REyF Revista de Economía y Finanzas

www.reveyf.es

2025 – Vol. 3 – n.º 7 - Artículo 1

Transitory and permanent components of exchange rate volatility: Further evidence from causality tests

Amalia Morales-Zumaquero[a] and Simón Sosvilla-Rivero[b]

[a] *Department of Economic Theory and Economic History, Universidad de Málaga, Málaga. Spain.*

[b] *Complutense Institute for Economic Analysis, Universidad Complutense de Madrid, Madrid. Spain.*

JEL CODES:
C32; F33; G12; G13

KEYWORDS:
Conditional variance;
Component model;
Causality analysis;
Exchange rates

Abstract: We present new evidence on the volatility behaviour of major exchange rates, focusing on their permanent (long-run) and transitory (short-run) components. To achieve this, we conduct a causality analysis to explore their statistical relationship and identify their mutual influences. Our findings indicate that shocks to economic fundamentals (which correspond to the permanent volatility component) and market sentiment (associated with the transitory volatility component) reinforce one another, transmitting and intensifying tensions on a global scale, thus creating a complex and tightly interconnected network.

CÓDIGOS JEL:
C32; F33; G12; G13

PALABRAS CLAVE:
Varianza Condicional; Modelo de Componentes; Análisis de Causalidad; Tipos de Cambio

Resumen: En este trabajo se presenta nueva evidencia sobre el comportamiento de la volatilidad de los principales tipos de cambio, centrándose en los componentes permanente (largo plazo) y transitorio (corto plazo). Para ello, se lleva a cabo un análisis de causalidad para explorar su relación estadística e identificar influencias mutuas. Los resultados sugieren que las perturbaciones sobre los fundamentos (que se identifican con el componente permanente de volatilidad) y sobre la confianza de los mercados (que se identifica con el componente transitorio) se refuerzan mutuamente, transmitiendo e intensificando tensiones a escala global, creando una red compleja y estrechamente interconectada.

E-mail: amalia@uma.es; sosvilla@ccee.ucm.es
https://doi.org/10.32826/reyf.v3i7.383

1. Introduction

Analysing exchange rate volatility is crucial for several reasons. First, it helps businesses and investors manage risk. Currency fluctuations can significantly affect the profitability of transactions, investments, and international trade (see McKenzie, 1999; Görg and Wakelin, 2002; Goldberg, 2009; and Lal et al., 2023, among others). By understanding the level of volatility, businesses can hedge against potential losses due to unfavorable currency fluctuations. Second, assessing exchange rate volatility helps policymakers design appropriate monetary and fiscal policies (Wagner, 2005). It can indicate economic stability or instability and guide decisions on interest rates and foreign exchange interventions (Berganza and Broto, 2012). Third, understanding currency volatility trends allows those involved in international trade, tourism, or remittances to plan more effectively, reducing the potential negative effects of currency fluctuations on their financial situation (see, e. g., Agiomirgianakis et al., 2016; and Ilyas et al., 2024). Finally, high volatility can indicate underlying economic challenges, such as inflation or political instability, making monitoring important for market participants and analysts (Hays, et al. 2003; Menkhoff Taylor, 2007).

In the companion paper (Morales-Zumaquero and Sosvilla-Rivero, forthcoming), we examine the volatility of major currency exchange rates employing Engel and Lee's (1999) component-GARCH (C-GARCH) model to decompose volatility into permanent and transitory components and conduct a correlation analysis between these two volatility components to explore their statistical relationship, unravel their mutual influence, perform principal component analysis on long-term and short-term volatility, and identify clusters among them.

In this paper we offer further evidence by applying causality analysis between permanent and transitory volatilities to examine their statistical association between them and disentangle their mutual influence.

The paper is organised as follows. Section 2 describes the econometric methodology adopted in this study. Section 3 presents the data and the empirical result, and Section 4 offers some concluding remarks. An Appendix provides detailed analyses.

2. Econometric Methodology

The Granger (1969) approach to test for causality is based on the time series notion of predictability: given two variables, variable *X* causes variable *Y* if the present value of *Y* can be predicted more accurately by using the past values of *X* and *Y* than by using only past values of *X*.

Following this approach, we run bivariate regressions of the form:

$$X_t = \alpha_0 + \sum_{i=1}^{m} \delta_i X_{t-i} + \sum_{j=1}^{n} \gamma_j Y_{t-j} + \varepsilon_t \quad [1]$$

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \delta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j} + \zeta_t \quad [2]$$

for all possible pairs of currencies (*X*, *Y*) under examination and compute the Wald statistics for the joint hypothesis $\gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ for each equation. In the first regression the null hypothesis is that *Y* does not Granger-cause *X*, while in the second regression the null hypothesis is that *X* does not Granger-cause *Y*.

3. Data and Empirical Results

3.1. Data

We utilise daily spot exchange rate data for 16 currencies against the US dollar, from January 4, 1999, to January 6, 2023, obtained from the Federal Reserve Bank of St. Louis. The currencies include the Australian dollar (AUD), Brazilian real (BRL), Canadian dollar (CAD), Swiss franc (CHF), Chinese yuan (CNY), European euro (EUR), British pound sterling (GBP), Indian rupee (INR), Japanese yen (JPY), South Korean won (KRW), Mexican peso (MXN), Norwegian krone (NOK), New Zealand dollar (NZD), Swedish krone (SEK), Singapore dollar (SGD), and South African rand (ZAR). These currencies account for 188.1% of the average daily turnover (BIS, 2022)[1].

3.2. Empirical Results

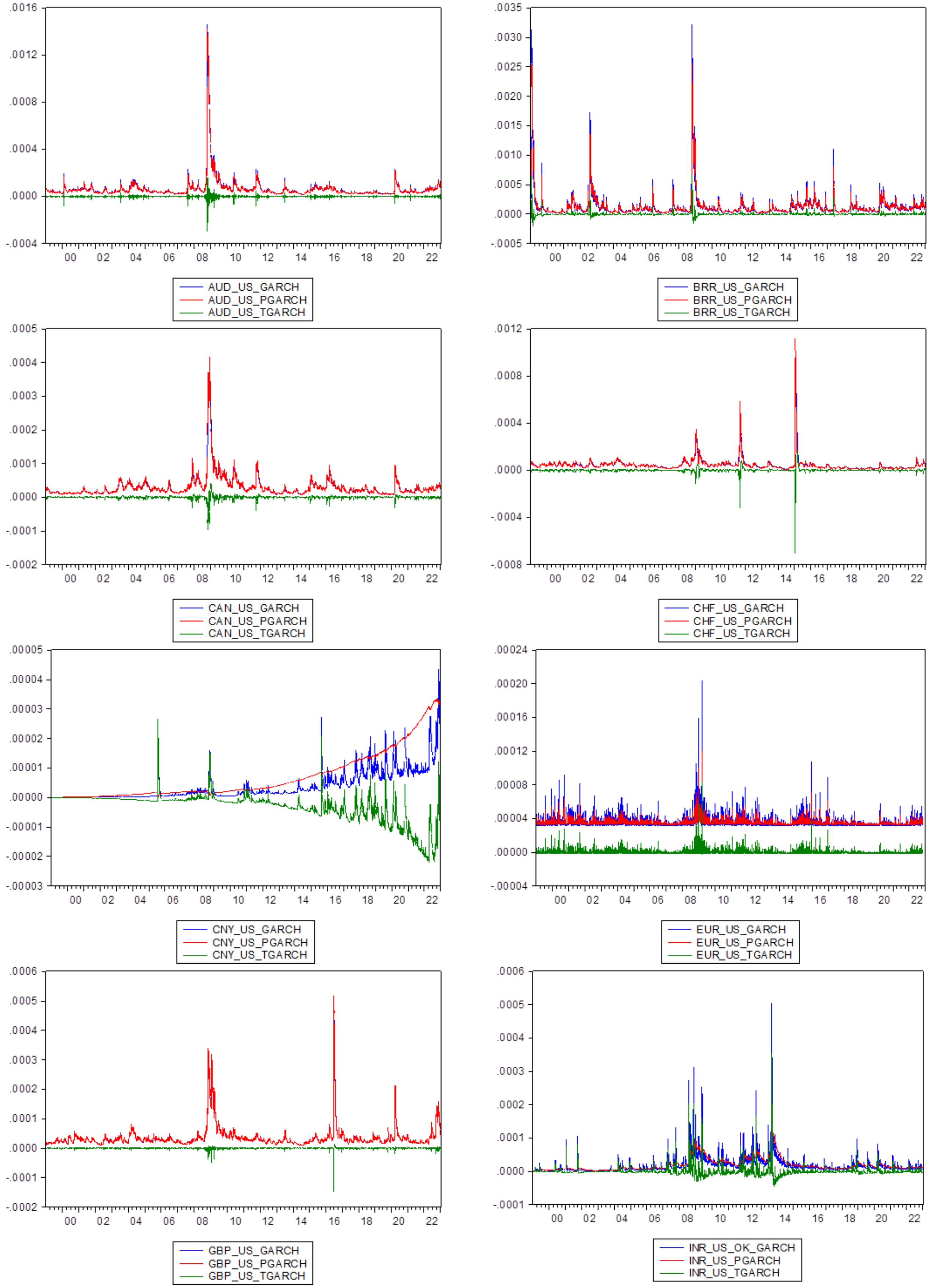
3.2.1. Step 1: Permanent and transitory components

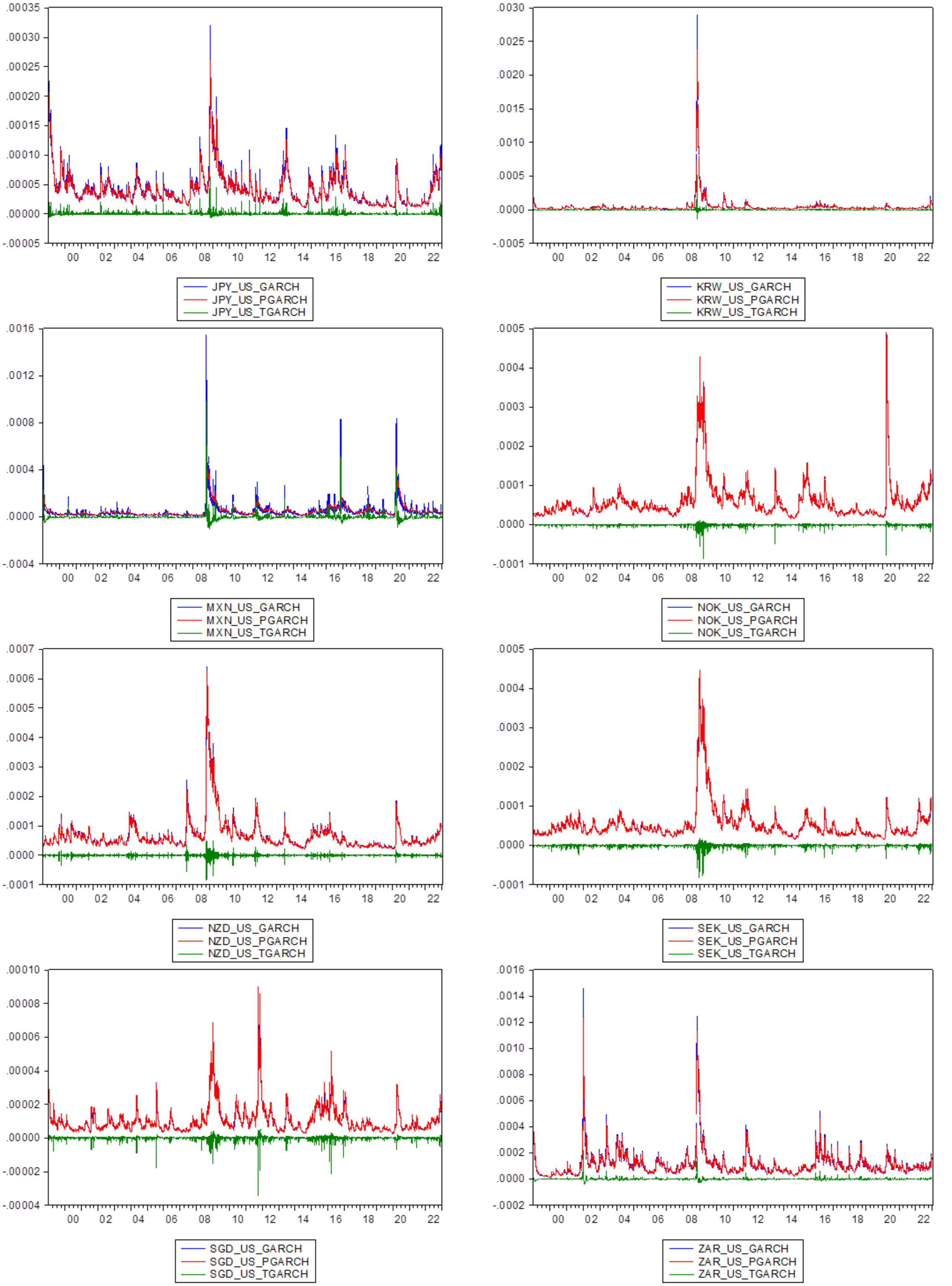
The C-GARCH model allows a better understanding of volatility dynamics and how shocks can influence foreign exchange markets across different time horizons. The permanent component represents structural and long-term volatility associated with more lasting changes in the economic and financial environment. In contrast, the transitory component represents temporary and short-term volatility associated with events or shocks that affect the market immediately but whose effects fade over time.

Figure 1 displays the total, permanent, and transitory variance of daily spot exchange rates. As can be seen, we can identify several key patterns. First, the permanent volatility component is consistently higher than the transitory component across all currencies. Second, both the permanent and transitory volatility components reflect the most significant events of the turbulent 21st century.

[1] Notice that since each transaction involves two currencies, the total percentage shares of the individual currencies add up to 200% rather than 100%.

Figure 1: Total, permanent and transitory variance of daily spot exchange rates




JPY_US_GARCH
JPY_US_PGARCH
JPY_US_TGARCH
KRW_US_GARCH
KRW_US_PGARCH
KRW_US_TGARCH
MXN_US_GARCH
MXN_US_PGARCH
MXN_US_TGARCH
NOK_US_GARCH
NOK_US_PGARCH
NOK_US_TGARCH
NZD_US_GARCH
NZD_US_PGARCH
NZD_US_TGARCH
SEK_US_GARCH
SEK_US_PGARCH
SEK_US_TGARCH
SGD_US_GARCH
SGD_US_PGARCH
SGD_US_TGARCH
ZAR_US_GARCH
ZAR_US_PGARCH
ZAR_US_TGARCH
00 02 04 06 08 10 12 14 16 18 20 22

3.2.2. Step 2: Causality analysis

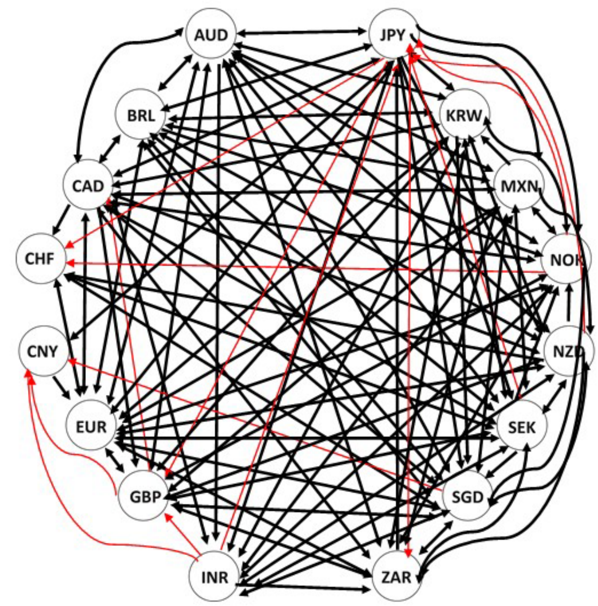
We now present results from the Granger causality approach (1969) to explore the relationship between all possible pairs of currencies in our sample, both for the permanent and transitory volatility components.

Tables A1 and A2 in the Appendix report the value of F-Statistic used to test the null hypothesis that all the coefficients of the past values of the auxiliary variable are zero for the permanent and transitory components, respectively.

On the one hand, the causality between the permanent components of volatility in different exchange rates may reflect the structural interdependence between countries or economies, suggesting the presence of common macroeconomic or political factors that influence the long-term stability of both economies. Analysing causality between these permanent components can also reveal how one country's monetary or fiscal policies might persistently impact the volatility of other exchange rates. This is especially relevant for interconnected or emerging economies highly dependent on larger countries' political and economic decisions, such as the US or the Eurozone.

To help us to identify transmitters (drivers) and receivers (absorbers) of volatility among the currencies under study, Figure 2 displays the dense web of causal relationships among permanent volatility components. The direction of the arrows represents the direction of the causal connection between each exchange-rate volatility, where the black, red and orange links (black, grey and light grey when viewed in grayscale) correspond to the 1%, 5% and 10% of the significance level. As shown in Figure 2, the number of currencies transmitting volatility is generally smaller than the number of currencies receiving it. However, in many cases, causality operates in both directions. Specifically, the permanent volatility components of the currencies under study form a complex and densely interconnected network. Our results indicate that AUD, BRL, EUR, GBP, KRW, and ZAR are the primary recipients of volatility from other currencies. Additionally, JPY emerges as a significant transmitter of volatility for other currencies.

Figure 2: Pairwise Granger causality tests among permanent volatility components

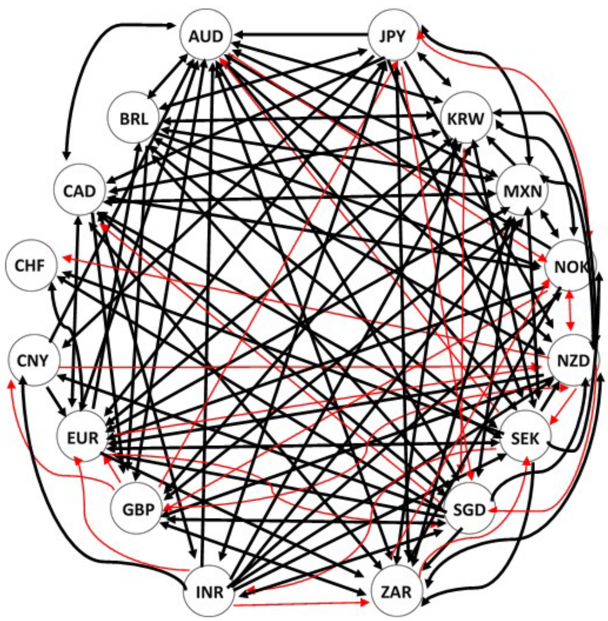


Note: Black and red links (black and grey when viewed in grayscale) correspond to the 1% and 5% significant levels, respectively.

On the other hand, causality between the transitory components of exchange rate volatility reflects short-term effects, where temporary shocks—such as unexpected economic events, market changes, or political announcements—quickly spread across currency markets. This transmission of transitory shocks is crucial for understanding contagion, especially during financial crises or geopolitical events. Short-term fluctuations in exchange rates are often driven by speculative expectations and investor reactions, making the causality between these components key to understanding how movements in one market can trigger fluctuations in others.

As can be seen in Figure 3, the number of currencies that transmit transitory volatility is smaller than the number that absorbs it, similar to the pattern observed with permanent components. The main absorbers of this volatility are the AUD, BRL, EUR, GBP, KRW, and ZAR, while the JPY and INR are identified as the key drivers. Furthermore, results in Figure 3 suggest that they create an even more complicated and intricately linked network, significantly influencing each other. This finding indicates that exchange rate movements in the short term are more interconnected and responsive to sudden market shocks or transient factors (reacting fast to temporary shocks, news, rumours, speculative movements, or events, and these effects can spill over across currencies often leading to more pronounced causal relationships among currencies in the short term). At the same time, the permanent volatility components are influenced by more persistent and gradual economic trends or structural factors in the economy that are more gradual. Their impact is usually spread over time, meaning the relationships between permanent volatility components may be weaker because their effects unfold over a longer period and are less prone to abrupt changes that can lead to quick cross-currency causality.

Figure 3: Pairwise Granger causality tests among transitory volatility components



Note: Black and red links (black and grey when viewed in grayscale) correspond to the 1% and 5% significant levels, respectively.

4. Concluding Remarks

By examining Granger causality between permanent and transitory components of volatility of various exchange rates, we can identify the channels of propagation of shocks and interactions between currency markets. At the permanent level, causality may reflect global structural and political relationships affecting currency markets, while at the transitory level, causality could highlight the rapidity with which short-term shocks diffuse across markets. This provides a richer view of interdependence and volatility dynamics in a globalized financial system.

Therefore, this study offers valuable insights into the behaviour of different components of exchange rate volatility, shedding light on key aspects that have not been sufficiently addressed.

Although it is imperative to recognize that the foreign exchange market is subject to a complex interaction between several factors, our results suggest that shocks to economic fundamentals (captured in the permanent volatility component) and market sentiment (captured by transient volatility) feed each other, transmitting and intensifying tensions at a global level and creating an intricate and densely interconnected network. Notably, the causal relationships are particularly string among the transitory volatility components, highlighting their critical role in understanding market behavior. This finding underscores the importance of considering both components together to fully comprehend the complexities of volatility dynamics.

Regarding policy implications, the complex interrelationships in the transitory volatility components call for a more proactive, flexible, and coordinated approach to managing currency fluctuations, with an emphasis on real-time monitoring, adaptive policy responses, and enhanced financial stability mechanisms.

Funding

This paper is based on work financed by the Spanish Ministry of Science and Innovation [grants PID2019-105986GB-C21 and TED2021-129891B-I00] and the Spanish State Investigation Agency [grant AEI/10.13039/501100011033].

References

Agiomirgianakis, G., Serenis, D. and Tsounis, N. (2016). The effects of exchange rate volatility on tourist flows: Evidence from the UK and Sweden. *International Journal of Tourism Policy*, 6, 1-16.

Berganza, J. C. and Broto, C (2012). Flexible inflation targets, forex interventions and exchange rate volatility in emerging countries. *Journal of International Money and Finance*, 31, 428-444.

Engle, R. F. and Lee, G. G. J. (1999) A permanent and transitory component model of stock return volatility, in R. Engle and H. White (eds.), *Cointegration, Causality, and Forecasting: A Festschrift in Honor of Clive W.J.* Granger, Oxford University Press, Oxford, 475-497.

Goldberg, L. S. (2009). Exchange rates and foreign direct investment. *The Princeton Encyclopedia of the World Economy*, 1, 393-396.

Görg, H. and Wakelin, K. (2002). The impact of exchange rate volatility on US direct investment. *The Manchester School*, 70, 380-397.

Granger, C.W.J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, 37(3), 424-438.

Hays, J. C, Freeman, J. R., and Nesseth, H. (2003). Exchange rate volatility and democratization in emerging market countries. *International Studies Quarterly*, 47, 203-228.

Ilyas, S., Ahmad, T., Saeed, K., Dilawar, S., and Sheikh, M. R. (2024). Exchange rate volatility and foreign remittances in SAARC countries. *Journal of Asian Development Studies*, 13, 1019-1035.

Lal, L., Kumar, S., Pandey, D. K., Rai, V. K and Lim, W. M. (2023). Exchange rate volatility and international trade. *Journal of Business Research*, 167, 114156.

Menkhoff, L. and Taylor, M. P. (2007). The obstinate passion of foreign exchange professionals: Technical analysis. *Journal of Economic Literature*, 45, 936-972.

McKenzie, M. D. (1999). The impact of exchange rate volatility on international trade flows. *Journal of Economics Surveys*, 13, 71-106.

Morales-Zumaquero, A. and Sosvilla-Rivero, S. (forthcoming). An empirical evaluation of transitory and permanent components of the exchange rate volatility. Applied Economics.

Wagner, H. (2005). Globalization and financial instability: Challenges for exchange rate and monetary policy. *International Journal of Social Economics*, 32, 616-638.

Appendix

Table A1: Pairwise Granger causality tests among permanent volatility components

Null Hypothesis:	Obs.	F-Statistic	Prob.
BRR_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	11.3099	1.E-05
AUD_US_PGARCH does not Granger Cause BRR_US_PGARCH		31.5966	2.E-14
CAN_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	39.0063	1.E-17
AUD_US_PGARCH does not Granger Cause CAN_US_PGARCH		139.026	9.E-60
CHF_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	1.01959	0.3608
AUD_US_PGARCH does not Granger Cause CHF_US_PGARCH		3.63756	0.0264
CNY_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	1.01237	0.3634
AUD_US_PGARCH does not Granger Cause CNY_US_PGARCH		0.99222	0.3708
EUR_US_PGARCH does not Granger Cause AUD_US_PGARCH	5975	19.8591	3.E-09
AUD_US_PGARCH does not Granger Cause EUR_US_PGARCH		122.165	1.E-52
GBP_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	18.9818	6.E-09
AUD_US_PGARCH does not Granger Cause GBP_US_PGARCH		44.5463	6.E-20
INR_US_OK_PGARCH does not Granger Cause AUD_US_PGARCH	6020	0.99385	0.3702
AUD_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		8.85677	0.0001
JPY_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	4.88767	0.0076
AUD_US_PGARCH does not Granger Cause JPY_US_PGARCH		13.5835	1.E-06
KRW_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	6.32758	0.0018
AUD_US_PGARCH does not Granger Cause KRW_US_PGARCH		503.350	7E-203
MXN_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	38.7249	2.E-17
AUD_US_PGARCH does not Granger Cause MXN_US_PGARCH		5.55789	0.0039
NOK_US_PGARCH does not Granger Cause AUD_US_PGARCH	6008	11.0082	2.E-05
AUD_US_PGARCH does not Granger Cause NOK_US_PGARCH		26.2899	4.E-12
NZD_US_PGARCH does not Granger Cause AUD_US_PGARCH	6008	38.4838	2.E-17
AUD_US_PGARCH does not Granger Cause NZD_US_PGARCH		34.1256	2.E-15
SEK_US_PGARCH does not Granger Cause AUD_US_PGARCH	6008	30.2899	8.E-14
AUD_US_PGARCH does not Granger Cause SEK_US_PGARCH		48.7816	1.E-21
SGD_US_PGARCH does not Granger Cause AUD_US_PGARCH	6021	17.5966	2.E-08
AUD_US_PGARCH does not Granger Cause SGD_US_PGARCH		19.1347	5.E-09
ZAR_US_PGARCH does not Granger Cause AUD_US_PGARCH	6008	11.6971	9.E-06
AUD_US_PGARCH does not Granger Cause ZAR_US_PGARCH		48.1562	2.E-21
CAN_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	0.17068	0.8431
BRR_US_PGARCH does not Granger Cause CAN_US_PGARCH		35.5488	4.E-16
CHF_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	0.51169	0.5995
BRR_US_PGARCH does not Granger Cause CHF_US_PGARCH		1.20344	0.3002
CNY_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	0.12644	0.8812
BRR_US_PGARCH does not Granger Cause CNY_US_PGARCH		0.29275	0.7462

EUR_US_PGARCH does not Granger Cause BRR_US_PGARCH	5975	2.81552	0.0600
BRR_US_PGARCH does not Granger Cause EUR_US_PGARCH		35.2600	6.E-16
GBP_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	1.12829	0.3237
BRR_US_PGARCH does not Granger Cause GBP_US_PGARCH		15.0984	3.E-07
INR_US_OK_PGARCH does not Granger Cause BRR_US_PGARCH	6020	2.00348	0.1350
BRR_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		2.54961	0.0782
JPY_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	9.93340	5.E-05
BRR_US_PGARCH does not Granger Cause JPY_US_PGARCH		9.10609	0.0001
KRW_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	1.83278	0.1601
BRR_US_PGARCH does not Granger Cause KRW_US_PGARCH		43.9281	1.E-19
MXN_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	55.5020	1.E-24
BRR_US_PGARCH does not Granger Cause MXN_US_PGARCH		2.90572	0.0548
NOK_US_PGARCH does not Granger Cause BRR_US_PGARCH	6008	0.59293	0.5527
BRR_US_PGARCH does not Granger Cause NOK_US_PGARCH		9.49883	8.E-05
NZD_US_PGARCH does not Granger Cause BRR_US_PGARCH	6008	7.14751	0.0008
BRR_US_PGARCH does not Granger Cause NZD_US_PGARCH		14.5185	5.E-07
SEK_US_PGARCH does not Granger Cause BRR_US_PGARCH	6008	5.49472	0.0041
BRR_US_PGARCH does not Granger Cause SEK_US_PGARCH		16.3223	9.E-08
SGD_US_PGARCH does not Granger Cause BRR_US_PGARCH	6021	6.96835	0.0009
BRR_US_PGARCH does not Granger Cause SGD_US_PGARCH		6.48646	0.0015
ZAR_US_PGARCH does not Granger Cause BRR_US_PGARCH	6008	2.35210	0.0953
BRR_US_PGARCH does not Granger Cause ZAR_US_PGARCH		13.9892	9.E-07
CHF_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	2.02305	0.1323
CAN_US_PGARCH does not Granger Cause CHF_US_PGARCH		5.43830	0.0044
CNY_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	0.12274	0.8845
CAN_US_PGARCH does not Granger Cause CNY_US_PGARCH		0.23769	0.7885
EUR_US_PGARCH does not Granger Cause CAN_US_PGARCH	5975	12.6313	3.E-06
CAN_US_PGARCH does not Granger Cause EUR_US_PGARCH		131.638	1.E-56
GBP_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	3.95521	0.0192
CAN_US_PGARCH does not Granger Cause GBP_US_PGARCH		23.9264	4.E-11
INR_US_OK_PGARCH does not Granger Cause CAN_US_PGARCH	6020	4.90724	0.0074
CAN_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		5.97487	0.0026
JPY_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	15.4901	2.E-07
CAN_US_PGARCH does not Granger Cause JPY_US_PGARCH		2.05665	0.1280
KRW_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	107.508	1.E-46
CAN_US_PGARCH does not Granger Cause KRW_US_PGARCH		442.137	7E-180
MXN_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	39.0581	1.E-17
CAN_US_PGARCH does not Granger Cause MXN_US_PGARCH		7.76394	0.0004
NOK_US_PGARCH does not Granger Cause CAN_US_PGARCH	6008	2.43114	0.0880
CAN_US_PGARCH does not Granger Cause NOK_US_PGARCH		12.9783	2.E-06

NZD_US_PGARCH does not Granger Cause CAN_US_PGARCH	6008	34.7881	1.E-15
CAN_US_PGARCH does not Granger Cause NZD_US_PGARCH		1.26218	0.2831
SEK_US_PGARCH does not Granger Cause CAN_US_PGARCH	6008	15.4867	2.E-07
CAN_US_PGARCH does not Granger Cause SEK_US_PGARCH		39.8083	7.E-18
SGD_US_PGARCH does not Granger Cause CAN_US_PGARCH	6021	3.38436	0.0340
CAN_US_PGARCH does not Granger Cause SGD_US_PGARCH		23.6553	6.E-11
ZAR_US_PGARCH does not Granger Cause CAN_US_PGARCH	6008	14.2029	7.E-07
CAN_US_PGARCH does not Granger Cause ZAR_US_PGARCH		7.67467	0.0005
CNY_US_PGARCH does not Granger Cause CHF_US_PGARCH	6021	1.10159	0.3324
CHF_US_PGARCH does not Granger Cause CNY_US_PGARCH		0.46799	0.6263
EUR_US_PGARCH does not Granger Cause CHF_US_PGARCH	5975	8.08070	0.0003
CHF_US_PGARCH does not Granger Cause EUR_US_PGARCH		21.2003	7.E-10
GBP_US_PGARCH does not Granger Cause CHF_US_PGARCH	6021	2.05660	0.1280
CHF_US_PGARCH does not Granger Cause GBP_US_PGARCH		0.95040	0.3866
INR_US_OK_PGARCH does not Granger Cause CHF_US_PGARCH	6020	1.01673	0.3618
CHF_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		0.44996	0.6377
JPY_US_PGARCH does not Granger Cause CHF_US_PGARCH	6021	3.24879	0.0389
CHF_US_PGARCH does not Granger Cause JPY_US_PGARCH		0.62910	0.5331
KRW_US_PGARCH does not Granger Cause CHF_US_PGARCH	6021	1.79232	0.1667
CHF_US_PGARCH does not Granger Cause KRW_US_PGARCH		0.53291	0.5869
MXN_US_PGARCH does not Granger Cause CHF_US_PGARCH	6021	1.22101	0.2950
CHF_US_PGARCH does not Granger Cause MXN_US_PGARCH		1.62498	0.1970
NOK_US_PGARCH does not Granger Cause CHF_US_PGARCH	6008	3.13847	0.0434
CHF_US_PGARCH does not Granger Cause NOK_US_PGARCH		0.69032	0.5015
NZD_US_PGARCH does not Granger Cause CHF_US_PGARCH	6008	6.83680	0.0011
CHF_US_PGARCH does not Granger Cause NZD_US_PGARCH		1.57212	0.2077
SEK_US_PGARCH does not Granger Cause CHF_US_PGARCH	6008	11.1631	1.E-05
CHF_US_PGARCH does not Granger Cause SEK_US_PGARCH		0.12721	0.8806
SGD_US_PGARCH does not Granger Cause CHF_US_PGARCH	6021	2.67610	0.0689
CHF_US_PGARCH does not Granger Cause SGD_US_PGARCH		14.2559	7.E-07
ZAR_US_PGARCH does not Granger Cause CHF_US_PGARCH	6008	1.48204	0.2273
CHF_US_PGARCH does not Granger Cause ZAR_US_PGARCH		1.55676	0.2109
EUR_US_PGARCH does not Granger Cause CNY_US_PGARCH	5975	0.50054	0.6062
CNY_US_PGARCH does not Granger Cause EUR_US_PGARCH		17.0769	4.E-08
GBP_US_PGARCH does not Granger Cause CNY_US_PGARCH	6021	3.16470	0.0423
CNY_US_PGARCH does not Granger Cause GBP_US_PGARCH		0.65622	0.5188
INR_US_OK_PGARCH does not Granger Cause CNY_US_PGARCH	6020	6.20779	0.0020
CNY_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		0.20917	0.8113
JPY_US_PGARCH does not Granger Cause CNY_US_PGARCH	6021	12.0362	6.E-06
CNY_US_PGARCH does not Granger Cause JPY_US_PGARCH		0.24699	0.7812

KRW_US_PGARCH does not Granger Cause CNY_US_PGARCH	6021	0.78881	0.4544
CNY_US_PGARCH does not Granger Cause KRW_US_PGARCH		0.08567	0.9179
MXN_US_PGARCH does not Granger Cause CNY_US_PGARCH	6021	0.90391	0.4050
CNY_US_PGARCH does not Granger Cause MXN_US_PGARCH		0.77019	0.4630
NOK_US_PGARCH does not Granger Cause CNY_US_PGARCH	6008	1.18384	0.3062
CNY_US_PGARCH does not Granger Cause NOK_US_PGARCH		0.15021	0.8605
NZD_US_PGARCH does not Granger Cause CNY_US_PGARCH	6008	1.01575	0.3622
CNY_US_PGARCH does not Granger Cause NZD_US_PGARCH		0.50406	0.6041
SEK_US_PGARCH does not Granger Cause CNY_US_PGARCH	6008	0.29376	0.7455
CNY_US_PGARCH does not Granger Cause SEK_US_PGARCH		0.33500	0.7154
SGD_US_PGARCH does not Granger Cause CNY_US_PGARCH	6021	42.9030	3.E-19
CNY_US_PGARCH does not Granger Cause SGD_US_PGARCH		0.66993	0.5118
ZAR_US_PGARCH does not Granger Cause CNY_US_PGARCH	6008	0.15486	0.8565
CNY_US_PGARCH does not Granger Cause ZAR_US_PGARCH		1.93587	0.1444
GBP_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	60.9421	6.E-27
EUR_US_PGARCH does not Granger Cause GBP_US_PGARCH		1.57142	0.2078
INR_US_OK_PGARCH does not Granger Cause EUR_US_PGARCH	5975	23.3430	8.E-11
EUR_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		0.76875	0.4636
JPY_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	56.4392	5.E-25
EUR_US_PGARCH does not Granger Cause JPY_US_PGARCH		11.9075	7.E-06
KRW_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	100.652	1.E-43
EUR_US_PGARCH does not Granger Cause KRW_US_PGARCH		31.5969	2.E-14
MXN_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	58.0752	1.E-25
EUR_US_PGARCH does not Granger Cause MXN_US_PGARCH		9.81737	6.E-05
NOK_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	80.0229	5.E-35
EUR_US_PGARCH does not Granger Cause NOK_US_PGARCH		2.84205	0.0584
NZD_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	152.699	2.E-65
EUR_US_PGARCH does not Granger Cause NZD_US_PGARCH		4.72023	0.0089
SEK_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	145.127	3.E-62
EUR_US_PGARCH does not Granger Cause SEK_US_PGARCH		2.64031	0.0714
SGD_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	61.0648	6.E-27
EUR_US_PGARCH does not Granger Cause SGD_US_PGARCH		9.36839	9.E-05
ZAR_US_PGARCH does not Granger Cause EUR_US_PGARCH	5975	59.7458	2.E-26
EUR_US_PGARCH does not Granger Cause ZAR_US_PGARCH		10.1113	4.E-05
INR_US_OK_PGARCH does not Granger Cause GBP_US_PGARCH	6020	3.34484	0.0353
GBP_US_PGARCH does not Granger Cause INR_US_OK_PGARCH		2.82732	0.0592
JPY_US_PGARCH does not Granger Cause GBP_US_PGARCH	6021	8.95908	0.0001
GBP_US_PGARCH does not Granger Cause JPY_US_PGARCH		1.38808	0.2496
KRW_US_PGARCH does not Granger Cause GBP_US_PGARCH	6021	51.8828	5.E-23
GBP_US_PGARCH does not Granger Cause KRW_US_PGARCH		53.9925	6.E-24

MXN_US_PGARCH does not Granger Cause GBP_US_PGARCH	6021	19.3350	4.E-09
GBP_US_PGARCH does not Granger Cause MXN_US_PGARCH		10.6698	2.E-05
NOK_US_PGARCH does not Granger Cause GBP_US_PGARCH	6008	15.9975	1.E-07
GBP_US_PGARCH does not Granger Cause NOK_US_PGARCH		3.08528	0.0458
NZD_US_PGARCH does not Granger Cause GBP_US_PGARCH	6008	31.5528	2.E-14
GBP_US_PGARCH does not Granger Cause NZD_US_PGARCH		1.06733	0.3440
SEK_US_PGARCH does not Granger Cause GBP_US_PGARCH	6008	8.92754	0.0001
GBP_US_PGARCH does not Granger Cause SEK_US_PGARCH		9.95908	5.E-05
SGD_US_PGARCH does not Granger Cause GBP_US_PGARCH	6021	8.60746	0.0002
GBP_US_PGARCH does not Granger Cause SGD_US_PGARCH		10.8765	2.E-05
ZAR_US_PGARCH does not Granger Cause GBP_US_PGARCH	6008	15.7097	2.E-07
GBP_US_PGARCH does not Granger Cause ZAR_US_PGARCH		4.42943	0.0120
JPY_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6020	4.63863	0.0097
INR_US_OK_PGARCH does not Granger Cause JPY_US_PGARCH		4.15337	0.0158
KRW_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6020	13.2481	2.E-06
INR_US_OK_PGARCH does not Granger Cause KRW_US_PGARCH		0.76518	0.4653
MXN_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6020	3.98634	0.0186
INR_US_OK_PGARCH does not Granger Cause MXN_US_PGARCH		15.5327	2.E-07
NOK_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6008	4.76602	0.0085
INR_US_OK_PGARCH does not Granger Cause NOK_US_PGARCH		10.5863	3.E-05
NZD_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6008	8.71492	0.0002
INR_US_OK_PGARCH does not Granger Cause NZD_US_PGARCH		6.65332	0.0013
SEK_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6008	7.61808	0.0005
INR_US_OK_PGARCH does not Granger Cause SEK_US_PGARCH		7.50758	0.0006
SGD_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6020	5.17654	0.0057
INR_US_OK_PGARCH does not Granger Cause SGD_US_PGARCH		42.1245	7.E-19
ZAR_US_PGARCH does not Granger Cause INR_US_OK_PGARCH	6008	2.67123	0.0692
INR_US_OK_PGARCH does not Granger Cause ZAR_US_PGARCH		4.85611	0.0078
KRW_US_PGARCH does not Granger Cause JPY_US_PGARCH	6021	19.3803	4.E-09
JPY_US_PGARCH does not Granger Cause KRW_US_PGARCH		6.07218	0.0023
MXN_US_PGARCH does not Granger Cause JPY_US_PGARCH	6021	2.22562	0.1081
JPY_US_PGARCH does not Granger Cause MXN_US_PGARCH		3.79408	0.0226
NOK_US_PGARCH does not Granger Cause JPY_US_PGARCH	6008	4.31764	0.0134
JPY_US_PGARCH does not Granger Cause NOK_US_PGARCH		9.55706	7.E-05
NZD_US_PGARCH does not Granger Cause JPY_US_PGARCH	6008	3.75417	0.0235
JPY_US_PGARCH does not Granger Cause NZD_US_PGARCH		5.53124	0.0040
SEK_US_PGARCH does not Granger Cause JPY_US_PGARCH	6008	3.28345	0.0376
JPY_US_PGARCH does not Granger Cause SEK_US_PGARCH		24.2997	3.E-11

SGD_US_PGARCH does not Granger Cause JPY_US_PGARCH	6021	0.71997	0.4868
JPY_US_PGARCH does not Granger Cause SGD_US_PGARCH		6.43757	0.0016
ZAR_US_PGARCH does not Granger Cause JPY_US_PGARCH	6008	6.52712	0.0015
JPY_US_PGARCH does not Granger Cause ZAR_US_PGARCH		4.55523	0.0105
MXN_US_PGARCH does not Granger Cause KRW_US_PGARCH	6021	53.8501	7.E-24
KRW_US_PGARCH does not Granger Cause MXN_US_PGARCH		1.27458	0.2796
NOK_US_PGARCH does not Granger Cause KRW_US_PGARCH	6008	19.0711	6.E-09
KRW_US_PGARCH does not Granger Cause NOK_US_PGARCH		25.0597	1.E-11
NZD_US_PGARCH does not Granger Cause KRW_US_PGARCH	6008	138.623	1.E-59
KRW_US_PGARCH does not Granger Cause NZD_US_PGARCH		27.7254	1.E-12
SEK_US_PGARCH does not Granger Cause KRW_US_PGARCH	6008	101.529	4.E-44
KRW_US_PGARCH does not Granger Cause SEK_US_PGARCH		40.2326	4.E-18
SGD_US_PGARCH does not Granger Cause KRW_US_PGARCH	6021	0.31280	0.7314
KRW_US_PGARCH does not Granger Cause SGD_US_PGARCH		9.14453	0.0001
ZAR_US_PGARCH does not Granger Cause KRW_US_PGARCH	6008	137.118	6.E-59
KRW_US_PGARCH does not Granger Cause ZAR_US_PGARCH		20.9432	9.E-10
NOK_US_PGARCH does not Granger Cause MXN_US_PGARCH	6008	27.3911	1.E-12
MXN_US_PGARCH does not Granger Cause NOK_US_PGARCH		9.73426	6.E-05
NZD_US_PGARCH does not Granger Cause MXN_US_PGARCH	6008	2.80671	0.0605
MXN_US_PGARCH does not Granger Cause NZD_US_PGARCH		12.5473	4.E-06
SEK_US_PGARCH does not Granger Cause MXN_US_PGARCH	6008	6.08085	0.0023
MXN_US_PGARCH does not Granger Cause SEK_US_PGARCH		12.7245	3.E-06
SGD_US_PGARCH does not Granger Cause MXN_US_PGARCH	6021	22.2176	2.E-10
MXN_US_PGARCH does not Granger Cause SGD_US_PGARCH		13.2349	2.E-06
ZAR_US_PGARCH does not Granger Cause MXN_US_PGARCH	6008	17.5902	2.E-08
MXN_US_PGARCH does not Granger Cause ZAR_US_PGARCH		17.0877	4.E-08
NZD_US_PGARCH does not Granger Cause NOK_US_PGARCH	6008	14.0061	9.E-07
NOK_US_PGARCH does not Granger Cause NZD_US_PGARCH		1.57949	0.2062
SEK_US_PGARCH does not Granger Cause NOK_US_PGARCH	6008	9.52095	7.E-05
NOK_US_PGARCH does not Granger Cause SEK_US_PGARCH		2.03988	0.1301
SGD_US_PGARCH does not Granger Cause NOK_US_PGARCH	6008	1.50314	0.2225
NOK_US_PGARCH does not Granger Cause SGD_US_PGARCH		6.99790	0.0009
ZAR_US_PGARCH does not Granger Cause NOK_US_PGARCH	6008	4.72220	0.0089
NOK_US_PGARCH does not Granger Cause ZAR_US_PGARCH		6.74405	0.0012
SEK_US_PGARCH does not Granger Cause NZD_US_PGARCH	6008	8.14406	0.0003
NZD_US_PGARCH does not Granger Cause SEK_US_PGARCH		39.1956	1.E-17
SGD_US_PGARCH does not Granger Cause NZD_US_PGARCH	6008	6.43163	0.0016
NZD_US_PGARCH does not Granger Cause SGD_US_PGARCH		16.3795	8.E-08
ZAR_US_PGARCH does not Granger Cause NZD_US_PGARCH	6008	4.18880	0.0152
NZD_US_PGARCH does not Granger Cause ZAR_US_PGARCH		23.4524	7.E-11

SGD_US_PGARCH does not Granger Cause SEK_US_PGARCH	6008	1.72005	0.1791
SEK_US_PGARCH does not Granger Cause SGD_US_PGARCH		8.32405	0.0002
ZAR_US_PGARCH does not Granger Cause SEK_US_PGARCH	6008	15.3017	2.E-07
SEK_US_PGARCH does not Granger Cause ZAR_US_PGARCH		5.77245	0.0031
ZAR_US_PGARCH does not Granger Cause SGD_US_PGARCH	6008	7.58047	0.0005
SGD_US_PGARCH does not Granger Cause ZAR_US_PGARCH		16.3581	8.E-08

Table A2: Pairwise Granger causality tests among transitory volatility components

Null Hypothesis:	Obs.	F-Statistic	Prob.
BRR_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	56.1594	7.E-25
AUD_US_TGARCH does not Granger Cause BRR_US_TGARCH		35.2305	6.E-16
CAN_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	6.38579	0.0017
AUD_US_TGARCH does not Granger Cause CAN_US_TGARCH		5.35105	0.0048
CHF_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	0.71579	0.4888
AUD_US_TGARCH does not Granger Cause CHF_US_TGARCH		1.60069	0.2018
CNY_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	5.47175	0.0042
AUD_US_TGARCH does not Granger Cause CNY_US_TGARCH		0.38229	0.6823
EUR_US_TGARCH does not Granger Cause AUD_US_TGARCH	5975	18.5470	9.E-09
AUD_US_TGARCH does not Granger Cause EUR_US_TGARCH		12.0533	6.E-06
GBP_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	17.6877	2.E-08
AUD_US_TGARCH does not Granger Cause GBP_US_TGARCH		14.1879	7.E-07
INR_US_OK_TGARCH does not Granger Cause AUD_US_TGARCH	6020	3.14182	0.0433
AUD_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		2.29963	0.1004
JPY_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	28.7750	4.E-13
AUD_US_TGARCH does not Granger Cause JPY_US_TGARCH		2.52141	0.0804
KRW_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	38.3854	3.E-17
AUD_US_TGARCH does not Granger Cause KRW_US_TGARCH		358.473	8E-148
MXN_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	125.358	5.E-54
AUD_US_TGARCH does not Granger Cause MXN_US_TGARCH		61.4143	4.E-27
NOK_US_TGARCH does not Granger Cause AUD_US_TGARCH	6008	9.03895	0.0001
AUD_US_TGARCH does not Granger Cause NOK_US_TGARCH		3.92495	0.0198
NZD_US_TGARCH does not Granger Cause AUD_US_TGARCH	6008	36.5503	2.E-16
AUD_US_TGARCH does not Granger Cause NZD_US_TGARCH		4.76512	0.0086
SEK_US_TGARCH does not Granger Cause AUD_US_TGARCH	6008	29.9471	1.E-13
AUD_US_TGARCH does not Granger Cause SEK_US_TGARCH		3.90142	0.0203
SGD_US_TGARCH does not Granger Cause AUD_US_TGARCH	6021	16.6895	6.E-08
AUD_US_TGARCH does not Granger Cause SGD_US_TGARCH		4.37497	0.0126
ZAR_US_TGARCH does not Granger Cause AUD_US_TGARCH	6008	9.65475	7.E-05
AUD_US_TGARCH does not Granger Cause ZAR_US_TGARCH		41.0225	2.E-18

CAN_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	6.65773	0.0013
BRR_US_TGARCH does not Granger Cause CAN_US_TGARCH		31.0496	4.E-14
CHF_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	0.27730	0.7578
BRR_US_TGARCH does not Granger Cause CHF_US_TGARCH		0.21892	0.8034
CNY_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	0.65722	0.5183
BRR_US_TGARCH does not Granger Cause CNY_US_TGARCH		0.11370	0.8925
EUR_US_TGARCH does not Granger Cause BRR_US_TGARCH	5975	5.04197	0.0065
BRR_US_TGARCH does not Granger Cause EUR_US_TGARCH		2.91054	0.0545
GBP_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	1.76048	0.1721
BRR_US_TGARCH does not Granger Cause GBP_US_TGARCH		7.27655	0.0007
INR_US_OK_TGARCH does not Granger Cause BRR_US_TGARCH	6020	2.63589	0.0717
BRR_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		1.40077	0.2465
JPY_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	5.22139	0.0054
BRR_US_TGARCH does not Granger Cause JPY_US_TGARCH		8.06497	0.0003
KRW_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	9.66806	6.E-05
BRR_US_TGARCH does not Granger Cause KRW_US_TGARCH		153.546	9.E-66
MXN_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	62.6149	1.E-27
BRR_US_TGARCH does not Granger Cause MXN_US_TGARCH		3.59803	0.0274
NOK_US_TGARCH does not Granger Cause BRR_US_TGARCH	6008	1.27681	0.2790
BRR_US_TGARCH does not Granger Cause NOK_US_TGARCH		13.3751	2.E-06
NZD_US_TGARCH does not Granger Cause BRR_US_TGARCH	6008	15.5609	2.E-07
BRR_US_TGARCH does not Granger Cause NZD_US_TGARCH		36.5586	2.E-16
SEK_US_TGARCH does not Granger Cause BRR_US_TGARCH	6008	8.11614	0.0003
BRR_US_TGARCH does not Granger Cause SEK_US_TGARCH		6.06002	0.0023
SGD_US_TGARCH does not Granger Cause BRR_US_TGARCH	6021	7.50070	0.0006
BRR_US_TGARCH does not Granger Cause SGD_US_TGARCH		4.92117	0.0073
ZAR_US_TGARCH does not Granger Cause BRR_US_TGARCH	6008	2.89380	0.0554
BRR_US_TGARCH does not Granger Cause ZAR_US_TGARCH		40.8106	2.E-18
CHF_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	2.67444	0.0690
CAN_US_TGARCH does not Granger Cause CHF_US_TGARCH		2.65583	0.0703
CNY_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	1.67104	0.1881
CAN_US_TGARCH does not Granger Cause CNY_US_TGARCH		0.21118	0.8096
EUR_US_TGARCH does not Granger Cause CAN_US_TGARCH	5975	15.9052	1.E-07
CAN_US_TGARCH does not Granger Cause EUR_US_TGARCH		7.63238	0.0005
GBP_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	2.80023	0.0609
CAN_US_TGARCH does not Granger Cause GBP_US_TGARCH		9.64436	7.E-05
INR_US_OK_TGARCH does not Granger Cause CAN_US_TGARCH	6020	8.13830	0.0003
CAN_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		7.22589	0.0007
JPY_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	12.4463	4.E-06
CAN_US_TGARCH does not Granger Cause JPY_US_TGARCH		1.76087	0.1720

KRW_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	14.7498	4.E-07
CAN_US_TGARCH does not Granger Cause KRW_US_TGARCH		433.930	9E-177
MXN_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	75.6908	3.E-33
CAN_US_TGARCH does not Granger Cause MXN_US_TGARCH		12.4872	4.E-06
NOK_US_TGARCH does not Granger Cause CAN_US_TGARCH	6008	4.86469	0.0077
CAN_US_TGARCH does not Granger Cause NOK_US_TGARCH		10.6584	2.E-05
NZD_US_TGARCH does not Granger Cause CAN_US_TGARCH	6008	0.81434	0.4430
CAN_US_TGARCH does not Granger Cause NZD_US_TGARCH		1.92157	0.1465
SEK_US_TGARCH does not Granger Cause CAN_US_TGARCH	6008	14.9267	3.E-07
CAN_US_TGARCH does not Granger Cause SEK_US_TGARCH		17.7032	2.E-08
SGD_US_TGARCH does not Granger Cause CAN_US_TGARCH	6021	4.44280	0.0118
CAN_US_TGARCH does not Granger Cause SGD_US_TGARCH		12.5304	4.E-06
ZAR_US_TGARCH does not Granger Cause CAN_US_TGARCH	6008	9.65399	7.E-05
CAN_US_TGARCH does not Granger Cause ZAR_US_TGARCH		10.7346	2.E-05
CNY_US_TGARCH does not Granger Cause CHF_US_TGARCH	6021	0.00140	0.9986
CHF_US_TGARCH does not Granger Cause CNY_US_TGARCH		0.41098	0.6630
EUR_US_TGARCH does not Granger Cause CHF_US_TGARCH	5975	9.96099	5.E-05
CHF_US_TGARCH does not Granger Cause EUR_US_TGARCH		1.52245	0.2183
GBP_US_TGARCH does not Granger Cause CHF_US_TGARCH	6021	1.03741	0.3544
CHF_US_TGARCH does not Granger Cause GBP_US_TGARCH		0.15512	0.8563
INR_US_OK_TGARCH does not Granger Cause CHF_US_TGARCH	6020	0.47603	0.6213
CHF_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		0.12108	0.8860
JPY_US_TGARCH does not Granger Cause CHF_US_TGARCH	6021	0.42448	0.6541
CHF_US_TGARCH does not Granger Cause JPY_US_TGARCH		0.79463	0.4518
KRW_US_TGARCH does not Granger Cause CHF_US_TGARCH	6021	0.17803	0.8369
CHF_US_TGARCH does not Granger Cause KRW_US_TGARCH		0.27498	0.7596
MXN_US_TGARCH does not Granger Cause CHF_US_TGARCH	6021	0.57384	0.5634
CHF_US_TGARCH does not Granger Cause MXN_US_TGARCH		1.03411	0.3556
NOK_US_TGARCH does not Granger Cause CHF_US_TGARCH	6008	0.83522	0.4338
CHF_US_TGARCH does not Granger Cause NOK_US_TGARCH		0.11668	0.8899
NZD_US_TGARCH does not Granger Cause CHF_US_TGARCH	6008	4.22541	0.0147
CHF_US_TGARCH does not Granger Cause NZD_US_TGARCH		0.64351	0.5255
SEK_US_TGARCH does not Granger Cause CHF_US_TGARCH	6008	6.43291	0.0016
CHF_US_TGARCH does not Granger Cause SEK_US_TGARCH		0.22483	0.7987
SGD_US_TGARCH does not Granger Cause CHF_US_TGARCH	6021	4.70115	0.0091
CHF_US_TGARCH does not Granger Cause SGD_US_TGARCH		4.70720	0.0091
ZAR_US_TGARCH does not Granger Cause CHF_US_TGARCH	6008	0.15899	0.8530
CHF_US_TGARCH does not Granger Cause ZAR_US_TGARCH		1.19205	0.3037
EUR_US_TGARCH does not Granger Cause CNY_US_TGARCH	5975	0.95159	0.3862
CNY_US_TGARCH does not Granger Cause EUR_US_TGARCH		24.6186	2.E-11

GBP_US_TGARCH does not Granger Cause CNY_US_TGARCH	6021	2.99913	0.0499
CNY_US_TGARCH does not Granger Cause GBP_US_TGARCH		0.55569	0.5737
INR_US_OK_TGARCH does not Granger Cause CNY_US_TGARCH	6020	6.19471	0.0021
CNY_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		0.42674	0.6527
JPY_US_TGARCH does not Granger Cause CNY_US_TGARCH	6021	11.3567	1.E-05
CNY_US_TGARCH does not Granger Cause JPY_US_TGARCH		1.08138	0.3392
KRW_US_TGARCH does not Granger Cause CNY_US_TGARCH	6021	0.64663	0.5238
CNY_US_TGARCH does not Granger Cause KRW_US_TGARCH		2.29033	0.1013
MXN_US_TGARCH does not Granger Cause CNY_US_TGARCH	6021	0.11717	0.8894
CNY_US_TGARCH does not Granger Cause MXN_US_TGARCH		2.10154	0.1224
NOK_US_TGARCH does not Granger Cause CNY_US_TGARCH	6008	0.78692	0.4553
CNY_US_TGARCH does not Granger Cause NOK_US_TGARCH		0.83788	0.4327
NZD_US_TGARCH does not Granger Cause CNY_US_TGARCH	6008	1.22944	0.2925
CNY_US_TGARCH does not Granger Cause NZD_US_TGARCH		4.45501	0.0117
SEK_US_TGARCH does not Granger Cause CNY_US_TGARCH	6008	0.46955	0.6253
CNY_US_TGARCH does not Granger Cause SEK_US_TGARCH		1.16385	0.3124
SGD_US_TGARCH does not Granger Cause CNY_US_TGARCH	6021	44.0201	1.E-19
CNY_US_TGARCH does not Granger Cause SGD_US_TGARCH		0.77424	0.4611
ZAR_US_TGARCH does not Granger Cause CNY_US_TGARCH	6008	0.11862	0.8881
CNY_US_TGARCH does not Granger Cause ZAR_US_TGARCH		2.31785	0.0986
GBP_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	4.44209	0.0118
EUR_US_TGARCH does not Granger Cause GBP_US_TGARCH		1.37820	0.2521
INR_US_OK_TGARCH does not Granger Cause EUR_US_TGARCH	5975	7.46931	0.0006
EUR_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		1.38994	0.2492
JPY_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	7.29401	0.0007
EUR_US_TGARCH does not Granger Cause JPY_US_TGARCH		5.55114	0.0039
KRW_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	12.9402	2.E-06
EUR_US_TGARCH does not Granger Cause KRW_US_TGARCH		27.9207	9.E-13
MXN_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	7.33801	0.0007
EUR_US_TGARCH does not Granger Cause MXN_US_TGARCH		9.36314	9.E-05
NOK_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	17.5020	3.E-08
EUR_US_TGARCH does not Granger Cause NOK_US_TGARCH		0.78000	0.4585
NZD_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	10.9290	2.E-05
EUR_US_TGARCH does not Granger Cause NZD_US_TGARCH		3.75647	0.0234
SEK_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	30.1475	9.E-14
EUR_US_TGARCH does not Granger Cause SEK_US_TGARCH		4.92557	0.0073
SGD_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	9.39067	8.E-05
EUR_US_TGARCH does not Granger Cause SGD_US_TGARCH		3.20276	0.0407

ZAR_US_TGARCH does not Granger Cause EUR_US_TGARCH	5975	1.30693	0.2707
EUR_US_TGARCH does not Granger Cause ZAR_US_TGARCH		15.8073	1.E-07
INR_US_OK_TGARCH does not Granger Cause GBP_US_TGARCH	6020	1.63722	0.1946
GBP_US_TGARCH does not Granger Cause INR_US_OK_TGARCH		2.26463	0.1040
JPY_US_TGARCH does not Granger Cause GBP_US_TGARCH	6021	1.22876	0.2927
GBP_US_TGARCH does not Granger Cause JPY_US_TGARCH		3.20147	0.0408
KRW_US_TGARCH does not Granger Cause GBP_US_TGARCH	6021	10.2755	4.E-05
GBP_US_TGARCH does not Granger Cause KRW_US_TGARCH		54.2925	4.E-24
MXN_US_TGARCH does not Granger Cause GBP_US_TGARCH	6021	7.09539	0.0008
GBP_US_TGARCH does not Granger Cause MXN_US_TGARCH		11.6757	9.E-06
NOK_US_TGARCH does not Granger Cause GBP_US_TGARCH	6008	3.21703	0.0401
GBP_US_TGARCH does not Granger Cause NOK_US_TGARCH		0.65469	0.5196
NZD_US_TGARCH does not Granger Cause GBP_US_TGARCH	6008	7.07046	0.0009
GBP_US_TGARCH does not Granger Cause NZD_US_TGARCH		4.54047	0.0107
SEK_US_TGARCH does not Granger Cause GBP_US_TGARCH	6008	0.90963	0.4027
GBP_US_TGARCH does not Granger Cause SEK_US_TGARCH		0.98170	0.3747
SGD_US_TGARCH does not Granger Cause GBP_US_TGARCH	6021	5.04454	0.0065
GBP_US_TGARCH does not Granger Cause SGD_US_TGARCH		7.57479	0.0005
ZAR_US_TGARCH does not Granger Cause GBP_US_TGARCH	6008	6.24957	0.0019
GBP_US_TGARCH does not Granger Cause ZAR_US_TGARCH		5.61357	0.0037
JPY_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6020	4.73559	0.0088
INR_US_OK_TGARCH does not Granger Cause JPY_US_TGARCH		5.23589	0.0053
KRW_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6020	2.52493	0.0801
INR_US_OK_TGARCH does not Granger Cause KRW_US_TGARCH		3.55176	0.0287
MXN_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6020	1.42317	0.2410
INR_US_OK_TGARCH does not Granger Cause MXN_US_TGARCH		14.1343	8.E-07
NOK_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6008	2.12681	0.1193
INR_US_OK_TGARCH does not Granger Cause NOK_US_TGARCH		10.0673	4.E-05
NZD_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6008	2.61052	0.0736
INR_US_OK_TGARCH does not Granger Cause NZD_US_TGARCH		8.20031	0.0003
SEK_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6008	4.52189	0.0109
INR_US_OK_TGARCH does not Granger Cause SEK_US_TGARCH		5.62500	0.0036
SGD_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6020	9.26624	0.0001
INR_US_OK_TGARCH does not Granger Cause SGD_US_TGARCH		40.4860	3.E-18
ZAR_US_TGARCH does not Granger Cause INR_US_OK_TGARCH	6008	0.95326	0.3855
INR_US_OK_TGARCH does not Granger Cause ZAR_US_TGARCH		4.42302	0.0120
KRW_US_TGARCH does not Granger Cause JPY_US_TGARCH	6021	9.39042	8.E-05
JPY_US_TGARCH does not Granger Cause KRW_US_TGARCH		48.3895	1.E-21
MXN_US_TGARCH does not Granger Cause JPY_US_TGARCH	6021	10.9461	2.E-05
JPY_US_TGARCH does not Granger Cause MXN_US_TGARCH		47.0689	5.E-21

NOK_US_TGARCH does not Granger Cause JPY_US_TGARCH	6008	4.00842	0.0182
JPY_US_TGARCH does not Granger Cause NOK_US_TGARCH		4.45378	0.0117
NZD_US_TGARCH does not Granger Cause JPY_US_TGARCH	6008	2.68308	0.0684
JPY_US_TGARCH does not Granger Cause NZD_US_TGARCH		20.1080	2.E-09
SEK_US_TGARCH does not Granger Cause JPY_US_TGARCH	6008	2.09605	0.1230
JPY_US_TGARCH does not Granger Cause SEK_US_TGARCH		17.9170	2.E-08
SGD_US_TGARCH does not Granger Cause JPY_US_TGARCH	6021	0.74046	0.4769
JPY_US_TGARCH does not Granger Cause SGD_US_TGARCH		3.50322	0.0302
ZAR_US_TGARCH does not Granger Cause JPY_US_TGARCH	6008	9.64663	7.E-05
JPY_US_TGARCH does not Granger Cause ZAR_US_TGARCH		14.2515	7.E-07
MXN_US_TGARCH does not Granger Cause KRW_US_TGARCH	6021	187.435	1.E-79
KRW_US_TGARCH does not Granger Cause MXN_US_TGARCH		1.01505	0.3624
NOK_US_TGARCH does not Granger Cause KRW_US_TGARCH	6008	18.1358	1.E-08
KRW_US_TGARCH does not Granger Cause NOK_US_TGARCH		11.9532	7.E-06
NZD_US_TGARCH does not Granger Cause KRW_US_TGARCH	6008	159.431	3.E-68
KRW_US_TGARCH does not Granger Cause NZD_US_TGARCH		17.4250	3.E-08
SEK_US_TGARCH does not Granger Cause KRW_US_TGARCH	6008	100.292	1.E-43
KRW_US_TGARCH does not Granger Cause SEK_US_TGARCH		15.0100	3.E-07
SGD_US_TGARCH does not Granger Cause KRW_US_TGARCH	6021	0.24658	0.7815
KRW_US_TGARCH does not Granger Cause SGD_US_TGARCH		3.71806	0.0243
ZAR_US_TGARCH does not Granger Cause KRW_US_TGARCH	6008	142.291	4.E-61
KRW_US_TGARCH does not Granger Cause ZAR_US_TGARCH		5.70923	0.0033
NOK_US_TGARCH does not Granger Cause MXN_US_TGARCH	6008	18.1037	1.E-08
MXN_US_TGARCH does not Granger Cause NOK_US_TGARCH		35.9155	3.E-16
NZD_US_TGARCH does not Granger Cause MXN_US_TGARCH	6008	10.8548	2.E-05
MXN_US_TGARCH does not Granger Cause NZD_US_TGARCH		47.2891	4.E-21
SEK_US_TGARCH does not Granger Cause MXN_US_TGARCH	6008	6.49789	0.0015
MXN_US_TGARCH does not Granger Cause SEK_US_TGARCH		8.97920	0.0001
SGD_US_TGARCH does not Granger Cause MXN_US_TGARCH	6021	23.4936	7.E-11
MXN_US_TGARCH does not Granger Cause SGD_US_TGARCH		11.2380	1.E-05
ZAR_US_TGARCH does not Granger Cause MXN_US_TGARCH	6008	21.1710	7.E-10
MXN_US_TGARCH does not Granger Cause ZAR_US_TGARCH		84.8327	5.E-37
NZD_US_TGARCH does not Granger Cause NOK_US_TGARCH	6008	4.60744	0.0100
NOK_US_TGARCH does not Granger Cause NZD_US_TGARCH		3.61578	0.0270
SEK_US_TGARCH does not Granger Cause NOK_US_TGARCH	6008	8.94990	0.0001
NOK_US_TGARCH does not Granger Cause SEK_US_TGARCH		2.53850	0.0791
SGD_US_TGARCH does not Granger Cause NOK_US_TGARCH	6008	1.84497	0.1581
NOK_US_TGARCH does not Granger Cause SGD_US_TGARCH		0.56778	0.5668

ZAR_US_TGARCH does not Granger Cause NOK_US_TGARCH	6008	3.43987	0.0321
NOK_US_TGARCH does not Granger Cause ZAR_US_TGARCH		6.25843	0.0019
SEK_US_TGARCH does not Granger Cause NZD_US_TGARCH	6008	7.45048	0.0006
NZD_US_TGARCH does not Granger Cause SEK_US_TGARCH		5.82422	0.0030
SGD_US_TGARCH does not Granger Cause NZD_US_TGARCH	6008	6.09493	0.0023
NZD_US_TGARCH does not Granger Cause SGD_US_TGARCH		3.21334	0.0403
ZAR_US_TGARCH does not Granger Cause NZD_US_TGARCH	6008	14.2751	7.E-07
NZD_US_TGARCH does not Granger Cause ZAR_US_TGARCH		21.5479	5.E-10
SGD_US_TGARCH does not Granger Cause SEK_US_TGARCH	6008	2.68520	0.0683
SEK_US_TGARCH does not Granger Cause SGD_US_TGARCH		0.27365	0.7606
ZAR_US_TGARCH does not Granger Cause SEK_US_TGARCH	6008	4.51729	0.0110
SEK_US_TGARCH does not Granger Cause ZAR_US_TGARCH		15.6015	2.E-07
ZAR_US_TGARCH does not Granger Cause SGD_US_TGARCH	6008	2.44053	0.0872
SGD_US_TGARCH does not Granger Cause ZAR_US_TGARCH		17.3478	3.E-08