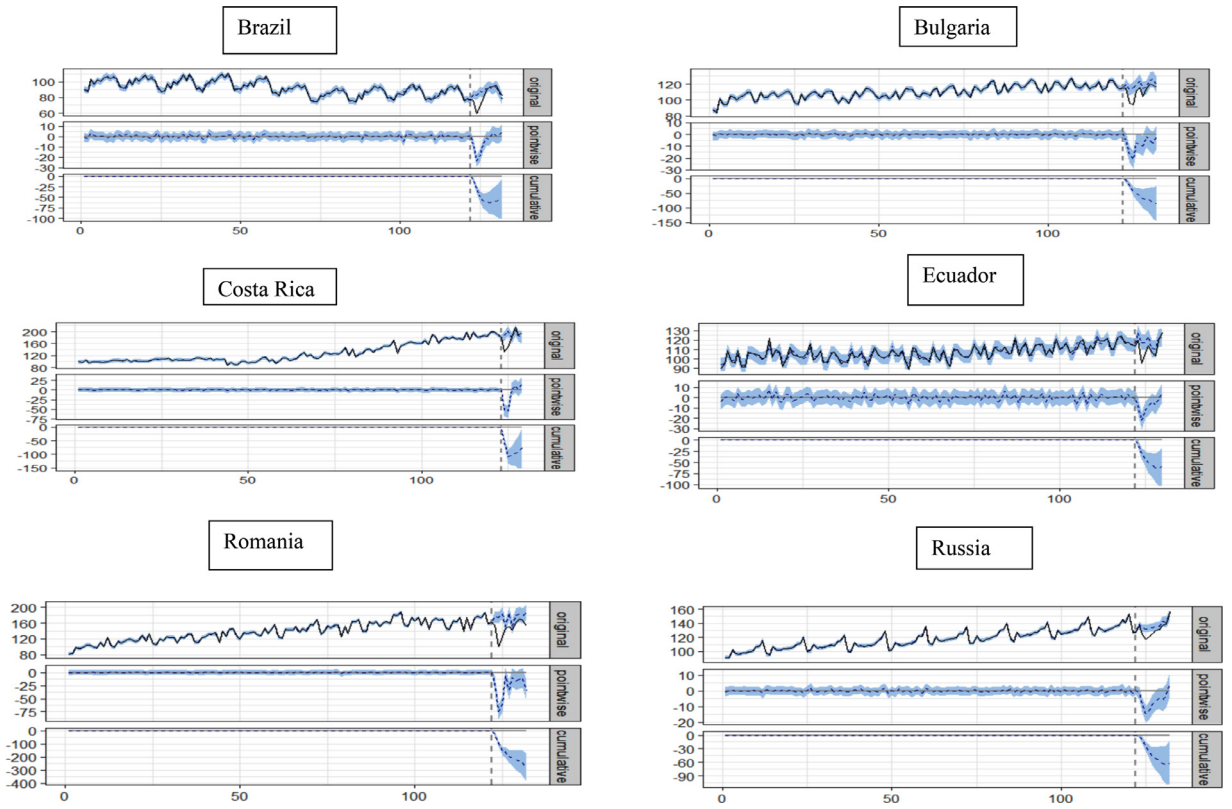


**Fig. 1.** Bayesian posterior distribution graphs for the causal effect of COVID-19.

Generally, the results obtained above are consistent with what has been documented in the literature by Roberts (202), Dzansi, et al. [12]; Beyer et al. [3]; Asante and Mills [2]; Aduhene and Osei-Assibey [1]; Bukari et al. [5]; Chudik et al. [8], among others.

*Bayesian posterior distribution graphs*

This section discusses the impact of the COVID-19 on economic activities using the posterior distribution graphs. In particular we analyze the time path of the causal effect of the pandemic on the real sectors in the 18 developing economies. Figs. 1 and 2 show the posterior distribution graphs for each of the countries. Specifically, Fig. 1 shows the graphs for the six countries which experienced a quantitatively negative impact of COVID-19 on their economic activities while Figs. 2A and 2B show the posterior distribution graphs of the remaining 12 countries which saw no significant impact of the pandemic on their economic activities. Notably, the blue-dotted lines in each graph indicate the time path of the forecasted series of economic activities, whereas the black lines indicate the time path of the actual series of the same variable. Here, the difference between those two lines (i.e., the original panel) measures the average causal impact of the COVID-19 pandemic (i.e., the pointwise panel) while the cumulative panel measures the cumulative casual impact. Also, the blue areas indicate 95% confidence intervals or bands.

Using the pointwise and cumulative panels, it can be seen from Fig. 1 that the negative impacts of the COVID-19 pandemic on economic activities are statistically significant for Romania, Bulgaria, Costa Rica, Ecuador, Brazil, and Russia. This is because the blues lines within the 95% confidence interval are all well below zero during the post-COVID-19 periods. This finding confirms the quantitative results obtained and discussed above.

However, the significant or insignificant impact of the COVID-19 pandemic changes across time for the remaining twelve countries. For example, from Figs. 2A and 2B, it can be seen that, within the first three months of the occurrence of the COVID-19 pandemic, the economic activities of Ghana, India, South Korea, Paraguay, Serbia, Turkey, and Uzbekistan saw a significant reduction. It is only after about five to six months later that the impact became statistically insignificant for those countries. These results suggest that the real sectors in those countries have seen a recovery after being adversely affected by the COVID1–19 pandemic. Interestingly, however, the economic activities of Bosnia and Herzegovina, Mongolia, and Montenegro saw no significant reduction during all periods of the COVID-19 pandemic.

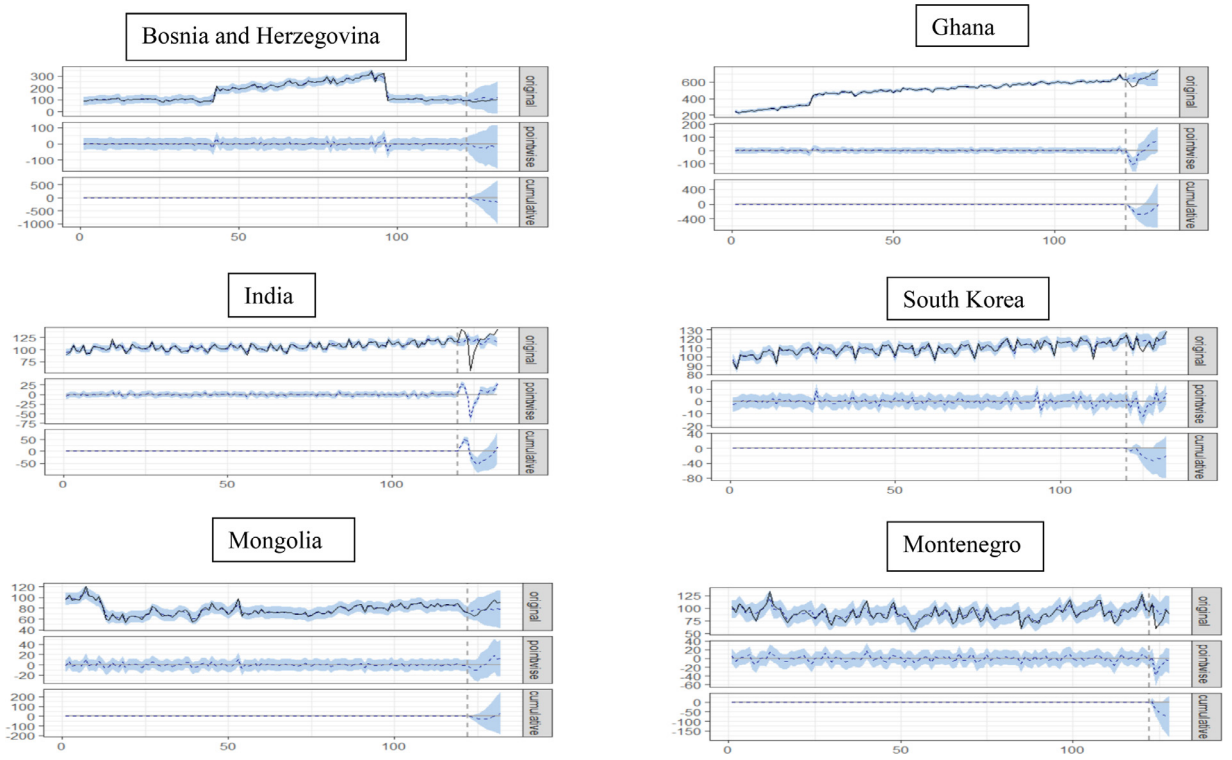


**Fig. 2A.** Bayesian posterior distribution graphs for the causal effect of COVID-19.

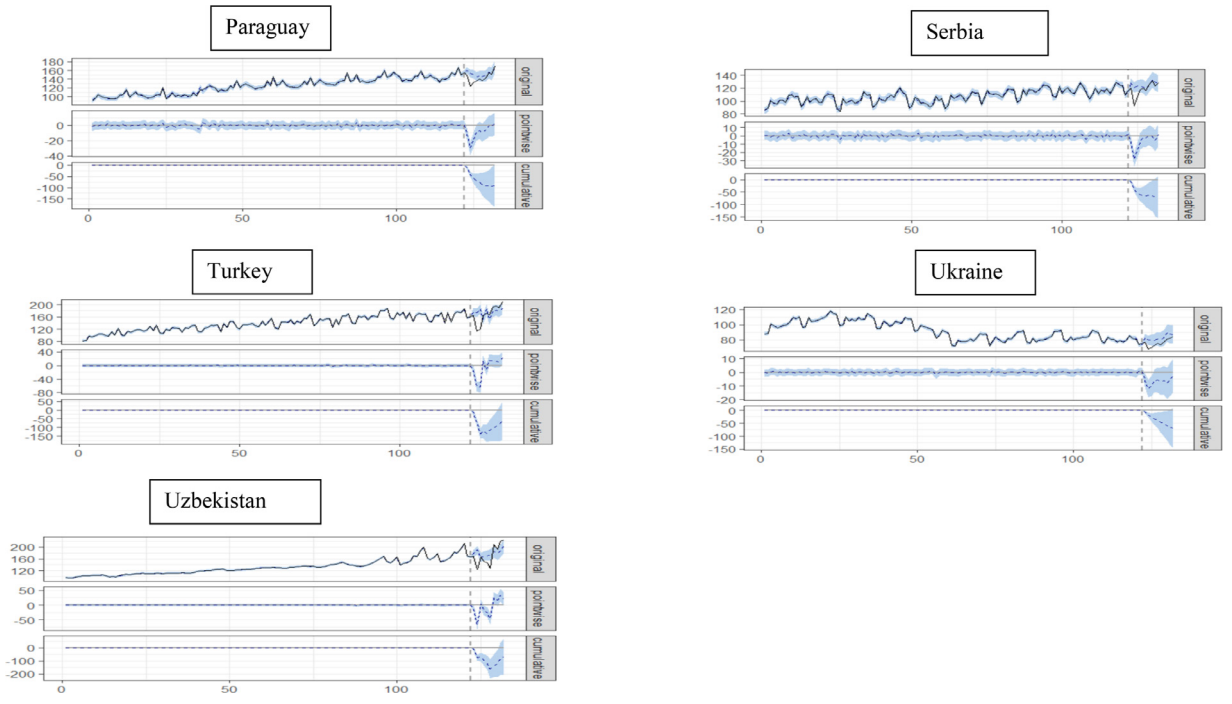


**Fig. 2B.** Bayesian posterior distribution graphs for the causal effect of COVID-1.

## Conclusion

This paper investigates the potential impact of the COVID-19 pandemic on economic activities (the real sector) in eighteen (18) developing countries. These countries include: Bosnia and Herzegovina, Brazil, Bulgaria, Costa Rica, Ecuador, Ghana, India, South Korea, Mongolia, Montenegro, Paraguay, Romania, Russia, Serbia, Turkey, Ukraine, and Uzbekistan. We use monthly time series data spanning January 2010 to December 2020 on Composite Index of Economic Activity for Ghana and Industrial Production Index for the rest of the countries as proxies for economic activities in each country. We employ a state-space model (i.e., a Bayesian structural time series model) to evaluate and quantify the short-run absolute and relative impacts of the COVID-19 pandemic on economic activities in each country.

Evidence from our simulation exercise, given rise to the Bayesian posterior estimates, suggests that the COVID-19 pandemic had a significant reducing impact on the real sectors of six countries. However, the rest of the countries saw no significant impact of the COVID-19 pandemic on their economic activities, although the impacts were negative. In the very short-run (within three to four months of the occurrence of COVID-19), the results from our Bayesian posterior distribution graphs indicate that all the countries within our sample except Bosnia and Herzegovina; Mongolia; and Montenegro saw a significant reduction in their economic activities due the pandemic.

Quantitatively, our results show that, in relative terms, Romania has its real sector largely affected by the COVID-19 pandemic, about 16% reduction in economic activities in relative terms, followed by Bulgaria (−7.1%), Costa Rica (−6.8%), Ecuador (−6.2%), Brazil (−6.1%), with the least affected country being Russia (−4.4%). However, the real sectors in Ghana, Bosnia and Herzegovina, India, South Korea, Mongolia, Montenegro, Paraguay, Serbia, Turkey, Ukraine, and Uzbekistan were not significantly affected by the COVID-19 pandemic within our sample period.

Qualitatively, our results show the significant negative impacts of the COVID-19 pandemic on economic activities of most of the countries within our sample are rather short-lived. This finding suggests that the real sectors of those countries have seen a recovery after being adversely affected by the COVID-19 pandemic, which we could attribute partly to the various COVID-19 economic policy responses by many governments around the world.

Finally, we find that, within our sample period, there is almost zero probability that the COVID-19 pandemic would have positively impacted the economic activities (the real sectors) in all the countries considered in this study. The findings from our study contribute to the research on the economic impact of the COVID-19 by empirically providing evidence that the COVID-19 pandemic has had restrictive effects on the real sectors (economic activities) of developing countries. We recommend a continuation of the policy tools introduced by the central banks and the international organizations with a key focus on sectors of that economy that involves significant human interactions such as the hospitality and tourism as well as the aviation industry which was hugely hit by the pandemic.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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