

A Note on the COVID-19 Shock and Real GDP in Emerging Economies: A Counterfactual Analysis from the Threshold-Augmented Global Vector Autoregressive Model

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Abstract

In this study, we estimate a multi-country Threshold-Augmented Global Vector Autoregressive (TGVAR) model of Chudik et al., (2020) to analyse the response of real GDP of emerging economies (Brazil, India, China and South Africa) as well as the US (as a reference country) to the COVID-19 shock. The result of the counterfactual analysis beyond the 2019Q4 indicates that the impact of COVID-19 shock on real GDP is pervasive and heterogeneous but more prevalent in the US than the emerging economies. We expect real GDP in the selected emerging economies, but not the US, to revert to pre-COVID levels.

Keywords: Real GDP, COVID-19, threshold-augmented GVAR, emerging economies, US

JEL codes: C33, I18, O47, O57

1. Introduction

Motivated by the dearth of research on the real economy in the COVID-19 pandemic literature (see Narayan (2020a))¹, this study examines the output effects of the COVID-19 pandemic induced shock in the BICS (Brazil, India, China and South Africa) emerging countries plus the United States (US). The study is conducted within a multi-country model framework that accounts for global trade and financial interlinkages as well as uncertainty shock spillovers due to the spread of different variants of the disease globally which is currently in its third wave. Since the first wave, the health and socioeconomic impacts of the pandemic have been shown to be transmitted globally albeit unequally in terms of slowdown of economic activities, disruption of supply chains and rise

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¹ There is a growing body of empirical literature showing the adverse effects of the current pandemic on financial markets (see Narayan, 2020b,c; Narayan et al. 2020a,b; Salisu and Akanni, 2020; Salisu et al., 2020; Sharma, 2020, among others), however, very little is known about its impact on the real economy perhaps due to data constraint (Narayan, 2020a).

in macroeconomic uncertainties with ripple effects on investor sentiments, outputs, unemployment and inequality (Ludvigson et al. 2020; Brodeur et al. 2021).

We mount the contribution of our paper on previous efforts by Caggiano et al., (2020) which estimates a conventional VAR model containing world-level variables to show 14% cumulative reduction in world output due to the pandemic-induced shock. Rather, we base our analysis of the impact of the pandemic shock on real GDP on a counterfactual analysis in line with the thinking that the pandemic raised uncertainty to levels previously unparalleled (Baker et al., 2020), hence, analysis with historical data is rendered redundant for a study of this nature. We situate our study within the Threshold-Augmented Global Vector Autoregressive (TGVAR) framework of Chudik et al., (2020), which improves on the multi-country model of Chudik and Pesaran (2016) and Chudik et al., (2016) with threshold effects caused by the pandemic. In all, we highlight the differences in the real GDP effects of the pandemic among the BICS emerging countries and the advanced economy of the US. We follow up this section with description of data and methodology. We discuss the findings in Section 3 and conclude the paper in Section 4.

2. Methodology and Data

We estimate a threshold-augmented dynamic multi-country model of Chudik et al., (2020) christened as TGVAR model which is an extension of the standard GVAR model of Chudik and Pesaran (2016) and Chudik et al. (2016) as it simultaneously accommodates both unobserved external common factors and threshold effects. Notwithstanding the focus of the study which is the BICS (excluding Russia due to lack of data), the model includes 33 interconnected economies accounting for more than 90% of world GDP and involves data covering the period of 1979Q2 to 2021Q1 where data for the period of 1979Q2 to 2019Q4 are drawn from the updated GVAR dataset of Mohaddes and Raissi (2020), and the 2020Q1 data involves the growth forecast revisions of IMF in order to identify the COVID-19 shock for the counterfactual analysis. Each economy comprises of four domestic (endogenous) variables namely logarithm of real GDP (gdp_{it}), nominal long-term interest rate (lr_{it}), the logarithm of real equity prices (eq_{it}), and the logarithm of the real exchange rate (the nominal exchange rate deflated by the consumer price index), ep_{it} and all the variables are expressed in first-differences to circumvent highly persistence effects. Thus, the country-specific endogenous variables are given as:

$$y_{it} = (\Delta gdp_{it}, \Delta lr_{it}, \Delta eq_{it}, \Delta ep_{it})' ; i = 0, 1, 2, \dots, n ; t = 1, 2, \dots, T \quad (1)$$

where the US economy takes $i = 0$ and given that y_{it} has a dimension k_i which differs across countries, i , we can write a single $k \times 1$ vector of y_t to collect all country-specific variables, $y_t = (y'_{0t}, y'_{1t}, y'_{2t}, \dots, y'_{nt})'$. With the inclusion of external common factors [both observed (g_t) and unobserved (\tilde{y}_t) global factors]² and foreign (trade-weighted domestic) variables³ (y_{it}^*), we specify the threshold-augmented GVAR model:

$$y_{it} = c_{y,i} + \Phi_i y_{i,t-1} + B_i y_{i,t-1}^* + A_{0,i} f_t + A_{1,i} f_{t-1} + \lambda_i z_{t-1}(\gamma_i) + u_{it} \quad (2)$$

where f_t is a vector of external (global) factors, $f_t = (g'_t, \tilde{y}'_t)'$; g_t , \tilde{y}_t , y_{it} and y_{it}^* retain their previous definitions; while $z_{t-1}(\gamma_i)$ is the threshold indicator defined as:

$$z_{t-1}(\gamma_i) = I \left[(0, 1)' g_{t-1} > \gamma_i \right] = I (grve_{t-1} > \gamma_i) \quad (3)$$

where $grve_t$, the global volatility, is the threshold variable whose effect is restricted to output, i.e., $\lambda_{y,i} = (\lambda_{\Delta gdp,i}, 0, 0, 0)'$, since our focus in this paper is to evaluate the output effects of the COVID-19 shock.⁴ The variables $\Delta \tilde{lr}_t$, $\Delta \tilde{eq}_t$ and $\Delta \tilde{ep}_t$ are excluded from the US model given the dominant role of the US economy in the global financial market. The COVID-19 shock is identified using the IMF's forecast revisions in 2020Q1 following the pandemic (Chudik et al., 2020). In other words, up to 2019Q4 ($t = 1, 2, \dots, T$), u_{it} in (2) is given as:

$$u_{it} = \Gamma v_t + \varepsilon_t \quad (4)$$

² Note that the $g_t = (\Delta poil_t, grve_t)'$ where $\Delta poil_t$ measures changes in log oil prices and $grve_t$ is global volatility measured as realized equity returns for a large number of countries, while $\tilde{y}_t = (\Delta \tilde{gdp}_t, \Delta \tilde{lr}_t, \Delta \tilde{eq}_t, \Delta \tilde{ep}_t)'$ obtained as the weighted cross-sectional averages (using PPP-GDP weight of country i , \tilde{w}_i) of the domestic variables, where, for example, $\tilde{gdp}_t = \sum_{i=0}^n \tilde{w}_i gdp_{it}$ and the same transformation is followed for others.

³ The foreign variables obtained as the country-specific trade-weighted averages $\left[y_{it}^* = (\Delta gdp_{it}^*, \Delta lr_{it}^*, \Delta eq_{it}^*, \Delta ep_{it}^*)' \right]$ allow for the transmission of shocks through the trade channel as in the standard GVAR model, where, for example, $gdp_{it}^* = \sum_{j=1}^n w_{ij} gdp_{jt}$, $\{w_{ij}\}$ are the trade weights, $j = 0, 1, 2, \dots, n$, $w_{ii} = 0$, and $\sum_{j=0}^n w_{ij} = 1$. The same procedure is followed for other foreign variables - Δlr_{it}^* , Δeq_{it}^* and Δep_{it}^* (for further technical details on the construction of w_{ij} , see Chudik and Pesaran (2016), Chudik et al., (2016) and Mohaddes and Raissi (2020)).

⁴ Some technical details on the threshold variable are provided in Chudik et al., (2020).

where u_t is a vector of reduced form shocks, composed of global (v_t) and idiosyncratic shocks (ε_t). However, for Q1 to Q4 of 2020, (4) is augmented as:

$$u_{T+q} = \omega_{T+q} + \Gamma v_{T+q} + \varepsilon_{T+q} \quad (5)$$

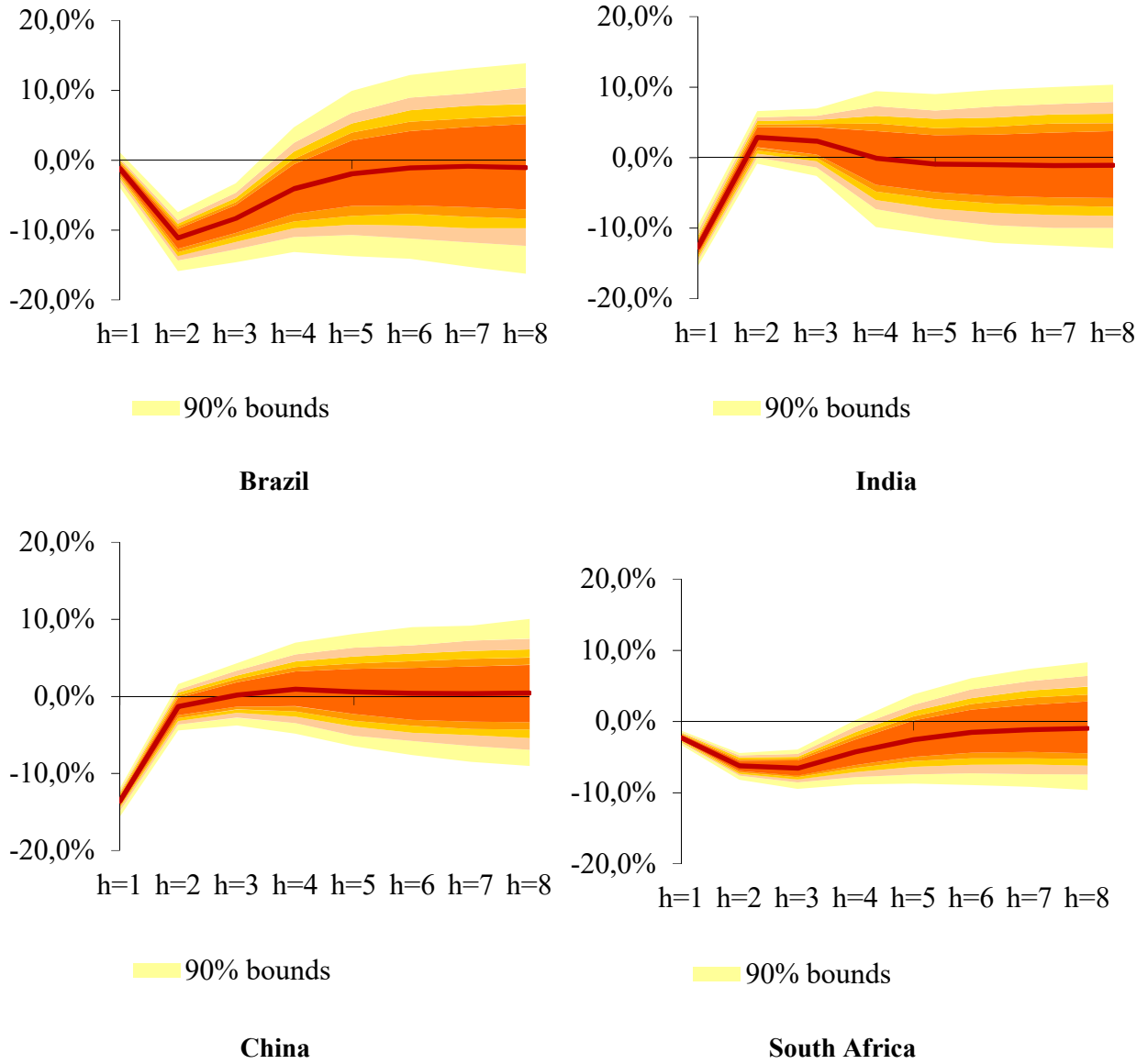
where ω_{T+q} measures the Covid-19 shock in the period $T+q$ identified using the size of IMF's forecast revisions at the end of 2020Q1 and $\omega_t = 0$ for $t \leq T$ but nonzero, otherwise particularly for $t = T+1, T+2, T+3, T+4$.

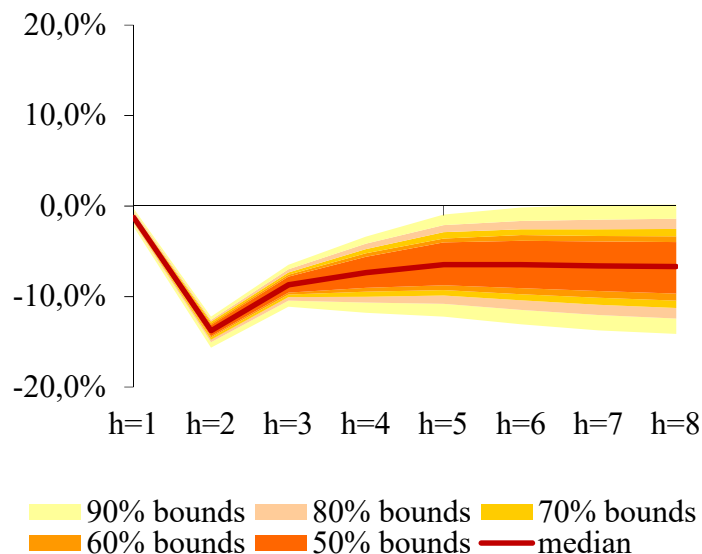
3. Results

We estimate the multi-country TGVAR model (see Chudik et al., (2020) for further details on the estimation process)⁵, and present generalised impulse responses for the counterfactual impact of the COVID-19 pandemic shock on the emerging BICS economies and the US. The GIRFs in Figure 1 compares the impacts of the COVID-19 identified shock on the real GDP of the countries relative to the natural path of the real outputs (without the pandemic) over the eight quarters of the post COVID-19 forecast horizon (2020Q1 to 2021Q4). The solid lines represent the GIRFs accompanied by the confidence bounds to indicate probability of statistical significance of the impulse responses. The results show the adverse impacts of COVID-19 on the real GDP of the US over the entire forecast horizon. The negative impact is less prevalent on the emerging BICS countries, lasting till 2020Q2 (h=2) in China and India, 2020Q4 (h=4) in Brazil and 2021Q1 (h=5) in South Africa, based on statistical significance. The immediate impacts of the pandemic are also pervasive and heterogeneous. COVID-19 reduced real GDP the most in China and India by 13% and 12% respectively compared to the pre-crisis path of real GDP (if there was no pandemic). The immediate negative impacts were lower in Brazil, South Africa and the US where real GDP fell by 2%, 2.5% & 2% below the pre-COVID path.

⁵ The estimates of the threshold effects are obtained by running a dynamic threshold-augmented dynamic output growth model given by $\Delta y_{it} = c_i + \rho_i \Delta y_{i,t-1} + \varphi_i z_{t-1}(\gamma) + u_{it}$ where Δy_{it} is the first difference of the logarithm of real GDP in country i during quarter t while z_t is as defined in (3). These estimates which are available in Chudik et al., (2020) (see Table 1) show evidence of statistically significant threshold effects in the output growth models of Brazil and US while those of the other countries (China, India and South Africa) are not significant. As noted by Chudik et al., (2020, countries where there is no evidence of threshold effects (perhaps due to the choice of threshold regression), their output growth could well be non-linearly affected by localized events (e.g., natural disasters; banking, currency and sovereign crises) or external shocks (e.g., commodity price volatility and capital flow reversals), and be exacerbated by country-specific characteristics (internal and external imbalances).

Figure 1: The Impact of COVID-19 shock on Real GDP of BICS + US (percent deviation from baseline)

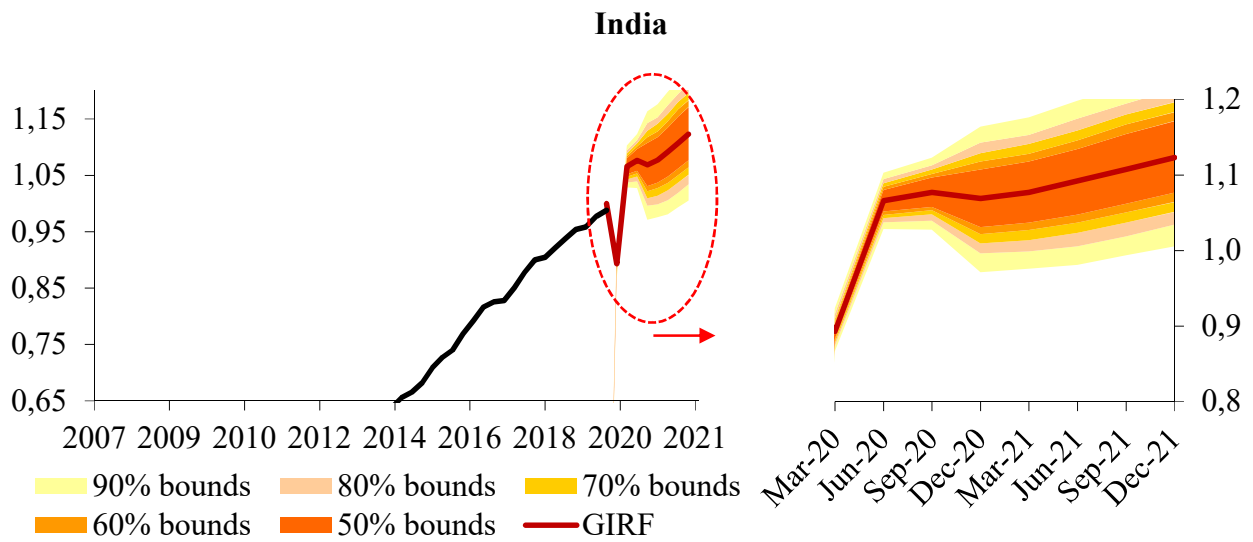
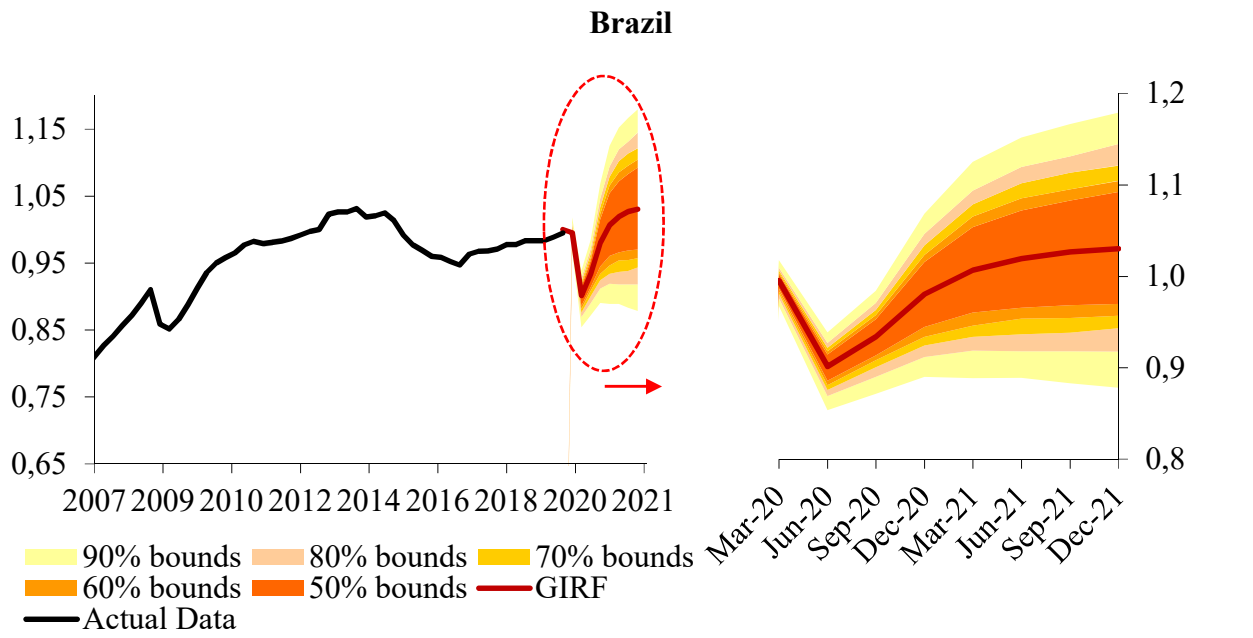




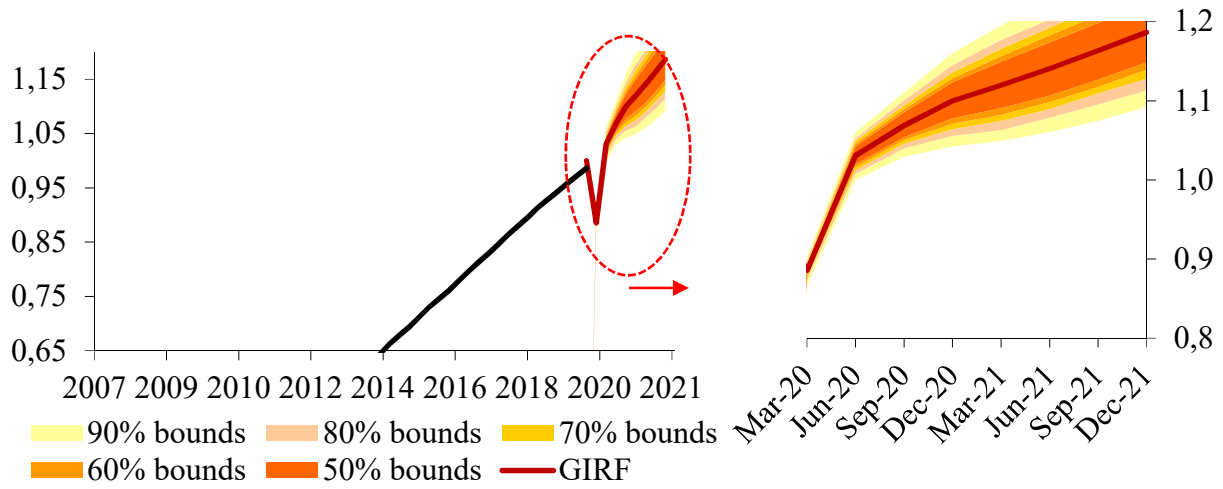
United States

In Figure 2, we trace the evolution of the real GDP for the countries following the COVID-19 shock from 2019Q4 over the eight-month forecast horizon (2020Q1 to 2021Q4). Here, the counterfactual analysis indicates the length of time it takes the real GDP to revert to its pre-COVID 19 shock levels. There are differences in the economic recovery between the US and the emerging economies. While the results show that the real GDP of the BICS economies would revert more rapidly to the pre-COVID levels, the recovery will take longer time for the US real GDP to do so. We do not expect the US to gain back the income losses due to the pandemic by the end of the forecast horizon in 2021Q4 (see Chudik et al., (2020) for similar observations). Nonetheless, magnitudes differ among the emerging economies although all of them are expected to end 2021 with real GDP figures above the 2019Q4 levels before the COVID-19 pandemic. The order for economic recovery among the BICS emerging economies by 2021Q4 is South Africa (2% above 2019Q4 real GDP level), Brazil (3.5% above 2019Q4 real GDP level), India (13.5% above 2019Q4 real GDP level), and the highest, China (20.1% above 2019Q4 real GDP level).

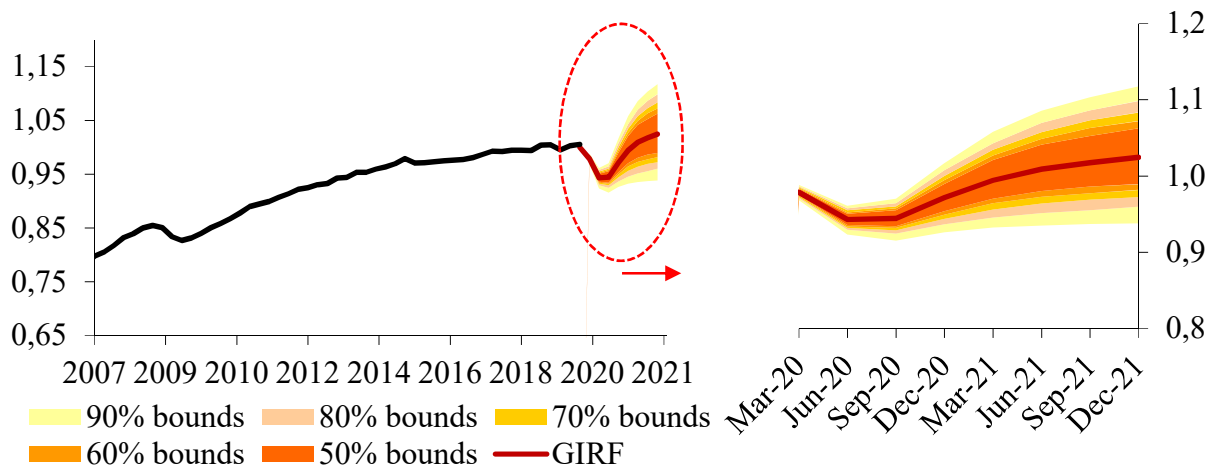
Figure 2: Dynamics of Real GDP Following the Covid-19 Shock (in logs; 2019Q4=1)

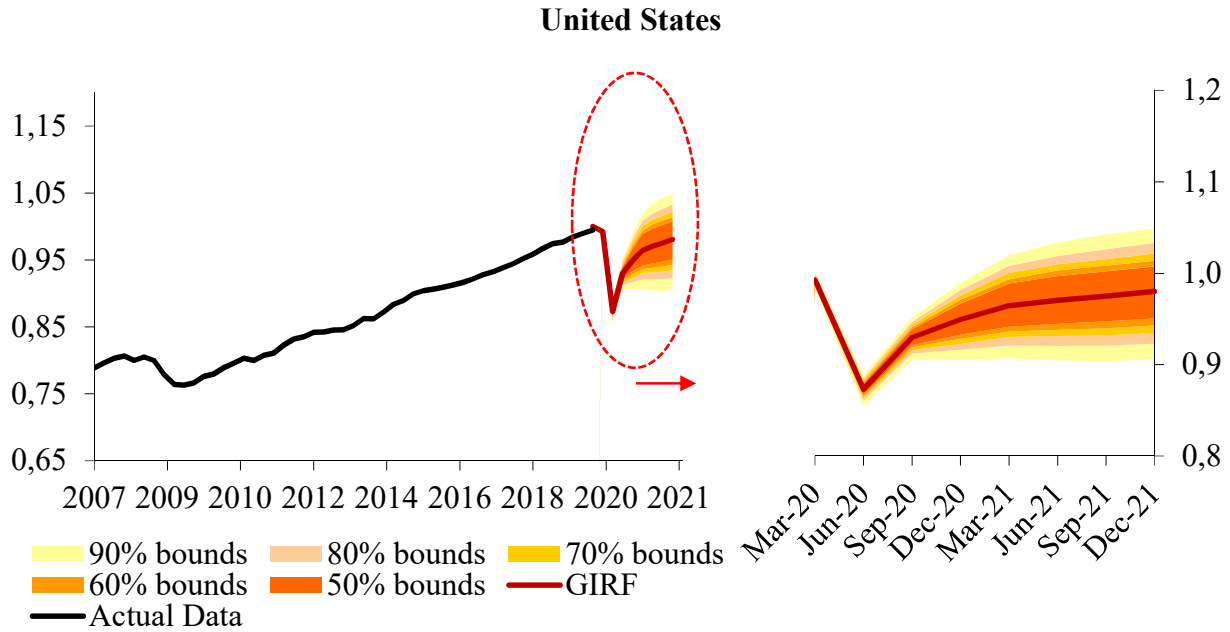


China



South Africa





4. Conclusion

In this study, we examine the response of real GDP to COVID-19 shock within a multi-country multivariate model with global macroeconomic interlinkages and threshold effects. We therefrom conduct a counterfactual analysis to compare the real GDP for the countries of interest (United States, Brazil, India, China, and South Africa) before and after the COVID-19 shock. This allows us to maintain our focus on emerging countries while still able to reference an advanced economy.

We employ the threshold-augmented GVAR model of Chudik et al., (2020), an extension of the standard GVAR model of Chudik and Pesaran (2016) and Chudik et al., (2016), which allows us to identify the COVID-19 shock with threshold effect. Some of the attractions of the framework is that: one, it simultaneously accommodates both unobserved external common factors and threshold effects; two, ability to study complex financial, trade and other interactions among several countries of the world (for instance, the GVAR toolbox contains 33 economies that account for more than 90% of world GDP). We adopt the updated GVAR dataset of Mohaddes and Raissi (2020) to estimate a 33-country GVAR model involving four domestic (endogenous) variables; real GDP, nominal long-term interest rate, logarithm of real equity prices, and the logarithm of the real exchange rate. However, we obtain the impulse responses for the emerging countries of interest and the US for the responses of real GDP to the pandemic shock.

The outcome is twofold. First, we show that the pandemic has negative impacts on the real GDP of the countries but with more lasting impacts on the US than the emerging economies. The immediate impacts are heterogeneous with the pandemic leading to instantaneous reductions to the tune of 13% in China, 12% in India, 2% in Brazil and US, and 2.5% in South Africa, compared to the pre-COVID period. Second, further analysis show that while the emerging economies are expected to see their real GDP at the end of the forecast horizon in 2021Q4 revert to their pre-COVID levels in 2019Q4, the same is not expected for the US. Hence, more targeted counter-measures may be required in the United States, than the emerging economies, to regain the income losses due to the pandemic. Future studies may extend the analysis to other macroeconomic fundamentals while taking note of cross-country differences.

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