The Behaviour of Forex Market During the First and Second Wave of COVID-19: A Wavelet Analysis

Ahmed Arif (Corresponding Author)

FAST School of Management, National University of Computer and Emerging Sciences, Lahore-Campus, Pakistan. E-mail: ahmed.arif@nu.edu.pk

Asif Saeed

FAST School of Management, National University of Computer and Emerging Sciences, Lahore-Campus, Pakistan. E-mail: asif.saeed@nu.edu.pk

Umer Farooq

Lincoln International Business School, University of Lincoln, United Kingdom. E-mail: ufarooq@lincoln.ac.uk

The Behaviour of Forex Market During the First and Second Wave of COVID-19: A Wavelet Analysis

Abstract
This study evaluates the behaviour of the forex market during the first and the second wave of COVID-19. We have analysed the behaviour of exchange rates of CNY, JPY, CHF, and GBP in response to daily cases of COVID-19 and daily deaths, using Continuous Wavelet Transform and Wavelet Transform Coherence. The results show that the second wave has been more aggressive. The relationship of new cases and deaths has been more significant and negative with the exchange rates during the second wave of COVID-19. The currencies that are considered safe havens are severely affected by COVID-19 during the second wave.

Keywords: COVID-19, COVID-19 Waves, Forex Market, Wavelet Analysis
JEL Code: C-50; E-44; G-15

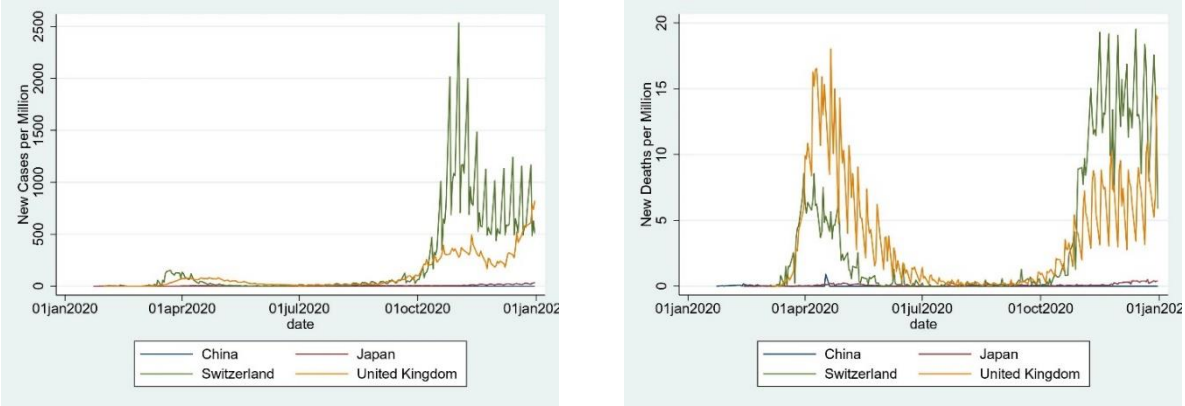
1. Introduction

The World Health Organization (WHO) declared COVID-19 as a pandemic in March 2020 (WHO, 2020). It started from Wuhan, China, but soon spread to other countries. The harsh measures to contain the spread of COVID-19 gave rise to economic uncertainty. According to Humala & Rodriguez (2013), macroeconomic uncertainty increases the volatility in the Forex and other markets. This study evaluates the behaviour of the forex market during this pandemic and analyses the association of forex rates with new positive cases and the death toll of COVID-19.

Figure 1 shows the daily cases per million (DCM) and daily death per million (DDM) from 22-Jan-2020 till 31-Dec-2020. This figure shows that the world has experienced two waves of COVID-19 till the end of 2020. There is a period when cases and deaths reduce significantly. We call this a stable period. The time before and after this period is classified as the first and the second wave, respectively. It is evident from Figure 1 that the second wave has been more contagious and aggressive, as higher numbers of DCM and DDM are visible in this period. The previous studies about the economic impact of COVID-19 do not make the classification of the first and the second wave (see e.g. Feng et al., 2021; Iqbal et al., 2020). The second wave is still under-investigated in the emerging literature on COVID-19.

This study is an endeavour to evaluate the behaviour of the forex market during the first and the second wave of COVID-19. We have analysed that how the forex market responded to DCM and DDM in these two waves by using the data from Jan-2020 till Dec-2020 for four countries, namely China, Japan, Switzerland, and United Kingdom. The analysis is performed through Continuous Wavelet Transform (CWT) and Wavelet Transform Coherence (WTC). This analysis helps understand how the forex market reacted to the changes in the number of COVID-19 cases and resultant deaths.

Figure 1: Country-Wise Situation of COVID-19



2. Material and Methods

2.1. Data

The forex market data fetch from Meta Quotes Software Corp, while the data of COVID-19 come from Worldometer.com. We have used DCM and DDM to gauge the severity of COVID-19 waves in the selected countries. These countries are selected as the first case of COVID-19 was officially reported in China, whereas the Japanese Yen (JPY) and Swiss Franc (CHF) are considered as safe havens in the forex market, and Great Britain Pound (GBP) is a major currency in the forex market.

2.2. Methodology

We have employed CWT to see the variation of exchange rates during the COVID-19 period and WTC to analyse the association of DCM and DDM with the exchange rate. Wavelet analysis provides multiple benefits, as we can relax the assumptions of stationarity and normal distribution and it offers more accurate tracking of co-movements of different time series (Iqbal et al., 2020).

The use of Wavelet analysis is increasing in the studies of economics and finance (Gherghina & Simionescu, 2021; Iqbal et al., 2020). Jammazi et al. (2015) argue about the suitability of wavelet methods to detect extreme movements while controlling the noise in forex market data. It represents the signal both in terms of frequency and time at the same time. A signal is decomposed in some basic functions called the daughter wavelets, denoted by $\psi_{\tau,s}(t)$. The mother wavelet (Ψ_t) is expressed as a function of the time position τ and the scale parameter s. Wavelets are defined as:

$$\psi_{\tau,s} = \frac{1}{\sqrt{s}}\,\psi\left\{\frac{t-\tau}{s}\right\} \; where\; s \neq 0, \tau \in \Re \qquad 1$$

The wavelet coefficient contains the information about the wavelet-based decomposition of $\psi_{\tau,s}$, and the function x(t). It is defined as:

$$W_x(\tau,s) = \frac{1}{\sqrt{s}}\int_{-\infty}^{+\infty} x(t)\;\psi^*_{\tau,s}\left(\frac{t-\tau}{s}\right) \qquad 2$$

where ψ^* is the complex conjugate of ψ. We selected Morlet Wavelet, following some previous studies (Firouzi & Wang, 2019; Iqbal et al., 2020), as it provides an optimal resolution with respect to time and frequency. We used WTC to analyse the co-movement of forex rates along with DCM and DDM. WTC is defined as (Torrence & Webster, 1999):

$$R_{xy}^2(\tau, s) = \frac{\left|S\left(W_{xy}(\tau,s)\right)\right|^2}{S(|W_x(\tau,s)|^2).S(|W_y(\tau,s)|^2)} \quad 3$$

where S is the smoothing operator applied to time and frequency. WTC gauges the extent to which two time-series move together over time and frequency (see e.g. Akoum et al., 2012). The value of $R_{xy}^2(\tau, s)$ varies from 0 to 1, where the value close to 1 shows a strong relationship between the two time-series and vice versa.

3. Results and Discussion

Table 1 presents the country-wise descriptive statistics. This table shows that although the COVID-19 pandemic started in China, the alarming situation that is visible in Switzerland and United Kingdom during the second wave is not seen in China. However, comparatively moderate measures taken by other countries like Switzerland resulted in higher cases of COVID-19 in the second wave[1].

Table 1: Descriptive Statistics

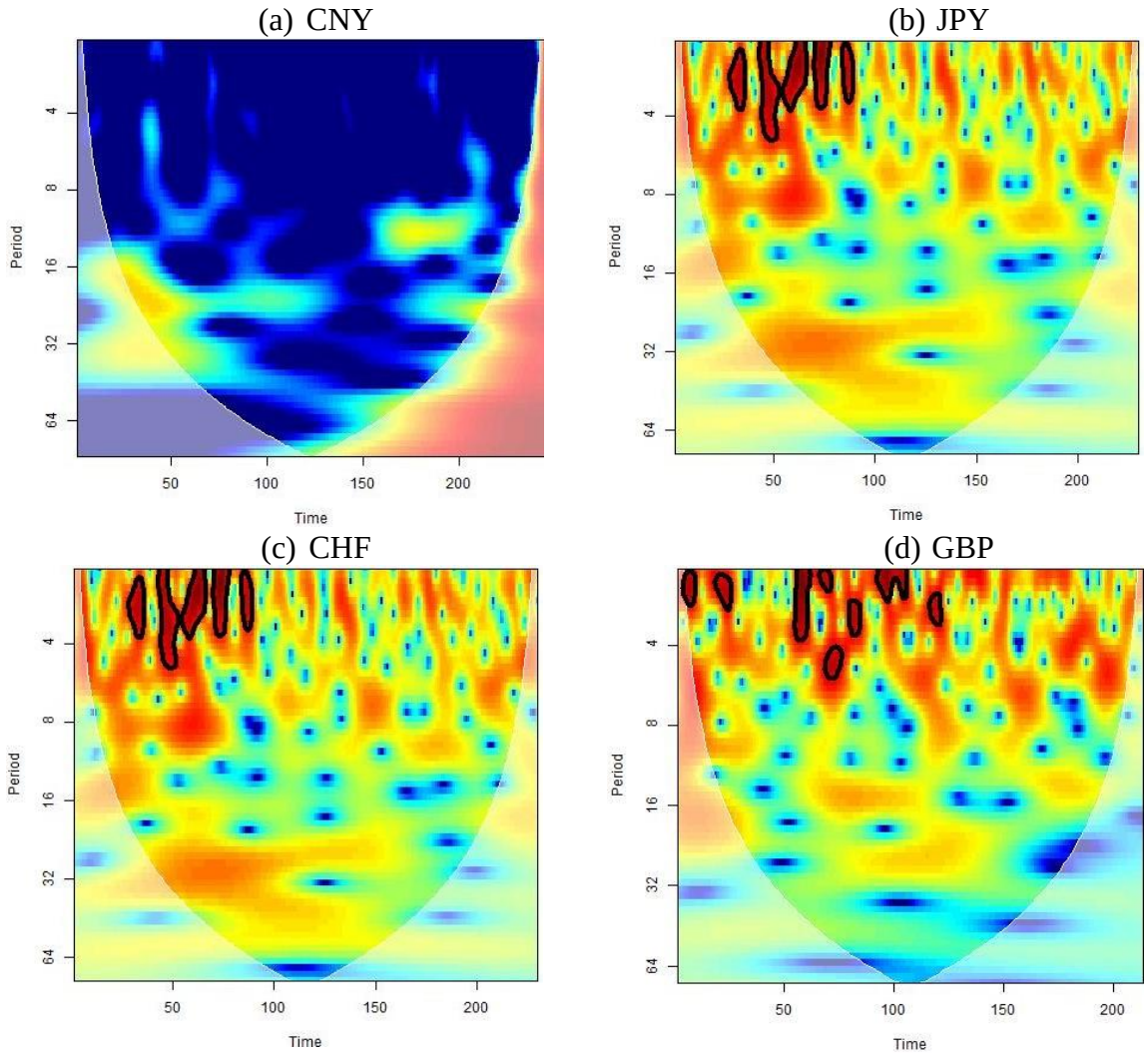
Stats	**Covid-19 1st Wave**			**Covid-19 2nd Wave**		
	NCM	**NDM**	**EXC**	**NCM**	**NDM**	**EXC**
Panel A: China						
Obs.	103	103	103	87	87	87
Mean	0.421	0.024	7.055	0.034	0.000	6.662
Std	1.248	0.092	0.065	0.025	0.001	0.114
Panel B: Japan						
Obs	103	88	103	87	87	87
Mean	0.933	0.059	108.186	10.557	0.140	104.755
Std	1.279	0.063	1.597	8.310	0.125	0.863
Panel C: Switzerland						
Obs	80	73	80	86	86	86
Mean	31.668	2.346	0.965	541.066	6.894	0.907
Std	43.984	2.528	0.012	495.329	6.549	0.012
Panel D: United Kingdom						
Obs	97	72	97	87	87	87
Mean	32.051	6.202	0.799	260.883	4.188	0.761
Std	28.828	5.228	0.023	174.176	3.672	0.014

Figure 2 provides CWT, showing the variance intensity of all the four currencies taken in this study. The x-axis presents time, and the y-axis shows the frequency component ranging from scale 1 (1 day) to 64 (more than 64 days). Figure *2*(a) shows that there has not been any significant variance in CNY during the period under observation. Although China was the first epicentre of COVID-19, the variation in CNY is not significant (most of the area in the plot is blue) as the spread was contained in China. Figures 2(b), 2(c), and 2(d) present CWT for JPY, CHF, and GBP,

[1] https://www.youtube.com/watch?v=HpVH358oxAA

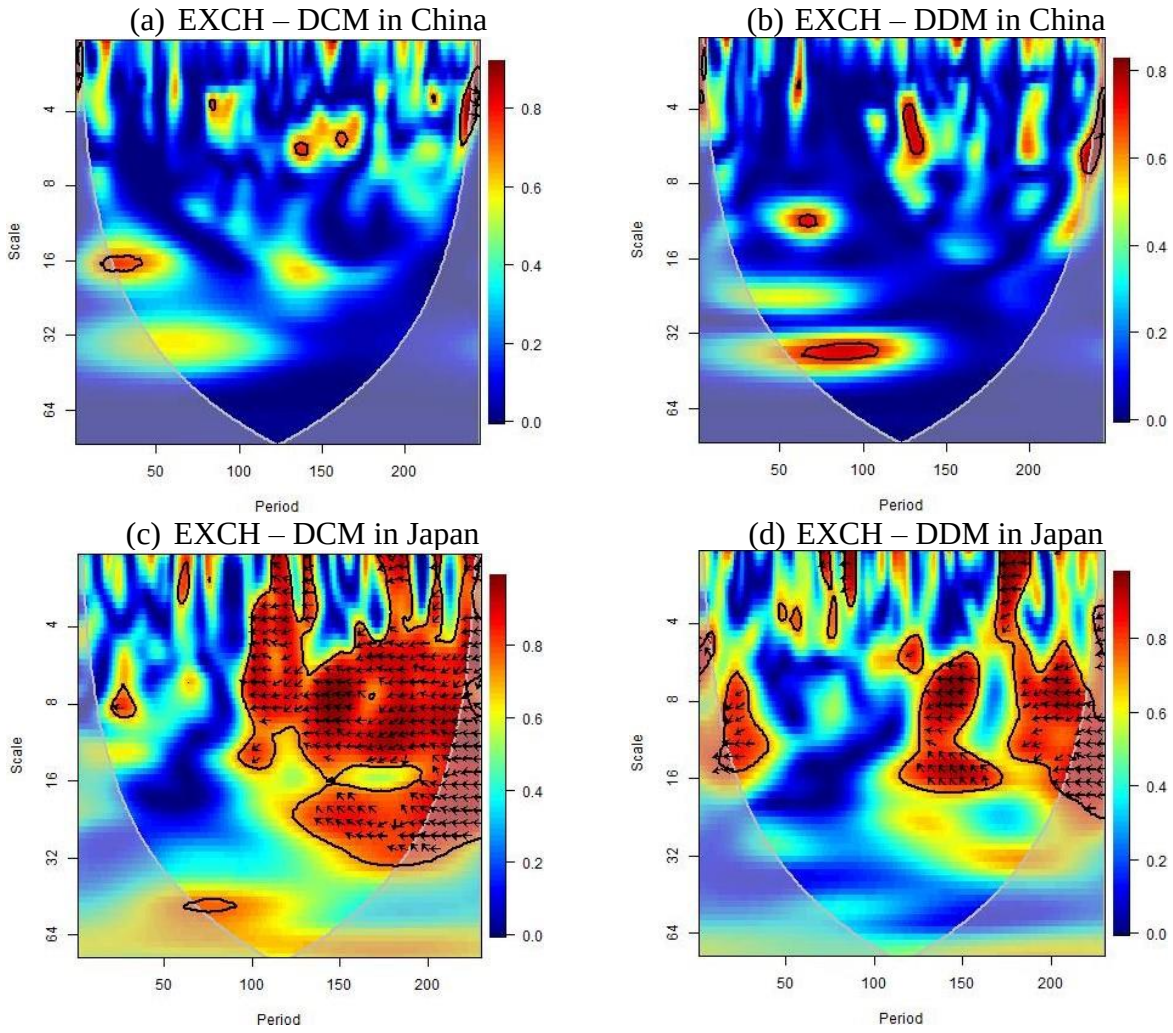
respectively. Unlike Figure 2(a), there are no large blue areas in these figures. This shows that the exchange rate of these currencies has higher variations as compared to CNY. These figures show significant variations in the exchange rate of these three currencies during the first wave in the frequency domain of 0-4 and 4-8 (5% significance is represented by black contours) during the 3rd to 6th month of observations.

Figure 2: Continuous Wavelet Transform of Exchange Rates During COVID-19



We have employed WTC to analyse the association of DCM and DDM with the exchange rates. Figure 3 presents these results. Figures 3(a) and 3(b) present WTC plots showing the association of DCM and DDM in China with the exchange rate of CNY, respectively. We can see some circles and ovals in these graphs, but overall, we do not find any evidence of a high correlation of DCM and DDM with the exchange rate of CNY. The spread of COVID-19 was well-contained in China, as shown in Table 1, hence, the correlations here are insignificant.

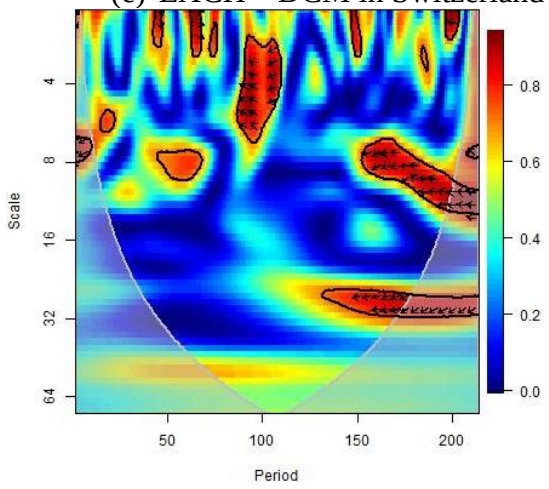
Figure 3: Wavelet Transform Coherence



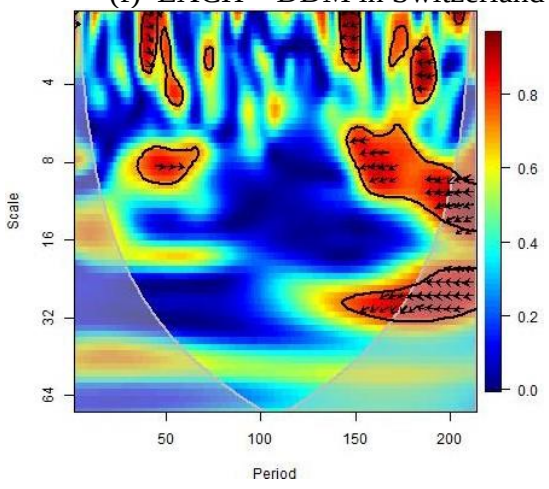
Figures 3(c) and 3(d) shows big islands in the second wave. This depicts that the exchange rate of JPY is significantly correlated with DCM and DDM in Japan. The ← shows a negative association of the JPY exchange rate with DCM and DDM. The relationship holds for the short term and long in the second wave of COVID-19, as the islands extend from top to bottom. A situation somewhat akin to the one observed in Figures 3(c) and 3(d) is visible in Figures 3(e) to 3(h) for CHF and GBP. DCM and DDM in Switzerland and UK have significantly affected the exchange rates of CHF and GBP. The negative relationship of DCM and DDM in Switzerland with the exchange rate of CHF holds in both the short run and the long run. However, for GBP this relationship only holds in the short run. These negative correlations suggest that COVID-19 has contagious effects on the exchange rate of JPY, CHF, and GBP. Gherghina & Simionescu (2021) have reported similar results for the stock market. The currencies considered as safe havens, JPY and CHF, are affected both in the short run and long run by DCM and DDM.

Figure 3: Wavelet Transform Coherence (continued…)

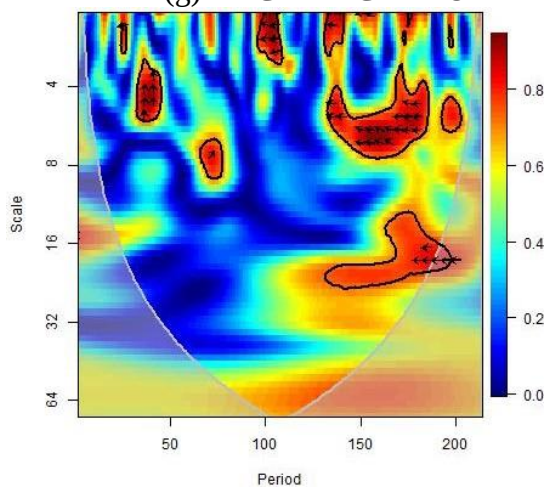
(e) EXCH – DCM in Switzerland



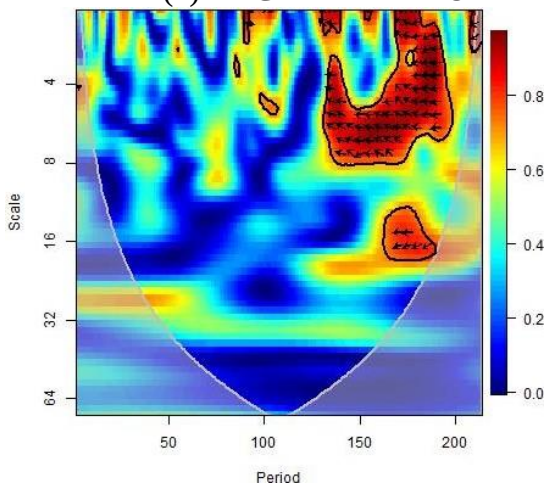
(f) EXCH – DDM in Switzerland



(g) EXCH – DCM in UK



(h) EXCH – DDM in UK



4. Concluding Remarks

This study presents empirical evidence on the association between COVID-19 (DCM and DDM) and exchange rates of four major currencies in the forex market during the first and the second wave of COVID-19. The WTC analysis provides evidence that high DCM and DDM in a country are negatively correlated with the exchange rate of its currency. JPY and CHF are considered safe havens, but they are negatively affected by the increasing DCM and DDM in Japan and Switzerland, respectively. Our findings show that the second wave has been a hard test for the world because of relaxing the measures during the summer that has led to the second wave (Soriano et al., 2021). As the second wave has been more aggressive, its effects on the forex market are also more severe. According to the best of our knowledge, this study provides a first insight into the impact of new cases and the death toll of the pandemic on the exchange rate specifically over the first along with the second wave of COVID-19.

References

Akoum, I., Graham, M., Kivihaho, J., Nikkinen, J., & Omran, M. (2012). Co-movement of oil and stock prices in the GCC region: A wavelet analysis. *Quarterly Review of Economics and*

Finance, *52*(4), 385–394. https://doi.org/10.1016/j.qref.2012.07.005

Feng, G. F., Yang, H. C., Gong, Q., & Chang, C. P. (2021). What is the exchange rate volatility response to COVID-19 and government interventions? *Economic Analysis and Policy*, *69*, 705–719. https://doi.org/10.1016/j.eap.2021.01.018

Firouzi, S., & Wang, X. (2019). A comparative study of exchange rates and order flow based on wavelet transform coherence and cross wavelet transform. *Economic Modelling*, *January*. https://doi.org/10.1016/j.econmod.2019.09.006

Gherghina, Ș. C., & Simionescu, L. N. (2021). Exploring the co-movements between stock market returns and COVID - 19 pandemic : evidence from wavelet coherence analysis. *Applied Economics Letters*, 1–9. https://doi.org/10.1080/13504851.2021.1937034

Humala, A., & Rodriguez, G. (2013). Some stylized facts of return in the foreign exchange and stock markets in Peru. *Studies in Economics and Finance*, *30*(2), 139–158. https://doi.org/10.1108/10867371311325444

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

Jammazi, R., Lahiani, A., & Nguyen, D. K. (2015). A wavelet-based nonlinear ARDL model for assessing the exchange rate pass-through to crude oil prices. *Journal of International Financial Markets, Institutions & Money*, *34*, 173–187. https://doi.org/10.1016/j.intfin.2014.11.011

Soriano, V., Ganado-Pinilla, P., Sanchez-Santos, M., Gómez-Gallego, F., Barreiro, P., de Mendoza, C., & Corral, O. (2021). Main differences between the first and second waves of COVID-19 in Madrid, Spain. *International Journal of Infectious Diseases*, *105*, 374–376. https://doi.org/10.1016/j.ijid.2021.02.115

Torrence, C., & Webster, P. J. (1999). Interdecadal changes in the ENSO-monsoon system. *Journal of Climate*, *12*(8), 2679–2690. https://doi.org/10.1175/1520-0442(1999)012<2679:icitem>2.0.co;2

WHO. (2020). *WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020*. WHO Director General's Speeches. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020