Assessing the Financial Implications of COVID-19 Within the SVAR Framework for Some Asian Countries

Seema Narayan¹, Evita Purnaningrum² and Baqir Khawari³

Abstract
This article examines the structural responses of foreign exchange and equity markets to the COVID-19 pandemic in seven Asian countries over its first 4 months (31 December 2019 to 1 May 2020). Marginal effects derived from a structural vector autoregression (SVAR) model suggest that a 1% increase in incidence of COVID-19 cases significantly diminished Indonesia’s equity market returns by 4.7%, depreciated the Indian rupee against the US dollar by 4.8%, but improved equity prospects in South Korea by 4.1%. For the other financial markets, the effect of COVID-19 was found to be insignificant. Further, the impulse response analyses imply that the influence of COVID-19 on foreign exchange and equity markets is only transitory in nature. Additional SVAR analysis for India and Indonesia over recent months (2 May 2020 to 22 January 2021) showed that their financial markets remained (or became) resistant to the escalating incidence of COVID-19 inflections and deaths.

JEL Code: G15

Keywords
COVID-19, Asia, stock market, exchange rate market, structural VAR

I. Introduction
Globally, social distancing, self-isolation, travel restrictions, declarations of a state of emergency and localised or nationwide lockdown restrictions have been the key strategies implemented to contain the COVID-19 pandemic. These unprecedented actions slowed down or shut down business activity, sending shock waves across interconnected financial and commodity markets. A burgeoning research in the area indicates that the pandemic caused some disruptions in the financial markets, although this was not always negative or significant.

¹ Independent Researcher, Melbourne, Australia.
² Management Department, Faculty of Economy, Universitas PGRI Adi Buana Surabaya, Jawa Timur, Indonesia.
³ Finance and Banking Department, Samangan Higher Education Institute, Northeast Aybak City, Samangan, Afghanistan.

Corresponding author:
Seema Narayan, Independent Researcher, Melbourne, Australia.
E-mail: swdhar27@gmail.com
The majority of studies indicate that the global pandemic has been responsible for increased market risk and/or reduced returns in some equity markets (see Al-Awadhi et al., 2020; Baker, et al., 2020; Harjoto et al., 2020; He et al., 2020; Liu et al., 2020; Nicola et al., 2020; O’Donnell et al., 2021; Salisu et al., 2020; Sergi et al., 2021; Takyi & Bentum-Ennin, 2020; Zhang & Hamori, 2021; Zhang et al., 2020). Using daily data on stock market returns in 10 top COVID-19-affected countries over the period from February 2020 to March 2020, Zhang et al. (2020) showed that as a result of the pandemic, global financial market risk rose considerably. Using Google Trend data on COVID-19 over the period from 2 January 2020 to 9 April 2020, Papadamou et al. (2020) find that out of the 13 stock markets in Asia, Europe, the USA and Australia, the effects of the pandemic were most felt in the stock markets in Europe (also see Ahundjanov et al., 2020 and Amstad, et al., 2020). Harjoto et al. (2020) report that emerging and developed equity markets reacted differently to COVID-19 data on deaths and infections. Al-Awadhi et al. (2020) indicate that over the period from 10 January to 6 March 2020, the daily growth of confirmed cases and total mortality linked with COVID-19 had a significant negative impact on the stock returns of all Chinese companies. Takyi and Bentum-Ennin (2020) argue that the negative effect of the pandemic on some African stock markets during the period from 31 December 2019 to 30 June 2020 was short-lived. Based on their event study of leading stock market indices in countries affected by the new COVID-19 cases over the period from 21 February 2020 to 18 March 2020, Liu et al. (2020) note that the Asian stock market response to COVID-19 was quick, transitional and negative. The study also found that some markets had already started to recover, albeit slowly. On the other hand, using Wavelet Coherence and Partial Wavelet Coherence on daily data over the period from 1 February 2020 to 13 May 2020, Sharma et al. (2021) conclude that the pandemic had long-term negative implications for the equity markets of some of the affected nations. In contrast, Narayan et al. (2021) show that the lockdowns, travel bans and economic stimulus over the period from 31 December 2020 to 16 April 2020 had a positive effect on the stock markets of G7 markets. Ashraf (2020) also emphasises that the stock market’s reaction to the pandemic was not uniform over the period from 22 January 2020 to 17 April 2020.

A few studies examine the exchange rate markets’ reaction to the pandemic (Gunay, 2020; Iqbal et al., 2020; Sharma et al., 2021). On the one hand, China, where the new COVID-19 virus was first detected, saw its currency depreciate slightly against the US dollar (Iqbal et al., 2020). On the other hand, Sharma et al. (2021) show that the rise in the number of COVID-19 cases has significantly impacted the fluctuation and volatility of affected nations’ exchange rate. Gunay (2020) finds that through stand-alone risk analysis that selected US dollar-based exchange rates, including the Euro, Chinese Yuan, Japanese Yen, Brazilian Real and Turkish Lira, during the initial months of the COVID-19 pandemic, was not as tumultuous as that in the global financial crisis (GFC). However, an examination of the co-movements and volatility spillovers between these exchange rates indicated that the COVID-19 effects were severe than the GFC. Of the exchange rates examined by Gunay (2020), the emerging markets were found to be most affected in both crises.

We investigate the influence of COVID-19 cases in selected Southeast and East Asian countries on their US-based foreign exchange and equity markets in the first 4–13 months of the pandemic. Our study differs from the above-mentioned single-equation-based studies, in that we employ a structural vector autoregression (SVAR) model that exploits the endogenous relationships between financial markets (and their determinants) to investigate the impact of the COVID-19 shock. The SVAR model developed here caters for the sluggish response of the US stock market, government bond yield and COVID-19 with respect to shocks to other variables in the model, including the returns of oil price, US-based exchange rates and stock markets for the seven Asian nations. More importantly, in this article, the SVAR restrictions exploit the bidirectional relationships between oil prices and stock markets, or oil prices and exchange rate, evident in the recent literature. The seven Southeast and East
Asian countries studied are China, India, Indonesia, Japan, Malaysia, Singapore and South Korea, where the COVID-19 cases, over the period from 31 December 2019 to 1 May 2020, were among the highest. We repeat the SVAR analysis over the period from 2 May 2020 to 22 January 2021 for India and Indonesia, where the COVID-19 cases escalated to serious levels. The COVID-19 event is captured in the SVAR model in terms of total cases of infection, deaths or new cases as a percentage of total cases in most of the seven Asian countries.

Foreshadowing our key results, we find that the impact of COVID-19—measured in terms of total cases of infection, deaths or new cases as a percentage of total cases—in the seven Asian countries had varying effects in the period examined. In three out of seven cases, COVID-19 left a significant mark on the exchange rate and stock markets by the close of business on 1 May 2020. Our impulse response analysis confirms that COVID-19 shocks have thus far been strongly transitory in nature, and while markets showed reaction to COVID-19 shocks, they were able to recover within a few days. The SVAR analysis with more recent data (2 May 2020 to 22 January 2021) suggest resilience of financial markets in India and Indonesia in the face of higher incidence of the COVID-19 inflections and deaths over the recent months.

The remainder of the article is organised as follows. Section II presents the econometric model, and economic and financial literature governing the structural restrictions. Section III explains the data and presents some preliminary analysis. Section IV reports and discusses the results, while the Section V concludes the study.

II. Model and Theory

The literature and the econometric framework employed in developing and estimating the empirical models are outlined here.1

In the study of equity or exchange rate markets, it has become conventional to model oil prices and stock or forex markets. Further, several studies have indicated that there can be a bidirectional relationship between stock market and oil price or between exchange rate and oil price. We explore these features of the current literature on stock and exchange rate within an SVAR system. The SVAR methodology is best suited here, given the strong presence of endogeneity between the variables we seek to examine. The SVAR method uses time series data, which means we can provide individual country effects. This is particularly important in the case of clarifying the initial effects of the COVID-19 pandemic as the experience of the pandemic in each country has been different, in terms of the total number of cases of infection, new cases, deaths and new deaths.

We begin with the following reduced form of VAR model:

\[ Y_t = A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \mu_t \]  

Here, \( Y_t \) is a \((6 \times 1)\) vector of variables at time \( t \) and comprises \((\text{SMR}_{US,t}, \text{RFR}_t, \text{COVID-19}_t, \text{Oilpr}_t, \text{ERR}_t, \text{SMR}_{\text{domestic},t})\). \( \text{SMR}_{US} \) is the MSCI-based stock return for the USA. \( \text{RFR} \) is the 3-month (or 1-year) government bond yield or risk-free rate. \( \text{COVID-19} \) is captured as daily new cases of infection as a ratio of total cases (\( \text{NC} / \text{TC}, \% \)), total confirmed cases of infection (\( \text{TC} \)) or total deaths (\( \text{TD} \)) due to COVID-19. \( \text{Oilpr} \) is the oil price return; \( \text{ERR} \) is the US-based local exchange rate return; and \( \text{SMR}_{\text{domestic}} \) is the Morgan Stanley Capital International (MSCI)-based local equity returns. All variables appear in their stationary form. The \( A_i \)'s are fixed \((K \times K)\) coefficient matrices, \( p \) is the order of the
VAR model and $u$ is a $(6 \times 1)$ vector of VAR observed residuals, with zero mean and covariance matrix $E(u_t u_t^\prime) = \Sigma u_t$.

The innovations of the reduced form model, $u_t$, can be expressed as a linear combination of the structural shocks, $\varepsilon_t$, as in Breitung et al. (2004):

$$u_t = A^{-1} B \varepsilon_t$$

(2)

where $B$ is a structural form parameter matrix. Substituting Equation (2) into Equation (1) and following some minor manipulations, we get the structural representation of Equation (1):

$$AY_t = A_1' Y_{t-1} + \ldots + A_p' Y_{t-p} + B \varepsilon_t$$

(3)

Here, $A_j$ is a $(6 \times 6)$ coefficient matrix, where $A_j = A^{-1} A_j'$, where $j = 1, \ldots, p$. $\varepsilon_t$ is a $(6 \times 1)$ vector of unobserved structural shocks, with $\varepsilon_t \sim (0, I_K)$. The structural covariance matrix, $\Sigma = E(\varepsilon_t, \varepsilon_t^\prime)$, is an identity matrix, $I_K$. The AB model is estimated as:

$$Au_t = B \varepsilon_t$$

(4)

The orthonormal innovations, $\varepsilon$, ensure the identifying restrictions on $A$ and $B$:

$$A \Sigma A = B B$$

(5)

We use the model A, where $B = I_K$. Hence, $K (K - 1)/2$ restrictions need to be implemented for identification of the system. Simple zero exclusion restrictions are used to identify the system. The elements of the system that are estimated are assigned as $\gamma_{rc}$. Estimations follow maximum likelihood using the scoring algorithm (Amisano & Giannini, 1997; Breitung et al., 2004). Over-identification of the system leads to a formal likelihood ratio (LR) test to check whether the identification is valid. The LR statistic is computed as:

$$LR = T (tr (P) - \log (P) - K)$$

(6)

where $P = A^{-1} B^\prime B^{-1} A \Sigma$. The LR test is formulated with the null hypothesis that the identification is valid. The test statistic is asymptotically distributed with a chi-square distribution, $\chi^2 (q - k)$, where $q$ is the number of identifying restrictions.

The system (4) represented as model A takes the following form:

$$
\begin{bmatrix}
\gamma_{11} & 0 & 0 & 0 & 0 & 0 \\
0 & \gamma_{22} & 0 & 0 & 0 & 0 \\
0 & 0 & \gamma_{33} & 0 & 0 & 0 \\
\gamma_{41} & 0 & \gamma_{43} & \gamma_{44} & \gamma_{45} & \gamma_{46} \\
0 & 0 & \gamma_{53} & \gamma_{54} & \gamma_{55} & \gamma_{56} \\
\gamma_{61} & \gamma_{62} & \gamma_{63} & \gamma_{64} & \gamma_{65} & \gamma_{66}
\end{bmatrix}
\begin{bmatrix}
SMR_{US} \\
RFR \\
COVID-19 \\
Oilpr \\
ERR \\
SMR_{domestic}
\end{bmatrix}
= 
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
\varepsilon_{t,SMR_{US}} \\
\varepsilon_{t,RFR} \\
\varepsilon_{t,COVID-19} \\
\varepsilon_{t,Oilpr} \\
\varepsilon_{t,ERR} \\
\varepsilon_{t,SMR_{domestic}}
\end{bmatrix}
$$

(7)

The first three equations in the system (4) represent the US stock market, the domestic government bond yield and COVID-19 shocks in the system. These equations depict the sluggish response of the US stock
market, government bond yield and COVID-19 to shocks to other variables in the model, including the Oilpr, ERR and SMR Domestic.

The final three equations are several unidirectional relations flowing from SMR (US) to Oilpr; COVID – 19 to Oilpr; COVID – 19 to ERR; COVID – 19 to SMR (domestic); and government bond yields to SMR (domestic). The last three equations also depict bidirectional relationships between Oilpr SMR (domestic); ERR – SMR (domestic); and Oilpr – ERR. We explain these relationships as follows:

**SMR (US) → SMR (domestic):** The US stock market is widely seen as a key source of shock for stock markets in Asia (see Dooley & Hutchison, 2009; Lin & Lin, 2018; Narayan & Rehman, 2018, 2020; Narayan et al., 2014). Lin and Lin (2018) find that the USA exerts more influence on selected Asian countries than China, although after adding control variables, such as the world MSCI index, the Asian financial crisis and the GFC, the authors find a rise in China’s influence on Asian markets and highlight the declining influence of the USA, particularly after the GFC. Narayan and Rehman (2018) show that the US stock market was a significant predictor of emerging and frontier Asian (EFA) markets over the period from 2000 to 2013. They find that the foreign and oil markets reduce the importance of developed stock markets, but these markets are not as important to EFA markets as the US market. Narayan and Rehman (2020) examine the relationships between the USA and EFA markets separately over an extended period from 2000 to 2018 and find continued importance of the US stock market to Asian markets, but to varying degrees.

**SMR (US) → Oilpr:** We acknowledge a strand of the literature that suggests significant correlation between stock markets and demand and supply shocks affecting the oil market (see Ahmadi et al., 2016; Demirer et al., 2019; Kang et al., 2015). The presence of US stock return shocks is captured in the Oilpr equation to proxy global consumption demand shocks affecting the oil market. Ahmadi et al. (2016) show that stock market returns are more responsive to consumption demand shocks than supply shocks and speculative demand shocks affecting the oil market. Kang et al. (2015) reveal that the covariance of US stock returns and volatility is negatively associated with oil shocks, driven by demand in the oil market. Using a large sample of developed and emerging economies, Demirer et al. (2019) find that stock market returns are positively affected by oil demand shocks.

**COVID-19 → Oilpr, ERR and SMR (domestic):** The effect of extreme events—whether they are man-made (e.g., financial crisis, sovereign debt crisis, terrorism, internal conflict, war) or due to a natural cause (e.g., natural disaster, extreme weather)—on the commodity and financial markets are extensively examined in the recent literature. Economic theory implies that since these extreme events are unanticipated in nature and not factored into the decisions of economic agents, such shocks send investors and traders into a panic mode that is now known to cause contagion as they all attempt to cut their losses and take cover in anticipation of additional risk from the event. The actual impact of these events is an empirical issue. Empirical studies generally show that the impact of extreme events can be either positive or negative, depending on which market/country one is examining. The magnitude, as well as the significance, of the effect on any market depends on a number of factors, some of which include whether the event was anticipated or unanticipated, the importance of the event to the market/ country and how long it lasts. The impact of infectious diseases, which become an epidemic or a pandemic can be anticipated to behave similarly to any other extreme unanticipated event. However, as experience has now shown, epidemics and pandemics are unlike any other natural occurrence. It seems that the spread of an epidemic or pandemic can be contained, and the effort that a government puts into containing it is an important factor in determining the impact it will have. The exact effect can only be examined empirically.

As covered in the first section, several researchers investigated effects of the COVID-19 pandemic on the financial markets. In the case of the exchange rate markets, evidence of the impact is still scarce. For
the stock markets, the findings are mixed. The effect of COVID-19 on the oil (or Gasoline) market has been found to be negative (Ahundjanov et al., 2021; Narayan, 2020; Salisu et al., 2020). Narayan (2020) shows that over the period from 31 December 2020 to 5 May 2020, COVID-19 exerts a stronger effect on oil price after the number of new COVID-19 cases surpasses 84,479. Ahundjanov et al. (2021) find that COVID-19 sentiments derived from Google Search volumes over the period from 22 January 2020 to 2 July 2020 negatively affected the gasoline market, but it left the oil market unaffected.

Research on the financial impact of the severe acute respiratory syndrome (SARS) epidemic in 2002–2003 also shows that impact can be varied. Nippani and Washer (2004) note that, except for China and Vietnam, SARS did not negatively impact the stock market in the other affected countries (Canada, Hong Kong, Indonesia, Singapore and Thailand) for the period from 1 June 2002 to 17 June 2003. Chen et al. (2007) find that SARS had a significant impact on Taiwanese hotel stock efficiency, while Wang et al. (2013) show that the SARS epidemic influenced the efficiency of Taiwan’s biotechnology stocks.

**Government bond yields → SMR (domestic):** Local government bond yields allow for a risk-free rate in the determination of stock market returns, consistent with asset pricing models. We turn now to three bidirectional relationships covered in the SVAR models:

**Oilpr ↔ ERR:** The monetary approach to exchange rate determination sees domestic and foreign income shocks as an important determinant of exchange rate. Given the strong importance of this energy source to economic growth, oil price is readily seen as an important income shock. Further, as the US dollar is the major invoicing and settlement currency in the international market, theoretically, higher (lower) energy prices will increase (reduce) demand for the US dollar (see Zhang et al., 2008). In return, increased (reduced) demand for the US dollar should lead to depreciation (appreciation) of the currency of (non-US) importers of energy sources against US currency. And, if a higher price of crude oil occurs simultaneously with higher demand for oil by a non-US importer, the effect can be a much higher depreciation for the non-US importer currency, which will suffer a larger depreciation against the US dollar. Several studies find this depreciating effect of higher oil prices for the currencies of other industrialised nations against the US dollar (see, e.g., Amano & van Norden, 1998; Bashir et al., 2012; Camarero & Tamarit, 2002; Chen & Chen, 2007; Lizardo & Mollick, 2010). The possibility of a bidirectional link between oil price and exchange rate is explored by Bloomberg and Harris (1995), who explain that the higher purchasing power of importing nations from a depreciation of the US dollar can induce an increase in the oil price in US dollar terms.

**Oilpr ↔ SMR (domestic):** Stock returns of oil producers and companies that rely on oil as an important input to their production processes can be sensitive to oil price movements as well. Most of the Gulf Cooperation Council’s stock markets benefit from a positive shock in oil prices (Hammoudeh & Choi, 2006). Alsalman (2016) shows that US stock returns are not significantly affected by oil price volatility. Using a VAR model, Güntner (2014) finds that real stock returns of oil-exporting Organisation for Economic Co-operation and Development (OECD) countries are positively affected by oil price, while the effect of oil price on oil-importing countries’ stock markets is negative. Also using a VAR model, Apergis and Miller (2009) find that the reaction of stock markets to oil shocks in Australia, Canada, France, Germany, Italy, Japan, the UK and the USA are small (for other similar studies, see Abdullah et al., 2016; Al-hajj et al., 2018; O’Neill et al., 2008).

Positive demand shocks also coincide with bullish stock market conditions and higher stock market returns under such conditions that put pressure on the oil market that cause oil prices to increase. Hence, a bidirectional relationship has also been found for stock market returns and oil prices. Salisu and Oloko (2015) note that there is a bidirectional relationship between the oil market and US stock markets.

**ERR ↔ SMR (domestic):** The monetary approach to exchange rate determination sees domestic income shocks as an important determinant of exchange rate. Stock market movements serve well as a
proxy for changes in domestic income. Further, several empirical studies indicate that there is a two-way relationship between exchange rates and stock markets. Zhao (2010) shows that the connection between stock price and the renminbi (RMB) real effective exchange rate has a bidirectional volatility spillover effect that suggests that past innovation in the exchange rate market determines future volatility in the Chinese stock market, and vice versa. Taking the case of the Japanese Yen and the country’s stock market, Narayan et al. (2021) showed that this relationship strengthened more over the COVID-19 period (January 2020 to August 2020) as compared to the period prior to the COVID-19 pandemic.

III. Data and Preliminary Analysis

This study employs daily data over the period from 31 December 2019 to 1 May 2020. Our choice of SVAR variables has depended on the availability of data. The main COVID-19 pandemic-related data series include total confirmed cases of infections, new cases of infection and total deaths, all of which are extracted from Our World in Data. Financial data, including daily oil prices, MSCI-based national stock market for the USA, MSCI-based national stock market and bond yield for the seven Southeast and East Asian countries, namely China, India, Indonesia, Japan, Malaysia, Singapore and South Korea, are extracted from the Fusion Media Investing.com website (see Table A1).

Table 1 explains the nature of the pandemic-related lockdowns in the seven Asian countries as of 1 May 2020. India and Malaysia were under national lockdowns, and these restrictions were ongoing on from 1 May 2020. Localised states of emergency were declared in Japan and South Korea. In China, Indonesia and Singapore, there were incidents of localised lockdowns. The localised lockdowns in China were terminated on 8 April 2020.

Some common statistics on COVID-19 and the financial variables are presented in Tables 2 and 3. COVID-19 cases, averaged over the period from 31 December 2019 to 1 May 2020, are presented in Table 3. As of 1 May 2020, China, on average, had the most cases of total infections (54,987), daily new cases (736), total deaths (2,186) and daily new deaths (42). COVID-19 cases in South Korea ranked second, but they were considerably lower than China. By 1 May 2020, in South Korea, average daily

| Country    | Lockdown Date       | Nature of the Lockdown                                      |
|------------|---------------------|-------------------------------------------------------------|
| China      | 23-01-2020 to 08-04-2020 | Localised lockdown                                         |
| India      | 22-03-2020 to ongoing | National lockdown (Localised lockdown from 22/03/2020 until 24-03-2020) |
| Indonesia  | 10-04-2020 to ongoing | Localised lockdown                                         |
| Japan      | 20-02-2020 to ongoing | State of Emergency—localised                               |
| Malaysia   | 18-03-2020 to ongoing | National lockdown                                         |
| Singapore  | 07-04-2020 to ongoing | Localised lockdown                                         |
| South Korea| 23-02-2020 to ongoing | State of Emergency—localised                               |

Source: Lockdown data for China from Bloomberg News (2020a); for India from The Economic Times (2020) and BBC News (2020a); for Indonesia from Bloomberg News (2020b); for Japan, Malaysia and South Korea from BBC News (2020b); for Singapore from South China Morning Post (2020).
total infections were 4,732, new cases were 79, and total and new deaths were 78 and 2, respectively. India was just behind South Korea, followed by Japan, Singapore, Indonesia and Malaysia.

Table 2. Average COVID-19 Cases for the Period from 31 December 2019 to 1 May 2020.

| Countries   | Total Cases | New Cases | Total Deaths | New Deaths |
|-------------|-------------|-----------|--------------|------------|
| Average (no. of persons) |             |           |              |            |
| China       | 54,987      | 736       | 2,186        | 42         |
| India       | 3,950       | 291       | 125          | 10         |
| Indonesia   | 1,496       | 80        | 127          | 6          |
| Japan       | 2,408       | 98        | 55           | 4          |
| Malaysia    | 1,439       | 49        | 22           | 1          |
| Singapore   | 1,750       | 137       | 3            | 0          |
| South Korea | 4,732       | 79        | 78           | 2          |
| Coefficient of variation (%) |       |           |              |            |
| China       | 65          | 253       | 75           | 337        |
| India       | 216         | 187       | 220          | 194        |
| Indonesia   | 186         | 157       | 184          | 186        |
| Japan       | 175         | 159       | 188          | 301        |
| Malaysia    | 147         | 138       | 160          | 190        |
| Singapore   | 224         | 218       | 170          | 361        |
| South Korea | 100         | 184       | 120          | 126        |

Source: The authors.

Table 3. Other SVAR Variables: Common Statistics.

| Date           | China   | India   | Indonesia | Japan   | Malaysia | Singapore | S. Korea |
|----------------|---------|---------|-----------|---------|----------|-----------|----------|
| Average: 31 Dec 2019—1 May 2020 |         |         |           |         |          |           |          |
| ERR            | −0.012  | −0.067  | −0.074    | 0.021   | −0.055   | −0.057    | −0.064   |
| SMR (domestic) | −0.131  | −0.203  | −0.372    | −0.160  | −0.164   | −0.253    | −0.150   |
| RFR            | 1.954   | 4.721   | 3.903     | −0.180  | 2.785    | 1.210     | 1.092    |
| NC/TC          | 0.061   | 8.358   | 6.114     | 7.445   | 5.301    | 7.182     | 6.675    |
| Oilpr          |         |         |           | −0.784  |          |           |          |
| SMR (US)       |         |         |           | −0.234  |          |           |          |
| Coefficient of variation |       |         |           |         |          |           |          |
| ERR            | −2660   | −765    | −1291     | 3933    | −775     | −682      | −1,142   |
| SMR (domestic) | −1393   | −1542   | −1016     | −1136   | −1115    | −949      | −2,095   |
| RFR            | 22      | 11      | 13        | −48     | 8        | 38        | 17       |

(Table 3 continued)
In terms of the coefficient of variation (CV), which allows comparisons of volatility of the COVID-19 statistics across countries, the key observations are as follows: of the four COVID-19 measures captured in Table 3, daily new deaths for China, Japan, Malaysia and Singapore displayed most variation, while, for India and Indonesia, total confirmed cases of infection were most volatile. However, total confirmed cases of COVID-19 infection in Singapore, compared to other countries, displayed more volatility, closely followed by India. In comparison to the other six countries, China showed the least variation in the total daily infections and total deaths, although new daily confirmed cases were most volatile in China and least in Malaysia. For South Korea, of all four COVID-19 statistics, new daily confirmed cases were most volatile.

For the average experience in the financial markets of seven Asian countries surveyed, we turn to Table 3. All financial variables are expressed in their return form. All countries, except Japan, experienced a depreciation in their exchange rate. China suffered the least fall in the value of its currency against the US dollar (−0.01%). The other nations showed depreciation of their currencies against the US dollar in the range from 0.05% (Malaysia) to 0.07% (Indonesia). All countries suffered a fall in stock market return—this was most felt by Indonesia (−0.37%). The decline in equity returns in the other six countries ranged from 0.16% (Malaysia) to 0.25% (Singapore). On average, the US MSCI return fell by 0.23%. Brent oil price fell much more—by 0.78%. In the highly volatile markets, these average falls in returns remained close to 0 over the 4 months. In all countries, the foreign exchange markets were most volatile, followed by the equity markets and the global oil market. According to Table 3, the US exchange rate against the Japanese Yen, followed by the Chinese Renminbi, and Indonesian Rupiah, and equity markets in South Korea, followed by the USA, India and China were among the most volatile.

Figure 1 presents new cases as a ratio of total cases (NC/TC, %), and all other SVAR variables over the 4 months. Strikingly, during the period when new cases were increasing at an escalating pace in the early stage of the pandemic, which is shown by the increase in NC/TC, all other markets (equity, exchange rate, bond and oil) showed very little movement, but by the middle of the second month of the COVID-19 pandemic, we begin to see increased movements (or economic activity), although these were very volatile in nature. Only more detailed analysis will indicate whether the volatility evident in the later months of the first 4 months of the COVID-19 pandemic was transitory or more enduring in nature.

Next, we examine the stationarity of the variables. As mentioned earlier, all variables appear in the SVAR model in their stationary form. The standard augmented Dickey–Fuller (ADF) test results presented in Table A2 show that Brent oil price and the MSCI-based US stock returns are stationary, as are MSCI-based stock returns of all seven Asian countries. Exchange rate returns and NC/TC are stationary in their level forms or are I(0). Government bond yield (RFR) is non-stationary in level form.
but becomes stationary in the first-difference form or is I(1). Hence, DRFR, where D denotes first difference, is used in the SVAR models. Other measures of COVID-19, including TC and TD, for most countries are I(1). TD in China and South Korea follow the I(0) process, while both TC and TD in Indonesia follow the I(1) process in the SVAR models.

IV. Empirical Results: Structural Vector Autoregression Model

This section presents the empirical findings from our SVAR analysis. We interpret the structural coefficients from the A matrices and discuss the structural impulse responses to COVID-19 shocks by examining them in three ways—total COVID-19 cases (TC), total COVID-19 deaths (TD) and new

---

**Figure 1.** COVID-19 and Other Economic and Financial Factors: 31 December 2019 to 1 May 2020.

**Source:** The authors.
cases as a percentage of total cases (NC / TC). We also briefly cover the response of the US-based exchange rates and equity markets to other structural shocks captured in our SVAR model.

**Structural Coefficients from A Matrices**

The structural coefficients relating to the last three rows of the A matrix of each measure of COVID-19 cases are presented in Table 4. The signs of the A matrix coefficients are reversed as per Equation (3) (also see Mehrotra, 2007). The appropriate lag length of the endogenous variables, presented in Table 5, are determined using the Akaike Information Criteria. The LR tests, also reported in Table 5, do not reject the under-identifying restrictions at the 5% level for all seven cases examined for models with NC / TC and TC. However, the under-identifying restrictions at the 5% level are rejected for Indonesia and Malaysia in the case of TD-related SVARs. As a result, the TD-related SVARs for the two countries have undergone a slight modification (Table 5).

**Table 4. SVAR Results: COVID-19 Effects.**

|   | Model | NC/TC | TC      | TD     |
|---|-------|-------|---------|--------|
| China | ERR  | -0.008 | -1.817  | -2.082 |
|     |      | (0.016) | (1.347) | (1.647) |
|     | SMR  | -0.025 | -2.291  | +0.210 |
|     |      | (0.015) | (1.426) | (1.662) |
| India | ERR  | +0.003 | -4.667* |        |
|      |      | (0.008) | (1.407) |        |
|      | SMR  | -0.010 | -1.412  |        |
|      |      | (0.008) | (1.649) |        |
| Indonesia | ERR  | +0.017 | -1.593  | -1.323 |
|       |      | (0.012) | (1.839) | (2.127) |
|       | SMR  | +0.007 | -0.787  | -4.775* |
|       |      | (0.027) | (2.097) | (1.469) |
| Japan  | ERR  | +0.006 | +1.377  | +2.450 |
|       |      | (0.008) | (2.228) | (1.946) |
|       | SMR  | -0.003 | +1.161  | -0.754 |
|       |      | (0.009) | (2.425) | (2.562) |
| Malaysia | ERR  | -0.018 |        | -0.274 |
|        |      | (0.014) |         | (1.492) |
|        | SMR  | -0.010 |        | -1.271 |
|        |      | (0.015) |         | (1.463) |
| Singapore | ERR  | -0.002 | -5.338  | -7.974 |
|          |      | (0.015) | (4.382) | (4.104) |
|          | SMR  | +0.013 | -5.419  | -0.707 |
|          |      | (0.009) | (6.103) | (4.632) |

(Table 4 continued)
Table 4 continued

| Country       | NC/TC | TC       | TD       |
|---------------|-------|----------|----------|
| South Korea   | ERR   | -0.001   | -2.662   | +1.386   |
|               |       | (0.008)  | (1.687)  | (3.190)  |
|               | SMR   | +0.005   | -0.026   | +4.078*  |
|               |       | (0.008)  | (2.378)  | (2.047)  |

Source: The authors.

Note: (a) This table presents the structural coefficients (γ) and standard errors (SE, in parenthesis) of the last two rows of the A Matrix. These relate to the structural effects of new cases of COVID-19 infection as a percentage of total cases of infection (NC/TC), total cases of infection (TC) and total deaths (TD) on exchange rate returns (ERR) and stock market returns (SMR). \( t \) -statistics = \( \frac{\hat{\gamma}}{SE(\hat{\gamma})} \). (b) * Indicates significance at the 5% level or better.

Table 5. SVAR Results: Lags and Over-Identification Test.

| Country       | NC/TC | TC       | TD       |
|---------------|-------|----------|----------|
|               | Lags  | Log Likelihood Ratio (LR) | Lags  | Log Likelihood Ratio (LR) | Lags  | Log Likelihood Ratio (LR) |
| China         | 1     | -334.02 3.986 (0.263) | 1     | 56.39 3.595 (0.309) | 1     | 49.93 3.798 (0.284) |
| India         | 4     | -435.53 3.991 (0.263) | 2     | -39.66 3.77 (0.287) | 2     | -144.71 3.989 (0.263) |
| Indonesia     | 2     | -586.93 1.307 (0.728) | 2     | -144.71 3.989 (0.263) | 1     | -113.53 9.232* (0.026) |
| Japan         | 2     | -419.75 1.276 (0.735) | 2     | 42.02 1.221 (0.748) | 1     | -26.36 2.231 (0.526) |
| Malaysia      | 2     | -303.33 0.830 (0.842) | 2     | 18.30 8.164* (0.043) | 1     | -18.30 8.164* (0.043) |
| Singapore     | 2     | -424.52 2.001 (0.572) | 2     | 16.34 4.083 (0.253) | 1     | -9.90 5.938 (0.115) |
| South Korea   | 2     | -420.40 2.263 (0.520) | 2     | -18.70 1.690 (0.639) | 1     | -55.24 1.330 (0.722) |

Source: The authors.

Note: This table presents the lags in the VAR structure. The maximum lag length was set at 5. Also reported are the Log likelihood and LR test relating to the null of under-identification. Reported for the LR test are the \( \chi^2 \) (3 degrees of freedom) and \( p \)-value in parenthesis.

The point estimates, reported in Table 5, deserve some attention as they have important policy and theoretical implications. We begin with the structural effects of COVID-19 shock on exchange rates and stock market returns during the period from 31 December 2019 to 1 May 2020. The key result is that the COVID-19 pandemic is found to have a significant effect in the case of India, Indonesia and South Korea.

In terms of how the pandemic strikes these markets, we can make two important observations from the three highly significant cases. First, the impact of the pandemic is heterogeneous. In India, the foreign exchange market is significantly affected, while the stock markets in Indonesia and South Korea are
impacted. Where COVID-19 has struck the same markets in different countries, the impact is not necessarily the same. We find that the impact is not standard in the case of equity markets. For Indonesia, the COVID-19 pandemic reduced the stock market returns, while, in the case of South Korea, the effect was found to be positive.

Second, it seems that markets are affected by different COVID-19 data. In the case of India, the US-based forex market was impacted significantly by total cases of confirmed infections. India’s total deaths to total confirmed cases, averaged over the 4-month period, was lower (3%) than the new cases to total confirmed cases (7%), which may explain a rather significant reaction to total infection. The equity market in Indonesia was, on the other hand, affected by total deaths, with total deaths as a percentage of confirmed cases of infections averaging 8% as of 1 May 2020.

Of the seven Asian nations in this study, Indonesia was one of the last to begin reporting COVID-19 cases (see Figure 1). Both the international and local news media emphasised the slow response of the Indonesian government in handling the COVID-19 pandemic (Pierson, 2020; The Jakarta post, 2020). An escalating death toll in a country, which was failing to take sufficient action, would have raised alarm bells, and as indicated by the SVAR analysis, the response to the uncertain times was reflected in its equity market. On the other hand, South Korea, which was one of the first countries to show positive signs of recovery from the COVID-19 pandemic, saw regained confidence as a result of reduced total deaths. By 1 May 2020, South Korea’s total deaths as a percentage of confirmed cases was 1.6%.

In terms of the size of the impact of COVID-19, this period of the pandemic led to a rather strong depreciation of India’s rupee against the US dollar. A 1% increase in the COVID-19 cases led to a 4.7% depreciation of the rupee against the US dollar. In Indonesia, the COVID-19 pandemic led to a fall in the stock market, with a 1% increase in total number of COVID-19-related deaths, wiping 4.8% off its stock market returns. For these two populous nations, a sudden acceleration in COVID-19 infections invited fear in the markets. On the other hand, in South Korea, the containment of COVID-19 infections—which is evident from the fall and levelling of NC / TC (see Figure 1) by the second month—would have boosted public confidence in that country’s ability to tackle the pandemic. This probably explains the improvement seen in the South Korean stock market amid higher total deaths, but stabilised infection rates. Here, a 1% increase in total COVID-19-related deaths saw an increase in stock market returns of 4.1%. There are three things at work here with respect to the COVID-19 pandemic in South Korea: first, data show that there was some lag between new infections and deaths; second, deaths due to COVID-19 occupied a very small percentage of the total infections (1.6% averaged over the 4-month period); and, third, unlike most of the countries in the sample, during the study period, South Korea had only gone as far as declaring a state of emergency and had not introduced blanket lockdown restrictions.

For the other four countries, namely China, Japan, Malaysia and Singapore, we find no case of significance at the 5% level, or better. As with the significant cases, we note that with insignificant cases, there are differing effects of COVID-19 on the returns of foreign exchange rates and stock markets.

**Structural Impulse Response Analysis**

The structural impulse response (IR) analysis provides evidence on the dynamic responses of ERR and SMR to COVID-19 effects. The bootstrap percentile of 95% confidence intervals are constructed to illustrate parameter uncertainty. Responses of up to 20 days ahead are considered by using 1,000 bootstrap replications. For each measure of COVID-19 incidence, all countries are reported, with the exceptions of India, which is not covered for TD, and Malaysia for TC, as for these two countries, these variables are I (2).
The dynamic effects of the COVID-19 pandemic on the forex and equity markets, represented by their price returns, ERR and SMR, are depicted in Figures 2 and 3, respectively. The charts are organised by the three measures of COVID-19, namely NC / TC, TC and TD. All the charts in these figures present insignificant impulse responses to COVID-19 shocks.

![Figure 2. Impulse Responses of SMR (Domestic) to COVID-19 Shocks.](image)

**Source:** The authors.

**Note:** The structural impulse responses of domestic stock market returns (SMR (domestic)) to a one standard deviation increase in COVID-19 cases. Each row, respectively, represents the impulse responses to COVID-19 shocks from the SVAR model with (a) New cases of infection as a percentage of total cases of infection (NC / TC), (b) Total cases of infection (TC); or total deaths (TD). The impact of COVID-19 shocks on SMR (domestic) is plotted with a bootstrap percentile at 95% confidence intervals. Responses of up to 20 days ahead are considered using 1,000 bootstrap replications.
Figure 3. Impulse Responses of ERR to COVID-19 Shocks.

Source: The authors.

Note: The structural impulse responses of nominal exchange rate returns (ERR) to a one standard deviation increase in COVID-19 cases. Outcomes that show significant response in few or all days are reported. Each row, respectively, represents the impulse responses to COVID-19 shocks from the SVAR model with (a) New cases of infection as a percentage of total cases of infection (NC / TC). (b) Total cases of infection (TC). (c) Total deaths (TD). The impact of COVID-19 shocks on ERR are plotted with a bootstrap percentile at 95% confidence intervals. Responses of up to 20 days ahead are considered using 1,000 bootstrap replications.
In comparison, the structural impulse responses of the equity and US-based exchange rate markets to shocks, other than COVID-19, within the SVAR model, are significant in some, but limited cases during the first 3 months of COVID-19. Figure 4 captures the response of our seven Southeast and East Asian countries’ stock markets to US stock market shocks, which are significant. The charts (see Figure 4) for the significant cases are organised by each of the three measures of COVID-19. Recall that each measure of COVID-19 was implemented in the SVAR one at a time. In the SVAR models with NC / TC, for the stock returns of China and South Korea, a one standard deviation increase in the SMR (US) leads to an instantaneous positive effect. The response to US shocks is somewhat delayed from Indonesia, Japan and Singapore. In all cases, except China, domestic markets increased further up to day 2 before reverting, and the effect of the US shocks dissipated by days 6–12. For China, the US market had a strong positive instantaneous effect, which dissipated after day 1, but continued to cause minor (insignificant) jitters in the market up to day 5. The impulse response was significant for China until all the initial effects of the SMR (US) shocks had dissipated.

**Figure 4.** Impulse Responses of SMR (domestic) to SMR (US) Shocks.

**Source:** The authors.

**Note:** The structural impulse responses of stock market returns (SMR (domestic)) to a one standard deviation increase in the SMR (US). Only those that show a significant response in few or all days are reported. Each row, respectively, represents the impulse responses to SMR(US) shocks from the SVAR model with (a) New cases of infection as a percentage of total cases of infections (NC / TC). (b) Total cases of infection (TC). The impact of the SMR (US) shocks on SMR (domestic) are plotted with a bootstrap percentile at 95% confidence intervals. Responses of up to 20 days ahead are considered using 1,000 bootstrap replications.
The response of the Indian equity market to SMR (US) shocks is negative in both NC / TC and TC related SV ARs. A one standard deviation increase in US stock market returns receives a significant response from the Indian stock market for up to 4–5 days.

Figure 5 captures the structural impulse response of the stock markets in Indonesia and Japan to a one standard deviation increase in the ERR in the first 4 months of COVID-19. Note in both cases that the response is delayed and significant during days 1–3. The structural impulse response of other stock markets to the ERR shock in SV AR with NC / TC is insignificant. All cases are insignificant under the TC and TD SV ARS. Further, when we checked the structural impulse response of the ERR to SMRs, we found that all the impulse responses were insignificant during the first 4 months of the COVID-19 pandemic.7

V. COVID-19 IMPACTS in Recent Months: India and Indonesia

On 1 May 2020, total COVID-19 inflections (deaths) stood at 35,043 (1,147) and 10,118 (792) in India and Indonesia, rising, respectively, to 10,639,684 (153,184) and 965,283 (27,453) by 22 January 2021.

Given the sharp increase in COVID-19 cases in India and Indonesia in the recent months, we present in Table 6 some additional SVAR model (7) results for two periods: 2 May 2020 to 22 January 2021 (panel 1) and 31 December 2019 to 22 January 2021 (panel 2). For both countries, our analyses suggest that the COVID-19 pandemic had an insignificant effect on the stock market and US-based foreign exchange market over the two sample periods, confirming the transitory nature of the pandemic found for the two countries in the first 4 months of the pandemic.
Table 6. Additional SVAR Results for India and Indonesia: COVID-19 Effects over the Period from 2 May 2020 to 22 January 2021.

|                  | India                        | Indonesia                     |
|------------------|------------------------------|-------------------------------|
|                  | NC/TC                        | TC                            | TD                            | NC/TC                        | TC                            | TD                            |
| ERR Coef.        | 0.034                        | 0.066                         | 0.056                         | -0.143                       | -0.160                        |
| ERR SE           | 0.038                        | 0.050                         | 0.045                         | 0.220                        | 0.301                         |
| ERR T-stat       | 0.899                        | 1.327                         | 1.252                         | -0.647                       | -0.531                        |
| SMR Coef.        | -0.201                       | -0.181                        | -0.236                        | -1.433                       | 1.363                         |
| SMR SE           | 0.227                        | 0.175                         | 0.228                         | 2.512                        | 2.759                         |
| SMR T-stat       | -0.887                       | -1.033                        | -1.032                        | -0.570                       | 0.494                         |

Panel 2: 31 December 2019 to 22 January 2021

|                  | India                        | Indonesia                     |
|------------------|------------------------------|-------------------------------|
|                  | NC/TC                        | TC                            | TD                            | NC/TC                        | TC                            | TD                            |
| ERR Coef.        | -0.041                       | -0.023                        | 347.677                       | 265.551                       | -87.281                       |
| ERR SE           | 0.040                        | 0.031                         | 4001.087                      | 1012.535                      | 1713.313                      |
| ERR T-stat       | -1.017                       | -0.738                        | 0.087                         | 0.262                        | -0.051                        |
| SMR Coef.        | 6.412                        | 0.978                         | -0.174                        | 0.004                         | -0.138                        |
| SMR SE           | 37.678                       | 1.003                         | 2.360                         | 0.677                         | 1.065                         |
| SMR T-stat       | 0.170                        | 0.975                         | -0.074                        | 0.006                         | -0.129                        |

Source: The authors.

Note: This table presents the structural coefficients (γ) and standard errors (SE, in parenthesis) of the last two rows of the A matrix. These relate to the structural effects of new cases of COVID-19 infection as a percentage of total cases of infection (NC/TC), total cases of infection (TC) and total deaths (TD) on exchange rate returns (ERR) and stock market returns (SMR).

\[ T-\text{statistics} = \frac{\gamma}{SE(\gamma)}. \]

* Indicates significance at the 5% level or better.

VI. Concluding Remarks

This study investigates the influence of COVID-19 cases in seven Southeast and East Asian countries on their US-based foreign exchange and equity markets in the first 4 months of the pandemic. An SVAR model was developed to allow for the endogenous relationships between these two markets in the investigation of the impact of COVID-19 shock. The study finds that the impact of COVID-19, measured in terms of total cases of infection, total deaths or new cases as a ratio of total cases in the seven Asian countries, had varying effects. Until 1 May 2020, COVID-19 significantly diminished Indonesia’s equity market returns, depreciated India’s rupee against the US dollar and improved equity prospects in South Korea. In all other cases, the pandemic failed to leave a significant mark on the exchange rate and stock markets by close of trade on 1 May 2020. It suggests that much of the major day-to-day impact of COVID-19 structural shocks on the US-based exchange rate and MSCI-based stock equities were temporary in nature. Our impulse response analysis confirms that COVID-19 shocks in the first 4 months of the pandemic were strongly transitory in nature, and, while both markets showed reactions to COVID-19 shocks, they were able to recover within a few days.
Overall, countries, which displayed most vulnerability during the first 4 months of the COVID-19 pandemic, saw significant deterioration of some of their key financial markets. India and Indonesia are two such examples. However, the daily market effects of the COVID-19 pandemic in its first 4 months were transitory in nature, lasting only few days. Additional analyses suggest that the equity and US-based foreign exchange markets of the two countries became (or remained) resilient in the face of growing cases of COVID-19 inflections and deaths in India and Indonesia over the recent months (2 May 2020 to 22 January 2021).

Appendix A

Table A1. SVAR Variables: Definitions and Sources of Data.

| Endogenous Variable | Description                                      | Form | Data                                              | Source                                                                 |
|---------------------|--------------------------------------------------|------|---------------------------------------------------|------------------------------------------------------------------------|
| SMR (US)            | Stock market return                              | %    | MSCI-based national stock market index (USD)     | Investing.com: https://www.investing.com/indices/global-indices       |
| SMR (domestic)      | Stock market return                              | %    | MSCI-based national stock market index (USD)     | Investing.com: https://www.investing.com/indices/global-indices       |
| RFR                 | Risk-free rate                                   | %    | Government bond yield: 3 months (India, Indonesia, Japan, And Singapore); 1 year (China); and 3 years (Malaysia) | Investing.com: https://www.investing.com/rates-bonds/world-government-bonds |
| OILPR               | Oil price return                                 | %    | Brent oil price                                  | Investing.com: https://www.investing.com/commodities/brent-oil        |
| ERR                 | Exchange rate return                             | %    | US based local currencies                        | Investing.com: https://www.investing.com/currencies/single-currency-crosses |
| NC/TC               | New infection cases to total infection cases     | %    | New cases and total cases                         | Our World in Data: https://ourworldindata.org/coronavirus-source-data |
| TC                  | Total cases of infection                         | Logs | Total cases                                       | Our World in Data: https://ourworldindata.org/coronavirus-source-data |
| TD                  | Total deaths                                     | Logs | Total deaths                                      | Our World in Data: https://ourworldindata.org/coronavirus-source-data |

Note: This table explains the daily data, their source and the form of the variables captured in the SVAR models over the period from 31 December 2019 to 1 May 2020.
| Country        | Variables       | I(0)  | I(1)  |
|---------------|----------------|-------|-------|
|               | SMR (US)        | −5.234| 0.000 |
|               | Oilpr           | −7.496| 0.000 |
| China         | RFR             | 0.799 | 0.994 |
|               | SMR (domestic)  | −10.154| 0.000 |
|               | ERR             | −10.646| 0.000 |
|               | NC/TC           | −4.524| 0.000 |
|               | TC              | −2.644| 0.088 |
|               | TD              | −11.039| 0.000 |
| India         | RFR             | 1.090 | 0.997 |
|               | SMR (domestic)  | −11.269| 0.000 |
|               | ERR             | −9.959| 0.000 |
|               | NC/TC           | −8.578| 0.000 |
|               | TC              | 0.049 | 0.959 |
|               | TD              | −2.505| 0.124 |
| Singapore     | RFR             | −0.375| 0.908 |
|               | SMR (domestic)  | −9.427| 0.000 |
|               | ERR             | −4.298| 0.001 |
|               | NC/TC           | −8.487| 0.000 |
|               | TC              | 0.734 | 0.992 |
|               | TD              | −4.972| 0.000 |
| Japan         | RFR             | −2.294| 0.176 |
|               | SMR (domestic)  | −6.751| 0.000 |
|               | ERR             | −12.824| 0.000 |
|               | NC/TC           | −5.503| 0.000 |
|               | TC              | −0.488| 0.888 |
|               | TD              | −2.264| 0.187 |
| South Korea   | RFR             | −0.301| 0.920 |
|               | SMR (domestic)  | −5.217| 0.000 |
|               | ERR             | −10.082| 0.000 |
|               | NC/TC           | −7.184| 0.000 |
|               | TC              | −1.365| 0.596 |
|               | TD              | −3.048| 0.039 |
| Indonesia     | RFR             | −1.671| 0.443 |
|               | SMR (domestic)  | −7.675| 0.000 |
|               | ERR             | −3.382| 0.014 |

(Table A2 continued)
### Table A2 (continued)

| Country | Variables       | I(0)  | I(1)  |
|---------|-----------------|-------|-------|
| NC/TC  | −8.147          | 0.000 |       |
| TC     | −5.038          | 0.000 |       |
| TD     | −5.461          | 0.000 |       |
| Malaysia | RFR         | −1.420 | 0.569 | −6.935 | 0.000 |
| SMR (domestic) |         | −9.065 | 0.000 |       |       |
| ERR    | −6.926          | 0.000 |       |
| NC/TC  | −4.046          | 0.002 |       |
| TC     | −2.447          | 0.132 | −1.570 | 0.494 |
| TD     | −2.147          | 0.229 | −6.140 | 0.000 |

**Source:** The authors.

**Note:** This table reports the augmented Dickey–Fuller (ADF) test results for models with intercept only. Oilpr is Brent oil price return (%), and SMR (US) is MSCI-based US stock market return (%). For each of the seven Southeast Asian countries, we have the nominal US-based exchange rate return (%) for each of the six nations (ERR); the MSCI-based national stock market return (SMR (domestic, %); RFR is the risk-free rate: 3-month (India, Indonesia, Japan, Singapore), 1-year (China and South Korea) and 3-year (Malaysia) government bond yield; new cases of COVID-19 infection as a percentage of total cases of infection (NC/TC); total cases of infection (TC); and total deaths (TD).

### Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

### Funding

The authors received no financial support for the research, authorship and/or publication of this article.

### Notes

1. The SVAR methodology follows the discussion in Narayan (2013).
2. We found that model B and model AB produced similar results as those reported here.
3. If the focus is on the exchange rate of the exporter vis-à-vis the importer, then theory suggests transfer of wealth between the exporter and importer due to oil price changes. Higher (lower) prices may see an appreciation (depreciation) of the importer currency against that of the exporter (for this theory, see Corden, 1984; De Grauwe, 1996; Krugman, 1983).
4. Also see Akram (2009); Reboredo and Rivera-Castro (2013); and Salisu and Mobolaji (2013) for empirical evidence.
5. A free access collaborative data resource hosted by the Oxford Martin Programme on Global Development, University of Oxford (Oxford Martin School, n.d.).
6. Like us, Harjoto et al. (2020) found that emerging markets react to cases of inflections and deaths.
7. For brevity, we did not report these results. These charts are available on request.

### ORCID iDs

Seema Narayan | https://orcid.org/0000-0002-3993-4981
Evita Purnaningrum | https://orcid.org/0000-0002-7445-5898
Baqir Khawari | https://orcid.org/0000-0001-5142-4784
References

Abdullah, A. M., Saiti, B., & Masih, M. (2016). The impact of crude oil price on Islamic stock indices of South East Asian countries: Evidence from MGARCH-DCC and wavelet approaches. Borsa Istanbul Review, 16(4), 219–232. https://doi.org/10.1016/j.bir.2015.12.002

Ahmadi, M., Manera, M., & Sadeghzadeh, M. (2016). Global oil market and the U.S. stock returns. Energy, 114, 1277–1287. https://doi.org/10.1016/j.energy.2016.08.078

Ahundjanov, B. B., Akhundjanov, S. B., & Okhunjanov, B. B. (2020). Information search and financial markets under COVID-19. Entropy, 22(7), 791.

Ahundjanov, B. B., Akhundjanov, S. B., & Okhunjanov, B. B. (2021). Risk perception and oil and gasoline markets under COVID-19. Journal of Economics and Business. https://doi.org/10.1016/j.jeconbus.2020.105979

Akram, Q. F. (2009). Commodity prices, interest rates and the dollar. Energy Economics, 31, 838–851.

Al-Awadhi, A. M., Alsaifi, K., Al-Awadhi, A., & Alhammadi, S. (2020). Death and contagious infectious diseases: Impact of the COVID-19 virus on stock market returns. Journal of Behavioral and Experimental Finance, 27. https://doi.org/10.1016/j.jbef.2020.100326

Al-hajj, E., Al-Mulali, U., & Solarin, S. A. (2018). Oil price shocks and stock returns nexus for Malaysia: Fresh evidence from nonlinear ARDL test. Energy Reports, 4, 624–637. https://doi.org/10.1016/j.egyr.2018.10.002

Alsalan, Z. (2016). Oil price uncertainty and the U.S. stock market analysis based on a GARCH-in-mean VAR model. Energy Economics, 59, 251–260. https://doi.org/10.1016/j.eneco.2016.08.015

Amano, R. A., & van Norden, S. (1998). Oil prices and the rise and fall of the US real exchange rate. Journal of International Money and Finance, 17, 299–316.

Amisano, G., & Giannini, G. (1997). Topics in structural VAR econometrics (2nd ed.). Springer Verlag.

Amstad, M., Cornelli, G., Gambacorta, L., & Xia, F. D. (2020). Investors’ risk attitudes in the pandemic and the stock market: New evidence based on internet searches (BIS Bulletin No. 25). SSRN. https://ssrn.com/abstract=3654374

Apergis, N., & Miller, S. M. (2009). Do structural oil-market shocks affect stock prices? Energy Economics, 31(4), 569–575.

Ashraf, B. N. (2020). Stock markets’ reaction to COVID-19: Moderating role of national culture. Finance Research Letters. https://doi.org/10.1016/j.frl.2020.101857

Basher, S. A, Haug, A. A., & Sadorsky, P. (2012). Oil Prices, Exchange Rates and Emerging Stock Markets. Energy Economics, 34(1), 227–240.

Baker, S. R., Bloom, N., Davis, S. J., Kost, K., Sammon, M., & Viratyosin, T. (2020). The unprecedented stock market reaction to COVID-19. The Review of Asset Pricing Studies, 10(4), 742–758.

BBC News. (2020a). Coronavirus: India lockdown extended for two more weeks. https://www.bbc.com/news/world-asia-india-52505436

BBC News. (2020b). Coronavirus: The world in lockdown in maps and charts. https://www.bbc.com/news/world-52103747

Bloomberg News. (2020a). China to lift lockdown over virus epicenter Wuhan on April 8. https://www.bloomberg.com/news/articles/2020-03-24/china-to-lift-lockdown-over-virus-epicenter-wuhan-on-april-8

Bloomberg News. (2020b). Jakarta orders offices to close, bans gatherings to combat virus. https://www.bloomberg.com/news/articles/2020-04-07/jakarta-orders-offices-to-close-bans-gatherings-to-combat-virus

Bloomberg, S. B., & Harris, E. S. (1995). The commodity-consumer price connection: Fact or fable? Federal reserve board of New York. Economic Policy Review, 1(3), 21–38.

Breitung, J., Bruggermann, R., & Lutkepohl, H. (2004). Structural vector autoregressive modelling and impulse responses. In H. Lutkepohl, & M. Kratzig (Eds.), Applied time series econometrics (Chapter 4, pp. 159–196). Cambridge University Press.

Camarero, M., & Tamarit, C. (2002). Oil prices and Spanish competitiveness: A cointegrated panel analysis. Journal of Policy Modeling, 24(6), 591–605.
Chen, S. S., & Chen, H. C. (2007). Oil prices and real exchange rates. *Energy Economics*, 29(3), 390–404.

Chen, M. H., Jang, S. C. (Shawn), & Kim, W. G. (2007). The impact of the SARS outbreak on Taiwanese hotel stock performance: An event-study approach. *International Journal of Hospitality Management*, 26(1), 200–212. https://doi.org/10.1016/j.ijhm.2005.11.004

Corden, W. M. (1984 November). Booming sector and Dutch disease economics: Survey and consolidation. *Oxford Economic Papers*, 35, 359–80.

De Grauwe, P. (1996). *International money: Post war—Trends and theories*. Oxford University Press.

Demirer, R., Ferrer, R., & Shahzad, S. J. H. (2019). Oil price shocks and financial markets: A comparative analysis of stock and sovereign bond markets. *Energy Economics*, 88. https://doi.org/10.1016/j.eneco.2020.104771

Dooley, M., & Hutchison, M. (2009). Transmission of the U.S. subprime crisis to emerging markets: Evidence on the decoupling-recoupling hypothesis. *Journal of International Money and Finance*, 28(8), 1331–1349.

Gunay, S. (2020). Comparing COVID-19 with the GFC: A shockwave analysis of currency markets. *Research in International Business and Finance*. https://doi.org/10.1016/j.ribaf.2020.101377

Güntner, J. H. F. (2014). How do international stock markets respond to oil demand and supply shocks? *Macroeconomic Dynamics*, 18(8), 1657–1682.

Hammoudeh, S., & Choi, K. (2006). Behavior of GCC stock markets and impacts of US oil and financial markets. *Research in International Business and Finance*, 20(1), 22–44. https://doi.org/10.1016/j.ribaf.2005.05.008

Harjoto, M. A., Ross, F., Lee, R., & Sergi, B. S. (2020). How do equity markets react to COVID-19, Evidence from emerging and developed countries. *Journal of Economics and Business*. https://doi.org/10.1016/j.jeconbus.2020.105966

He, Q., Liu, J., Wang, S., & Yu, J. (2020). The impact of COVID-19 on stock markets, *Economic and Political Studies*, 8(3), 275–288.

Iqbal, N., Fareed, Z., Shahzad, F., He, X., Shahzad, U., & Lina, M. (2020). The nexus between COVID-19, temperature and exchange rate in Wuhan city: New findings from partial and multiple wavelet coherence. *Science of the Total Environment*, 729, 138916. https://doi.org/10.1016/j.scitotenv.2020.138916

Kang, W., Ratti, R. A., & Yoon, K. H. (2015). The impact of oil price shocks on the stock market return and volatility relationship. *Journal of International Financial Markets, Institutions and Money*, 34, 41–54. https://doi.org/10.1016/j.intfin.2014.11.002

Krugman, P. (1983). *Oil and the dollar*. In B. Jagdeeps, & B. H. Putnam (Eds.), *Economic interdependence and flexible exchange rates*. MIT Press.

Lin, L., & Lin, W.-Y. (2018). Does the major market influence transfer? Alternative effect on Asian stock markets. *The Review of Quantitative Finance and Accounting*, 50(4), 1169–1200.

Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 outbreak and affected countries stock markets response. *International Journal of Environmental Research and Public Health*, 17(8). https://doi.org/10.3390/ijerph17082800

Lizardo, R. A., & Mollick, A.V. (2010). Oil price fluctuations and US dollar exchange rate. *Energy Economics*, 32, 399–408.

Mehrotra, A. (2007). Exchange and interest rate channels during a deflationary era: Evidence from Japan, Hong Kong and China. *Journal of Comparative Economics*, 35(1), 188–210.

Narayan, S. (2013). A structural VAR model of the Fiji Islands. *Economic Modelling*, 31, 238–244.

Narayan, P. K. (2020). Oil price news and COVID-19—Is there any connection? *Energy Research Letters*, 1(1). https://doi.org/10.46557/001c.13176

Narayan., S., & Rehman, M. (2018). Portfolio diversification opportunities within emerging and frontier stock markets: Evidence from ten Asian countries. *Bulletin of Monetary Economics and Banking*, 21(1), 1–21.

Narayan, S., & Rehman, M. (2020). International portfolio strategies and opportunities: The case of the US, Japan and Asia. *Finance Research Letters*. https://doi.org/10.1016/j.frl.2019.101358

Narayan, S., Srianathakumar, S., & Islam, S. Z. (2014). Stock market integration of emerging Asian economies: Patterns and causes. *Economic Modelling*, 39, 19–31.
Narayan, P. K., Devpura, N., & Wang, H. (2020). Japanese currency and stock market—What happened during the COVID-19 pandemic? Economic Analysis and Policy, 68, 191–198.

Narayan, P. K., Phan, D. H. B., & Liu, G. (2021). COVID-19 lockdowns, stimulus packages, travel bans, and stock returns. Finance Research Letters, 38. https://doi.org/10.1016/j.frl.2020.101732

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the Coronavirus and COVID-19 pandemic: A review. International Journal of Surgery. https://doi.org/10.1016/j.ijsu.2020.04.018

Nippani, S., & Washer, K. M. (2004). SARS: A non-event for affected countries’ stock markets? Applied Financial Economics, 14(15), 1105–1110.

O’Donnell, N., Shannon, D., & Sheehan, B. (2021). Immune or at-risk? Stock markets and the significance of the COVID-19 pandemic. Journal of Behavioral and Experimental Finance, 30. https://doi.org/10.1016/j.jbef.2021.100477

O’Neill, T. J., Penn, J., & Terrell, R. D. (2008). The role of higher oil prices: A case of major developed countries. Research in Finance, 24, 287–299. https://doi.org/10.1016/S0196-3821(07)00211-0

Oxford Martin School (n.d.). Oxford martin programme on global development. University of Oxford. https://ourworldindata.org/

Papadamou, S., Fassas, A., Kenourgios, D., & Dimitriou, D. (2020). Direct and indirect effects of COVID-19 pandemic on implied stock market volatility: Evidence from panel data analysis (MPRA Paper 100020). University Library of Munich.

Reboredo, J. C., & Rivera-Castro, M. A. (2013). A wavelet decomposition approach to crude oil price and exchange rate. Economics Modelling, 32, 42–57.

Pierson, D. (2020). Dying doctors. Too many coffins. Indonesia late in battle against coronavirus. Los Angeles Times. https://www.latimes.com/world-nation/story/2020-04-24/coronavirus-indonesia-response

Salisu, A. A., & Mobolaji, H. (2013). Modelling returns and volatility transmission between oil price and US–Nigeria exchange rate. Energy Economics, 39, 169–176.

Salisu, A. A., & Oloko, T. F. (2015). Modeling oil price-US stock nexus: A VARMA-BEKK-AGARCH approach. Energy Economics, 50, 1–12. https://doi.org/10.1016/j.eneco.2015.03.031

Salisu, A. A., Ebuh, G. U., & Usman, N. (2020). Revisiting oil-stock nexus during COVID-19 pandemic: Some preliminary results. International Review of Economics and Finance, 69, 280–294.

Sergi, B. B., Harjoto, A. A., Rossi, F., & Lee, R. (2021). Do stock markets love misery? Evidence from the COVID-19. Finance Research Letters. https://doi.org/10.1016/j.frl.2021.101923

South China Morning Post. (2020). Singapore extends coronavirus ‘circuit breaker’ measures to June 1. https://www.scmp.com/week-asia/health-environment/article/3080880/singapore-extends-coronavirus-circuit-breaker-measures

Sharma, G. D., Tiwari, A. K., Jain, M., Yadav, A., & Erkut, B. (2021). Unconditional and conditional analysis between COVID-16 cases, temperature, exchange rate and stock markets using wavelet coherence and wavelet partial coherence approaches. Heliyon, 7(2), 1–30.

Takyi, P. O., & Bentum-Ennin, I. (2020). The impact of COVID-19 on stock market performance in Africa: A Bayesian structural time series approach. Journal of Economics and Business. https://doi.org/10.1016/j.jeconom.2020.105968

The Economic Times. (2020). India to observe ‘Janata curfew’ on Sunday amid spurt in Coronavirus cases. https://economictimes.indiatimes.com/news/politics-and-nation/india-to-observe-Janata-curfew-on-sunday-amid-spurt-in-coronavirus-cases/articleshow/74750784.cms?from=mdr

The JakartaPost. (2020). Indonesia late to respond to COVID-19 pandemic, former VP Kalla says. thejakartapost.com. https://www.thejakartapost.com/news/2020/03/19/indonesia-late-to-respond-to-covid-19-pandemic-former-vp-kalla-says.html.
Wang, Y. H., Yang, F. J., & Chen, L. J. (2013). An investor’s perspective on infectious diseases and their influence on market behavior. *Journal of Business Economics and Management, 14*(SUPPL1). https://doi.org/10.3846/1611699.2012.711360

Zhang, W., & Hamori, S. (2021). Crude oil market and stock markets during the COVID-19 pandemic: Evidence from the US, Japan and Germany. *International Review of Financial Analysis, 74*, 1–13.

Zhang, Y. J., Fan, Y., Tsai, H. T., & Wei, Y. M. (2008). Spillover effect of US dollar exchange rate on oil prices. *Journal of Policy Modeling, 30*(6), 973–991. https://doi.org/10.1016/j.jpolmod.2008.02.002

Zhang, D., Hu, M., & Ji, Q. (2020). Financial markets under the global pandemic of COVID-19. *Finance Research Letters*. https://doi.org/10.1016/j.frl.2020.101528

Zhao, H. (2010). Dynamic relationship between exchange rate and stock price: Evidence from China. *Research in International Business and Finance, 24*(2), 103–112. https://doi.org/10.1016/j.ribaf.2009.09.001