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COVID-19 uncertainty, financial markets and monetary policy effects in case of two emerging Asian countries

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ABSTRACT

This paper examines the effectiveness of the monetary policies undertaken by the central bank on economic growth during COVID-19 uncertainty in case of India and Indonesia. We use an innovative framework of Growth-at-Risk as oppose to standard macroeconomic models, which can predict the growth in a much robust way particularly when an economy is facing shocks like COVID-19. The empirical results based on Growth-at-Risk model clearly reveal that effect of COVID-19 pandemic on economic growth is much adverse in comparison to actual declines. Further, this study shows the effectiveness of monetary and financial policies undertaken by the central banks of both India and Indonesia, which have actually subsided the adverse impact of COVID-19.

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1. Introduction

The emerging market economies (EMEs) were already experiencing weakness even before COVID-19 pandemic mainly because of economic uncertainty around the world. In addition, the impact of COVID-19 was so deep that most forecasters predict the global economy would face recession in 2020. The economy was expected to experience degrowth in 2020 and recover thereafter. However, the speed of recovery was expected to be highly uncertain and conditional on how the pandemic would pan out, the pace of reversing the lockdown and finding out the vaccine for the virus. Generation and publication of economically meaningful point forecast based on models became almost impossible. At that time, most of the forecasts provided by various agencies were based on their judgements rather than by using any economic or statistical model. Given these difficulties, it became a challenge for the policy makers to communicate point forecasts as these forecasts disregard the risk around the central forecast. Economic models are generally designed to provide expected mean forecast while ignoring the volatility and other higher moment of distribution. This may lead to systematic underestimation of downside risk to growth. Hence, it is also difficult to formulate the policy suitable for the economy.

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In this context, financial variables, expected to have information about future path of the economy, come as a savior to forecast GDP growth, particularly the downside risk to growth.

As against the above backdrop, the main objective of our paper is to examine the effectiveness of monetary policy in two big emerging Asian countries, India and Indonesia, during the first wave of COVID-19. To best of our knowledge, there is no such study which has addressed this issue. We focus on India and Indonesia because both the countries have several common characteristics, viz. demographic structure, adopted flexible inflation target, have floating exchange rate system with intervention policy focusing on managing excess volatility, bank dominated economy with vibrant financial markets. First, both India and Indonesia come under low-middle income category as per the new classification of the World Bank. However, other big emerging countries like Brazil, China, Russia, South Africa and Turkey come under upper-middle income countries. The per capita gross national income at constant 2010 US\$ of India and Indonesia were US\$ 1942 and US\$ 4312, respectively, in 2020. Second, the demographic structure of both countries is broadly similar with the average annual population growth rate during last one decade (2011–2020) for India and Indonesia were 1.1 per cent and 1.2 per cent, respectively. The growth rate has been also steadily declining over last ten years in these two countries (UN World Population Prospects). Third, the acceleration in the pace of economic activity, favourable demographic structure and improvement in per-person productivity are expected to lead India to be the second largest economy (exceeding the US's GDP in PPP terms) before 2040 and Indonesia to be the fourth largest economy before 2035 (overtaking the Japan's GDP in PPP terms) as per a report by the PricewaterhouseCoopers (PwC). Fourth, both India and Indonesia are worse affected countries by COVID-19 in Asia. Fifth, the government and central bank in both nations have announced various fiscal and monetary measures to tackle the COVID-19 pandemic to bring back the economic growth to pre-pandemic periods.

The effect of the COVID-19 pandemic on economic growth and financial markets has been extensively researched during last two years. There are two prominent studies by [Narayan \(2021\)](#) and [Padhan and Prabheesh \(2021\)](#) which cover literature survey on the economics of COVID-19 pandemic and highlight the future research on COVID-19 pandemic. Similarly, a handful number of studies, which examined the impact of COVID-19 on financial markets particularly by emphasizing on stock market ([Sharma and Sha, 2020](#); [Sha and Sharma, 2020](#); [Mishra et al., 2020](#); [Sharma, 2020](#); [Sharma et al., 2021](#); [Behera and Rath, 2021](#); [Yan and Qian, 2020](#); [Dinh and Narayan, 2020](#); [Prabheesh, 2020](#); [Bannigidmath et al., 2021](#); [Bing, 2021](#); [Bal and Mohanty, 2021](#); [Christos et al., 2021](#); [Oliyide et al., 2021](#); [Li, 2021](#)). Likewise, another strand of literature which focuses on the effect of COVID-19 on energy markets ([Narayan, 2020c,a,b](#); [Gil-Alana and Claudio-Quiroga, 2020](#); [Gil-Alana and Monge, 2020](#); [Phan and Narayan, 2020](#); [Al-Awadhi et al. 2020](#); [Apergis and Apergis, 2020](#); [Devpura and Narayan, 2020](#); [lyke, 2020a](#); [Owuru, 2021](#); [Liu et al., 2020](#); [Rath and Akram, 2021](#); [Shi and Kong, 2021](#)).

There is also a reasonable number of empirical studies in the literature, which specifically examine the effect of monetary policies on financial markets both pre and during COVID-19 pandemic (for example, [Ali et al., 2021](#); [Chundakkadan and Sasidharan, 2022](#); [Narayan et al., 2021a](#); [Njindan lyke et al., 2021](#); [Prabheesh et al., 2021](#); [Rizvi et al., 2021](#); [Zhang et al., 2021](#)); on exchange rates ([Bouakez and Normandin, 2010](#); [Inoue and Rossi, 2019](#)), and on stock index returns ([Bayraci et al., 2018](#); [Ferrer et al., 2016](#)). [Wei and Han \(2021\)](#) examine the impact of the COVID-19 pandemic on the transmission of monetary policy to financial markets. By using data from 37 countries, the study found that the advent of pandemic has weakened the transmission of monetary policy to financial markets. Similarly, [Singh et al. \(2021\)](#) examines the effectiveness of policy interventions on stock market returns and its volatility for China and Russia during pandemic periods. By employing both event study and Markov Regime Switching Models, the authors found that interventions were effective in case of China but not for Russia. [Rizvi et al. \(2021\)](#) examine the effect of fiscal and monetary policy stimulus actions on stock markets of four ASEAN countries during the COVID-19 pandemic. Their finding indicates that seven days after the policy announcement, fiscal policies helped support financial market losses in Indonesia, Singapore and Thailand. There are few studies which made an attempt to examine the effect of government intervention, fiscal stimulus, economic policy uncertainty and exchange rate on different economies during the COVID-19 pandemic (for example, [Narayan et al., 2021b](#); [Yang and Deng, 2021](#); [Haldar and Sethi, 2020](#); [lyke, 2020b](#); [Devpura, 2020](#)).

Summarizing the literature, it is clear that any type of crises and extreme events adversely impact the global economy. Most of these aforementioned studies use time-series models or event study analysis to evaluate the effects of COVID-19 either on economic growth or financial markets including stock and foreign exchange markets or energy markets. Some of these studies also look into the effectiveness of government intervention through both monetary and fiscal policies on economy during pandemic. But most of these studies focused on parametric models to evaluate the impact of COVID-19 on key macro and financial related indicators. However, the present study evaluates the performance of financial variables along with monetary policy on economic growth based on a flexible non-parametric model.

In the post-global financial crisis period, economists and policy makers incrementally accepted that financial shocks, not necessarily driven by monetary policy actions, may have a stronger effect on the real economic activity ([Koop and Korobilis, 2014](#)). Moreover, the relationship between financial condition and economic activity is found to be non-linear, with relatively weak linkages when financial condition is loose; and the macroeconomic outcome turning (extremely) adverse when financial condition tightens significantly ([Adrian et al., 2019](#)). During the periods of economic slump, the effectiveness of monetary policy depends on how best it can bring back financial conditions to normalcy. It is, therefore, important for a central bank to understand the interplay of monetary policy, financial conditions and the real economy.

The novelties of this paper are as follows. First, we use the information contain in financial variables to forecast the tail risk to GDP growth. This paper is motivated by the modern approach to forecast conditional distribution of growth rather than the conventional mean forecasts following [Adrian et al. \(2019, 2020\)](#), [Reichlin et al. \(2020\)](#) and [Adams et al.](#)

(2021). To be more specific, this paper aims to use the relevant information contain in financial variables during COVID-19 uncertainty periods to forecast the tail risk to GDP growth using Growth-at-Risk (GaR) approach. Most of the financial variables are obtainable at a high frequency and real time basis. Events affecting both the financial markets and the economic activity can, therefore, be detected at an early stage on the financial markets, which can be used to predict future economic outcomes.

Principal component analysis (PCA) is used to extract few factors, from a set of financial and macroeconomic variables, representing broad features of the risks and economic activity. Financial variables, apart from containing useful information, are not free from noise. Therefore, one need to filter out these noises to use them meaningfully for forecasting purpose. At a particular point of time, one segment of financial market may witness stress while other segments remain calm; however, all the segments usually experience significant stress during the period of financial turmoil or real sector crisis like COVID-19 pandemic. It is, therefore, essential to develop a summary measure of all the market segments using PCA approach to understand overall financial conditions.

Second, the extracted factors are regressed on GDP growth by using a quantile regression framework to understand the linkages of these factors at different quantiles of GDP growth. This is again a methodological innovation which was not exclusively employed in the literature. In this way, we try to connect the growth risks with economic meaningful factors.

Third, we aim to examine whether financial stress build up during COVID-19 are eased following the announcements of several monetary measures by the central banks. In the literature, it has been recognized that both monetary and fiscal policies are important for maintaining growth with stability. And coordination between fiscal and monetary policies are also important for overall macroeconomic policy. However, each policy has their own effects on the economy. The present study only confines to see the effect of monetary policy because it is more effective in short-run. By doing so, we examine whether the degree of expected downturn in these two countries have declined due to various monetary measures undertaken by the central banks. [Hatzius et al. \(2010\)](#) argue that the exogenous shifts in financial conditions impact future path of economic activity and should be distinguished from the endogenous reflection of past economic activity. However, financial condition could also change when financial market players expect any risks to economic activity. For example, the press release of a much lower than expected GDP number by the National Statistical Office could alter the financial conditions as market participants revise their forecasts using current statistics. Hence, financial conditions may not be purely exogenous and could be driven by past economic activity.

This paper offers following insights. First, we find that the GaR at 5 per cent predicted a decline in India's GDP by 9.4 per cent for 2020:Q2 and 10.2 per cent for 2020–21 (as against an actual decline of 6.6 per cent). Second, the GaR at 5 per cent for Indonesia is estimated at (–) 0.2 per cent for 2020:Q2 and an average of 0.5 per cent for next four quarters. These findings are further corroborated from an alternative analysis using Bayesian factor augmented vector autoregressive (FAVAR) model. Our findings lend support to the use of GaR by tapping information from a large set of macro-financial data to forecast GDP growth during uncertainty as timely characterizations of risks to the economic outlook play an important role in both economic policy and private sector decisions.

The remainder of this paper is systemized as follows: Section 2 presents some stylized facts pertaining current state of economy of India and Indonesia. Section 3 describes the methodology and data. Section 4 presents the empirical results and Section 5 concludes.

2. Some stylized facts

With declaration by World Health Organization (WHO) COVID-19 novel coronavirus as pandemic on March 11, 2020, the countries across the world started imposing restrictions on travels and seized borders to restrict the entry of people from other countries. The spread and fear of the virus along with the consequential restrictions adopted by the government to protect the lives of people had created unprecedented economic devastation. Things moved very fast; given the uncertainty about the virus and how it would evolve, people had started comparing its impact with all other major pandemics and 'black swan' like events. Nevertheless, everyone was forced to make a call on the quantitative impact, as this was needed to incorporate in the forecasts to make decisions on policies, investments, etc.

With the first case in India detected on January 30, 2020 and the disease spreading to countries around the globe, the stock market began to fall beginning mid-February 2020 that deepened further as the COVID-19 engulfed more countries. On cumulative basis, Nifty lost nearly 38 per cent by March 23, 2020 from its peak of 12362 on January 14, 2020 ([Table 1](#)). Financing condition in money market segment tightened significantly – interest rate on 3-month commercial papers (CP) had increased by 305 basis points (bps) and that on certificates of deposit (CD) rose by 245 bps between January 31 and March 26, 2020.

Weighted average call money rate (WACR) – the operating target of the Reserve Bank of India – that was falling earlier in sync with the accommodative monetary policy stance of the RBI increased. Despite fall in yields on Government securities, corporate bond yield increased. Across the fixed income markets, financial conditions tightened due to panic sell-off by foreign portfolio investors (FPIs) in the EMEs, and subsequently lead to widening of term premia (the spread between G-sec yield and policy rate) and risk premia (*i.e.* spread between yields on corporate bonds and G-secs of same maturity). The spread of corporate bond yields over the repo rate remained elevated due to higher risk premia to compensate for coronavirus induced economic uncertainty. Credit-default swaps (CDS) premium of Indian banks had

Table 1

Impact of COVID-19 on financial markets.

Source: Datastream (Thomson Reuters); RBI and Bank Indonesia.

Country	Policy rate	Money market			Bond market			Credit market CDS Spread (SR 5-year ICICI Bank)	Equity market		Forex market	
		Repo rate	WACR	3-month T-bill yield	3-month CD rate	3-month CP rate	10-year G-sec yield		5-year AAA Corporate bond yield	Nifty 50 index	India VIX	USD/INR rate
India												
Jan 31, 2020	5.15	4.97	5.13	5.50	5.75	6.60	7.15	82	11962	17	71.55	5.10
March 24, 2020	5.15	5.35	5.05	7.95	8.80	6.30	7.31	293	7610	84	76.38	13.30
March 31, 2020	4.40	4.29	4.25	4.95	5.80	6.14	7.02	212	8598	64	75.34	10.81
June 30, 2020	4.00	3.65	3.15	3.23	3.75	5.89	6.16	132	10302	29	75.55	5.78
Sep 30, 2020	4.00	3.43	3.31	3.39	3.55	6.02	6.00	114	11248	20	73.57	6.25
Dec 31, 2020	4.00	2.70	3.07	3.00	3.60	5.89	5.51	79	13982	21	73.05	5.70
Change during Jan 31 and March 24	0.00	0.38	-0.08	2.45	3.05	-0.30	0.16	211	-4352	66	4.82	8.20
Change during March 24 and March 31	-0.75	-1.06	-0.80	-3.00	-3.00	-0.17	-0.29	-81	988	-19	-1.04	-2.49
Indonesia												
	7-Days Reverse Repo Rate	O/N IB rate	1-week IB rate	2-week IB rate	1-month IB rate	10-year G-sec yield	5-year AAA Corporate bond yield	5-year CDS Spread	JCI Index		USD/IDR rate	IDR 1-month FX Volatility
Dec 31, 2019	5.00	4.88	5.06	5.26	5.45	7.06	6.44	67	6300		13901	2.90
March 31, 2020	4.50	4.34	4.60	4.70	4.80	7.91	7.31	210	4539		16367	54.46
June 30, 2020	4.25	4.08	4.36	4.58	4.72	7.21	6.54	133	4905		14302	22.16
Sep 30, 2020	4.00	3.29	4.02	4.10		6.96	5.73	116	4870		14918	8.00
Dec 31, 2020	3.75	3.05	3.78	3.98		5.89	5.21	67	5979		14105	2.65
Change during Dec 31, 2019 and March 31, 2020	-0.50	-0.54	-0.46	-0.56	-0.65	0.85		147	-1761		2466	51.56
Change during March 24 and March 31	-0.75	-1.29	-0.82	-0.72		-2.02	0.87	-147	1440		2262	-51.81

gone up to six-year highs reflecting the rise in default risks due to COVID-19. Default risks on domestic non-financial firms more than doubled during March 1–25, 2020 (Fig. 1).

The increasingly volatile global financial market with high uncertainty has pushed risk off in the domestic market. Performance in both the primary and secondary government securities (G-sec) market, which until mid-February 2020 was bullish, turned negative. The benchmark 10-year tenor G-gsec yield (March 2020) increased by 85bps to 7.91 per cent. In the secondary market, the low volume of transactions led to large swings in yield movements. Indonesia's 5 years CDS spread increased sharply from 58 in mid-Feb-20 to the peak 292 in mid-Mar-20 then it turned back to 210 by end-March 2020. The Jakarta Composite Index (JCI) fell by 37.5 per cent from 6300 at the end of 2020 to 3937 at March 24, 2020 before increasing to 4539 at the end of March 2020. Increased economic outlook uncertainty has prompted investors to be more careful and re-compose their assets. This condition led to large capital outflows with investors switching from investments in assets of developing countries to safe assets, such as gold or US dollar and Japanese yen denominated government securities. This capital outflow triggered huge pressure on local currencies, including the Indonesian rupiah which depreciated sharply.

Reflecting the apprehensions and extreme risk aversions, the global financial markets rattled, and financial conditions tightened abruptly. Volatility in financial markets soared to extreme high levels, even exceeding that was last seen during the global financial crisis (GFC). Financial markets in the EMEs, including India and Indonesia, witnessed heavy sell-offs.

The meetings of the monetary policy committee (MPC) of the RBI scheduled for March 31, April 1 and 3, 2020 and June 3–5, 2020 were advanced to March 24, 26 and 27, 2020 and May 20–22, 2020, respectively, to ease financial conditions. The MPC in India cut the policy repo rate by 115 bps during March–May 2020, on top of a cumulative reduction of 135 bps during February 2019 to February 2020, leading policy repo rate to a record low of 4 per cent. To ease financial condition further, the RBI has shifted from a symmetric policy corridor (repo rate ± 25 bps) to an asymmetric wider corridor of 65 bps on March 27, 2020, by reducing the floor (the reverse repo rate) more to 40 bps below the policy repo rate (from 25 bps) while keeping the ceiling [i.e. marginal standing facility (MSF)] rate 25 bps above the repo rate as was earlier. To augment liquidity in the system further, the RBI undertook a series of policy measures – long-term repo operations (LTROs); targeted LTROs (TLTROs) for specific sectors and entities; cut the cash reserve ratio (CRR); provided more flexibility to banks in the daily maintenance of CRR; increase the limit under the marginal standing facility (MSF); refinance facility to all-India financial institutions; and special liquidity facility for mutual funds. Total liquidity injected by the Reserve Bank (up to March 31, 2021) since February 2020 have aggregated to ₹13.6 lakh crore (6.9 per cent of GDP). These conventional and unconventional policy measures are expected to have bolstered financial market sentiments while ensuring orderly market conditions. Interest rates and bond yields declined across market segments and spreads narrowed and induced record issuance of corporate bonds, even from entities with the lowest investment rating (BBB-). Overall, the Indian experience suggests that unconventional monetary policy measures are deemed to be effective even before conventional monetary policy has reached the zero lower bound.

In order to ease financial condition, the Bank Indonesia (BI) tried to maintain Rupiah stability as an anchor for market confidence by continuing to carry out Triple-Intervention, namely the purchase of Government securities, intervention in the exchange rate market and intervention in Domestic Non-Deliverable Forward (DNDF) market to stabilize and reduce spread between Non-Deliverable Forward (NDF) and DNDF. To maintain banking liquidity and orderly financial markets,

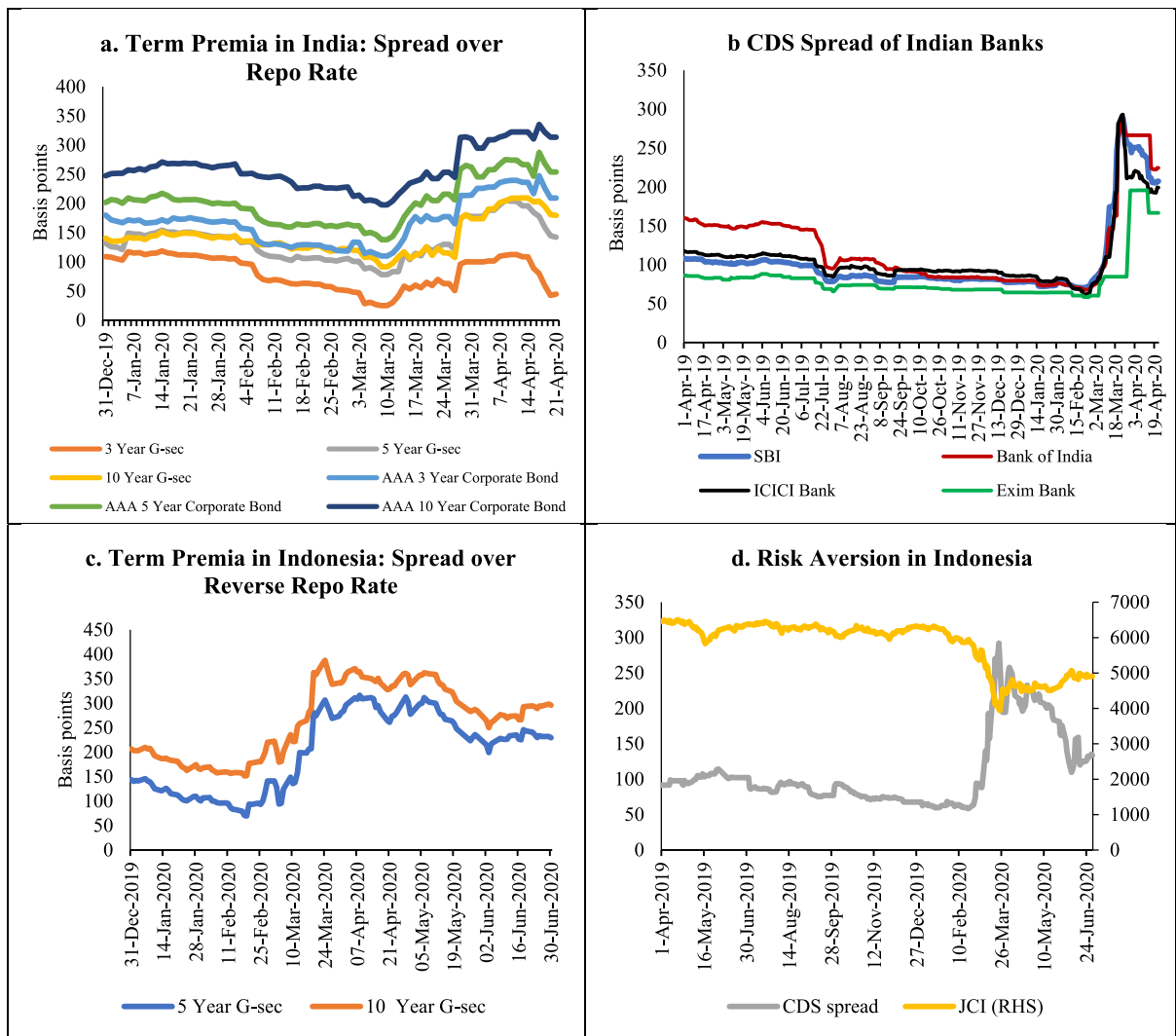


Fig. 1. Risk aversion during COVID-19.
 Source: Bloomberg; Datastream (Thomson Reuters); RBI.

BI lowered the 7-day reverse repo interest rate by 125 bps during 2020 and continued to lower it by 25 bps in 2021 to 3.50 percent, the lowest in history. In addition, a large amount of liquidity injection was carried out to reach Rp. 726.57 trillions or 4.7 per cent of GDP. The Reserve Requirement policy was also lowered, while BI’s Macroprudential Liquidity Buffer Ratio (PLM) was increased. This is to reduce bank liquidity risk by requiring banks to buy Surat Berharga Negara (SBN) or government securities in the primary market in order to place funds to support the issuance of SBN up to Rp110.2 trillions. During this period, a joint decree scheme has been implemented which allows BI to buy in the primary market.

To assist banks in rescuing disbursed loans, banks carried out restructuring based on relaxation of accounting rules. Relaxation is also given to finance companies in the form of the opportunity to delay credit payments for up to 6 months with interest subsidies. Meanwhile, to support the capital market, pre-emptive policies have been issued, including a short sell prohibition policy and an auto rejection policy by reducing the lower limit to a maximum of 7 per cent. The implementation of the policy was carried out more as an effort to slow down the decline and not to support the increase in the capital market index. The various policies adopted have resulted in the stability of the Rupiah being maintained. This condition was reinforced by the risk on global investors approaching the end of the first semester of 2020 which encouraged inflows in the Bond market. The volatility of the exchange rate reduced after reaching its peak at the 54.5 per cent in March 2020 to 26.7 per cent in April 2020 and continues to decline thereafter to 2.6 per cent by December 2020. The influence of BI QE and the purchase of government securities by the BI on inflation is relatively small because the funds are reabsorbed through monetary operations. The inflation was 1.7 per cent, marginally below the lower band

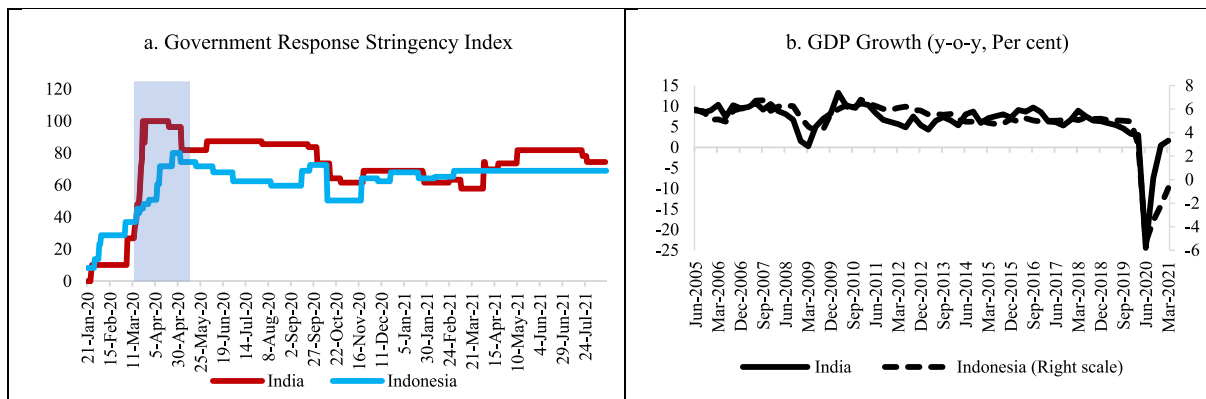


Fig. 2. COVID-19 pandemic and the real economy.
Source: Our World in Data, University of Oxford;
CEIC.

of the target. The JCI, which had experienced a decline of up to 38 per cent, began to improve even though volatility was still high.

Similarly, to protect lives and livelihoods, and contain the spread of the pandemic, the union government in India unleashed large scale fiscal stimulus measures and a series of economic reform measures cumulatively amounted to ₹17.2 lakh crore.¹ As a consequence of the above, the general government budget deficit widened from 7.1 per cent of GDP in 2019–20 to 13.5 per cent of GDP in 2020–21. In Indonesia, the government provided fiscal stimulus in terms of handling COVID-19 for the health sector, Social Safety Net; for industry in the form of tax reserves and stimulus for business activities, the National Economic Recovery Program (PEN); to help the households and MSMEs, the MSME Interest Subsidy program.

Despite several measures undertaken by the RBI and the government, the real GDP declined by 24.4 per cent and 7.4 per cent in Q2 and Q3 of 2020, respectively, before the growth turning marginally positive in Q4 (see Fig. 2). Several policy measures helped in improving financial conditions of the country, the economic activity slumped mainly driven by COVID-19 related lockdown measures. Moreover, it is difficult to say whether these policy measures have helped at all in limiting the impact of the pandemic. It is largely recognized that financial prices reflect the expectations of future economic activity and the elevated level of volatility and extreme stress build up in the financial markets before the announcement of policy measures show the economic agents were anticipating a large decline in economic activity with further evolution and spread of the virus and consequential lockdown measures. The stress reduced substantially in the post-announcement of policy measures as reflected in several financial variables – implying the effectiveness of active monetary and fiscal policies during the current pandemic. A formal examination of the policy measures through counterfactual analysis, using GaR framework, is being attempted in next section.

3. Methodology and data

3.1. Methodology

The GaR approach relates the macroeconomic and financial variables to the probability distribution of future economic growth – surrounding both upside and downside risks. It involves the estimation of predictive quantile regressions (QR) by linking future growth outcomes with current macro-financial conditions, measured through a set of macroeconomic and financial indicators. Apart from providing forecasts for entire distribution of GDP growth, it informs about the key drivers of future growth and their relative importance that may change across growth distribution and forecast horizon (Prasad et al., 2019). One of its key advantages is that no restrictions are imposed a priori on the nature of these non-linearities.

The GaR methodology has been implemented in three steps. First, the high frequency macro and financial variables are grouped into a few factors through principal component analysis or discriminant analysis or any such similar approach.

¹ On March 26, 2020, the government announced the Pradhan Mantri Garib Kalyan Package (PMGK) which focused on protecting lives and livelihoods of vulnerable sections of the population through measures like free foodgrains to the poor; direct benefit transfers to women, senior citizens and poor disabled; and paying both employee and employer contribution to provident fund corpus for organized sector workers. The second set of stimulus measures named AatmaNirbhar Bharat Abhiyan 1.0 (May 13–17) focused on providing liquidity support through government guarantees and low interest rate loans to micro, small and medium enterprises (MSMEs), non-banking financial companies (NBFCs), microfinance institutions (MFIs), housing finance companies (HFCs) and power distribution companies (DISCOMs) to help keep them afloat. Several structural reforms in sectors like coal, minerals, defence production and civil aviation were also part of this package, which were expected to have a salutary impact on growth in the long-term.

Second, the estimated group of factors are used in QR estimation to forecast the quantiles of the distribution of GDP growth. In the last step, density estimation techniques are used to get a distribution that fits the quantiles estimated in the second step.

In the first step, a series of macro-financial variable (F_{it}) are used to explain a few variables, called target variable (Z_{it}) as:

$$F_{it} = X_{it}\lambda^T + A \tag{1}$$

$$Z_{it} = X_{it}\beta^T + B \tag{2}$$

where X represents a group of factors to capture various sectors/partitions of the economy and λ denotes the factor loadings that maximize the covariance between Z and X. The method allows to extract a set of factors that summarizes the macro-financial variables.

In the second step, quantile regression is conducted by linking various quantiles of the distribution of dependent variable Y_{t+h} (in current case GDP growth) to a set of regressors (X_{it}). Particularly, the quantile regression of Y_{t+h} on X_{it} solves the following optimization by minimizing the sum of quantile-weighted value of errors:

$$\hat{\beta}_q = \operatorname{argmin}_{\beta} \sum_{t=1}^{T-h} \rho_q(Y_{t+h} - X'_{it}\beta) \tag{3}$$

$\rho_q(u) = u(q - 1_{\{u < 0\}})$ where h refers to forecast horizon, $\hat{\beta}_q$ is qth regression quantile [$q \in 0.1, 0.25, 0.5, 0.75, 0.9$] and $\rho_q(u)$ is called check function.

The predicted growth for qth quantile conditional on values of X_{it} , can be presented as:

$$Q(\hat{Y}_{t+h}^q | X_{it}) = X'_{it}\hat{\beta}_q \tag{4}$$

Once quantiles of GDP growth forecast are obtained, the density function can be fitted using those conditional quantiles. Following Adrian et al. (2019), a t-skew is fitted to derive probability distribution function.²

The GaR approach is also used to conduct counterfactuals to know whether decline in stress in the financial markets following various policy measures undertaken by the central banks has helped limiting decline in GDP in respective countries. The counterfactual analysis is conducted by simulating the impact on a shock of the raw variables on the future growth distribution. Using the quantile regressions estimated in step 2, the conditional quantiles are estimated based on new counterfactual factor $\hat{X}_{it} = X_{it} \times (1 + Shock)$.

As GaR is designed to gauge the likelihood of severely adverse macroeconomic outcomes, we estimate the distribution of future GDP growth using high frequency data available up to March 2020 (before the announcement of a series of policy measures by the authorities in India and Indonesia to stem the long-lasting effects of COVID-19 pandemic). As the severity of impact of COVID-19 shock on the real economy is reflected in sharp tightening of financial conditions, the objective is to extract the expected loss of economic activity by modelling the left tail of the distribution of GDP growth. Further, the counterfactual analysis is conducted by assessing the tail risks of GDP growth for a reduction³ in financial stress in the market, viz. VIX in Indian case and CDS spread in Indonesian context. The underlying assumption is that the stress in the financial market reduced following various policy measures undertaken by central banks in respective countries, which has helped in limiting drop-off of economic activity.

3.2. Data

To estimate GaR, data of different frequencies ranging from daily to quarterly for the period June 2004 to March 2020 are collected from Thomson Reuters (Eikon) Datastream, Bloomberg, CEIC database, Database on Indian Economy of the Reserve Bank of India, Economic Policy Uncertainty database, FRED Economic Data and Centre for Monitoring Indian Economy (CMIE). The macroeconomic variables are converted into quarterly taking averages of the period except GDP and capacity utilization which are available in quarterly frequency. The financial market variables observed at the end of the quarter are considered for the exercise.⁴ However, the financial variables observed before the announcement of policy measures (i.e. March 24, 2020 instead of March 31, 2020) are considered to capture pre-policy announcement COVID-impacts. Term premia is calculated taking the difference between 10-year G-sec yields and 3-month treasury bill yields

² The t-skew distribution is fully characterized by four parameters (location, degree of freedom, scale, and skewness) and is obtained by minimizing the distance between the empirical quantiles and the quantiles of a t-skew:

$$loc, scale, skew = \operatorname{argmin} \left[\sum_q \left\{ \text{tsk.quantile}(q, loc, df, scale, skew) - Q(\hat{Y}_{t+h}^q) \right\}^2 \right]$$

³ The magnitude of reduction is mapped with actual fall observed in VIX and CDS spread during post-policy announcement period (i.e. during March–June 2020).

⁴ Given the time value of money and real-time information content of the financial variables as a leading indicator of future economic outcome, they are considered at quarter-end while economic variables are used by taking quarterly averages.

Table 2

List of variables representing macro-financial conditions.

	Macroeconomic situation	Monetary condition	Leverage	External condition	Global uncertainty	Risk premium	Term premium
India	Manufacturing PMI; Unemployment rate; CPI (excluding food and fuel) inflation;	Policy repo interest rate; Weighted average call money rate; Tri-party market repo rate; 3-month CD rate; 3-month CP rate; 1-month deposit interest rate; 3-month TB rate; 3-month MIBOR; 1-month OIS		USD/INR exchange rate return; Changes in real effective exchange rates; CNX dividend index return; Nifty returns	CBOE VIX; Global economic policy uncertainty index	NSE Volatility index; CDS spread (5-year); USD/INR implied volatility;	10-year G-sec yield; 5-year corporate bond yield; Term premia; PE ratio; Future dividend yield
Indonesia	Capacity utilization; CPI inflation; Money supply(M2)	Policy reverse repo interest rate; Overnight interbank interest rate; 1-month interbank interest rate; Interbank call rate;	House price inflation; Credit growth; Lending interest rate; Equity price return	USD/IDR exchange rate return; Changes in real effective exchange rates	CBOE VIX; Global economic policy uncertainty index	CDS spread (5-year); USD/IDR implied volatility; World uncertainty index for Indonesia	10-year G-sec yield; Term premia; PE ratio

in the Indian context and deviation of 10-year G-sec yields from 3-month interbank interest rates in case of Indonesia. Return in exchange rates, stock indices and growth in house prices, CPI, M2, credit and real GDP are calculated by taking their year-on-year percentage changes. Financial variables are standardized to use in PCA.

4. Empirical results

To implement GaR, we use data on 26 and 21 macroeconomic and financial variables for India and Indonesia, respectively, for the period 2004:Q1 through 2020:Q1.⁵ These variables are partitioned into few major groups by examining their economic similarities. From 26 variables, six factors representing macroeconomic and financial conditions, viz. domestic macroeconomic situation, monetary condition, external condition, global uncertainty, risk premium and term premium, are extracted using PCA. Similarly, seven factors representing domestic macroeconomic situation, monetary condition, leverage, external condition, global uncertainty, risk premium and term premium are extracted from 21 variables in Indonesian context. The list of variables and their respective groups are provided in Table 2.

Quantile regression is conducted by regressing GDP growth on previously estimated macroeconomic and financial factors. The objective is to know how different quantile of growth is related with these factors – the quantile regression at 10th percentile estimates a relationship when growth is weak and at 90th percentile it estimates the relationship for stronger growth outcomes. The regression coefficients for different quantiles for one quarter horizon are plotted in Fig. 3. The chart shows heterogeneous effects of macro-financial variables on growth across quantiles. While domestic macroeconomic condition is positively and considerably related to future growth distribution in Indonesia, financial variables contain lead information and thereby contribute significantly in predicting tail risks for India. Financial indicators in both countries are negatively related to future growth outcomes at bottom quantile of the distribution. Few variables like global uncertainty, risk premium and leverage are negatively related to growth across the quantiles. In Indonesia, risk premium and leverage are the major contributor to negative growth outlook at lower quantiles as compared to other indicators. Similarly, term premium, risk premium and external sector uncertainty play major role in tail risks to growth in India. Tightening of monetary policy leads to a low/negative growth in both the countries while it is more effective to scale down upside risks to growth in India.⁶

⁵ Details of data and their sources are provided in Appendix. The variables are grouped broadly looking at the correlation coefficients as well as the factor loadings in a PCA of all the variables. The variables with greater factor loading in any particular principal component and if economically meaningful are combined in one category. For example, Nifty return is considered in the group where the weight of exchange rate is the largest followed by Nifty return, CNX dividends under one principal component and we named it as external condition. Given large number of companies in the Nifty index basket exports their goods and services, the higher weight of Nifty along with exchange rate justifies to group them in capturing external conditions.

⁶ On the other hand, the accommodative monetary policy stance does improve growth during uncertain situation like the COVID-19 pandemic as captured in coefficients of 10th quantile.

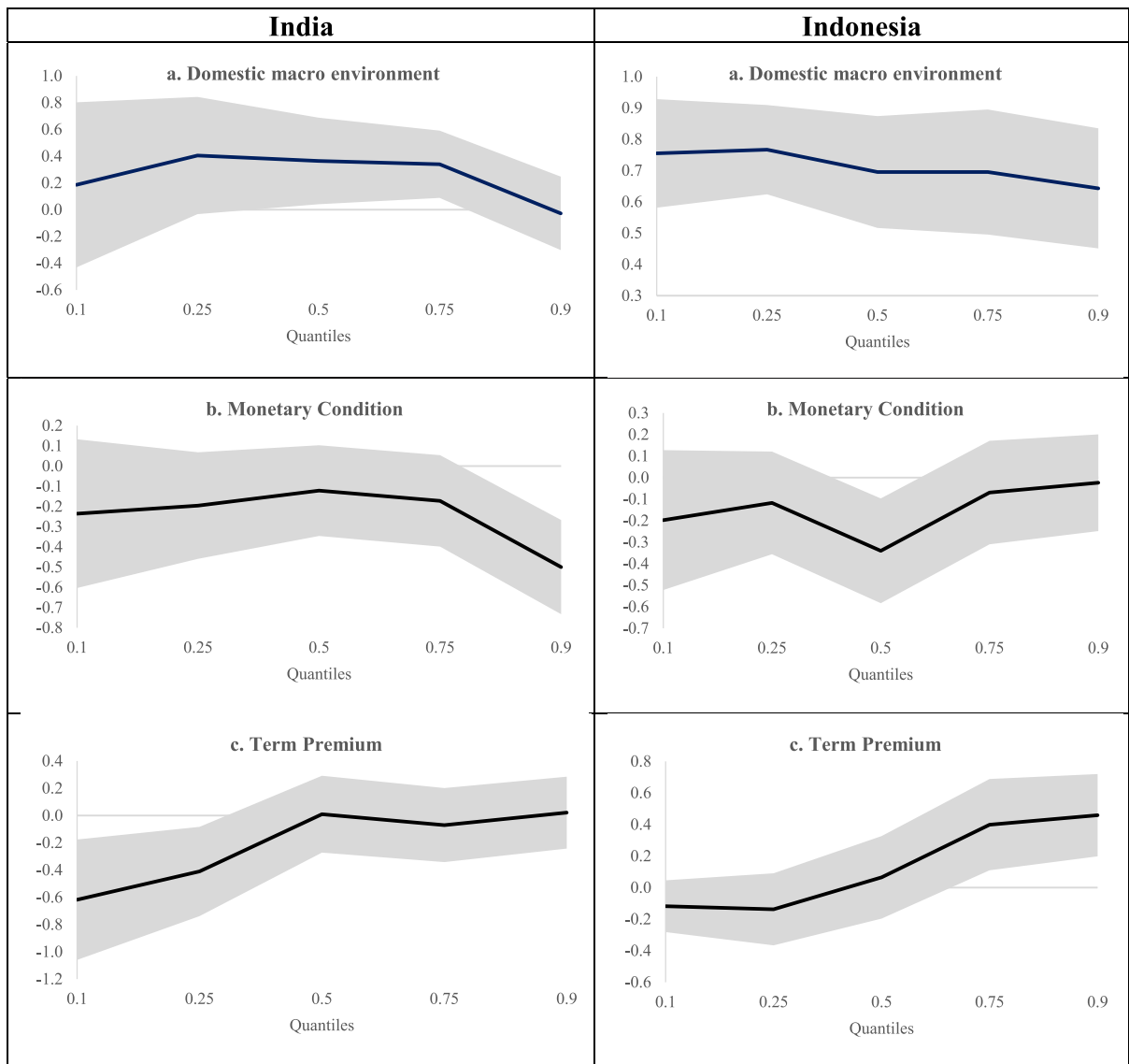


Fig. 3. Quantile regression coefficients. Note: Shaded area represents the 95% confidence intervals. Source: Authors own calculation.

The coefficient estimates from quantile regression are used to construct the measure of growth uncertainty, *i.e.* growth-at-risk. Before going into GaR analysis, we derive the fitted value of the QR model and examine the conditional growth distributions over time to know whether the macro-financial variables are able to explain shifts in the lower tail of the conditional growth distribution satisfactorily. The fitted median GDP growth estimates and their 0.10–0.90 quantile ranges along with realized growth numbers are presented in Fig. 4. The results show large drops in the bottom quantiles similar to actual growth movements during uncertain periods, *viz.* global financial crisis and arrival of COVID-19 pandemic (in 2020:Q1), while the median estimates are away from the realized growth outcomes during these times. However, median estimates track well the observed growth rates during normal times. Similarly, the upside risks to growth are largely captured in the upper quantile estimates. These findings underscore the benefit of modelling the entire distribution rather than depending on point estimates when tail risk is of main concern. Hence, these quantile estimates are used to generate future growth distributions and conduct counterfactuals to assess the effectiveness of monetary policy during COVID-19 pandemic.

To compute a smooth conditional probability distribution, we follow Adrian et al. (2019) to fit a skew-t distribution to the predicted values of our quantile regression estimates. The full distribution of future GDP growth conditional on macro-financial conditions enables us to assess the likelihood of future growth outcome at any point. The predictive density generated for 2020:Q2 using data up to March 2020 for both India and Indonesia are plotted in Fig. 5 and for 4-quarters ahead, ranging from 2020:Q2 to 2021:Q1, are reported in Table 3. The advantage of this exercise is to understand

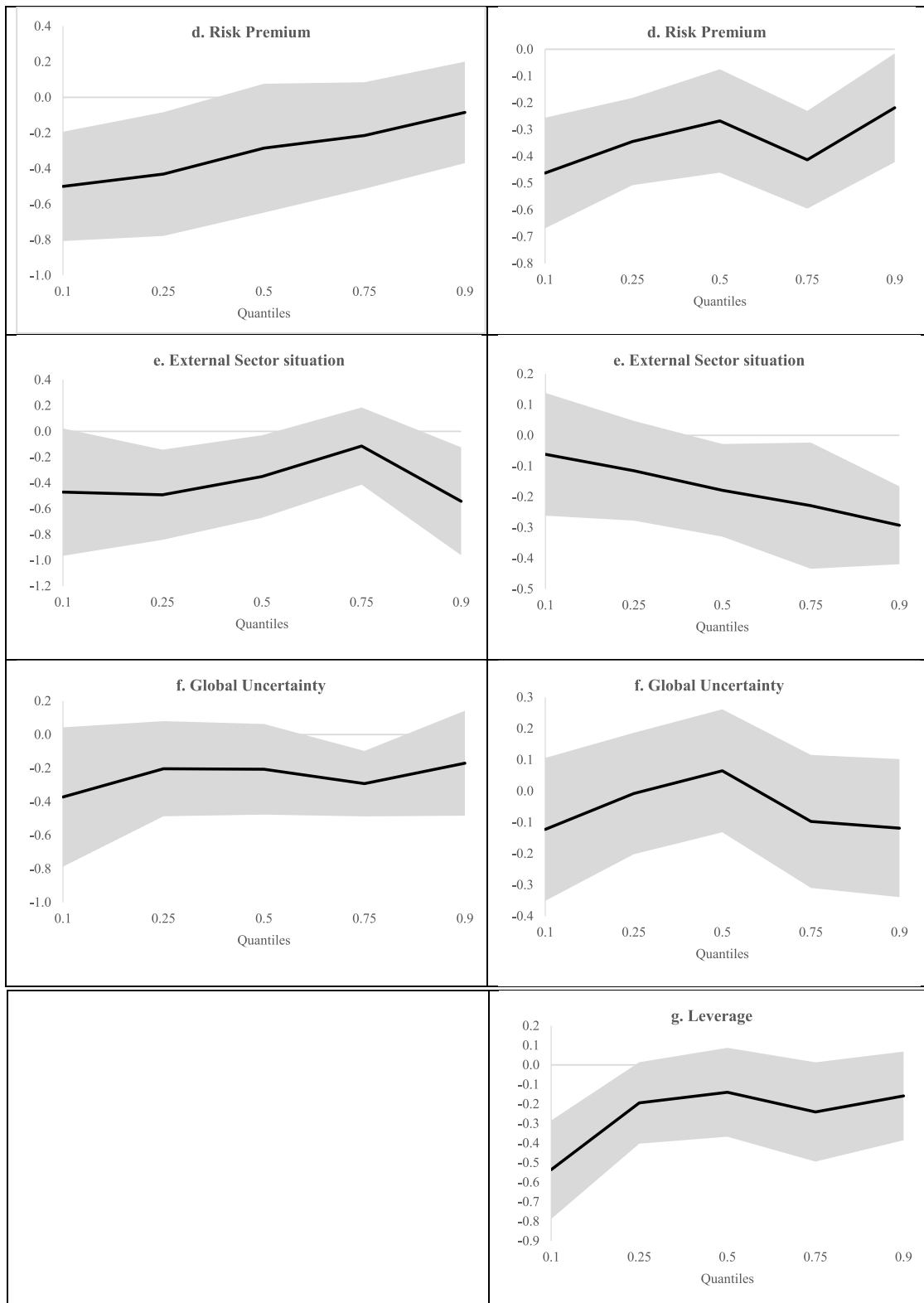


Fig. 3. (continued).

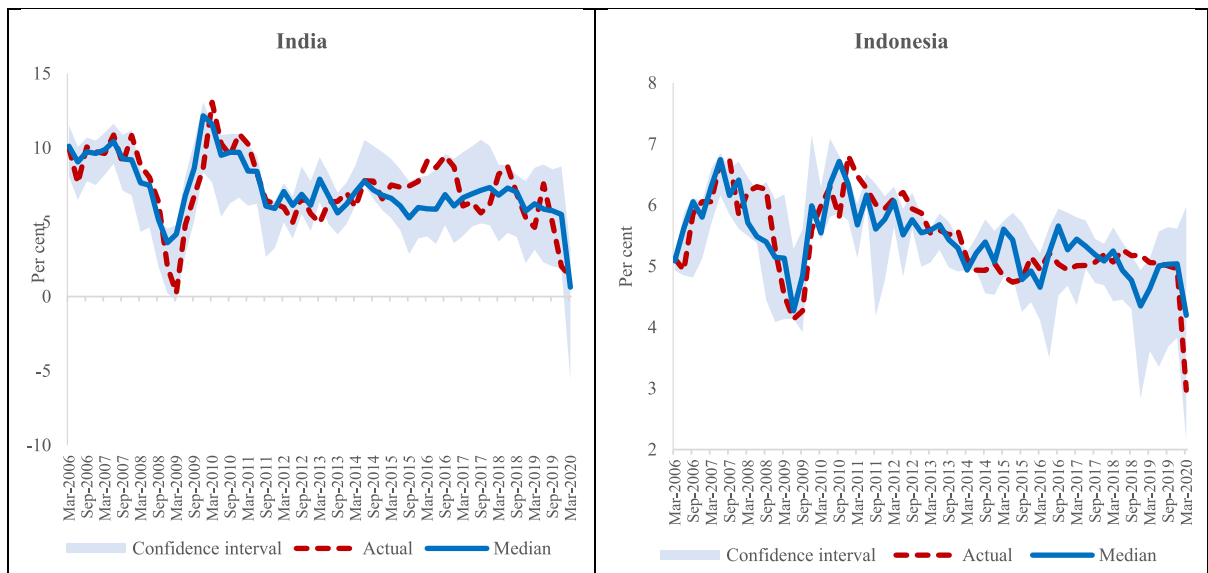


Fig. 4. GDP growth: actual vs. conditional quantiles.
 Source: Authors own calculation.

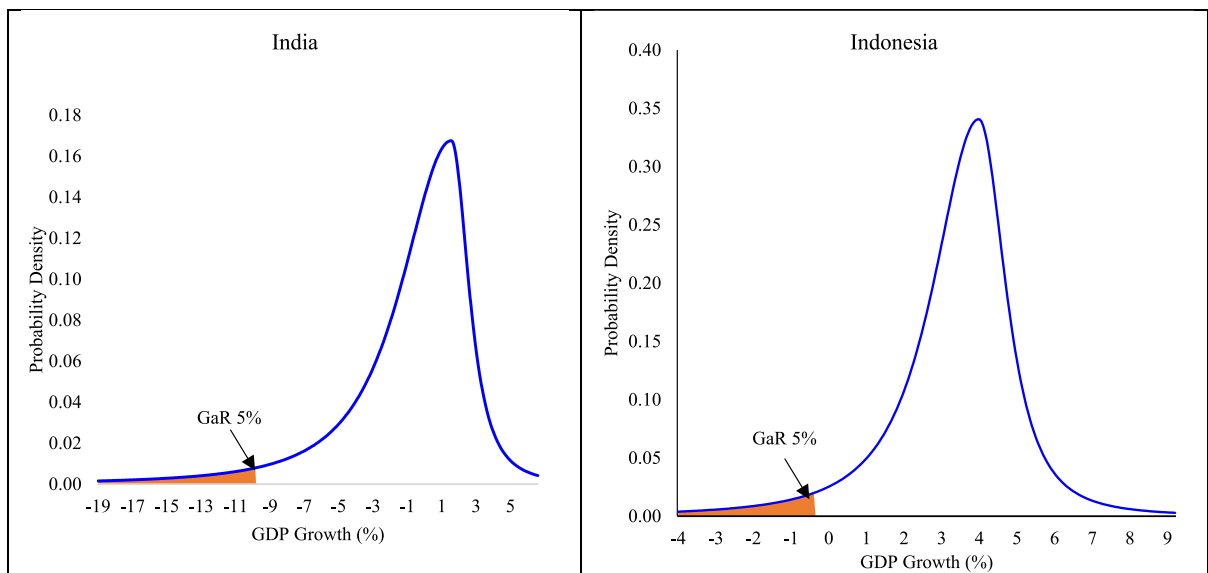


Fig. 5. Growth at Risk as on 2020:Q1.
 Source: Authors own calculation.

the downside risks to growth in a situation like pandemic and take appropriate policy measures. As per the estimates, the tail risk or GaR at 5 per cent probability predicts a decline in India’s GDP by 9.4 per cent for 2020:Q2 and 10.2 per cent for 2020–21. These forecasts are much different from the forecasts provided by the Survey of Professional Forecasters (SPF) during March 2020. SPF’s median growth forecasts for 2020:Q2 was (+)4.6 per cent and even the minimum of all forecasts was (+)3.7 per cent – far from the GaR estimates. Similarly, the SPF’s median forecast was 5.5 per cent and the minimum was 4.5 per cent for 2020–21. GaR at 5 per cent for Indonesia was (–)0.2 per cent for 2020:Q2 and the average for four quarters was (+)0.5 per cent. The additional advantage of using financial variables to estimate the tail risk is clearly visible from these results. Hence the initial apprehension of depressed economic activity due to COVID-19 was captured considerably in GaR at 5 per cent.

In order to know the robustness of the results, we use the same set of macro and financial variables in FAVAR framework to forecast the GDP growth of both the countries. As in our previous exercise, a few factors capturing the

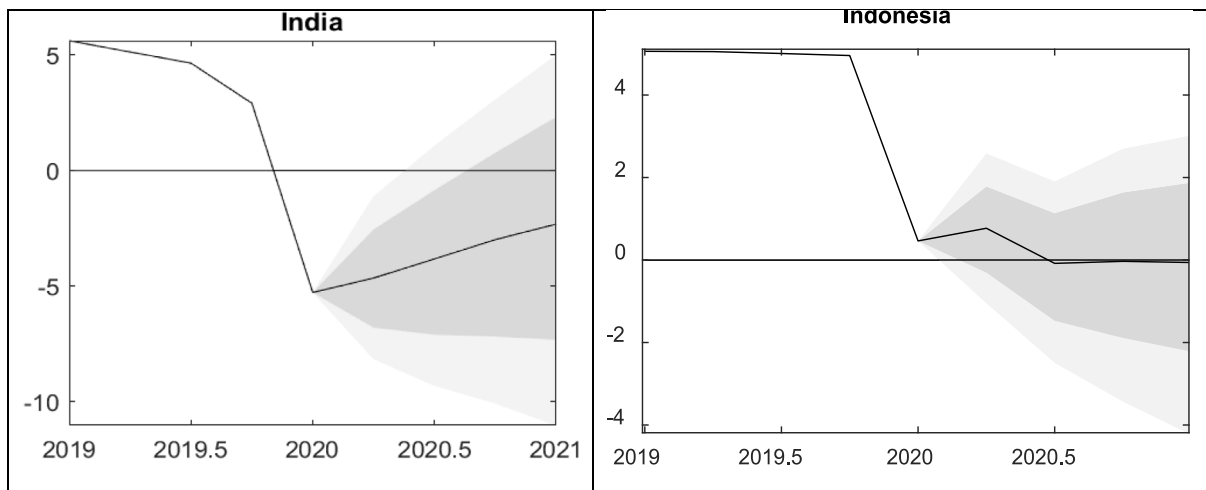


Fig. 6. GDP Growth (y-o-y) Forecasts using Bayesian FAVAR.

Forecasts are generated from 2020Q2 with median forecasts are presented as black lines and 68% (90%) credible bands are in the form of light (dark) grey shades.

behaviour of all the macro and financial variables are linked to GDP growth. The approach followed here is similar to that of Paccagnini (2017) and Madhou et al. (2020) and the Bayesian estimation is conducted by using Minnesota priors. One-quarter ahead median GDP growth forecasts from Bayesian FAVAR are $(-)$ 4.5 per cent and $(+)$ 0.5 per cent, respectively, for India and Indonesia. While the forecasts show an improvement in growth outlook in subsequent period for India, it deteriorates for Indonesia. On the other hand, the lower credible bands of 68 per cent probability show a negative growth trajectory for the forecasted period and they are comparable to 5th quantile growth forecasts from our earlier exercise, though they are different in magnitudes. This provides more credence to growth risks assessed from quantile regression framework (see Fig. 6).

As discussed in Section 3, financial conditions tightened during March 2020 in both the countries and improved after the announcement of a host of policy measures by the central banks in India and Indonesia. In order to examine the effectiveness of monetary policy in both countries, counterfactual analyses are conducted with the assumption that the policy actions undertaken by the central banks helped in reducing stress in the financial markets and supporting credit flows. Accordingly, the counterfactual analyses are conducted for reduction in the financial stress as captured in VIX (as a composite measure of stress in Indian context) and CDS spread (as a composite measure of stress in Indonesian context) to the tune of observed decline in respective variables during March–June 2020. The VIX and CDS spread are part of broad indicator of risks and are negatively correlated with growth outcomes at the bottom quantile of the distribution (as can be observed from Fig. 3b).

Comparing GaR at 5 per cent results of the baseline (area shaded in red and blue line) with the alternative scenario (area shaded in blue and green line) for reduction in stress in the financial markets, we find GDP in India to decline lesser by 125 basis points (bps), i.e. instead of a decline in GDP of 9.4 per cent in baseline scenario, we observe a fall of 8.2 per cent in 2020:Q2 alone (Fig. 7). There could be the effects of lockdown and other Covid related issues that finally led India's GDP to decline by 24.4 per cent. The number of measures undertaken by the Government and the RBI is reflected in reduction in risk premium, moderation in term premium and a reduction in interest rates which impacted the activity with lags.

We also find the evidence of recovery in growth outcomes for Indonesia after reduction in risk premia. The $(-)$ 0.2 per cent growth in baseline scenario improves to 1.1 per cent in alternative scenario in response to a 2 standard deviation reduction CDS spread. While tighter financial condition had increased downside risks to growth, the ease in financial conditions led by policy actions reduced risks to growth. Thus, the counterfactual analyses provided the evidence of the effectiveness of monetary and financial policy measures undertaken to ebb the long-lasting impacts of COVID-19 crisis on real economy.

With recognition of devastating effects of COVID-19, monetary authorities in both countries have taken several policy measures. Among the measures, the direct and immediate policy action was the reduction in benchmark policy rates, i.e. repo rate was cut by 75 bps in India on March 27, 2020 and 7-day reverse repo rate was reduced by 50 bps during February–March 2020. In order to find out the direct impact of policy rate actions on growth outcomes, the GaR analyses imply a reduction in tail risks to growth by about 50 bps in India and 25 bps in Indonesia (Fig. 8).

Table 3
Growth forecasts at 2020: Q1 (January–March).

	India				
	1-Quarter ahead	2-Quarter ahead	3-Quarter ahead	4-Quarter ahead	Average (2020–21)
Conditional mode	1.99	−1.78	4.03	7.56	2.95
Conditional median	0.47	−0.73	2.58	4.68	1.75
Conditional mean	−0.89	0.29	1.25	2.08	0.68
GaR5%	−9.44	−7.89	−8.18	−15.11	−10.15
GaR10%	−5.64	−5.59	−4.09	−7.55	−5.72
Probability of Negative Growth Rate	0.44	0.57	0.25	0.25	0.38
	Indonesia				
	1-Quarter ahead	2-Quarter ahead	3-Quarter ahead	4-Quarter ahead	Average
Conditional mode	4.20	5.27	4.57	4.29	4.59
Conditional median	4.10	4.45	4.01	4.18	4.18
Conditional mean	4.06	3.75	3.49	4.06	3.84
GaR5%	−0.18	−0.07	−0.01	2.13	0.47
GaR10%	1.32	1.69	1.52	2.88	1.85
Probability of Negative Growth Rate	0.05	0.05	0.05	0.01	0.04

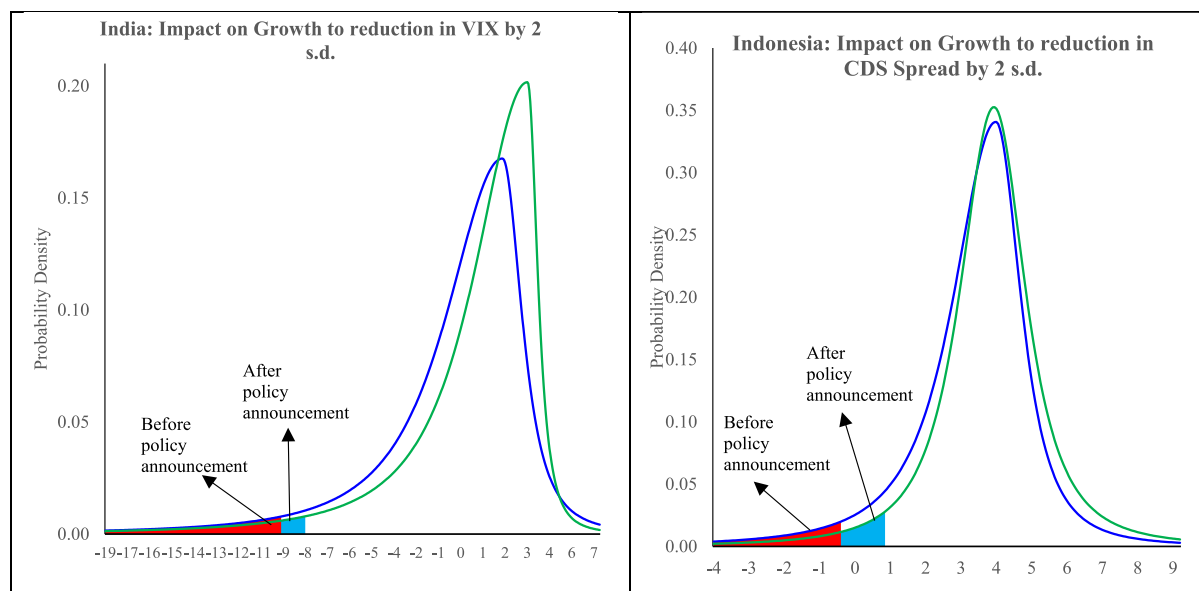


Fig. 7. Scenario analysis of reduction in stress in financial markets.
Source: Authors own calculation.

5. Conclusions

The sudden shock delivered by COVID-19 has tightened financial conditions abruptly by creating havoc in the financial markets. The adverse impact of the pandemic is reflected in heightened volatility, rise in CDS spread, increase in risk and term-premia in the financial markets as the pandemic shock could have derailed the real economy several years behind. Swift and decisive policy responses of the central banks across the globe by reducing the interest rates, expanding their balance sheets through large-scale asset purchase programmes, injecting vast amounts of liquidity into the financial

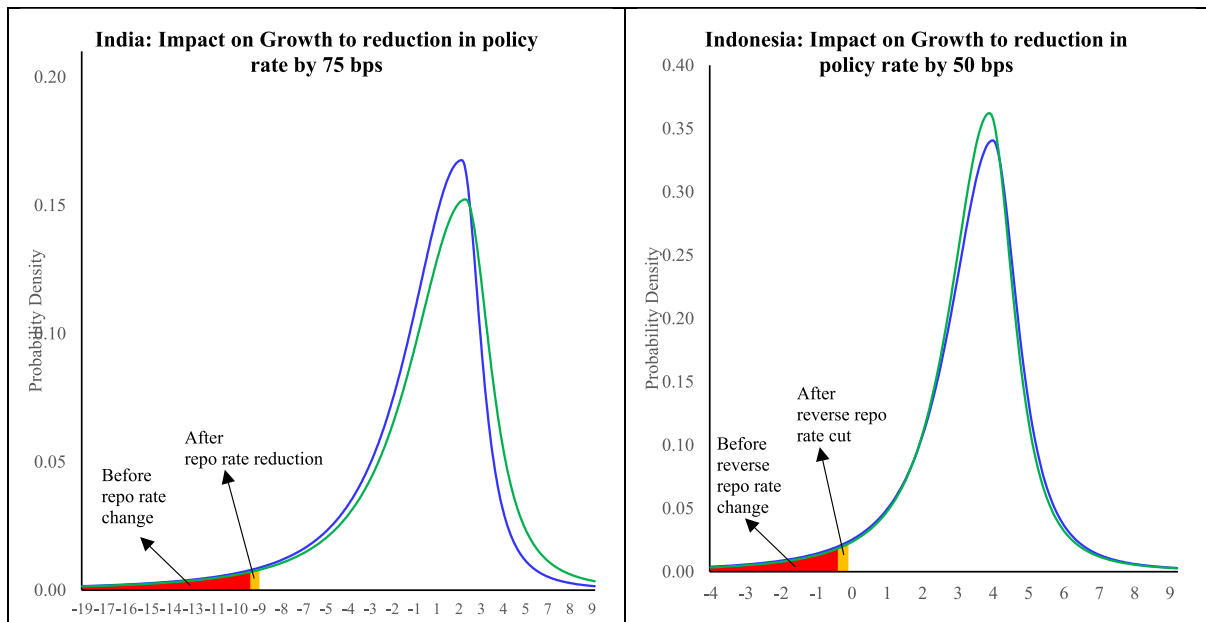


Fig. 8. Scenario analysis of reduction in policy interest rates.
 Source: Authors own calculation.

system, and ensuring smooth credit flows to the real economy are expected to have restored confidence in financial markets. The inherent forward-looking information content of financial variable imply that the policy actions of the central banks might have helped in stemming the adverse consequences of the pandemic. This paper examined the effectiveness of the policies undertaken by the central bank on economic growth during COVID-19 uncertainty in case of India and Indonesia. By using macroeconomic and financial variables and employing a GaR framework to model the tail risks posed by the pandemic, what otherwise is not captured in usual regression approach, we examine the hypothesis.

The quantile regression coefficients of extracted factors representing broad characteristics of the financial markets and the real economy are found to capture the shifts in the in lower tail of conditional growth distribution satisfactorily. The estimates suggest that term premium, risk premium and external sector condition play crucial roles in downside risks to growth in India during uncertain period, while risk premium and leverage are the dominant factors in the context of Indonesia. Therefore, policy measures targeting these indicators are expected to be more effective in containing growth risks during a crisis-like situation.

Further, using the information up to March 2020 (before the announcement of policy measures), the GaR at 5 per cent predicted a decline in India's GDP by 9.4 per cent for 2020:Q2 and 10.2 per cent for 2020–21 (as against an actual decline of 6.6 per cent). Similarly, the GaR at 5 per cent for Indonesia is estimated at (–) 0.2 per cent for 2020:Q2 and an average of 0.5 per cent for next four quarters. These results indicate that the economic activity would have depressed more than what is observed. The counterfactual analysis by reducing the stress in the financial markets as observed in post-policy announcement period provide the evidence of the effectiveness of monetary and financial policies undertaken by the central banks in limiting the adverse impacts of COVID-19. A direct assessment of policy rate reduction also confirms the ascendancy of policy actions in curbing the economic downturn.

As documented in the literature, growth at risk framework is proved to be superior to various traditional models in providing forecasts during uncertain times. Our study conducted during the first wave of COVID-19 provides the insights about future growth outlook with greater precision when others' forecasts were way different from the reality. The analysis could also provide additional strength to the policy makers in an environment where data collection was a major challenge due to lockdown and severe spread of the virus. The effective policy formulation requires correct assessment of future economic outlook. The assessment of the effectiveness of various policy measures undertaken by policy authorities are also crucial to continue with the support or withdraw them. In this context, our counter-factual analyses show an effective positive impact of various monetary measures on economic activity, which were later confirmed by the actual economic development. All these findings suggest a regular monitoring of tail risks to growth outlook so that to take appropriate policy measures to stabilize the business cycles.

Appendix

Data			
Variable	Source	Variable	Source
Real GDP	National Statistical Office	Real GDP	
CPI Inflation	(http://mospi.nic.in/)	CPI Inflation	
Manufacturing PMI	Bloomberg	House price index	
Unemployment Rate	Centre for Monitoring Indian Economy (CMIE)	Capacity utilization	CEIC Database
Policy repo interest rate	Reserve Bank of India	7-day policy reverse repo interest rate	
Weighted average call money rate		Overnight interbank interest rate	
Tri-party market repo rate		1-month interbank interest rate	
3-month CD rate		Interbank call rate	
3-month CP rate		Money supply(M2)	
1-month deposit interest rate		Bank credit	
3-month treasury bill rate		Equity Index (JCI)	
3-month MIBOR rate		PE ratio	
1-month OIS rate		Lending interest rate	
10-year G-sec yield		10-year G-sec yield	
NSE PE ratio		USD/IDR implied volatility	
Future dividend yield		USD/IDR exchange rate	
ICICI CDS spread (5-year)		Real effective exchange rates	
USD/INR implied volatility		CDS spread (5-year)	Thomson Reuters (Eikon) Datastream
USD/INR exchange rate		World uncertainty index for Indonesia	https://fred.stlouisfed.org
Real effective exchange rate		CBOE VIX	Bloomberg
CNX dividend index		Global economic policy uncertainty index	http://www.policyuncertainty.com/
Nifty 50 Index			
NSE Volatility index (VIX)	Thomson Reuters (Eikon) Datastream		
5-year corporate bond yield			
CBOE VIX	Bloomberg		
Global economic policy uncertainty index	http://www.policyuncertainty.com/		

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