In this paper, we examine the predictive content of uncertainty due to pandemics and epidemics (UPE) for the exchange rate movements of selected Asian economies. Our results show evidence of superior out-of-sample predictability of a UPE-based predictive model over the benchmark model. Nonetheless, the predictability of UPE is stronger before the COVID-19 pandemic than it is after the outbreak and the resilience of the Asian economies to UPE is mixed.

I. Introduction

In this paper, we examine the predictive content of uncertainty due to epidemics and pandemics (UPE) for exchange rate movements. Restrictions during epidemics and pandemics limit the movement of labour, goods and services and, by extension, cause instabilities in exchange movements (see Narayan, 2020b, 2020c). A few related studies (see Iyke, 2020b; Narayan, 2020b, 2020c; Narayan et al., 2020) offer a pointer in this regard albeit with a focus on in-sample predictability which does not necessarily translate into improved out-of-sample predictability. Thus, our main contribution to the literature involves assessing both the in-sample and out-of-sample forecasts of the UPE. Improved out-of-sample forecasts of exchange rates are crucial for monetary policy effectiveness, particularly in terms of minimizing exchange rate risk with associated favorable effects on capital inflows. The connection between the UPE and exchange rate hinges on the risk-return hypothesis (such as the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT)), which assumes that financial assets respond to systematic (undiversifiable or market) risk (see Iyke & Ho, 2021). We follow the procedure of Salisu & Adediran (2020) and Salisu & Sikiru (2020), where the UPE serves as a predictor, while we employ the approach of Westerlund & Narayan (2012, 2015) to analyze the model. We utilize the new UPE dataset by Baker et al. (2020), which covers all the known epidemics and pandemics and comparatively evaluate its predictive ability relative to a benchmark model that ignores the UPE variable. Our choice of Asia is underscored by its increasing integration in the global trade—a trade that has declined due to the stringent actions aimed at curtailling the spread of and the COVID-19 pandemic.

Following our experiment with the new dataset, we report results that further advance the literature on exchange rate forecasting. We find evidence that lends support to the inclusion of UPE in a predictive model of exchange rate for improved out-of-sample forecasts while the currency movements seem tolerant to COVID-19 in selected countries. Further analyses also show evidence of out-of-sample predictability. Following this section, the rest of the paper is structured as follows: Section II is about data and methodology; Section III has results and discussion; and Section IV contains concluding remarks.

II. Data and Methodology

This study utilizes daily exchange rates of nine Asian economies, using US dollars as the reference currency, alongside the UPE data. Our data span the period 30/01/2006 to 29/01/2021 and the analysis covers both the full...
sample and the COVID-19 sample (01/01/2020 to 29/01/2021) to capture the impact of the current pandemic specifically on the exchange rate movements. We also include as control variables: (1) oil price, which is the West Texas Intermediate (WTI) crude oil price following the literature (Narayan et al., 2008; Salisu, Cuhado, et al., 2020; Salisu & Mobolaji, 2015; Sharma et al., 2019); and (2) the COVID-19 variable (Iyke, 2020b; Narayan, 2020b, 2020c; Narayan et al., 2020; Salisu & Adefarati, 2020). We follow the estimation procedure of Westerlund & Narayan (2012, 2015) with the specification given as:

$$e_{t} = \alpha + \sum_{i=1}^{5} \frac{\gamma_{i}^{adj} UPE_{t-i}}{\tilde{\gamma}_{i}^{adj}} + \varphi(UPE_{t} - \rho_{0}UPE_{t-1}) + \psi OHI_{t-1} + e_{t} \quad (1)$$

where $e_{t}$ is the series to be predicted and is measured as log return of exchange rate; $\alpha$ is the intercept; $UPE_{t}$ is the predictor series using the Baker et al. (2020) uncertainty index due to infectious diseases; $OHI$ is the log of WTI crude oil price; and $\varphi$ is the zero mean idiosyncratic error term. The coefficient $\gamma_{i}^{adj}$ is adjusted to capture any inherent persistence effect in the model and measures the impact of the $UPE_{t}$ on the exchange rate returns. We allow for a maximum of five lags in order to capture more dynamics in the estimation process. Therefore, the underlying null hypothesis of no predictability involves a joint (Wald) test as: $\sum_{i=1}^{5} \hat{\gamma}_{i}^{adj} = 0$, where the exchange rate is expected to increase with the pandemic if $\sum_{i=1}^{5} \hat{\gamma}_{i}^{adj} \geq 0$ or shred its value during the pandemic if $\sum_{i=1}^{5} \hat{\gamma}_{i}^{adj} < 0$ (Salisu, Raheem, et al., 2020; Salisu & Sikiru, 2020). The additional term $\varphi(UPE_{t} - \rho_{0}UPE_{t-1})$ corrects for any endogeneity bias resulting from the correlation between the $UPE_{t}$ and $e_{t}$, as well as any inherent unit root problem in the $UPE_{t}$. Finally, we pre-weight all the data with the inverse of the standard deviation obtained from a typical GARCH-type model and thereafter estimate the resulting equation with the OLS.

We complete the analysis with the evaluation of the $UPE$-based model in improving the accuracy of exchange rate returns relative to the historical average (constant returns) model that disregards the $UPE$ while the 75:25 data split is used for the in-and-out-of-sample forecast evaluations with multiple out-of-sample forecast horizons of 10, 20 and 50 days. We employ the pair-wise forecast measure of Clark & West (2007) test to compare the forecast performance. It follows that the rejection of the null hypothesis suggests that the $UPE$-based model for exchange rate movements outperforms the benchmark model.

III. Main Findings

We begin the discussion of results with the predictability of exchange rate movements for selected Asian economies across three periods (Pre-COVID-19, COVID-19 and full sample periods). Our findings, as contained in Table 1, show that, in the pre-COVID-19 period, the $UPE$ is a good predictor of the exchange rate movements in virtually all the nine countries except China given the evidence of statistically significant relationship between the two variables. The relationship is positive for China, India, Japan, Singapore, South Korea, Sri Lanka, and Thailand, implying some resilience of these economies to uncertainty due to pandemics and epidemics. The relationship is, however, negative for Hong Kong and Malaysia, suggesting their vulnerability to the $UPE$ during the pre-COVID-19 period. The resilience seems to decline after the announcement of the current pandemic as some countries that were resilient before the pandemic, such as China, India, Japan, and Singapore, are found to be vulnerable during the pandemic. This is expected because these countries, especially China, India, and Japan, have large trading partnerships with Africa, America and Europe whose economies were adversely affected by the current pandemic. Thus, the incidence of the current pandemic contributes to the observed volatility in exchange rates of some Asian economies (see also, Narayan, 2020b, 2020c). However, South Korea, Sri Lanka and Thailand still retain their resilience while the opposite is the case for Hong Kong and Malaysia. Overall (using the full sample), about 60% of countries show some resilience to the $UPE$ while 40% of countries (China, Hong Kong, Malaysia, and South Korea) seem vulnerable to it.

Moreover, the in-sample forecast evaluation results in Table 2 show that in the pre-COVID-19 period, our proposed model outperforms the benchmark model for all the countries. The forecast efficiency of the $UPE$-based model slightly declines during the COVID-19 period relative to the period before it as the historical average model outperforms the proposed model for Thailand, China and Sri Lanka. In general, the proposed model outperforms the benchmark model for all the nine countries, contrary to the result of Chen et al. (2010) and Ferraro et al. (2015).

IV. Conclusion

We test the predictive contents of uncertainty due to pandemics and epidemics for exchange rate movements for nine Asian countries, covering the period before and during the current pandemic (COVID-19). On the average, the predictability of $UPE$ is stronger before the COVID-19 pandemic than it is after the outbreak. The vulnerabilities of the considered exchange rates are mixed: some countries became vulnerable after the outbreak of COVID-19 while the opposite is the case for others. On the whole, including the $UPE$ in the predictive model of exchange rate movements offers better out-of-sample forecast outcomes compared to the benchmark constant returns model.
Table 1: Vulnerability and predictability results

|                      | Pre-COVID-19 sample (1/30/2006 - 12/31/2019) | COVID-19 sample (1/1/2020 - 1/29/2021) | Full sample (1/30/2006 - 1/29/2021) |
|----------------------|-----------------------------------------------|----------------------------------------|--------------------------------------|
|                      | China                                        | Hong-Kong                              | India                                | Japan                                | Malaysia                              | Singapore                             | South Korea                          | Sri Lanka                             | Thailand                             |
| UPE                  | 9.08E-06                                     | -0.0006a                               | 0.0163a                              | 0.022a                               | -0.0028a                              | 0.0103a                               | 0.0214a                              | 0.0015a                              | 0.0049a                              |
|                      | [0.0014]                                     | [131.9939]                             | [130.7655]                           | [16.2329]                            | [8.0262]                               | [19.5120]                             | [28.5919]                            | [67.0820]                            | [25.5523]                            |
| Nobs                 | 3632                                         | 3632                                   | 3632                                 | 3632                                 | 3632                                   | 3632                                   | 3632                                 | 3632                                 | 3632                                 |
|                      |                                               |                                         |                                       |                                       |                                         |                                       |                                       |                                       |                                       |
| UPE                  | -0.0024a                                     | 6.64E-05a                              | -0.0022c                             | -0.0032b                             | 0.0003                                 | -0.0015                               | 0.0015                               | 0.0072a                              | 0.0036a                              |
|                      | [18.9797]                                    | [11.6602]                              | [3.3590]                             | [4.7377]                             | [1.2017]                               | [2.5525]                               | [2.4037]                             | [128.1038]                           | [64.1387]                            |
| Nobs                 | 283                                          | 283                                    | 283                                  | 283                                  | 283                                    | 283                                    | 283                                  | 283                                  | 283                                  |

This table shows the vulnerability and predictability results. UPE denotes uncertainty due to pandemics and epidemics and it is used to represent Equity Market Volatility: Infectious Disease Tracker, Index as developed by Baker et al. (2020). Values in square brackets represent F-statistic. Nobs is the number of observations. Finally, a, b and c represent 1%, 5% and 10% significance levels, respectively.
### Table 2: Out-of-sample forecast evaluation results

|                  | Pre-COVID-19 (1/30/2006 - 12/31/2019) | COVID-19 (1/1/2020 - 1/29/2021) | Full sample (1/30/2006 - 1/29/2021) |
|------------------|--------------------------------------|---------------------------------|--------------------------------------|
|                  | h = 10                  | h = 20          | h = 30          | h = 10                  | h = 20          | h = 30          | h = 10                  | h = 20          | h = 30          |
| China            | 0.000453<sup>a</sup>     | 0.000453<sup>a</sup> | 0.000452<sup>a</sup> | 0.000027                | 0.000313<sup>a</sup> | 0.0003046     | 0.000505<sup>a</sup>     | 0.000503<sup>a</sup> | 0.000502<sup>a</sup> |
|                  | (5.206)                  | (5.228)         | (5.226)         | (1.419)                  | (1.549)         | (1.566)         | (5.354)                  | (5.355)         | (5.350)         |
| Hong Kong        | 0.0000037<sup>c</sup>   | 0.00000368<sup>c</sup> | 0.00000366<sup>c</sup> | 0.0000588<sup>b</sup>   | 0.0000576<sup>c</sup> | 0.0000561<sup>b</sup> | 0.00000305<sup>c</sup> | 0.00000309<sup>c</sup> | 0.00000307<sup>c</sup> |
|                  | (1.903)                  | (1.903)         | (1.898)         | (2.225)                  | (2.272)         | (2.308)         | (1.578)                  | (1.603)         | (1.599)         |
| India            | 0.020841<sup>a</sup>    | 0.020777<sup>a</sup> | 0.020737<sup>a</sup> | 0.00278<sup>c</sup>   | 0.001933<sup>c</sup> | 0.001462<sup>c</sup> | 0.0018764<sup>a</sup> | 0.0018684<sup>a</sup> | 0.0018624<sup>a</sup> |
|                  | (7.772)                  | (7.775)         | (7.788)         | (0.434)                  | (0.308)         | (0.242)         | (7.904)                  | (7.896)         | (7.897)         |
| Japan            | 0.00914<sup>a</sup>     | 0.009023<sup>a</sup> | -0.001043<sup>c</sup> | -0.000668<sup>b</sup>  | -0.000884<sup>c</sup> | 0.013403<sup>a</sup> | 0.013307<sup>a</sup> | 0.013325<sup>a</sup> | 0.01325<sup>a</sup> |
|                  | (3.620)                  | (3.599)         | (-0.110)        | (-0.073)                 | (-0.101)        | (4.198)         | (4.181)                  | (4.177)         | (4.177)         |
| Malaysia         | 0.008349<sup>a</sup>    | 0.008349<sup>a</sup> | 0.005847<sup>c</sup> | 0.00569<sup>b</sup>   | 0.005319<sup>b</sup> | 0.007831<sup>a</sup> | 0.00078<sup>a</sup> | 0.007773<sup>a</sup> |
|                  | (7.116)                  | (7.144)         | (2.094)         | (2.115)                  | (2.053)         | (7.364)         | (7.359)                  | (7.356)         | (7.356)         |
| Singapore        | 0.022872<sup>a</sup>    | 0.022832<sup>a</sup> | 0.022821<sup>a</sup> | 0.004417<sup>d</sup>  | 0.004656<sup>b</sup> | 0.004162<sup>b</sup> | 0.021124<sup>a</sup> | 0.021052<sup>a</sup> | 0.02103<sup>a</sup> |
|                  | (11.617)                 | (11.634)        | (11.669)        | (0.835)                  | (0.854)         | (11.752)        | (11.747)                 | (11.774)        | (11.774)        |
| South Korea      | 0.022061<sup>a</sup>    | 0.02205<sup>a</sup> | 0.022108<sup>a</sup> | 0.006703<sup>d</sup>  | 0.007087<sup>b</sup> | 0.006906<sup>b</sup> | 0.022005<sup>a</sup> | 0.021917<sup>a</sup> | 0.021865<sup>a</sup> |
|                  | (4.4046)                 | (4.417)         | (4.444)         | (0.817)                  | (0.900)         | (0.913)         | (4.520)                  | (4.517)         | (4.519)         |
| Sri Lanka        | 0.00000533<sup>c</sup> | 0.00005558<sup>c</sup> | 0.0000524<sup>c</sup> | 0.004772                | 0.00462         | 0.004881        | 0.0000851<sup>c</sup>    | 0.0000822<sup>c</sup> | 0.0000807<sup>c</sup> |
|                  | (0.332)                  | (0.349)         | (0.329)         | (1.136)                  | (1.148)         | (1.261)         | (0.537)                  | (0.520)         | (0.513)         |
| Thailand         | 0.004901<sup>a</sup>    | 0.004867<sup>a</sup> | 0.00487<sup>a</sup> | 0.007362                | 0.007092        | 0.006237        | 0.0046064<sup>a</sup>    | 0.004064<sup>a</sup> | 0.004593<sup>a</sup> |
|                  | (6.083)                  | (6.059)         | (6.084)         | (1.589)                  | (1.599)         | (1.456)         | (6.164)                  | (6.176)         | (6.187)         |
| Nobs             | 3642                    | 3652            | 3662            | 293                     | 303             | 313             | 3925                     | 3935            | 3945            |

This table shows the out-of-sample forecast evaluation results. Nobs is the number of observations. The symbols <sup>a</sup>, <sup>b</sup> and <sup>c</sup> represent 1%, 5% and 10% significance levels, respectively. Values reported in parenthesis are the t-statistics. For the Clark and West test, the null hypothesis of a zero coefficient is rejected if this statistic is greater than +1.282 (for a one sided 0.10 test), +1.645 (for a one sided 0.05 test), and +2.00 for a one sided 0.01 test (for a one sided 0.01 test) (see Clark & West, 2007).
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