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# Can Uncertainty Due to Pandemic Predict Asia-Pacific Energy Stock Markets?

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In this note, we examine the predictability of the energy stock markets using the diseases-based uncertainty index within a nonparametric framework. The nonparametric causality test reveals that energy stocks' predictability driven by pandemic uncertainty is prevalent around the lower and upper quantiles for both the full sample of data and for the COVID-19 sample period.

### I. Introduction

The objective of this study is to examine the role of disease-based uncertainty in predicting energy stock markets. The motivation for our study is threefold. First, the current COVID-19 pandemic has shown that stock markets and financial markets of many countries are sensitive to the pandemic (see, Bouri et al., 2020). Second, uncertainty that created by pandemics that impact health have significant influence on investors' actions (Baker et al., 2020) and sentiments (HaiYue et al., 2020). Lastly, uncertainty due to the pandemic might restrain the demand for energy which subsequently leads to fall in stock prices and returns (see Sharma & Sha, 2020; and Sha & Sharma, 2020).

Several studies have documented that the fluctuations in the stock market during the pandemic can be tracked by the uncertainty resulting from economic and non-economic news. For instance, past studies have noted that disasters (Kowalewski & Spiewanowski, 2020) and epidemics (C. D. Chen et al., 2009; M.-H. Chen et al., 2007; Ichev & Marinč, 2018; Salisu & Adediran, 2020; Salisu & Vo, 2020) significantly influence the stock market. To be more specific, Salisu & Adediran (2020) unveil that uncertainty due to the pandemic tracks well the volatility in energy markets in both in-sample and out-of-sample tests. Furthermore, Salisu & Vo (2020) document that investors started to sell off their stocks during the early stages of the COVID-19 pandemic due to fear of loss. On the other hand, Liu et al. (2020) show that COVID-19 exerts a positive influence on the crude oil and stock returns.

To the best of our knowledge, there is limited understanding about the influence of uncertainty caused by pandemics on the Asia-Pacific energy stocks. On this note, we extend the literature by determining the role of pandemics in predicting energy stocks for the Asia-Pacific market. We partition our estimation into two by considering the full

sample of data and the COVID-19 sample of data. To this end, we utilize the novel nonparametric causality-in-quantiles approach recently developed by Balcilar et al. (2018). This approach is capable of testing non-linear causality of the  $k$ th order across all quantiles of the entire distribution of stock returns, and is robust to the presence of misspecification errors, structural breaks and frequent outliers, which are commonly found in financial time series data (Balcilar et al., 2018). Another motivation for using the nonparametric quantile-in-causality approach is that when we conduct a test for nonlinearity by applying the Brock et al. (BDS, 1996), the BDS test validates the adoption of the non-linear causality-in-quantiles approach (see for example Fasanya et al., 2021).

The rest of the paper is structured as follows. Section II provides a description of the methodology. Section III discusses the data and results and Section IV concludes.

### II. Methodology

This paper follows Balcilar et al. (2018) methodology, which is an extension of Nishiyama et al. (2011) and Jeong et al. (2012) nonlinear causality frameworks. As noted by Jeong et al. (2012), the variable  $x_t$  (EMV-ID) does not cause  $y_t$  (energy stock returns) in the  $\sigma$ -quantile with respect to the lag-vector of  $\{y_{t-1}, \dots, y_{t-q}, x_{t-1}, x_{t-q}\}$  if

$$Q_{\sigma}(y_t|y_{t-1}, \dots, y_{t-q}, x_{t-1}, \dots, x_{t-q}) = Q_{\sigma}(y_t|y_{t-1}, \dots, y_{t-q}) \quad (1)$$

While  $x_t$  causes  $y_t$  in the  $\sigma$ th quantile with respect to  $\{y_{t-1}, \dots, y_{t-q}, x_{t-1}, x_{t-q}\}$  if

$$Q_{\sigma}(y_t|y_{t-1}, \dots, y_{t-q}, x_{t-1}, x_{t-q}) \neq Q_{\sigma}(y_t|y_{t-1}, \dots, y_{t-q}) \quad (2)$$

Thus, they adopt the nonparametric Granger-quantile-causality approach of Nishiyama et al. (2011). To illustrate the causality in higher order moment, they assume:

$$y_t = h(V_{t-1}) + \vartheta(U_{t-1})\tau_t, \quad (3)$$

Where  $\tau_t$  is the white noise process and  $h(\cdot)$  and  $\vartheta(\cdot)$  equal the unknown functions that satisfy pertinent conditions for stationarity. Although this specification allows non granger-type causality testing from  $U_{t-1}$  to  $y_t$ , however, it could detect the “predictive power” from  $U_{t-1}$  to  $y_t^2$  when  $\vartheta(\cdot)$  is a general nonlinear function. Thus, Equation (3) is re-formulated to account for the null and alternative hypothesis for causality in Equations 4 and 5, respectively.

$$H_0 = P\left\{F_{y_t^2|W_{t-1}}\{Q_\sigma(y_t|W_{t-1})\} = \sigma\right\} = 1, \quad (4)$$

$$H_1 = P\left\{F_{y_t^2|W_{t-1}}\{Q_\sigma(y_t|W_{t-1})\} = \sigma\right\} < 1, \quad (5)$$

We obtain the feasible test statistic for testing the null hypothesis in Equation (4). With the inclusion of the Jeong et al. (2012) approach, Balciar et al. (2018) overcome the issue that causality in mean implies causality in variance. Specifically, they interpret the causality in higher-order moments through the use of the following model:

$$y_t = h(U_{t-1}, V_{t-1}) + \tau_t, \quad (6)$$

Thus, the higher order quantile causality is:

$$H_0 = P\left\{F_{y_t^k|W_{t-1}}\{Q_\sigma(y_t|W_{t-1})\} = \sigma\right\} = 1, \quad (7)$$

for  $k = 1, 2, \dots, k,$

$$H_1 = P\left\{F_{y_t^k|W_{t-1}}\{Q_\sigma(y_t|W_{t-1})\} = \sigma\right\} < 1, \quad (8)$$

for  $k = 1, 2, \dots, k.$

Overall, we test that  $x_t$  Granger causes  $y_t$  in  $\sigma$ th quantile up to the  $k$ -th moment through the use of Equation (7) to construct the test statistic of the equation of the first moment (null hypothesis) for each  $k$ . Failure to reject the null of  $k=1$  does not translate into non-causality in variance, thus, we construct the tests for  $k=2$ . Finally, we test for the existence of causality-in-mean and variance.

### III. Data and Results

#### A. Data and Preliminary Analyses

This paper covers energy stock indices (from which stock returns are computed) of 10 Asia-Pacific countries. These countries are Australia, China, Hong Kong, India, Indonesia, Japan, Korea, Singapore, Taiwan, and Thailand. We use daily data from January 1, 2004 to August 31, 2020 based on data availability. The analyses are conducted using both the full sample and the sample covering the COVID-19 pandemic (01/01/2020 to 31/08/2020). Data on the energy stock indices are obtained from the Thomson Reuters DataStream, and the Infectious Disease Equity Market Volatility (EMV-ID), developed by Baker et al. (2020) and is available for download from <http://www.policyuncertainty.com>.

Table 1 highlights the relevant descriptive properties of the data. The energy stock indices of all countries consid-

ered have positive returns on average, except for China, Japan, and Singapore, which carry negative average returns. However, a large difference is observed between the maximum and minimum values across all series, indicating potential high levels of fluctuations. Based on the standard deviation statistic, the Indonesian stock market is the most volatile while the Australian market experiences the least volatility. Concerning the statistical distribution of the return series, the skewness measure suggests that stock returns of Korea and Singapore are positively skewed, which means they have a long right tail while all others exhibit negative skewness. The kurtosis statistics also reveal that all series are largely leptokurtic (highly peaked). The Jarque-Bera statistic confirms non-normality. Furthermore, we explore the random walk properties of all the variables using the Ng-Perron, and Dickey-Fuller GLS tests, and all series appear to be stationary at the 5% significance level. This is a pre-requisite for our causality analysis.

#### B. Results

We begin the analysis by examining the causal effect of uncertainties due to infectious disease outbreaks on the returns of each of the energy stock indices from a linear perspective.<sup>1</sup> However, we perceive this may likely be due to nonlinearity in the series, as the presence of heavy tails, excess kurtosis, and non-normality are suggestive of the possibility of the nonlinear nature of the series.

Furthermore, to confirm our suspicion, we conduct a more formal test (BDS test) developed by Broock et al. (1996) to establish the presence of nonlinearity in the series. The BDS test results for the full sample and the COVID-19 regimes are reported in Table 2. Our analysis shows strong evidence of a nonlinear relationship between EMV\_ID and all return series as the null hypothesis of serial dependence is rejected at the highest levels of significance for all countries except China, Indonesia, and Taiwan (Panel B). These results imply strong evidence of nonlinearity in the relationship between EMV\_ID and energy stock returns. This means that relying on the linear Granger-causality test may lead to spurious conclusions as it could have suffered from misspecification errors.

Having established nonlinearity, we turn to the results of the quantiles-based causality tests. Figures 1 and 2 summarize the results of the nonparametric causality-in-quantiles in conditional mean and conditional variance tests, respectively. Each country’s stock-market returns are regressed on the EMV\_ID. The horizontal axis shows the quantiles, and the vertical axis shows the test results. The blue horizontal line represents the 90% critical value. The red line represents the results for the full sample, and the grey line represents the results for the COVID-19 sample.

<sup>1</sup> Available upon request from the authors.

**Table 1: Preliminary test results**

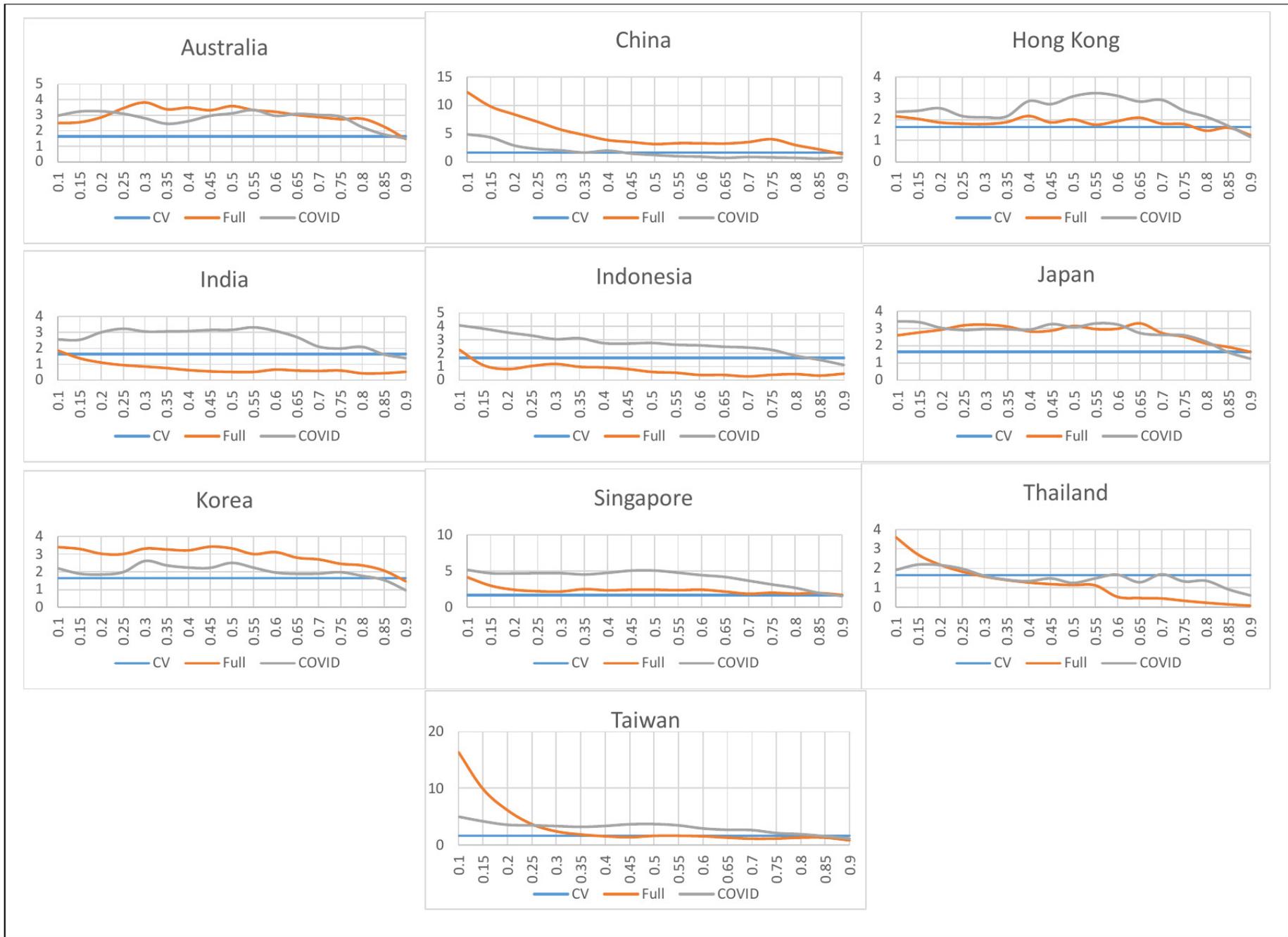
Countries	Panel A: Summary Statistics							Panel B: Unit Root Test	
	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	JB Stat.	Ng-Perron	DF-GLS
Australia	0.010	9.5502	-18.4318	1.5476	-0.8564	13.1282	19115.73***	-2168.55***	-62.840***
China	-0.0055	9.4292	-21.6925	1.8248	-0.2810	13.2020	18913.26***	-2173.32***	-66.532***
Hong Kong	0.0305	19.1451	-15.476	2.1868	-0.0703	9.8115	8409.035***	-2167.47***	-62.539***
India	0.0288	16.4636	-16.4616	1.7069	-0.7074	15.1549	27128.23***	-20.334**	-5.005***
Indonesia	0.0373	19.7579	-31.5353	2.3715	-0.3546	15.5845	28782.29***	-2167.70***	-62.600***
Japan	-0.0046	12.3267	-14.0222	1.8115	-0.2558	7.3283	3441.368***	-2171.78***	-64.091***
Korea	0.0214	16.9346	-14.5847	2.0804	0.0926	8.8016	6104.06***	-153.765***	-13.612***
Singapore	-0.0017	13.8816	-12.7891	1.7366	0.0632	10.3514	9793.816***	-1133.24***	-27.644***
Taiwan	0.0142	9.4433	-11.2462	1.5797	-0.0816	7.2166	3225.848***	-2171.46***	-67.971***
Thailand	0.0121	14.078	-30.0363	1.8795	-1.0876	25.4200	91921.72***	-1981.06***	-44.906***
EMV_ID	1.2457	68.37	0	5.1161	7.1915	62.9391	688354.6***	-25.067***	-3.553***

Note: This table is organized into two panels. Panel A presents descriptive statistics of the variables while Panel B presents results of the augmented Ng-Perron and the DF-GLS unit root tests. The symbols \*\*\*, \*\*, \* represent a rejection of the underlying null hypothesis of non-stationarity at the 1%, 5%, and 10% levels of significance, respectively.



**Figure 1: Quantile-based (nonlinear) causality test in conditional mean**

Note: The above figures are graphical representations of the causality-in-quantiles in conditional mean and conditional variance results. CV represents critical value at the 10% level.



**Figure 2: Quantile-based (nonlinear) causality test in conditional variance**

Note: The above figures are graphical representations of the causality-in-quantiles in conditional mean and conditional variance results. CV represents critical value at the 10% level.

**Table 2: BDS Test Results**

Panel A: Full sample					
	2	3	4	5	6
Australia	0.0221***	0.0439***	0.0600***	0.0696***	0.0735***
China	0.0275***	0.0567***	0.0793***	0.0931***	0.0994***
Hong Kong	0.0223***	0.0452***	0.0631***	0.0748***	0.0794***
India	0.0200***	0.0406***	0.0546***	0.0618***	0.0642***
Indonesia	0.0264***	0.0504***	0.0678***	0.0782***	0.0823***
Japan	0.0138***	0.0286***	0.0394***	0.0454***	0.0480***
Korea	0.0154***	0.0310***	0.0429***	0.0504***	0.0531***
Singapore	0.0326***	0.0617***	0.0844***	0.0981***	0.1057***
Taiwan	0.0117***	0.0254***	0.0347***	0.0398***	0.0418***
Thailand	0.0202***	0.0419***	0.0572***	0.0645***	0.0670***
Panel B: During COVID-19					
Australia	0.0408***	0.0828***	0.1185***	0.1342***	0.1347***
China	0.0111	0.0176	0.0321**	0.0370***	0.0353***
Hong Kong	0.0206***	0.0476***	0.0562***	0.0661***	0.0687***
India	0.0168**	0.0378***	0.0515***	0.0552***	0.0577***
Indonesia	-0.0051	0.0138	0.0257**	0.0313***	0.0305***
Japan	0.0186***	0.0299***	0.0440***	0.0468***	0.0454***
Korea	0.0297***	0.0600***	0.0734***	0.0797***	0.0772***
Singapore	0.0275***	0.0523***	0.0743***	0.0906***	0.0953***
Taiwan	0.0008	0.0182	0.0280*	0.0367**	0.0347**
Thailand	0.0370***	0.0817***	0.1131***	0.1304***	0.1336***

Note: Values in the cell represent the BDS test statistic. The symbols \*\*\*, \*\*, \* represent the rejection of the underlying null hypothesis of linearity at the 1%, 5%, and 10% levels of significance, respectively.

Our results show strong evidence supporting the rejection of the null hypothesis of no Granger-causality for both the full sample and for the COVID-19 period. The causal evidence is most significant at the lower and upper quantiles with a few reaching the median region. This indicates a strong causal relationship between uncertainty due to infectious diseases and energy stock returns in the Asia-Pacific region. By implication, investors in the Asia-Pacific energy market may need to consider the likely effects of global pandemics in the valuation of risk-adjusted returns for energy stocks in particular and perhaps in their diversification of financial assets in general. The risk management framework should be reassessed to address new and enhanced risks caused by the COVID-19 pandemic.

#### IV. Conclusion

In this study, we examine the causal relationship be-

tween uncertainties due to infectious disease outbreaks and the Asia-Pacific energy market. We utilize a new dataset by Baker et al. (2020) and employ the nonparametric quantile-based approach. Our findings strongly support the nonlinear causal relationship between uncertainties due to infectious disease outbreaks and the Asia-Pacific energy market. Investors may need to consider the likely effects of global pandemics in the valuation of risk-adjusted returns for energy stocks in particular and perhaps in their diversification of financial assets in general. This conclusion complements the emerging literature on the vulnerability of the energy market to the COVID-19 pandemic.

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## REFERENCES

- Baker, S. R., Bloom, N., Davis, S. J., & Terry, S. (2020). *Covid-induced economic uncertainty* (NBER Working Paper No. 26983). National Bureau of Economic Research. <https://doi.org/10.3386/w26983>
- Balcilar, M., Gupta, R., Pierdzioch, C., & Wohar, M. E. (2018). Terror attacks and stock-market fluctuations: Evidence based on a nonparametric causality-in-quantiles test for the G7 countries. *The European Journal of Finance*, 24(4), 333–346. <https://doi.org/10.1080/1351847x.2016.1239586>
- Bouri, E., Cepni, O., Gabauer, D., & Gupta, R. (2020). *Return Connectedness across Asset Classes around the COVID-19 Outbreak*. University of Pretoria, Department of Economics Working Paper Series. <https://doi.org/10.1016/j.irfa.2020.101646>
- Broock, W. A., Scheinkman, J. A., Dechert, W. D., & LeBaron, B. (1996). A test for independence based on the correlation dimension. *Econometric Reviews*, 15(3), 197–235. <https://doi.org/10.1080/07474939608800353>
- Chen, C. D., Chen, C. C., Tang, W. W., & Huang, B. Y. (2009). The positive and negative impacts of the SARS outbreak: A case of the Taiwan industries. *J. Dev. Areas*, 43, 281–293.
- Chen, M.-H., Jang, S. S., & 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>
- Fasanya, I., Oyewole, O., & Odei-Mensah, J. (2021). Infectious diseases-energy futures nexus: A quantile-on-quantile approach. *Energy Research Letters*, 1(4). <https://doi.org/10.46557/001c.18267>
- HaiYue, L., Yile, W., Dongmei, H., & Cangyu, W. (2020). Short term response of Chinese stock markets to the outbreak of COVID-19. *Applied Economics*. <https://doi.org/10.1080/00036846.2020.1776837>
- Ichev, R., & Marinč, M. (2018). Stock prices and geographic proximity of information: Evidence from the Ebola outbreak. *International Review of Financial Analysis*, 56, 153–166. <https://doi.org/10.1016/j.irfa.2017.12.004>
- Jeong, K., Härdle, W. K., & Song, S. (2012). A Consistent Non-parametric Test for Causality in Quantile. *Econometric Theory*, 28(4), 861–887. <https://doi.org/10.1017/s0266466611000685>
- Kowalewski, O., & Śpiewanowski, P. (2020). Stock market response to potash mine disasters. *Journal of Commodity Markets*, 20, 100124. <https://doi.org/10.1016/j.jcomm.2020.100124>
- Liu, L., Wang, E.-Z., & Lee, C.-C. (2020). Impact of the COVID-19 pandemic on the crude oil and stock markets in the US: A time-varying analysis. *Energy Research Letters*, 1(1). <https://doi.org/10.46557/001c.13154>
- Nishiyama, Y., Hitomi, K., Kawasaki, Y., & Jeong, K. (2011). A consistent non-parametric test for nonlinear causality-specification in time series regression. *Journal of Econometrics*, 165(1), 112–127. <https://doi.org/10.1016/j.jeconom.2011.05.010>
- Salisu, A. A., & Adediran, I. (2020). Uncertainty due to infectious diseases and energy market volatility. *Energy Research Letters*, 1(2). <https://doi.org/10.46557/001c.14185>
- Salisu, A. A., & Vo, X. V. (2020). Predicting stock returns in the presence of COVID-19 pandemic: The role of health news. *International Review of Financial Analysis*, 71, 101546. <https://doi.org/10.1016/j.irfa.2020.101546>
- Sha, Y., & Sharma, S. S. (2020). Research on Pandemics Special Issue of the Journal Emerging Markets Finance and Trade. *Emerging Markets Finance and Trade*, 56(10), 2133–2137. <https://doi.org/10.1080/1540496x.2020.1795467>
- Sharma, S. S., & Sha, Y. (2020). Part A: Special Section on COVID-19 Research. *Emerging Markets Finance and Trade*, 56(15), 3551–3553. <https://doi.org/10.1080/1540496x.2020.1858617>