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Synchronisation of policy related uncertainty, financial stress and economic activity in the United States

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Abstract

This study analyses the synchronisation of economic activity, financial stress and uncertainty in the United States by employing a wavelet-based approach of cohesion. Being innovative in the choice of the methodological framework as well as underlying factors of interest, we employed the monthly data on the policy-related uncertainty indexes, Chicago Fed National Activity Index (CFNAI) and Kansas City Federal Reserve Financial Stress Index (KCFSI). Our key empirical findings suggest that the co-movements of policy uncertainty, financial stress and economic activity are frequencies as well as time-dependent. The uncertainty indices are found to be synchronised at lower and intermediate frequencies for all of the pairs. In the nexus between uncertainty and economic activity, financial stress plays a crucial role. Co-movement of the policy uncertainty is observed to be more pronounced during the crisis periods though at different frequencies which indicated the usefulness of the proposed framework to analyse the implications of contemporaneous policy uncertainty and financial stress for the real economy. Concomitantly this informs the policy efforts to address the financial and economic instabilities which may arise as a consequence of financial stress and policy uncertainty.

KEYWORDS

Economic activity, financial instability, financial stress, KCFSI, policy uncertainty

1 | INTRODUCTION

The Global Financial Crisis of 2008 rejuvenated and re-signified the debate on the association between the financial sector and economy as well as the association between the macroeconomy and uncertainty, particularly the uncertainty about the future economic outlook. Since the crisis, there has been a growing strand of literature focusing on exploring the effects of uncertainty on the real economy.[1] Concomitantly, a number of empirical studies endeavoured to analyse and gauge the impact of uncertainty on the economy and financial sector. For instance, a study by Andreasson et al. (2016) reported a significant impact of policy uncertainty on the commodity prices in the US. Among the recent contributions, Bilgin et al. (2018) reported that the increase in economic policy uncertainty leads to an increase in the gold prices.[2] In further evidence from the US, Wisniewski and Lambe (2015) reported a significant impact of US policy uncertainty on the CDS spreads which led them to argue

that the country-level risk can permeate to the corporations. Whereas in the evidence from the UK, Antonakakis and Floros (2016), reported large spillovers of shocks from the economic policy uncertainty to macroeconomic factors including economic growth, inflation and monetary policy. In fact, the US policy uncertainty also has international spillovers effects. On this aspect, Hu et al. (2018) analysing the effects of the US economic policy uncertainty on the Chinese stock market reported significant and negative effects which also varied among different sectors. It led them to argue that the investors in Chinese stock required a premium to hold the share due to the US economic policy uncertainty. Concomitantly, all these studies provide ample evidence to infer that the policy-related uncertainty has profound implications for the economy and hence it is vital to have a good understanding of the nexus between policy uncertainty, financial sector and the real economy.

As a corollary to above and on a broader note, a number of studies contributed to the contemporary understanding of the vital nexus between uncertainty, financial sector and the real economy, though most of them investigated it in part exclusively focusing uncertainty and real economy or uncertainty and financial markets and often in the context of an event. For instance, some studies have analysed the impact of uncertainty on the financial market, for instance, a study by Bryan et al. (2016) analysed effects of political uncertainty and equity (option) market, whereas Wielechowski and Czech (2016) and later Nasir and Morgan (2018), investigated the impact of the Brexit associated uncertainty on the foreign exchange markets.[3] While analysing the consequences of uncertainty, it is intuitive that one shall not lose the sight of the context in which uncertainty emerges at first place. In terms of its causal direction and the causes of existence, Bachmann et al. (2010) argued that in fact, the recessions are the main cause for arising of uncertainty. Perhaps, this line of argument has an important aspect that uncertainty is state-contingent. Hence, in tandem, it raises the question that whether the association of uncertainty with other variables and entities is also state-contingent or time-variant. The available evidence on the subject which is also very limited suggests that the association between uncertainty and other aspects of economy for example, inflation has shown some time-variation. However, the nexus between uncertainty and output has been reported to be persistently negative (see Jones and Olson, 2013) which then bring us to infer that the other relations might be contingent on what uncertainty may imply for the real economy. Perhaps, there is one interesting dimension to the nexus between uncertainty and real economy which is non-trivial if one considers it in the context of financial stability and that is the *Financial Stress*. The nexus is underpinned and embedded in the theoretical and philosophical notion of self-fulfilling prophecies emphasised long ago by Merton (1948) and recently re-emphasised by Farmer (2010). On this aspect, in their remarkable work, David and Hakkio (2010) suggested that the increase in financial stress could have a stronger adverse impact on the real sector of the economy, particularly in a scenario where the subject is already in a state of distress. In fact, the rising levels of financial stress are so crucial that they can eventually lead a reasonably strong economy into recession. Concomitantly, it requires that the institutions and policymakers responsible for financial stability closely and consistently monitor the financial conditions and association between policies related uncertainty, financial stress and economic activity.

Theoretically, there are two relevant concepts which shed light on the association between financial stress and economic activity in the real sector. The first concept is related to the "real options" that take into account the uncertainty into the process of financial decision-making (e.g., whether to make the investment now or postpone the decision until the fog of uncertainty is settled). The second concept or school of thought is related to addressing the issue on how the increased deterioration of the financial conditions manifested in the financial stress affects the real economy by directly tying and making the cost of borrowing contingent on the financial condition of borrowing firms. The second school of thought tracks its roots in the concept of "financial accelerator". This accelerator shows how the deterioration in the financial condition of firms leads to the cost of borrowing of required funds and concomitantly leads to reduced investment which further leads to a reduction in profits and impairment of the financial condition of the firms (see discussion by Davig and Hakkio, 2010). In nutshell, both Real Option and Financial Accelerator, theories explicitly indicate that the lower economic activity can be the consequence of the high financial stress, as manifested and reflected primarily in the heightened uncertainty. Concomitantly, within this context, the analysis of financial stress, uncertainty, and economic activity is of much importance. The next point is the appropriate measurement of the variables of interest and empirical tools to be utilised for this purpose. Particularly, as most of the previous studies condoning the financial stress and solely focusing on the issue of the relationship between either uncertainty and macroeconomy has been inconclusive (for instance, contrast Bloom 2009, Bloom et al. 2009, Gilchrist et al. 2010, Bachmann et al. 2010, Panousi and Papanikolaou 2012, Jones and Olson 2013, Yin and Han 2014, Han et al. 2016, Robinson et al. 2016, Hassett and Sullivan 2016, Jawadi and Ftiti 2017,

Sangyup 2017 and Degiannakis et al. 2017). Nonetheless, when it comes to analysing the implications of uncertainty, it is vital to have an appropriate measure of it. For instance, using the New York Times, a study by Michelle and Jon (2015) created new indicators of uncertainty both general economic and policy specific which were based on the Text. Their results suggested that both general and policy-related uncertainty shocks were the cause of depressed economic activity. Nonetheless, they also led to an increase in the volatility of the stock market and a decrease in market returns. However, this approach towards the estimation of uncertainty requires to be taken with a pinch of salt. On this aspect, Shin et al. (2017) cautioned that the journalistic views about uncertainty can be quite different across countries and hence argued that one needs to be cautious about the use of news-based measures. On the other hand, Carriero et al. (2017, page 2) argued that "While a theory-based measure could be more efficient, it would be biased if the underlying model is incorrect".[4] Perhaps, the measure to analysing the impact of the uncertainty shall also have characteristics of capturing time-varying association among under analysis entities as a recent study by Sangyup (2017) on OECD countries reported that the impact of uncertainty on the economy (output) has increased over time.

As a corollary of above, this study is an endeavour to address these caveats in the existing body of knowledge and employ a measure that accounts for the issues discussed. We used a policy-related uncertainty index, which was developed by Baker et al. (2013) as a measure of US policy uncertainty. The financial stress is measured by an index developed by the Kansas City Federal Reserve and named Financial Stress Index (KCFSI). This is a comprehensive monthly index which conglomerates 11 economic and financial variables which provide a wide range of economic signals of financial stress. Specifically, the variables included in this index can be classified into two overarching categories that is, a) measures based on the actual or expected behaviour of asset prices and b) credit and liquidity spread. For economic activity, we employed the Chicago Fed National Activity Index (CFNAI). In terms of its construction and the underlying methodology, the CFNAI is analogous to the KCFSI; however, it entails data series of 85 macroeconomic variables and hence provides a very broad and inclusive measure of economic activity. The CFNAI is also useful in terms of its inclusiveness; furthermore, unlike real GDP that is often used as a measure of economic activity, data on the CFNAI is available at higher frequency that is, monthly.[5] Finally, to analyse the synchronisation of economic activity, financial stress and uncertainty, we employed a wavelet-based tool proposed by Rua (2010). The novelty of this framework is that it provides very fruitful and deep insights about several economic phenomena as it presents the dynamics of the co-movements of the variables in the time-frequency space within a unified framework. This makes wavelet analysis particularly suitable to study synchronisation of economic activity, uncertainty and financial stress as there is evidence suggesting that it has changed over time and depends on the frequency. Our prime objective is to gain an insight into the historical policy uncertainty-economic activity, policy uncertainty-financial stress, and real economic activity-financial stress. The application of this approach is also one of the unique contributions of the study. It leads us to gain further insight in the frequencies and time periods when there was the high or low degree of co-movement between the variables, contrary to an approach which provides the evidence of the relationship between economic activity and financial stress in the normal and distressed state using a regime-switching model or which provides evidence on uncertainty and output using Dynamic Conditional Correlation (DCC) GARCH model and thus only shows point estimates.[6] Our key findings showed that the co-movement of uncertainty is both frequencies as well as time-dependent. Furthermore, the uncertainty indices are synchronised at lower and intermediate frequencies for almost all the pairs. There was prima facie evidence of rather more pronounced co-movement of uncertainty during the crisis periods 2000–01 and 2007–08 though at different frequencies. It is a prima facie indication of the usefulness of the proposed approach to analyse the implications of contemporaneous uncertainty and financial stress for the real economy. The findings have profound implications for the policy formulation for financial and economic stability, particularly in times of high financial stress.

The organisation of the paper as follows: in Section 2, we will provide a brief insight into the employed methodological framework by describing the wavelet-based as a measure of the co-movement. In Section 3, we will present the empirical results which will be accompanied by a brief discussion and will lead us to conclude in Section 4.

2 | METHODOLOGY

Traditional econometric methods such as cointegration and error correction models ignore the frequency-based information in a signal and therefore cannot capture the full information contained in the time-series signals. To overcome these problems the Fourier transformation was developed which involves the application of sine and cosine based functions and assumes that signals are stationary. There are two issues with this method: (1) the

sine and cosine base functions are characterised by infinite energy as well as finite power and therefore, the time dependency of any signal is lost; (2) they assume that signals are stationary and there is no noise. To overcome the issues the Windowed Fourier transformation was developed which works on the fixed time-frequency window framework and has constant intervals in the time and frequency domains and therefore ignores adequate resolution for all frequencies (Rua, 2010). To address all the problems and analyse the issue in time-frequency framework a wavelet approach was developed. The wavelet transforms fine-tune the time resolution to the frequency and adjusts the window width on high frequencies (by narrowing down) and low frequencies (by widening). In addition to that, Wavelets are characterised by finite energy such that they grow and die out within a period. The Wavelets function may be expressed as follows:

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-\tau}{s}\right) \tag{1}$$

where τ, s, $\frac{1}{\sqrt{s}}$ and $\psi_{\tau,\ s}(t)$ respectively are the translation parameter, the dilation parameter, normalization factor and fundamental functions which are derived from a time-localized mother wavelet $\psi(t)$ and generated out of wavelet decomposition of a time series (For example, see, Percival and Walden, 2000). The continuous wavelet transform (CWT)[7] of a time $x(t)$ series with respect to $\psi(t)$ may be defined as follows:

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

where * denotes the complex conjugate. The wavelet power spectrum, which seizures the comparative impact of a time series signal at each time-scale is defined as$|W_x(\tau, s)|^2$ and one can obtain the total variance of the series by taking integration across $\tau$and$s$, that may be captured from the following equation,

$$\sigma_x^2 = \frac{1}{C_\psi}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}|W_x(\tau,s)|^2\frac{d\tau ds}{s^2} \tag{3}$$

Further, taking the idea from Croux et al. (2001) the cross-wavelet spectrum (which measures the covariance between two time-series namely, $x(t)$ and$y(t)$; and may be defined as $W_{xy}(\tau,s) = W_x(\tau,s)W_y^{*}(\tau,s)$ where $W_x(\tau,s)$ and $W_y(\tau,s)$ are in the time-frequency space of time series under consideration) can be decomposed into real and imaginary components as follows:

$$\rho_{xy}(\tau,s) = \frac{\Re\left(W_{xy}(\tau,s)\right)}{\sqrt{\left|W_x(\tau,s)\right|^2}\left|W_y(\tau,s)\right|^2} \tag{4}$$

where $\Re$and $\rho_{xy}(\tau, s)$, respectively, measures the contemporaneous variance the co-movement in the time-frequency space. Following, Rua (2010) the cross-wavelet spectrum may be used as a contemporaneous correlation coefficient in the time-frequency domain and therefore by its virtue it provides the information about the co-movement both at the frequency and time. Further, one may make use of the contour plot of the wavelet cross-spectrum, which can help in detecting the time-frequency regions over which the two series positively or negatively co-move.

2.1 | Data

We employed the monthly data on the policy-related uncertainty indexes (USEPUINDXM) originally constructed by Baker (2013), Chicago Fed National Activity Index (CFNAI) and Kansas City Federal Reserve Financial Stress Index (KCFSI). The KCFSI is selected for the period 1990M2-2016M9, NFCI is for 1973M1-2013M3 and USEPUINDXM is for 1985M1-2016M9. All series were obtained from the online database of Federal Reserve Bank of St. Louis and analysis was conducted on common dates for each pair analysed.

3 | EMPIRICAL FINDINGS AND DISCUSSION

In this section, we assessed the co-movement between financial stress, economic activity and uncertainty for the USA by employed the uncertainty index based on the seminal work by Baker (2013). To start with, we plotted the financial stress, economic activity and uncertainty indexes in Figure 1.

The plot of financial stress, economic activity and uncertainty indexes indicates that there is a reasonable amount of co-movement between these variables. The time period corresponding to the events like 9/11 and GFC, there seemed to be a significant increase in financial stress and uncertainty as well as a decrease in the economic activity. However, it is indistinct that how co-movement varies both across frequencies and over time. Concomitantly, the wavelet-based measure of cohesion is employed with the reason to comprehend the dynamics of the co-movement over time as well as across frequencies. Specifically, Equation 5 is estimated for all the pairs of variables under consideration and the results of

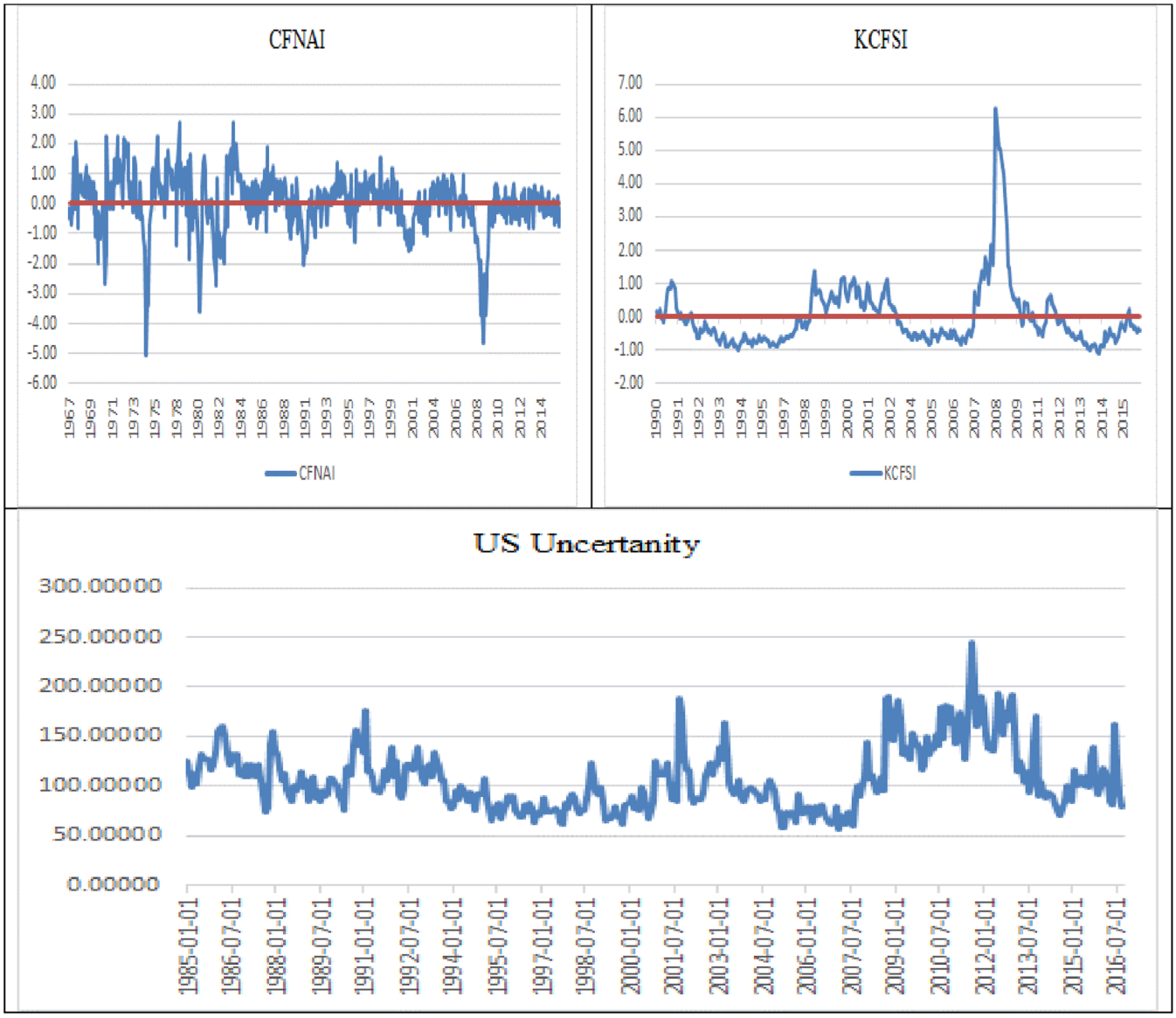

FIGURE 1 Time series plots [Colour figure can be viewed at wileyonlinelibrary.com]

estimation for all the pairs of variables under consideration are shown in Figures 2–4[8] using the contour plots. The x-axis and y-axis, respectively, measures the time period under the study and frequency/scales translated in terms of time (years). The colour bar ranges of from −1 (deep blue) to +1 (deep red) to measure the perfect negative cohesion and perfect positive cohesion. We have used contour plot to identify the positive and negative cohesion across time and frequencies that in turns help us to identify synchronisation of the pairs of variables under consideration.

The results of coherence between economic activity and financial stressed presented in Figure 2 entails a number of interesting aspects. It is clearly observed that there are higher co-movements at both intermediate as well as higher frequencies (i.e., intermediate and lower time periods). In particular, at very high frequencies that corresponds to less than 0.25 years cycle a very high degree of coherence is observed during the periods of 1992, 1998, 2000, and 2005; at intermediate frequencies that correspond to 0.25–0.5 years cycles a very high degree of coherence is observed during 1993–1994 and 2009; at lower frequencies that correspond to 0.5–-1 years cycles a very high degree of coherence is found in 1994–1995, and 2005–2006; and at very low frequencies that correspond to cycles of larger than 1 year a very high degree of coherence is found during 1998–2000. The period around GFC clearly indicates the increase in negative cohesions which despite some decrease still persistent implying that in the Post-GFC the financial stress became even more influential on economic activity. These findings can be seen in conjecture with the revival

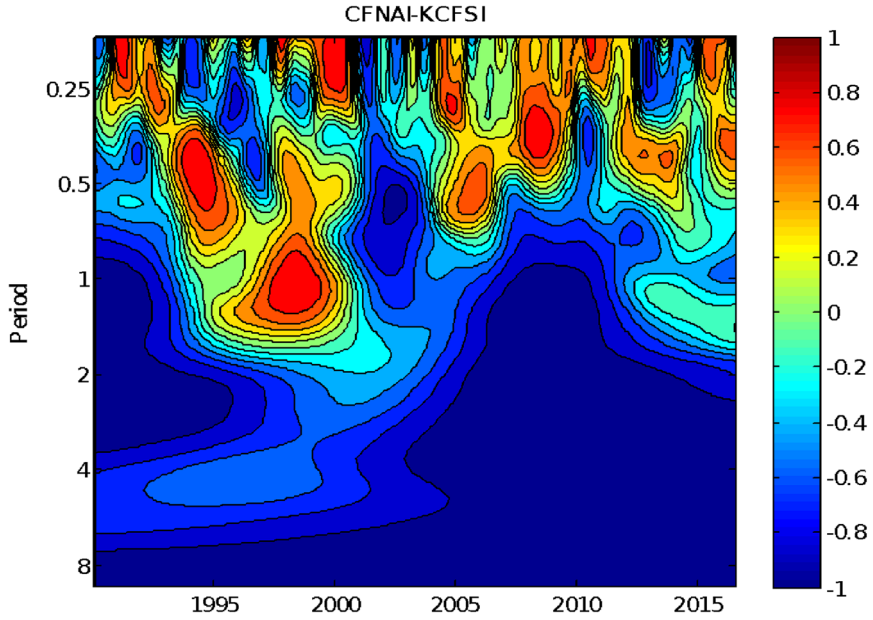

FIGURE 2 Coherence between economic activity and financial stress [Colour figure can be viewed at wileyonlinelibrary.com]

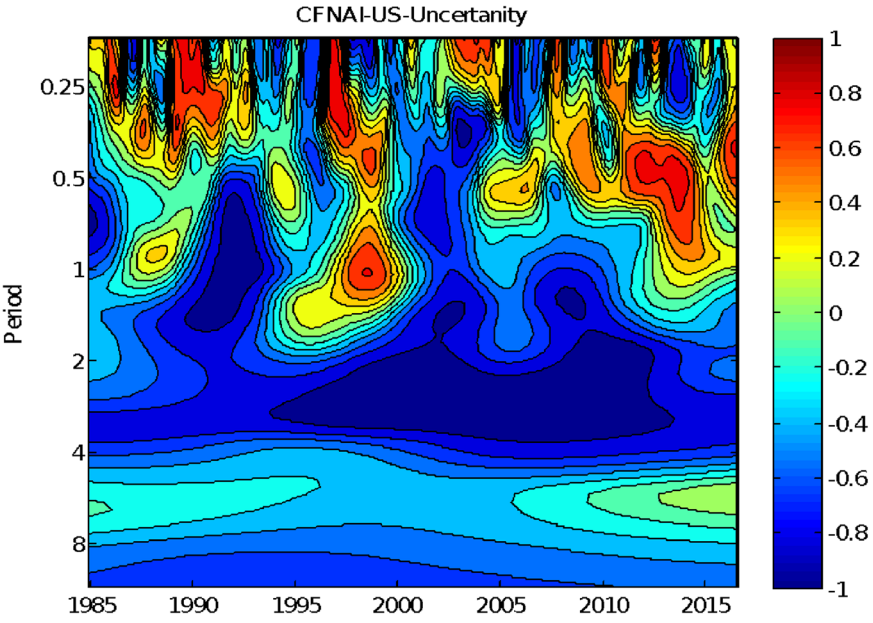

FIGURE 3 Coherence between economic activity and uncertainty [Colour figure can be viewed at wileyonlinelibrary.com]

of the significance of financial stability and various national and supranational initiatives been taken Post-GFC (See, Financial Stability Board, 2017).

The coherence between economic activity and uncertainty as depicted in Figure 3 reveals that analogous to financial stress and economic activity, there are also higher co-movements at intermediate and higher frequencies in this case. In particular at very high frequencies that corresponds to less than 0.25 years cycle a very high degree of coherence is observed during 1986, 1989–1993, 1997, 2004 and 2010; at intermediate frequencies that corresponds to 0.25–0.5 years cycles a very high degree of coherence is observed during 1987, 1989–1993, 1997 and 2010; at lower frequencies that correspond to 0.5–1 years cycles a very high degree of coherence is found in 2012, and at very low frequencies that correspond to cycles of larger than 1 year a very high degree of coherence is found during the period 1998–2000. Overall there is prima facie evidence of a negative coherence, however, the periods around, the early 1990s, 2001 and 2008 in particular, suggests high negative coherence between economic activity and uncertainty which can be associated with the events (for instance, Gulf war, 9/11, the dotcom bubble, GFC) surrounding these dates.

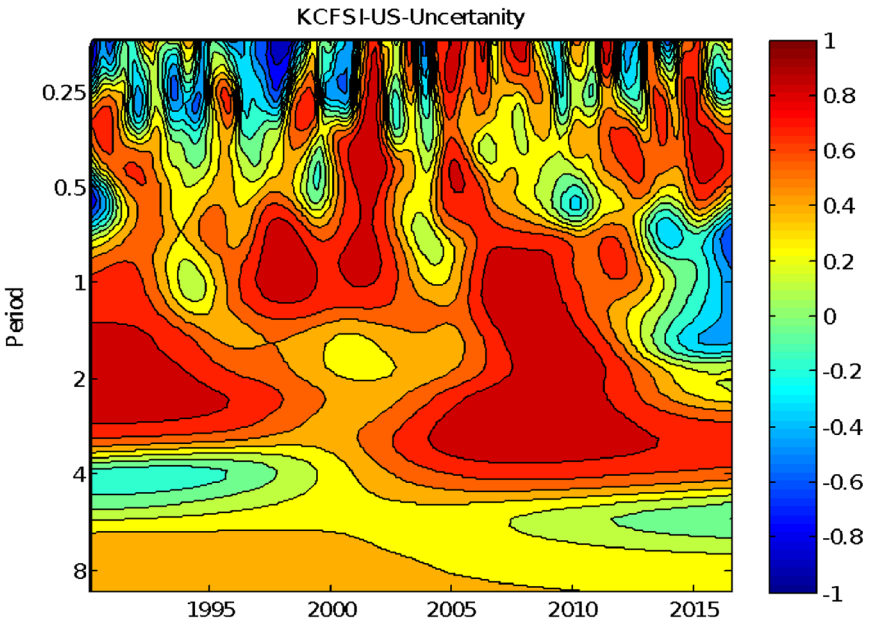

FIGURE 4 Coherence between financial stress and uncertainty [Colour figure can be viewed at wileyonlinelibrary.com]

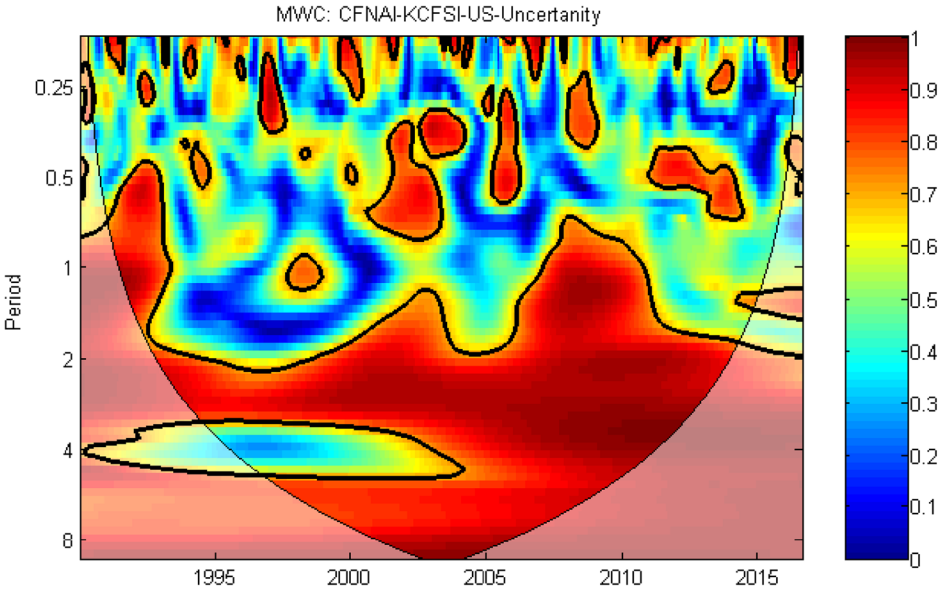

FIGURE 5 Multiple wavelet coherence (MWC) among economic activity, financial stress and uncertainty [Colour figure can be viewed at wileyonlinelibrary.com]

On the coherence between the financial stress and uncertainty, contrary to the previous two cases presented in Figures 2 and 3, it is observed that there are higher positive co-movements at lower and intermediate frequencies. In particular, at very high frequencies that corresponds to less than 0.25 years cycle a very high degree of coherence is observed during 2001, 2005–2008, and 2012; at intermediate frequencies that correspond to 0.25–0.5 years cycles a very high degree of coherence is observed during 1990–1992, 2001–2002, and 2005–2006; at lower frequencies that corresponds to 0.5–-1 years cycles a very high degree of coherence is found in 1993, 1998–2002, and 2005–2006; and at very low frequencies that correspond to cycles of larger than 1 year the period in which a very high degree of coherence was not found was 2000–2002. The period around GFC 2008 seemed to show the highest positive cohesion between financial stress and uncertainty that is fair initiative. Nonetheless, the periods around the early 1990s and early 2000s also suggest higher coherence between financial stress and uncertainty, which is very intuitive if we relate it to the events Gulf-war, 9/11 and Dotcom bubble.

Lastly, we employed the Multiple Wavelet Coherence (MWC); the noteworthy novelty of this approach is that it

is useful in seeking the resulting Wavelet Coherence of multiple variables, similar to multiple cross-correlations (See Ng and Chan [2012] for detailed insight). The MWCs of employed time series comprising of the sine waves of six different periods (0.25, 0.5,1, 2, 4, and 8 months) as shown in Figure 5. The cross-hatching indicates regions inside the Cone of Influx (COI) and the thick black contour indicates 95% confidence level. The results suggested almost perfect positive cohesion among economic activity, financial stress and uncertainty. The cohesion was at its peak around and post GFC period, this is intuitive as well as consistent with the earlier results. It leads us to a conclusion in the next section.

4 | CONCLUSION AND POLICY IMPLICATIONS

In this concise study, we endeavoured to contribute to the existing evidence and debate on the nexus between the policy uncertainty and its consequences for the financial sector and the real economy. In so doing, we analysed the synchronisation of economic activity, financial stress and policy uncertainty in the USA by employing a wavelet-based approach of cohesion. Being innovative in the choice of the methodological framework as well as underlying factors of interest, we employed the monthly data on the policy-related uncertainty indexes, Kansas City Federal Reserve Financial Stress Index (KCFSI) that includes eleven macroeconomic variables, which provide a wide range of economic signals, associated with the financial stress. Specifically, the underlying factors can be classified into two overarching classifications that is, measures based on the actual or expected behaviour of the prices of asset and the credit and liquidity spreads. Similarly, we employed the Chicago Fed National Activity Index (CFNAI), which entails event larger set of data series and hence provides a broad range of measures to inclusively account for the US economic activity.

In the light of empirical findings obtained by the employment of wavelet-based measures of cohesion to analyse the spillovers of uncertainty across frequencies and overtime in the USA, we can hereby conclude that co-movements of uncertainty are both frequency-dependent as well as time-dependent. Furthermore, there is also ample evidence to infer that the employed uncertainty indices are synchronised at intermediate as well as at lower frequencies for almost all the pairs of economic activity, policy uncertainty and financial stress. It is prima facie evidence that in the nexus between uncertainty and economic activity, financial stress plays a crucial role due to its implications for financial and economic stability. Concomitantly, it also leads us to further infer a practical policy implication that the consideration of financial stress shall be incorporated into the analysis when it comes to the nexus between economic activity and uncertainty. Our findings based on proposed wavelet-based method also showed that co-movement of uncertainty was more pronounced during the crisis period 2000–01 and 2007–08 though at different frequencies which indicate the usefulness of this approach to analyse the implications of contemporaneous uncertainty for the real economy in the time of economic and financial turmoil. To best of our knowledge, this is the first empirical endeavour to investigate the nexus between economic activity, financial stress and policy uncertainty. However, due to the importance of financial stress and policy uncertainty for the real economy, this area requires further exploration. This may include the extension of inquiry at these dimensions and specifically by including other variables of interests as well as international spills overs of the financial stress and policy uncertainty. Considering the limited scope of this study, we leave it for future research.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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ENDNOTES

[1] For instance, see, Bloom (2009) and Bloom et al. (2009), Gilchrist et al. (2010) and Panousi and Papanikolaou (2012), Yin and Han (2014), Han et al. (2016), Robinson et al. (2016), Shoaib et al. (2016), Hassett and Sullivan (2016) and most recently, Jawadi and Ftiti (2017), Sangyup (2017) and Degiannakis et al. (2017).

[2] Although, they reported an asymmetric impact as the decrease in the economic policy uncertainty did not lead to reduction of gold prices.

[3] Exchange rate of GBP against US$ and Real Effective Exchange Rate of Sterling respectively.

[4] Concomitantly, they used a theoretical Bayesian Vector Autoregressive model to analyse the association between uncertainty and the real economy.

[5] A point to note here is that although, their economic indicators, for instance nonfarm payrolls, are also available on monthly basis,

however, they focus on a single and very specific aspect of the economy for example, the outlook of labour market. Whereas the CFNAI is a lot more inclusive and incorporates data from several aspects and categories of macroeconomic data. The notion is to use highest possible frequency data, the underlying variables or entities are actually measures of activities over a span of time, and hence they are spread over the entire interval. Hence, in the debate on discrete or continuous variables the underlying phenomena can be seen from both prospective.

[6] E.g employed by Engle (2002) and Antonakakis (2012).

[7] In our analysis we choose the Morlet wavelet following Rua (2010) and Tiwari et al. (2014). This wavelet can be factored into real and imaginary parts which allows for the separation of the phase and the amplitude of a studied signal. Tiwari et al. (2014) has shown that Morlet performed better as compared to Paul and Dog Wavelet transformations. Finally, the values for the calibrated parameter are adopted from Table 1 of Tiwari et al. (2014).

[8] It is due to the reason that the three dimensions (frequency, time, and cohesion) are to possible to be presented on a figure which only two dimensional.

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