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The policy uncertainty and market volatility puzzle: Evidence from wavelet analysis

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ABSTRACT

This article communicates a new dimension on the relationship of market volatility (VIX) and Economic Policy Uncertainty (EPU) using the propositions of Pastor and Veronesi (2017) and Das and Kumar (2018) by resorting to the wavelet analysis. We empirically examine the VIX-EPU puzzle and investigate the role of international and domestic policy shocks. We find (a) The VIX-EPU relationship is not always positive and is time-variant; (b) The combined DEPU-USEPU influence on VIX is more coherent to the developed markets; and (c) The VIX of the developed markets are more receptive to USEPU.

1. Introduction

The question of whether or not the Volatility Index (VIX) co-moves with the economic policy uncertainty (EPU) was first highlighted by Baker et al. (2016). They use the VIX as a close comparator to the EPU index and show that these two indicators often move together. At the same time, they also emphasize some of the fundamental differences between the VIX and EPU. The EPU is a newspaper-based index, whereas the VIX is an indicator of 30-day ahead option-implied volatility. Baker et al. (2016) further assert that the VIX is more impacted by financial or stock market events, including financial crises, WorldCom fraud, etc. The EPU index is more responsive toward political events, such as presidential elections, disagreement over government spending and taxes, etc. However, Baker et al. (2016) uphold the fact that policy-related concerns are crucial determinants that induce volatility in stock markets. The relationship between the stock markets and EPU is now well established in the theoretical and empirical literature of financial economics (Brogaard and Detzel, 2015; Das and Kumar, 2018; Ko and Lee, 2015; Pastor and Veronesi, 2013, 2012).

The VIX could be viewed as a harbinger of near-term market volatility. Thus, the VIX may reflect expected changes in government policies. Theoretically, a higher level of uncertainty corresponds with the higher levels of the VIX (Pastor and Veronesi, 2013). Nonetheless, the premise of this theory has been challenged recently. Shortly before the US presidential election (November 08, 2016), the VIX rose above its average of 23. This underlying phenomenon could be associated with the uncertainty of the election outcomes (Kelly et al., 2016). However, the VIX stayed unusually low[1] despite the remarkably higher EPU[2] since the election. Pastor and Veronesi (2017) term this anomaly as the *"puzzle of high policy uncertainty and low market volatility"*.

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[1] The values of the VIX were low and floating within the narrow range of 10–14 for the next 6 months following the presidential elections. On May 08, 2017, the VIX closed at 9.77, which was the lowest value since 1993 (Pastor and Veronesi, 2017).

[2] The EPU index of Baker et al. (2016) was unusually high in its 32-year history (the third highest), during the month of the US presidential election (November 2016). For the subsequent 5 months. The index was floating at 160, which was above its long-run historical average of 110 (Pastor and Veronesi, 2017).

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To explain this phenomenon, Pastor and Veronesi (2017) emphasize an important condition to their theory and argue that the market volatility is an increasing function of the product of signal precision and EPU. For simplicity's sake, they consider the political signals to be time-invariant. However, the political signals may not be precise at all times, nor are all market participants equally sensitive to political nuances. Thus, the relationship is time-variant and may fluctuate across different events and time-horizons.[3] On a similar note, Das and Kumar (2018) highlight that the responsiveness of different country's stock markets will vary if the political information is country-specific (DEPU) or US-specific EPU (USEPU). Thus, some markets the participants may find country-specific signals to be more precise than the US-specific political signals or vice-versa.

In this article, we show the co-movement dynamics of EPU and the VIX in a time-frequency domain by applying the wavelet-based analysis. Specifically, we attempt to answer two intriguing questions: (a) first, how do the USEPU and DEPU co-move with the country-specific VIX and (b) second, which signal is more precise to the market participants, DEPU or USEPU? The logic of using wavelets is justified, as it can capture the time-frequency based variations.

We find that the joint impact of USEPU and DEPU on the VIX is more noticeable for developed markets than emerging markets. Additionally, we also find that for developed markets, the USEPU signals are more relevant than their own country-specific policy shocks (DEPU). In emerging markets, the findings are mixed; i.e. for Brazil, the VIX co-moves more with DEPU, whereas India shows a marginally higher responsiveness with DEPU. Korea and Russia are more sensitive to USEPU.

2. Estimation methodology

We estimate the co-movement of USEPU and DEPU with country-specific VIX using the multiple wavelet coherence (MWC) analysis i.e. $[y_n \Leftarrow x1_n, x2_n]$, where y_n is the country-specific VIX, $X1_n$ and $X2_n$ correspond to DEPU and USEPU, respectively. To assess the relationship of the VIX with DEPU and USEPU, we use the partial wavelet coherence (PWC) technique. It is expected that both DEPU and USEPU would influence the country-specific VIX. Further, Ko and Lee (2015) also show that there exist substantial co-movement between DEPU and USEPU. Thus, to show the pure country-specific and international impact, we study the co-movement between the VIX and DEPU, while eliminating the influence of USEPU upon the VIX and vice-versa. The PWC analysis eliminates the influence of the two time-series variables on a dependent variable. So, we write

$$[y_n \Leftarrow x1_n | x2_n] \text{ and } [y_n \Leftarrow x2_n | x1_n].$$

The MWC and PWC techniques are developed by Mihanović et al. (2009) and briefly explained as below:

Let, $W_n^Y(S)$, $W_n^{X1}(S)$, and $W_n^{X2}(S)$ be the wavelet transformation of y_n, $X1_n$, $X2_n$, respectively. To balance the required resolution of time-frequency and statistical significance, a smoothing parameter S is used. Thus, the cross-wavelet transforms results as $W_n^{YX1}(S)$, $W_n^{YX2}(S)$ and $W_n^{X1X2}(S)$. The absolute squared values resulting from the pair-wise wavelet coherences are calculated as:

$$R_n^2(s) = \frac{|S(s^{-1} W_n^{XY}(s))|^2}{S(s^{-1}|W_n^X(s)|^2).\, S(s^{-1}|W_n^Y(s)|^2)} \tag{1}$$

The squared coherence is calculated using the smoothed spectra of wavelet and cross-wavelet, with an explicit dependence scale omission:

$$\begin{aligned}
&R_n^{YX1} = S(s^{-1} W_n^{YX1}) / \sqrt{S(s^{-1}|W_n^Y|^2).\, S(s^{-1}|W_n^{X1}|^2)}; \qquad (R_n^{YX1})^2 = R_n^{YX1}.\, R_n^{YX1*},\\
&R_n^{YX2} = S(s^{-1} W_n^{YX2}) / \sqrt{S(s^{-1}|W_n^Y|^2).\, S(s^{-1}|W_n^{X2}|^2)}; \qquad (R_n^{YX2})^2 = R_n^{YX2}.\, R_n^{YX2*},\\
&R_n^{X2X1} = S(s^{-1} W_n^{X2X1}) / \sqrt{S(s^{-1}|W_n^{X2}|^2).\, S(s^{-1}|W_n^{X1}|^2)}; \qquad (R_n^{X2X1})^2 = R_n^{X2X1}.\, R_n^{X2X1*},
\end{aligned} \tag{2}$$

The PWC is mathematically defined as:

$$\begin{aligned}
(RP_n^{YX1_X2})^2 &= \frac{|R_n^{YX1} - R_n^{YX2}.\, R_n^{X2X1}|^2}{\left(1-(R_n^{YX2})^2\right)\left(1-(R_n^{X2X1})^2\right)}\\
(RP_n^{YX2_X1})^2 &= \frac{|R_n^{YX2} - R_n^{YX1}.\, R_n^{X2X1*}|^2}{\left(1-(R_n^{YX1})^2\right)\left(1-(R_n^{X2X1})^2\right)},
\end{aligned} \tag{3}$$

whereas, the MWC may be expressed as:

$$(RM_n^{YX2X1})^2 = \frac{(R_n^{YX1})^2 + (R_n^{YX2})^2 - 2Re(R_n^{YX1}.\, R_n^{YX2*}.\, R_n^{X2X1*})}{1-(R_n^{X2X1})^2} \tag{4}$$

3. Data

The data consists of four developed (France, Germany, Japan, and United Kingdom) and four emerging markets (Brazil, India,

[3] Pastor and Veronesi (2017) show that the co-movement between EPU and the VIX index for the US since January 2003 was high with a correlation of 48%; however, from May 2016 to April 2017 the correlation was only 16%.

Russia, Korea). The bifurcation between developed and emerging markets is based on Morgan Stanley Capital International market classifications. Besides, only those countries were screened for which both the country-specific VIX and EPU Index were available. The monthly available data for VIX of country-specific stock markets have been considered with varying dates which are as follows: France [CAC 40 Volatility IDX] (01/31/2000–03/31/2017), Germany [Volatility DAX] (01/29/1993–03/31/2017), Japan [Nikkei 225 Volatility Index] (01/31/2001–04/29/16), United Kingdom [Volatility FTSE] (01/31/2000–03/31/2017), Brazil [CBOE Brazil ETF Volatility Index] (03/31/2011–03/31/2017), India [NSE VIX] (11/03/2007–03/31/2017), Russia [Russian Volatility Index RTSVX] (01/31/2006–12/30/2016), Korea [KOSPI 200 Volatility Index] (01/31/2003–03/31/2017), dates in MM:DD:YYYY format. The VIX data is extracted from the Bloomberg Database. The corresponding data for EPU is gathered from the index created by Baker et al. (2016). The EPU data is available on the following link http://www.policyuncertainty.com.

4. Main results

Fig. 1 exhibits the multiple wavelet coherencies of DEPU and USEPU with the country-specific VIX. The vertical axis represents the units in terms of months, whereas the horizontal axis indicates the timeline. The degree of high (low) coherency is depicted by the red (blue) zones in the coherence maps. Additionally, the significant coherencies are determined by the black-bound contours in the surface of the maps. Significant coherencies (red-zoned areas) are more dominant for developed markets as compared to the emerging markets in general. With the exception of Korea, the emerging markets show a comparatively less coherent VIX-EPU co-movement, which is consistent with the findings of Das and Kumar (2018). The significant short to long-run (4 to over (or up to) 32 months) coherencies are observable from 2007 to 2010, which corresponds to the Global Financial Crisis (GFC) followed by the Euro Crisis, particularly for France, Germany, Japan, United Kingdom, Korea, and Russia. Brazil exhibits significant coherencies for the period 2014–16 for the frequency of up to 8 months (*see* Fig. 1(e)). The underlying reasons could be attributed to the Brazilian recessionary shock followed by the impeachment of the Brazilian president during this period.[4] The VIX-EPU co-movement has been minimum for India. Besides, we may also observe that the co-movements have been relatively tranquil since 2011.

Fig. 2 exhibits the results for PWC analysis. As Ko and Lee (2015) clearly shows that there exists significant co-movement between USEPU and DEPU, we examine the marginal co-movement behavior of USEPU-VIX, while controlling for DEPU and vice-versa. In addition, similar to Ko and Lee (2015) we also show the co-movement between USEPU and DEPU for the respective sample countries.[5] The results highlight two interesting phenomena. First, the arrows in the coherence map oscillate unsystematically, which indicates the relationship often moves from in-phase (→) to anti-phase (←). The in-phase relationship signifies a positive VIX-EPU relationship and vice-versa. The unsystematic nature of the relationship empirically supports the hypothesis of Pastor and Veronesi (2017) i.e. the VIX-EPU relationship is time-variant (and is not necessarily positive, as proposed earlier by Pastor and Veronesi (2013)). Because there are many signals in the econopolitical system, market-participants may discount certain political events that drive up political uncertainty. Thus, the empirical our results can be explained by the "signal-precision" theory of Pastor and Veronesi (2017).

Second, the results also show that the country-specific VIX displays more co-movement with the USEPU rather than DEPU. The developed markets clearly show higher VIX-USEPU coherencies. It is interesting to note that among the four developed markets, three are European. Colombo (2013) finds that the negative impact of Euro area-specific uncertainty shocks on industrial production is relatively modest as compared to the US-specific uncertainty shocks. Similarly, Das and Kumar (2018) claim that European stock markets are sensitive to USEPU rather than their own country-specific shocks. Our results in the context of the VIX are consistent with these two studies. Among the emerging markets, Brazil exhibits greater co-movement with DEPU. Similarly, India also shows a marginally higher VIX-DEPU coherency. Korea and Russia exhibit greater co-movement with USEPU. Thus, it can be argued that the co-movement dynamics of VIX-EPU varies for country-specific and international EPU; however, the co-movement of the VIX is more prominent with the USEPU. In other words, the signal precision is greater for US-specific policy shocks. This finding is a logical premise since US-specific shocks are benchmarked as international uncertainty for investment decisions. Ehrmann and Fratzscher (2009) argue that a monetary policy tightening in the US negatively impacts 50 global equity markets. Additionally, the emerging markets are also major recipients of foreign investments from the developed countries, which also expose them to international uncertainty shocks.

5. Conclusions

This article contributes to the literature on EPU in three ways: (a) first, it provides that the VIX-EPU relationship is time-variant and not positive at all the times. (b) Second, the combined influence of DEPU and USEPU on the VIX is more coherent to the developed than the emerging markets. Moreover, (c) the VIX of developed markets is more responsive to USEPU, whereas the results are mixed for the emerging markets. We believe our findings empirically support the propositions of Pastor and Veronesi (2017) and Das and Kumar (2018) and are relevant for international investment management.

[4] For a detailed discussion kindly refer, *what is driving Brazil's economic downturn?* (2016), European Commercial Bank, Economic Bulletin, available at the following link:
https://www.ecb.europa.eu/pub/pdf/other/eb201601_focus01.en.pdf?0a2354c07a93b382462a56da38e2654b

[5] We do not include the results in the paper because of length of the manuscript and brevity of the presentation. However, the results are available upon request directly to the first author of the study.

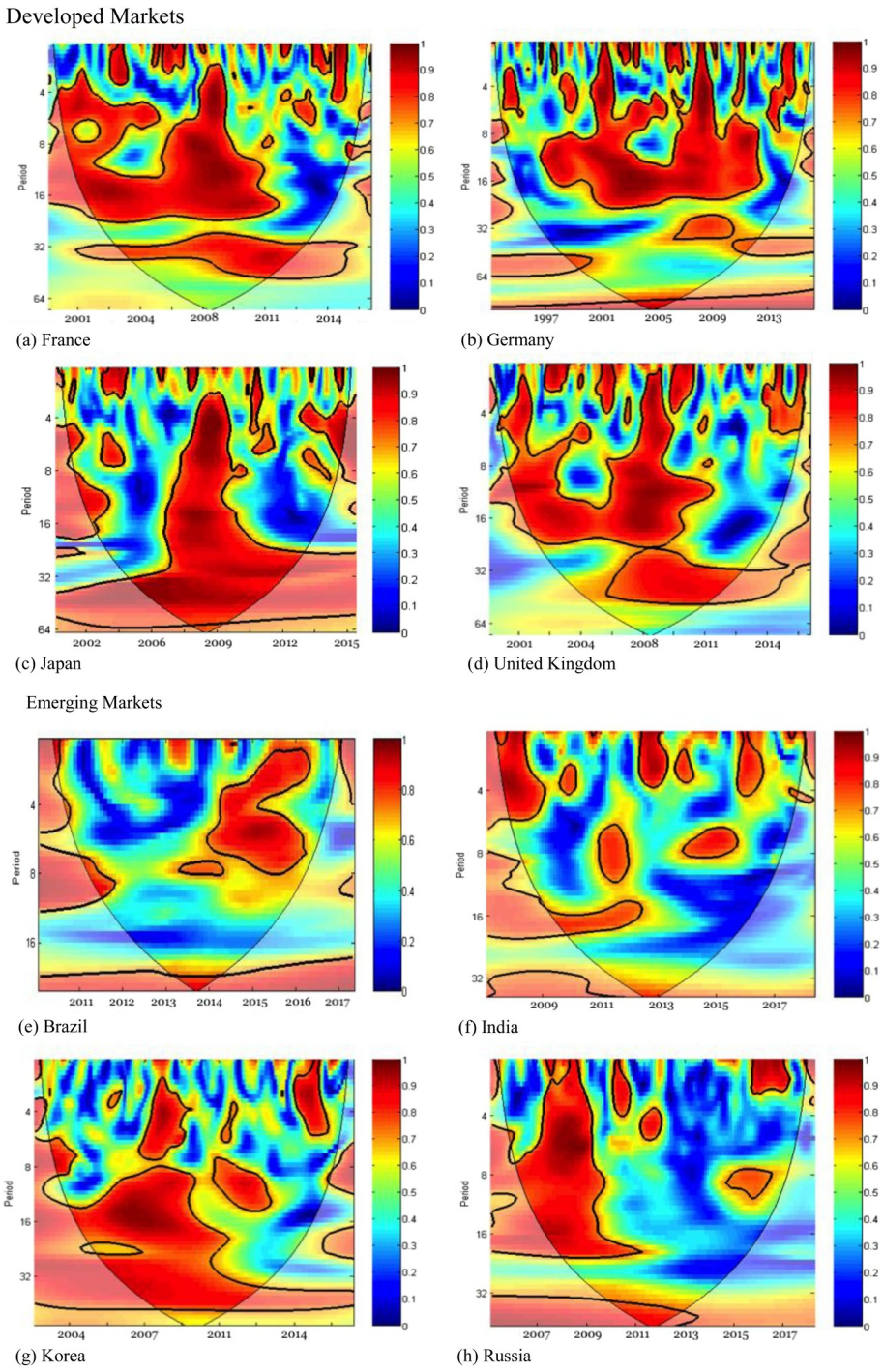

Fig. 1. Multiple wavelet coherence.

Note: Multiple wavelet coherencies computed to gauge the combined impact of DEPU and USEPU on country-specific VIX. The black contour designates the 5% significance level estimated from Monte Carlo simulations. The region with large (small) coherency is described in red (blue) colors. The coherence power scale is provided by the color bar on the right. The vertical axis represents frequencies in months. Figs. (a)–(d) correspond to developed markets. Figs. (e)–(h) represent emerging markets. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

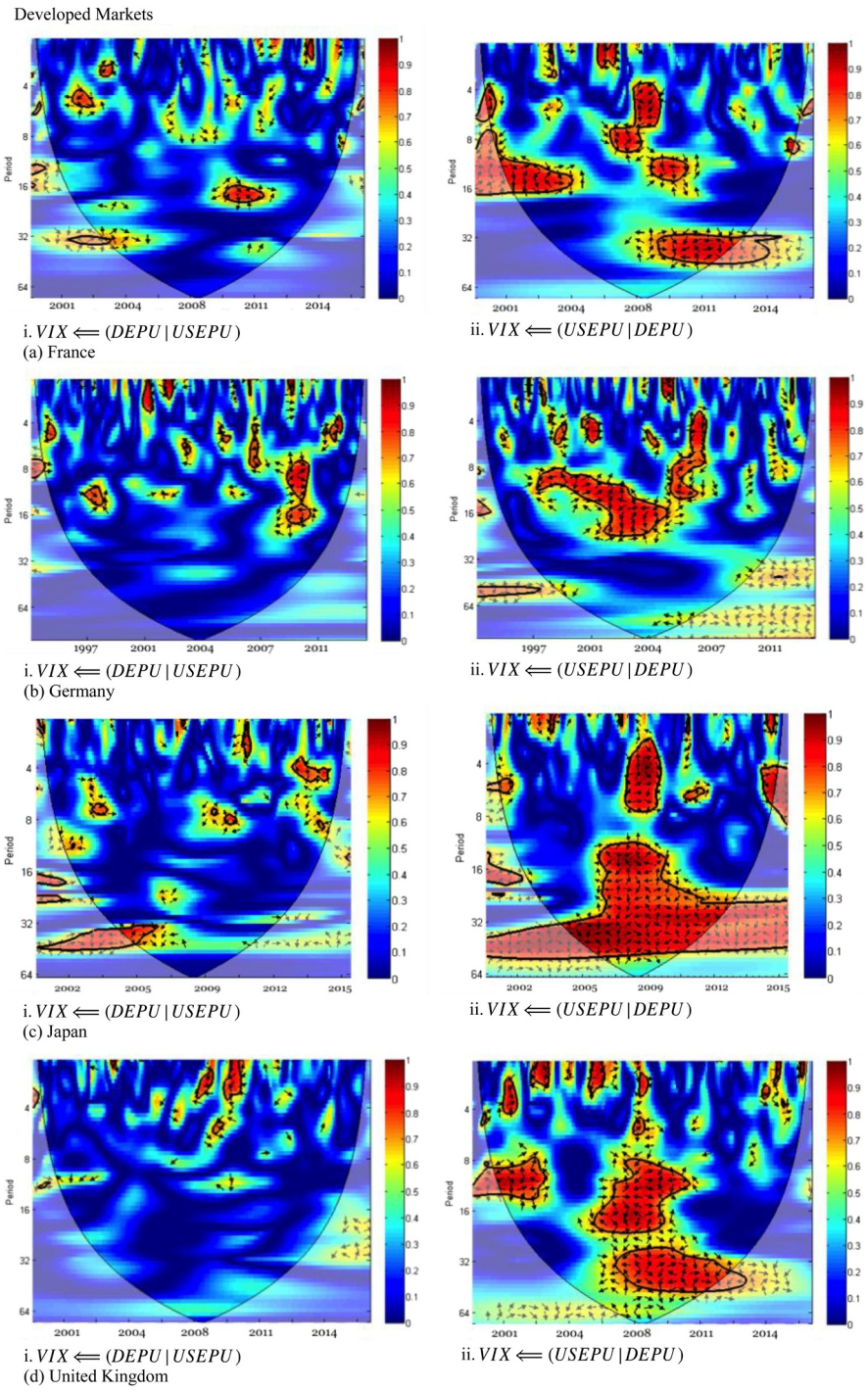

Fig. 2. Partial wavelet coherence.

Note: Partial wavelet coherencies computed to gauge the partial impact of DEPU and USEPU on country-specific VIX. The black contour designates the 5% significance level estimated from Monte Carlo simulations. The region with large (small) coherency is described in red (blue) colors. The coherence power scale is provided by the color bar on the right. Arrows indicate the phase differences. The vertical axis represents frequencies in months. Figs. (a)–(d) correspond to developed markets. Figs. (e)–(h) represent emerging markets. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

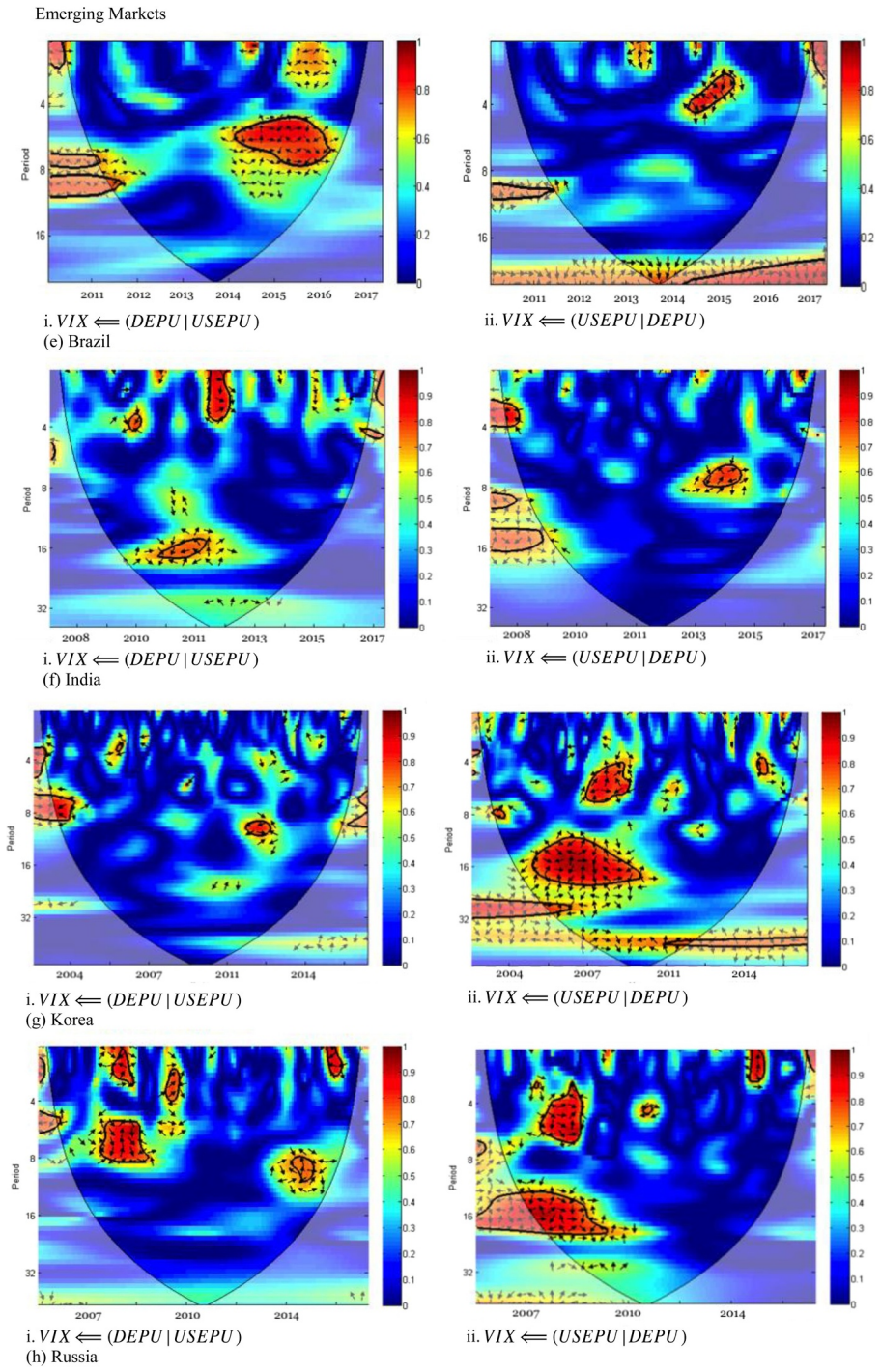

Fig. 2. (*continued*)

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