Ngo Thai Hung; Xuan Vinh Vo

Article

Asymmetric impact of the COVID-19 pandemic on foreign exchange markets : evidence from an extreme quantile approach

Reference: Ngo Thai Hung/Xuan Vinh Vo (2023). Asymmetric impact of the COVID-19 pandemic on foreign exchange markets : evidence from an extreme quantile approach. In: Economics and Business Letters 12 (1), S. 20 - 32. https://reunido.uniovi.es/index.php/EBL/article/download/18298/15575/57019. doi:10.17811/ebl.12.1.2023.20-32.

Economics and Business Letters

12(1), 20-32, 2023

Asymmetric impact of the COVID-19 pandemic on foreign exchange markets: Evidence from an extreme quantile approach

Ngo Thai Hung[1,*] • Vo Xuan Vinh[2]

[1]*University of Finance-Marketing, Ho Chi Minh City, Viet Nam*
[2]*Institute of Business Research and CFVG, University of Economics Ho Chi Minh City, Viet Nam*

Received: 4 April 2022
Revised: 8 July 2022
Accepted: 10 July 2022

Abstract

This study analyzes asymmetric transmission from the COVID-19 pandemic to major foreign exchange markets from 2 January 2020 to 2 June 2022. This paper contributes to the literature by investigating how the impact of COVID-19 on currency markets co-moves across market conditions and investment horizons. The article uses the recently developed cross-quantilogram framework to achieve this, which quantifies the cross-quantile dependency across time series without any moment condition requirement. The findings demonstrate that changes in the total daily global confirmed cases of COVID-19 can forecast changes in the currency markets under all market circumstances. These findings have significant implications for global investors and policymakers.

Keywords: COVID-19; exchange rate; cross-quantilogram dependence; spillover
JEL Classification Codes: C01, G15, G11

1. Introduction

The global COVID-19 epidemic, which began in December 2019, has had a negative impact on a number of world economies (Hung, 2020; Hung and Vo, 2021). As the crisis unfolds at breakneck speed, analyzing the economic consequences of the crisis becomes imperative from a policy standpoint (Fasanya et al., 2020). Foreign exchange markets are concerned with trade and transactions in foreign currency-denominated goods and services. Changes in the cash flows of these operations that are unexpected can harm one of the counterparties (Gunay, 2021). Because many financial institutions operate on a global scale, unexpected events and market movements in global markets can impact their profitability. It is evident that the COVID-19 outbreak produced a dramatic drop in global economic activity and, as a result, in the foreign exchange rate markets (Wang et al., 2021; Fasanya et al., 2020). The foreign exchange market, which is by far the largest financial market, has seen extraordinary changes since the commencement of the COVID-19 pandemic and is consequently being closely monitored by worldwide portfolio investors, market regulators, and policymakers (Aslam et al. 2020).

* Corresponding author. E-mail: hung.nt@ufm.edu.vn.

Citation: Hung, N. T., and Vinh, V. X. (2023) Asymmetric impact of the COVID-19 pandemic on foreign exchange markets: Evidence from an extreme quantile approach, *Economics and Business Letters*, 12(1), 20-32.

DOI: 10.17811/ebl.12.1.2023.20-32

So far, a limited number of studies have taken into consideration the relationship between the COVID-19 pandemic and foreign exchange rate markets (Sharma et al. 2022). Fasanya et al. (2020) find a high degree of interrelatedness between the global COVID-19 occurrences and the price spillover of the majorly traded currency pairs. Aslam et al. (2020) provide a first look at the efficiency of foreign exchange markets during the COVID-19 outbreak and suggest a decline in the efficiency of foreign exchange rate markets. Konstantakis et al. (2021) analyze how the COVID-19 crisis changed the Euro to Dollar exchange rate dynamics. They put forward that the COVID-19 outbreak has remarkably changed the determinants of the Euro to Dollar exchange rate. Umar and Gubareva (2020) report that there is high coherence between the fluctuations of the COVID-19 pandemic and the price moves in the Euro, British pound, and Renminbi currencies. Similarly, Sharma et al. (2021) indicate that COVID-19 cases have a significant long-term influence on the exchange rate markets. Njindan Iyke (2020) documents strong evidence that COVID-19 cases dramatically impact exchange rate returns and volatility predictions.

In addition, one subset of the COVID-19 literature investigates the impact and behavior of exchange rates. For instance, Narayan (2022) reports that total exchange rate shock spillovers account for approximately 37.7 percent of the forecast error variance in the exchange rate market, compared to only 26.1 percent prior to COVID-19. Beckmann and Czudaj (2022) unveil that policy responses to the COVID-19 outbreaks have the greatest impact on major currency markets. Similarly, Xu and Lien (2022) indicate the negative impacts of COVID-19 on dependences between CNY and other currencies in the BRICS countries. Li et al. (2021) have the same findings as Xu and Lien (2022) that the exchange rate is affected negatively due to the effect of COVID-19 cases and deaths in China and the US. This evidence leads us to believe that exchange rate shocks will have a greater impact on exchange rates. It is unknown how exchange rates have behaved over the COVID-19 period, and this empirical question is the focus of our paper.

Specifically, in an attempt to mitigate the effects of the "lockdowns" on overall economic activity, the European Central Bank and the Federal Reserve Bank announced generous stimulus packages for the European Union and the US economies, respectively, while also setting their interest rate targets close to zero. As a result, the COVID-19 outbreak has had a large impact on the overall macroeconomic, fiscal, monetary, and financial aspects of economic activity. Consequently, it is clear that the COVID-19 pandemic have had a significant impact on the fundamental determinants of the exchange rate dynamics of major currencies (Konstantakis et al. 2021). In this context, the current paper attempts to shed light on the arising research question, which can be stated as follows: What effect will the COVID-19 outbreak have on the dynamics of exchange rate currencies?

Motivated by these concerns, we extend the literature as mentioned earlier by examining the asymmetric associations between global foreign exchange markets (AUD, CAD, CHF, EUR, GBP, and JPY) and COVID-19 confirmed cases using the world's most traded currency pairs (Fasanya et al. 2020; Aslam et al. 2020). We concentrate on the tail distribution impact of COVID-19 on exchange rate returns in these major markets, which is indispensable since investors are hunting for alternative assets to counter excessive losses in other asset classes. To put it another way, this research aims to establish directional predictability in regular and exceptional market conditions using three quantiles (the lower, middle, and upper). The magnitude of the coefficient values spans from extremely negative (dark blue) to extremely positive (dark red), as represented by multicolor bars in the study's graphics. We present cross-quantile correlation estimates as heatmaps for various lag lengths. Heatmaps, which are graphical representations of the cross-quantile unconditional bivariate correlation between two distributions, provide a visual and intuitive means of capturing the entire dependence structure in cross quan-

tile estimations. Lower quantiles (quantile = 0.05) represent negative market conditions, medium quantiles (quantile = 0.50) represent typical market conditions, and upper quantiles (quantile = 0.95) represent bullish market situations (Pham, 2021; Rehman et al. 2021). In addition, the time-varying connectedness of the influence of the COVID-19 pandemic on exchange markets is also considered in this research, which is comparable to prior studies using various models.

Therefore, our research makes three contributions to the current state-of-the-art literature on currency markets. First, we fill a gap in the literature caused by the lack of scholars on dynamic interdependence maps of foreign exchange rates and the COVID-19 outbreak over various time horizons using a recent cross-quantilogram model developed by Han et al. (2016). Second, our paper contributes to the existing body of knowledge on currency market reactions to the COVID-19 pandemic. Our findings could be beneficial for investors, traders, risk managers, and currency market authorities because our sample period spans the most recent worldwide crisis triggered by the epidemic. Third, we show that the dependence structures between series are visible under different market conditions, and there is a bidirectional spillover between COVID-19 and exchange rate markets under consideration. As a result, during times of substantial global financial stress, cross-currency hedge strategies are not more likely to work.

The rest of the article is structured as follows: Section 2 represents the methodology and data. Section 3 documents the empirical results. Section 4 concludes the study.

2. Methodology

We adopt Han et al. (2016)'s cross-quantilogram technique to analyze the cross-quantile dependence between the COVID-19 and exchange rate series. The cross-quantilogram is a model-free method for determining the correlation between variables. The cross-quantilogram, on the other hand, estimates correlation across quantiles of distributions, unlike other correlation measurements. As a result, cross-quantile asymmetries in the dependent structure can be captured using this approach. The fact that the variables follow a stationary stochastic process is a prerequisite for using the cross-quantilogram model. The cross-quantilogram, invented by Linton and Whang (2007) and then extended into a bivariate framework by Han et al. (2016), is an easy-to-understand model that measures the lead-lag correlation between two time series over their tails.

Let consider two stationary time series as $\{x_{i,t}, t \in Z\}$, $i = 1,2$. In the current study, $x_{1,t}$ and $x_{2,t}$ present the COVID-19 confirmed cases and six major exchange rate markets, respectively. The density and distribution functions of series $x_{i,t}$ are denoted as $f_i(.)$and $F_i(.)$. The quantile of $x_{i,t}$ is expressed as $q_i(\alpha_i) = inf\{v: F_i(v) \geq \alpha_i\}$ for $\alpha_i \in (0,1)$, and the expression of two-dimensional series of quantiles are written by $(q_1(\alpha_1)q_2(\alpha_2))^\tau$ for $\alpha \equiv (\alpha_1, \alpha_2)^\tau$.

The cross-quantilogram for α −quantile with k lags can be written as:

$$\rho_\alpha(k) = \frac{E\left[\Psi_{\alpha 1}\left(x_{1,t} - q_1(\alpha_1)\right)\Psi_{\alpha_2}\left(x_{2,t-k} - q_2(\alpha_2)\right)\right]}{\sqrt{E\left[\Psi_{\alpha 1}^2\left(x_{1,t} - q_1(\alpha_1)\right)\right]}\sqrt{E\left[\Psi_{\alpha_2}^2\left(x_{2,t} - q_2(\alpha_2)\right)\right]}} \quad (1)$$

For $k = 0, \pm 1, \pm 2, \ldots$ and where $\Psi_\alpha(\mu) \equiv 1[\mu < 0]$, $1(.)$represents the indicator function and $1\left[x_{i,t} \leq q_i(\alpha_i)\right]$ is the quantile exceedance process.

The cross-quantilogram explores serial dependence between two variables at various quantile level and is invariant to any monotonic transformation used to both variables.

In case of two events, $\left\{x_{1,t} \leq q_{1,t}(\alpha_1)\right\}$ and $\left\{x_{2,t-k} \leq q_{2,t-k}(\alpha_2)\right\}$, $\rho_\alpha(k) = 0$ shows no cross dependence from event $\left\{x_{2,t-k} \leq q_{2,t-k}(\alpha_2)\right\}$ to event $\left\{x_{1,t} \leq q_{1,t}(\alpha_1)\right\}$.

The cross-quantilogram has several primary advantages over traditional econometric frameworks. Firstly, the cross-quantilogram model estimates the directional predictability from one-

time series to other quantiles of each variable's distribution (Pham, 2021). Put differently, this approach is robust to misspecification errors since it allows the dependence structure to co-vary through the distribution of the pair of variables. Secondly, when compared to linear regression-type models, the cross-quantilogram model can accommodate very long lags (Rehman et al. 2021). Therefore, it can quantify the strength of directional transmission through the short-, medium- and long-run investment horizons. Thirdly, the cross-quantilogram model is based on quantile hits and hence does not depend on any movement condition (Pham, 2021; Rehman et al., 2021), which is essential, in particular, when distributions of the time series are highly non-normal, found in financial data. More importantly, this technique has been utilized by several recent papers to perfectly capture the asymmetric relationship between financial series (Pham, 2021; Arif et al. 2021; Rehman et al. 2021; Shahzad et al. 2021).

3. Data

This study uses data from Datastream for the exchange rates of six major currencies traded in forex markets: GBP, JPY, EURO, CHF, AUD, and CAD (Aslam et al. 2020). The information was transferred from the daily global confirmed cases of COVID-19 from 2 January 2020 to 2 June 2022. We divide the whole period into two subperiods: (i) pre-vaccination (January 2020-December 2020); (ii) post-vaccination (January 2021-June 2022). The data on COVID-19 was retrieved from Our World in Data Platforms (https://ourworldindata.org/coronavirus). Some of the concerned series are overlapping. In this regard, some are subsets of others, which is useful to capture both aggregate and disaggregated influence of COVID-19. The high-frequency data more accurately accounts for long memory and structure changes because of improved distribution function continuity (Aslam et al. 2020). The stipulated currency exchange rates are expressed in indirect quotes against US dollars. To make comparisons easier, all of the series have been matched by date. The exmained variables were transformed into their natural logarithms to ensure there were no abnormalities during estimation.

Table 1 reports the descriptive statistics for the selected exchange rates and global COVID-19 confirmed cases. As shown, the average values were nearly zero during the COVID-19 period. Specifically, the COVID, CAN, and YEN remain positive while the EURO, CHF, and GBP turn negative. All series depict significant leptokurtic behavior as evidenced by the large kurtosis with respect to normal distribution. The Augmented Dicky -Fuller test results lead to the conclusion that there is no unit root in the return series at a 1% significance level. In the same vein, from Table 2, the non-linearity between COVID-19 and exchange rate markets is further endorsed by Brook, Scheinkman, Dechert and LeBaron (1996) test (BDS), in which the null hypothesis of non-linearity is accepted in all selected variables. The findings offer sufficient evidence of the non-linear association between COVID-19 and exchange rate returns. As a result, the influence of COVID-19 confirmed cases on exchange rate returns could be precisely captured by modeling cross-quantilograms (Naeem, et al., 2021).

Table 1. Summary statistics of COVID-19 confirmed cased and exchange rate markets.

	COVID	**EURO**	**CAN**	**CHF**	**YEN**	**AUD**	**GBP**
Mean	0.030	-0.018	0.002	-0.016	0.002	-0.016	-0.016
Max	1.386	1.859	2.084	2.120	2.084	2.120	2.720
Min	-8.114	-1.752	-2.693	-1.980	-2.693	-1.980	-3.129
Std. Dev	0.429	0.450	0.467	0.464	0.467	0.464	0.637
Skewness	-17.580	0.137	-0.218	0.278	-0.218	0.278	0.032
Kurtosis	336.901	4.931	8.801	5.997	8.801	5.997	6.082
J-B	1822.412***	61.520***	547.137***	150.244***	547.137***	150.2449***	153.645***
ADF	-19.478***	-17.365***	-17.593***	-18.678***	-17.593***	-18.678***	-19.013***

Notes: *** represent 1% significance level.

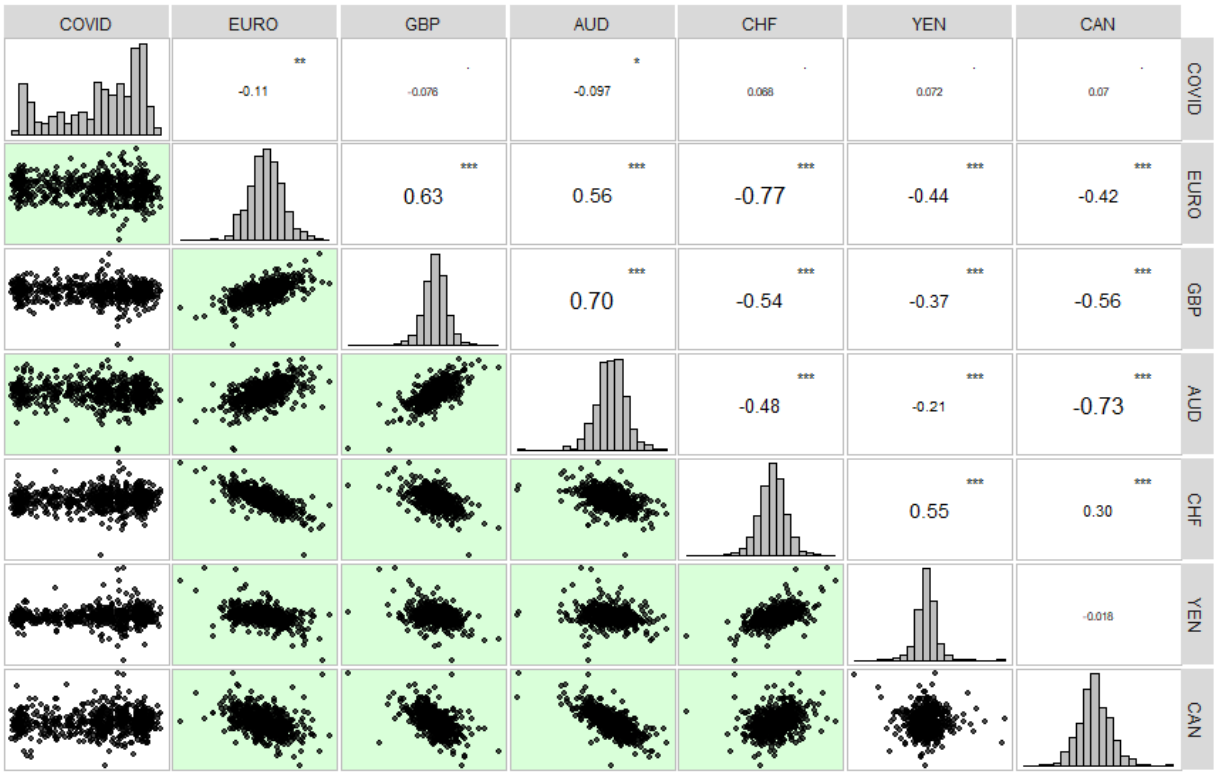
Table 2. BDS test of linearity.

	COVID	EURO	CAN	CHF	YEN	AUD	GBP
2	0.913***	1.413***	3.353***	3.147***	3.353***	3.147***	0.228***
3	4.871***	4.812***	6.464***	6.778***	6.464***	6.778***	6.490***
4	5.901***	5.688***	8.565***	8.547***	8.565***	8.547***	9.584***
5	6.284***	8.462***	10.355***	8.938***	10.355***	8.938***	12.667***
6	6.392***	11.742***	11.718***	10.741***	11.718***	10.741***	19.929***

Note: The entries represent the z-statistics of BDS test based on the residual of VAR estimations. m denotes the embedding dimensions of the BDS test. *** represents a 1% significance level.

Figure 1 visually depicts the general distribution of the concerned variables and pairwise interactions between series. Figure 1 shows that none of the variables that were being looked into had a normal distribution. Links were found between AUD and EURO and confirmed COVID-19 cases.

Figure 1. Plots of distribution and the pair-wise correlations of the variables.



4. Empirical results

4.1. Cross-quantilogram analysis

The lead-lag association between COVID-19 confirmed cases and exchange rate returns is determined using the cross-quantilogram approach. The results are presented in heat maps with the x- and y-axes denoting exchange rate returns and COVID-19 cases, respectively. Heat maps, which show the relationship between two series at different quantiles graphically, provide a thorough and succinct picture of the nexus. A useful color scheme also defines the strength and direction of an association, with red, green, and blue colors representing positive, neutral, and negative associations, respectively. The x-axis corresponds to the quantiles of the key exchange rate series, while y-axis represents the COVID-19 confirmed cases. These axes are highlighted by quantile hits [q = (0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.95)]. Each heat map has

121 (11 x 11) cells that show the quantile combinations of the time series. The interdependence is described on a color scale (ranging from -1.0 to +1.0). The absence of predictable directionality in the cross-quantile correlation is demonstrated by a cell with a correlation of zero. We take into account four alternative lag orders: lag 1 (day), lags 5 (week), lags 22 (month), and lags 66 (quarter). In general, this estimation explores quantile associations with lags spanning from daily to quarterly, which helps construct investment strategies and portfolio selection based on different time horizons (Hung, 2020; Hung and Vo, 2021; Rehman et al. 2021). Global COVID-19 confirmed cases and exchange rate markets are heterogeneously integrated across time horizons, as shown in Figure 2. The lag lengths included in the heat maps are given on the left-hand side of the figures.

Figure 2. Cross-quantilogram heat maps between COVID-19 outbreak and exchange markets.

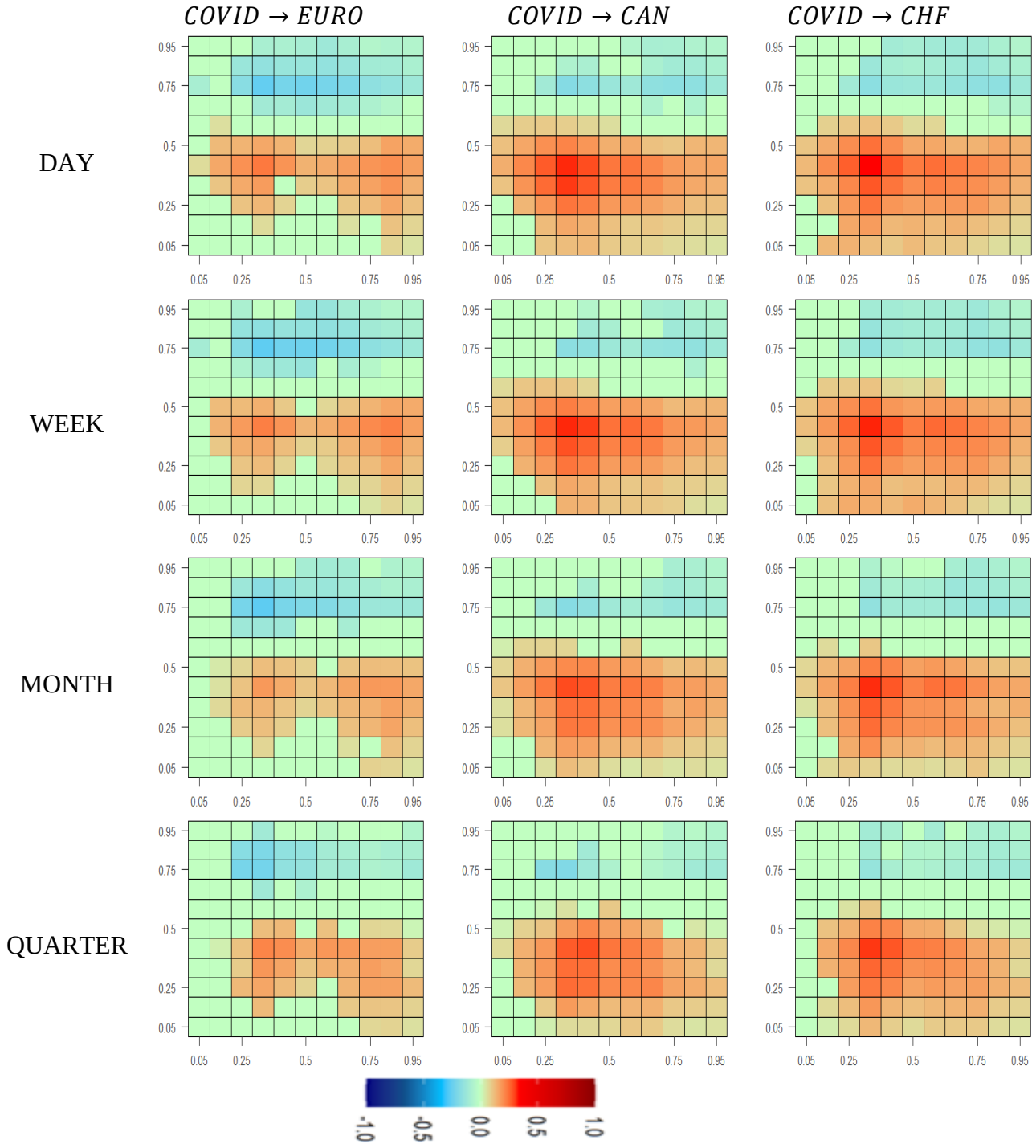
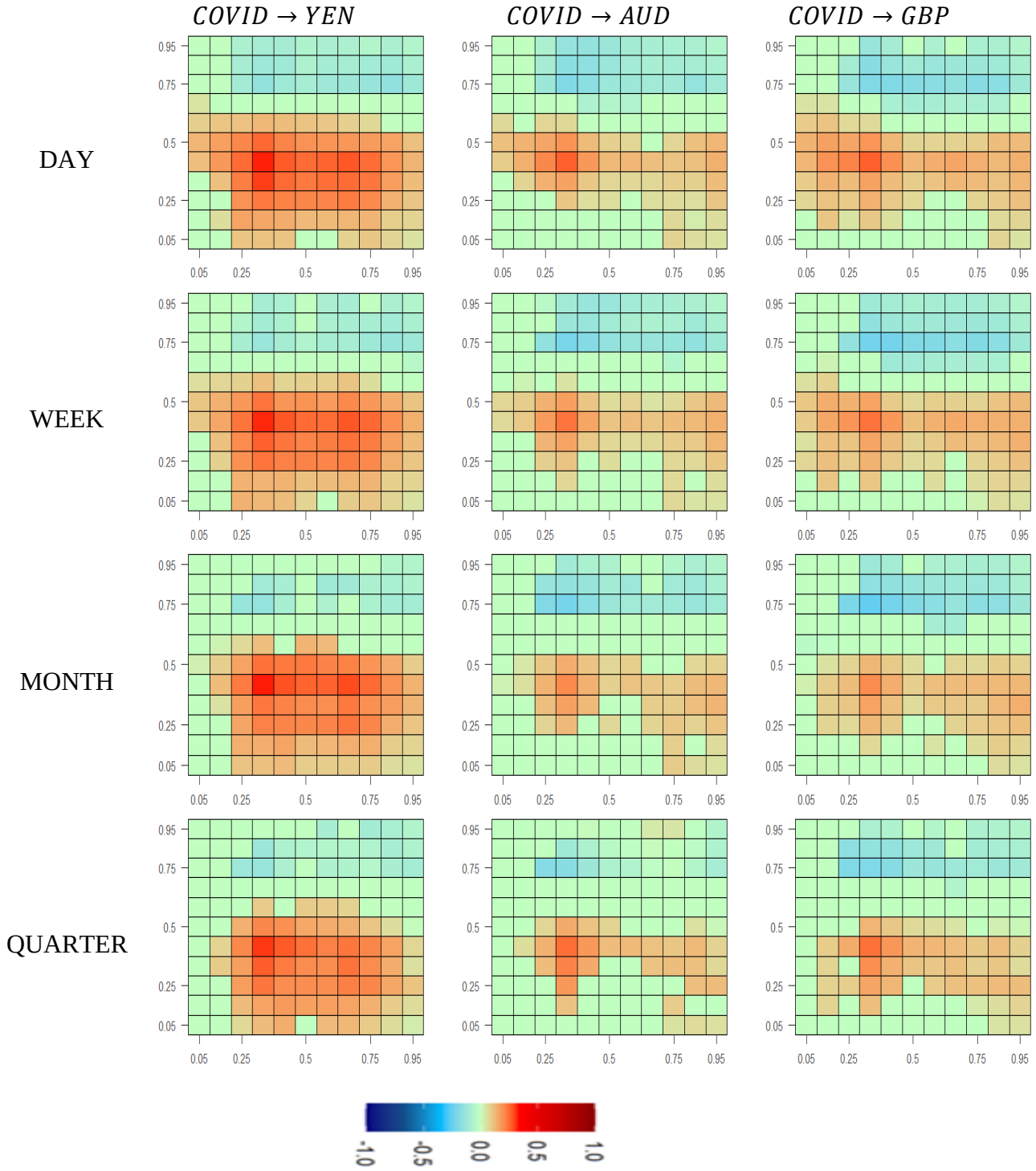


Figure 2. Cross-quantilogram heat maps between COVID-19 outbreak and exchange markets (cont.).



Notes: → demonstrates the direction of predictability. The heat maps are separated for four-time horizons: daily (k=1), weekly (k=5), monthly (k=22) and quarterly (k =66). In each heat map, the vertical axis shows the returns quantiles of exchange markets, while the horizontal axis illustrates quantiles of COVID-19 pandemic. The color scale at the bottom demonstrates the numerical values of the heat map colors.

Figure 2 shows the total sample cross-quantilogram estimates that illustrate the relationship between COVID-19 and foreign exchange rate markets at various time horizons, including the short,-medium- and long run. The cross-quantile correlation uncovers that orange dominates the heat map for the COVID versus CAN, YEN, EURO, and GBP at lag 1. This shows a positive

association between the two variables across low, medium, and high quantiles of the distribution, specifically, this nexus strengthens with longer lags. It is also true for lags 5. Therefore, the COVID-19 co-movements can predict movements in the major exchange markets for the following day. Put differently, in the upper quantiles of COVID-19, there is positive predictability for all selected exchange rate markets. Overall, these findings indicate that foreign exchange rate series for six major markets under consideration are tail-driven concerning correlations with COVID-19 confirmed cases. This implies a tendency for these currencies to exhibit considerable rises over the short, medium and long run which is short-lived directional positive predictability in these cases. Nevertheless, AUD and GBP have a weak correlation with the number of COVID-19 confirmed cases. Put another way, increases in the number of COVID-19 daily infections are predicted to lead to a strengthening of selected currency markets versus the US dollar. Our results corroborate with those of Fasanya et al. (2021) and Gubareva (2020), who also found a positive dependence structure between the COVID-19 pandemic and the key currency markets, which emphasizes the importance of CAN, YEN, EURO, CHF, and AUD currencies in the global foreign exchange markets even more. Nevertheless, these findings are not supported by the studies of Li et al. (2021) and Xu and Lien (2022), who document that there is a negative relationship between COVID-19 and currency markets.

Specifically, the pattern is maintained in the subsequent lags, and the strength of the nexus is statistically significant. There is scattered evidence of predictability with subsequent lags (22 and 66) because the latter directional influence almost appears. In other words, the COVID-19 pandemic exhibits a considerable influence on the currency markets in the medium and long run, as shown by the heat map's orange colors in Figure 2**.** Our findings show that the COVID-19 situation has a very great impact on the prices of globally traded currencies in the long run. This outcome is inconsistent with Sharma et al. (2021).

4.2. Dynamic connectedness analysis

This section provides snapshots of both pre-vaccination and post-vaccination periods using the framework of the spillover index of Diebold and Yilmaz (2012). The total connectedness table of both periods is represented in Table 3. First, the total spillover index in the pre-vaccination, 51.50%, is much higher compared to the post-vaccination period, 34.70%. This decrease is connected with lower systematic risk in the post-vaccination period, as discussed by (Li et al. 2021). Many factors contributed to the decrease in connectedness in the post-vaccination period, including stable sales, policy, and feedback; factors unique to this pandemic, such as the unlockdown stimulated the economy (Narayan, 2022; Beckmann and Czudaj, 2022). Put differently, during the period shown, we observe a bidirectional relationship between COVID-19 and the examined currency markets. In addition, the level of market effect in the post-vaccination period is lower than it was in the pre-vaccination period.

Figure 4 demonstrates the total dynamic connectedness plot, which fluctuates from 32% to 60%. In the pre-vaccination period, total connectedness remained at somewhat high values and reached its peak at the beginning of 2020, suggesting that the COVID-19 pandemic triggered the variations in the currency markets as indicated by (Konstantakis et al. 2021). After a year-long downward trend until the end of 2020, total connectedness decreased below 35%, the deepening of the COVID-19 crisis, along with the vaccination program, declined connectedness to 32% in the middle of 2022. We notice a gradual decline in connectivity levels throughout the course of the sample research period, which coincides with market expansion brought on, among other things, by government stimulus programs and vaccines. At this moment, it is reasonable to claim that many concerns relating to this epidemic have been cleared out, improving markets, and reducing connectivity as a result.

Table 3. Spillover index.

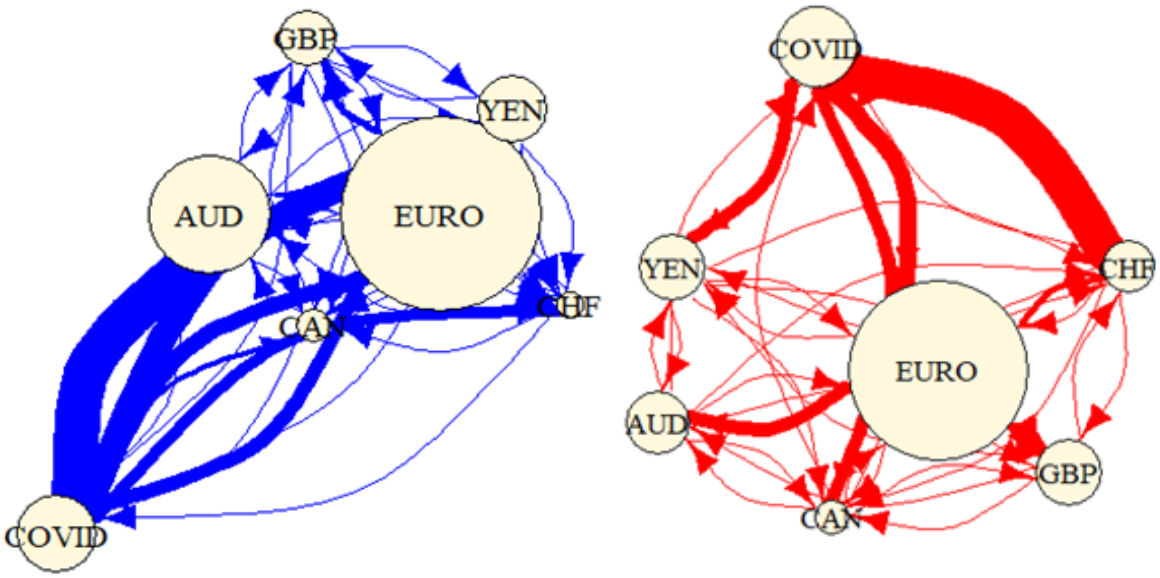
	COVID	EURO	GBP	AUD	CHF	YEN	CAN	From others
Pre-vaccination								
COVID	90.3	0.7	0.7	4.4	0.1	0.3	3.6	9.7
EURO	0.8	75.7	1.4	6.8	0.2	8.2	6.9	24.3
GBP	0	25.9	45.8	11.8	2	13.8	0.7	54.2
AUD	1	15.5	9.6	65.7	1.6	4.9	1.5	34.3
CHF	1.4	70.8	0.5	1.7	10	6.8	8.8	90
YEN	1	38.8	2.7	3.8	14.9	35.9	2.9	64.1
CAN	0.2	9.3	8.1	50.2	3.7	12.5	16	84
Contribution to others	4.4	160.9	23	78.8	22.5	46.5	24.3	360.5
Contribution including own	94.7	236.6	68.8	144.5	32.6	82.4	40.4	Spillover index = 51.50%
Post-vaccination								
COVID	97.3	0	0	1.9	0.7	0	0.1	2.7
EURO	4.3	86.3	1.2	0.5	0.5	5	2.1	13.7
GBP	0	44.3	51.2	0.3	0.2	2.7	1.2	48.8
AUD	0	26.4	16.6	54.4	0	2.3	0.3	45.6
CHF	1.1	37.1	0.9	0.6	56.5	1.5	2.3	43.5
YEN	0.6	11.8	0.2	6.3	8.1	73	0	27
CAN	0.2	25.5	14.8	17.6	1.4	1.8	38.5	61.5
Contribution to others	6.4	145.2	33.7	27.1	11	13.3	5.9	242.6
Contribution including own	103.7	231.5	84.9	81.5	67.5	86.3	44.5	Spillover index = 34.70%

Notes: These results are computed based on the framework of spillover index of Diebold and Yilmaz (2012).

Figure 3. Total dynamic connectedness between COVID-19 and exchange rate markets.

For the two aforementioned sub-periods, we additionally exhibit the net directional volatility spillover network topologies for all relevant series in Figure 4. Overall, we came to the conclusion that the COVID-19 pandemic continues to have positive directional net spillovers for these six major currencies, particularly the AUD, EURO, and YEN. This means that the uncertainty shock caused by the COVID-19 pandemic may ultimately be transmitted to all exchange rate markets in the pre-vaccination period. However, it is probably going to lessen variations in these marketplaces after vaccination.

Figure 4. The risk transmission network of COVID-19 and exchange rate markets.



(a) pre-vaccination (b) post-vaccination

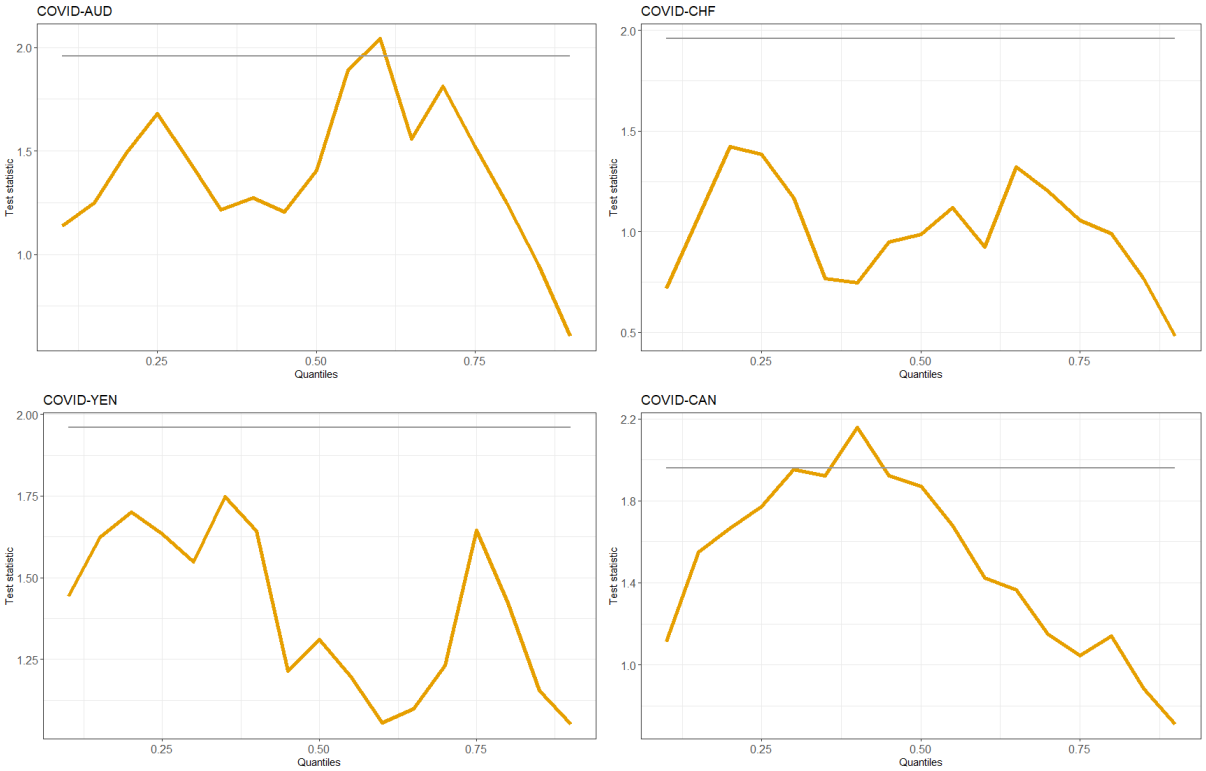
Notes: The size of the nodes reflects the strength of the total net spillovers. The larger the node, the stronger the net spillover effect. The thickness of the line and the size of the arrow show the strength of the pairwise net spillovers.

4.3. Robustness checks

The robustness tests of the results are represented in Figure 5. We employ the causality-in-quantiles test developed by Balcilar et al. (2017) to explore further the effects of COVID-19 on exchange rate returns. Figure 5 indicates that the null hypothesis of no Granger causality in quantiles from COVID-19 to exchange rate markets is not rejected at the most quantile levels of exchange rate returns. In general, we find that COVID-19 is an insignificant predictor of exchange rate prices across exchange rate quantiles, with the exception of extremely low or high quantiles. These estimates are in line with the main empirical results.

Figure 5. Causality in quantiles between COVID and exchange rate markets.

Figure 5. Causality in quantiles between COVID and exchange rate markets (cont.)



Notes: This figure summarizes the quantile Granger causality test statistics. The x-axis shows the quantiles and the y-axis shows the test statistics for a specific pair of series, and the corresponding estimate of the 5% critical value presented as the horizontal back solid line.

5. Conclusion

This study examines the asymmetric behavior of the global COVID-19 confirmed cases in correlation to the major foreign exchange rate markets, taking into account the whole range of return quantiles from the lowest to the highest, utilizing the cross-quantilogram approach developed by Han et al. (2016). Our results uncover that the interdependencies between the COVID-19 pandemic and foreign exchange markets are relatively heterogeneous. More importantly, the dependence structures between them are substantially evident at lag 1, but the nexus dissipates with longer lags, and there is little evidence of predictability in the low quantiles. In addition, the cross-quantile correlation between COVID-19 and the selected exchange markets exhibited a positive relationship at the beginning of the sample period, with a slight dip and variation in 2020. However, there was a weak (roughly zero) correlation in 2021 throughout the lower and upper quantile periods.

The analysis of the asymmetric impact of the COVID-19 crisis on major foreign exchange rate markets can help investors identify the optional investment portfolio. In this paper, we employ a cross-quantilogram approach to estimate the co-movement between the two variables, which allows us to investigate how the two series are affected in the short, medium, and long run. This information can help investors predict which markets will co-vary in various time horizons and whether the co-movement of the number of COVID-19 cases will have any influence on the foreign exchange markets.

Our research on how major currencies moved together and had spillover effects during the COVID-19 period is crucial for regulators and investors to assess systemic risk and develop the best risk management and financial stability strategies. From a policy point of view, the results of our study show that policymakers need to keep an eye on the effects of the global COVID-19 announcement and not ignore the overall risks of the financial markets by looking at the net

effect of financial market volatility on how the global foreign exchange markets behave. From the point of view of managing assets, the risk management framework should be reevaluated to deal with the new and enhanced risks caused by the COVID-19 outbreak. Policymakers could do a better job of smoothing out the effects of shocks to the transmission channel if they knew more about how prices affect each other in the foreign exchange market.

Acknowledgements

The first author thankfully acknowledges the support of University of Finance-Marketing. This paper is funded by the University of Economics Ho Chi Minh City.

References

Aslam, F., Aziz, S., Nguyen, D. K., Mughal, K. S., & Khan, M. (2020). On the efficiency of foreign exchange markets in times of the COVID-19 pandemic. *Technological forecasting and social change*, *161*, 120261.

Arif, M., Naeem, M. A., Hasan, M., M Alawi, S., & Taghizadeh-Hesary, F. (2021). Pandemic crisis versus global financial crisis: Are Islamic stocks a safe-haven for G7 markets?. *Economic Research-Ekonomska Istraživanja*, 1-21.

Beckmann, J., & Czudaj, R. L. (2022). Exchange rate expectation, abnormal returns, and the COVID-19 pandemic. *Journal of Economic Behavior & Organization*, *196*, 1-25.Balcilar, M.,

Bekiros, S., & Gupta, R. (2017). The role of news-based uncertainty indices in predicting oil markets: a hybrid nonparametric quantile causality method. *Empirical Economics*, *53*(3), 879-889.

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.

Fasanya, I. O., Oyewole, O., Adekoya, O. B., & Odei-Mensah, J. (2020). Dynamic spillovers and connectedness between COVID-19 pandemic and global foreign exchange markets. *Economic Research-Ekonomska Istraživanja*, 1-26.

Gunay, S. (2021). Comparing COVID-19 with the GFC: A shockwave analysis of currency markets. *Research in International Business and Finance*, *56*, 101377.

Hung, N. T., & Vo, X. V. (2021). Directional spillover effects and time-frequency nexus between oil, gold and stock markets: Evidence from pre and during COVID-19 outbreak. *International Review of Financial Analysis*, *76*, 101730.

Hung, N. T. (2020). Time-Frequency Nexus Between Bitcoin and Developed Stock Markets in the Asia-Pacific. *The Singapore Economic Review*, 1-26.

Han, H., Linton, O., Oka, T., & Whang, Y. J. (2016). The cross-quantilogram: Measuring quantile dependence and testing directional predictability between time series. *Journal of Econometrics*, 193(1), 251–270.

Konstantakis, K. N., Melissaropoulos, I. G., Daglis, T., & Michaelides, P. G. (2021). The euro to dollar exchange rate in the Covid-19 era: Evidence from spectral causality and Markov-switching estimation. *International Journal of Finance & Economics*.

Linton, O., & Whang, Y. J. (2007). The quantilogram: With an application to evaluating directional predictability. *Journal of Econometrics*, *141*(1), 250-282.

Li, C., Su, Z. W., Yaqoob, T., & Sajid, Y. (2021). COVID-19 and currency market: a comparative analysis of exchange rate movement in China and USA during pandemic. *Economic Research-Ekonomska Istraživanja*, 1-16.

Naeem, M. A., Nguyen, T. T. H., Nepal, R., Ngo, Q. T., & Taghizadeh–Hesary, F. (2021). Asymmetric relationship between green bonds and commodities: Evidence from extreme quantile approach. *Finance Research Letters*, 101983.

Njindan Iyke, B. (2020). The disease outbreak channel of exchange rate return predictability: Evidence from COVID-19. *Emerging Markets Finance and Trade*, *56*(10), 2277-2297.

Narayan, P. K. (2022). Understanding exchange rate shocks during COVID-19. *Finance Research Letters*, *45*, 102181.

Pham, L. (2021). How Integrated are Regional Green Equity Markets? Evidence from a Cross-Quantilogram Approach. *Journal of Risk and Financial Management*, *14*(1), 39.

Rehman, M. Z., Tiwari, A. K., & Samontaray, D. P. (2021). Directional predictability in foreign exchange rates of emerging markets: New evidence using a cross-quantilogram approach. *Borsa Istanbul Review*. https://doi.org/10.1016/j.bir.2021.03.003

Sharma, G. D., Tiwari, A. K., Jain, M., Yadav, A., & Erkut, B. (2021). Unconditional and conditional analysis between COVID-19 cases, temperature, exchange rate and stock markets using wavelet coherence and wavelet partial coherence approaches. *Heliyon*, *7*(2), e06181.

Shahzad, S. J. H., Gupta, R., Demirer, R., & Pierdzioch, C. (2020). Oil shocks and directional predictability of macroeconomic uncertainties of developed economies: Evidence from high-frequency data. *Scottish Journal of Political Economy*. https://doi.org/10.1111/sjpe.12280

Shahzad, S. J. H., Bouri, E., Roubaud, D., Kristoufek, L., & Lucey, B. (2019). Is Bitcoin a better safe-haven investment than gold and commodities?. *International Review of Financial Analysis*, *63*, 322-330.

Sharma, S., Yadav, M. P., & Jha, B. (2022). Impact of the COVID-19 Outbreak on the Currency Exchanges of Selected Countries. *International Journal of Sociotechnology and Knowledge Development (IJSKD)*, *14*(2), 73-91.

Umar, Z., & Gubareva, M. (2020). A time–frequency analysis of the impact of the COVID-19 induced panic on the volatility of currency and cryptocurrency markets. *Journal of Behavioral and Experimental Finance*, *28*, 100404.

Wang, Q. J., Chen, D., & Chang, C. P. (2021). The impact of COVID-19 on stock prices of solar enterprises: A comprehensive evidence based on the government response and confirmed cases. *International Journal of Green Energy*, *18*(5), 443-456.

Xu, Y., & Lien, D. (2022). COVID-19 and currency dependences: Empirical evidence from BRICS. *Finance Research Letters*, *45*, 102119.