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Do oil shocks predict economic policy uncertainty?

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***Highlights (for review)**

Research Highlights

- *I investigate the role of oil shocks on economic policies uncertainty.*
- *I generated disintegrated oil supply shock, aggregate demand shock and oil specific demand shock by structural VAR framework.*
- *Non-linear behavior of economic policy uncertainty is modeled in regime switching framework.*
- *Indian, Spanish and Japanese economic policy uncertainty responds to global oil price shocks.*

Do Oil Shocks Predict Economic Policy Uncertainty?

Abstract

Oil price fluctuations have influential role in global economic policies for developed as well as emerging countries. I investigate the role of international oil prices disintegrated into structural i) oil supply shock, ii) aggregate demand shock and iii) oil market specific demand shocks, based on the work of Kilian (2009) using structural VAR framework on economic policies uncertainty of sampled markets. Economic policy uncertainty, due to its non-linear behavior is modeled in a regime switching framework with disintegrated structural oil shocks. Our results highlight that Indian, Spain and Japanese economic policy uncertainty responds to the global oil price shocks, however aggregate demand shocks fail to induce any change. Oil specific demand shocks are significant only for China and India in high volatility state.

Keywords: *Global oil shocks; economic policy uncertainty; structural VAR.*

JEL Classification: *E31, E60, Q41, Q43.*

1. Introduction:

Since the work by Hamilton (1983), researchers in the past are intrigued by empirical evidences of the relationship between oil price shocks and macro-economic variables (Cunado and De Garcia, 2005; Lardic and Mignon, 2008). Among other macro-economic variables, effects of macro-economic uncertainty about the future sparks great interest. Existing literature on economic policy uncertainty provides evidence of its significant effects on equity portfolios (Andersen et al., 2009; Brogaard and Detzel, 2015), investment opportunities (Bloom et al., 2007) and returns volatility (Bloom, 2009).

Following the work by Hamilton (1983), many researchers investigated connection between oil price shocks and real economic activity in developed countries (see Jimenez-Rodrgiuez and Sanchez 2005; Cunado and De Gracia 2005; Cologni and Manera 2008). Kilian (2009) highlight the importance of distinguishing origin of oil price shocks in accessing their impact on real activity. According to him, increase in oil prices driven by precautionary oil demand in the presence of uncertainty about future oil supply has negative effect on real activity. He argues that while designing policies related to oil price shocks, a clear distinction regarding the origin of oil price shocks is essential.

Existing literature also documents the significance of economic policy uncertainty on real economic activity. According to Bloom (2009), both political and economic shocks to business cycles result in economic uncertainty. Baker et al. (2016) constructed an index to measure economic policy uncertainty and concluded that this economic policy uncertainty has a major influence on the intensity of economic recessions and their subsequent recoveries. An appropriate and timely response by policy makers in case of oil price shocks can have important implications for the underlying economy. Relative prices are influenced due to these global oil price shocks that further affect inflation, consumption, production, investment and welfare, thus eventually drawing interest of policy makers.

Considering the relationship between different economic activities (e.g. output, unemployment, inflation and GDP growth) and oil price relationship, it is of great interest to study the linkage between oil price shocks and economic policy uncertainty that can have significant policy implications (see Elder and Serletis, 2010; Kilian and Vigfusson, 2011). Relationship between oil prices and economic policy uncertainty is documented in current literature due to the global impact of oil prices on business cycles, organizations profitability, stock market spillover, financial markets integration etc. However, current literature has gap in presenting consistent findings on the relationship between economic policy uncertainty and oil shocks. Therefore, this study aims to provide detail insight into the information transmission between economic uncertainty and global oil price shocks.

I take the non-linear structure of included variables into account in the form of different regimes for three structurally disintegrated oil shocks having constant parameter within the regime but different apartment across the regimes. For this purpose, I apply Markov regime switching model an introduction of which is given by Hamilton (1994). This methodology allows time varying causality across different regimes that is not captured by the linear models with no structural changes and having constant parameters. Markov regime switching model provides advantage of using information about varying probabilities of regime switching being in a particular state. Linear models on the other hand estimate results for each regime separately. For this reason, estimation with linear models provide inaccurate results due to presence of many breaks in data that results in too small sub-samples. In Markov regime switching, more observations are used to overcome this issue by partly using the dynamics of system in another regime.

Oil price shocks to any economy requires appropriate and timely response by the policy makers. This is because these oil shocks have the power to change relative prices, distribution of income, expectations about real interest and inflation rates and economic policy uncertainty. Any increase in the oil prices caused by precautionary demand (resulting from the anticipation of oil shortage) can have association with economic policy uncertainty.

Non-linear structure of economic policy uncertainty is also discussed by Bekiros et al. (2016) reporting the predicting ability of economic policy uncertainty for equity returns volatility by allowing non-linear spillover effect and parameter instability. Non-linear structure of oil price shocks is addressed in many past studies for example Kilian and Vigfusson (2011) and Herrera et al. (2015). Current literature also provides evidence of non-linear and asymmetric effect of oil prices on real economic activity in the presence of structure instability between their relationships (see Hooker, 1999). Lee et al. (1995) and Hamilton (1996) argue that keeping in view the instability of international oil prices over the last couple of decades, asymmetric tests and non-linear frameworks can better measure their macro-economic impact in an effective way compared to traditional linear models.

In this study, author investigate the impact of structural oil supply shock, aggregate demand shock and oil specific demand shock on economic policy uncertainty. Previous studies report relationship between oil prices and economic policy uncertainty (e.g. Cunado and De Gracia 2005; Rahman and Serletis 2011) however our work differentiates from the existing literature in two aspects. Our first contribution is that the author use disintegrated oil price shocks using structural VAR framework to measure its effect on economic policy uncertainty. Current literature mostly use global oil prices in measuring their relationship with economic policy uncertainty regardless of any events that can result in international oil shocks. Second, evidence of linear relationship between economic policy uncertainty and oil shocks is present in current literature (see Kang and Ratti 2013; Antonakakis et al. 2014; Lei et al. 2016; Kang et al. 2017) however non-linear behavior of these variables has rarely been tested. I use regime switching model that considers the non-linear behavior of economic policy uncertainty and oil shocks by overcoming the problem of limited observations due to many structural breaks. Results of our study highlight that Indian, Spanish and Japanese economic policy uncertainty responds to global oil price shocks. Oil supply shocks fail to induce change in any country however, shocks to global economic activity are significant only for China and India in high volatility state.

Rest of the paper structure is as follows. Section 2 presents literature review. Section 3 presents data description. Section 4 explains the empirical methodology. Section 5 presents analysis and discussion. Section 6 highlights conclusion of our study.

2. Literature review:

Current literature provides insight on the spillover effect from global oil price shocks to economic policy uncertainty with mixed findings. According to Kang and Ratti (2013), positive aggregate demand shocks induce negative effect on economic uncertainty whereas oil specific demand shocks have the opposite effect. Lee and Ni (2002) supports that industrial sector activities are affected by oil price shocks through sectoral demands. The effects of disaggregated oil supply variables may act differently to inflation expectations and forecasts about government expenditures. Gelb (1988) is one of the earliest proponent of direct relationship between international oil prices and economic policy uncertainty. His results highlight an escalation in federal government purchases attributed to the increasing oil prices. Among others, Kang and Ratti (2013) and Antonakakis et al. (2014) investigate relationship between economic policy uncertainty and structural oil price shocks with the findings that supply-side shocks have no relationship however specific demand shocks have long term connection with economic policy uncertainty. These results are in line with the findings of Kilian (2009), Hamilton (2009) and Lippi and Nobili (2012) that demand side shocks are relatively more important as compared to supply-side shocks. Kilian (2009) generate oil price shocks and connect these structural shocks with the economy. Antonakakis et al. (2014) report an increased bidirectional influence and spillover between economic uncertainty and oil price shocks during the global financial crisis of 2008-09. Dakhlaoui and Aloui (2016) study the time varying effect of economic policy uncertainty and equity on oil returns and report positive relationship preceding the global financial crisis of 2008-09. Hamilton (1983) and many other researchers thereafter suggest strong negative influence of global oil prices on the economy. Moreover, current literature (e.g. Balke et al. 2010; Filis 2010; Tang et al. 2010) also report significant oil price effects on inflation and industrial production. Rahman and Serletis (2011) and Cologni and Manera (2008) highlight the significant impact of rising oil prices on US economic activity. Natal (2012) and Montoro (2012) report low production output and increased inflation in the presence of rising oil prices. However, this trade-off has concerns and results in an escalating pressure on policy makers while selecting an appropriate response towards oil price effects. According to Natal (2012) and Montoro (2012), oil price shocks affect inflation and is affected by the monetary policy tradeoff between output stabilization and inflation.

Bernanke et al. (2004) argues that transmission of oil price shocks to an economy is influenced by global oil shocks. Another strand of literature presents relationship between economic policy uncertainty and financial and economic variables (for example see Kang and Ratti 2013; Jebabli et al. 2014; Mensi et al. 2014; Chang et al. 2015).

According to Bloom (2009), economic activities are immediately affected by economic policy decisions. He also emphasize the role of economic policy uncertainty on business cycle. Antonakakis et al. (2013) report sensitivity (negative effect) of dynamic equity market correlation, economic policy uncertainty and implied volatility due to US recession and aggregate oil demand shocks. Investing activities of various firms are discouraged by increasing uncertainties from economic policy decisions, irrespective of their origin either in monetary policy or potential fiscal decisions. This is because the firms are uncertain about both, the future aggregate demand and the upward pressure on its financing costs (see Byrne and Davis 2004; Pastor and Veronesi 2013). This results in lower investment level by firms causing reduced oil demand and ultimately pushing oil prices downwards.

The process of disentangling oil price shocks is important in understanding its effect on economic policy uncertainty. Current literature on these lines include work of Kilian and Park (2009), Kilian and Lewis (2011), Filis et al. (2011), Lippi and Nobili (2012), Baumeister and Peersman (2013), Degiannakis et al. (2014). Although current literature discusses oil prices, majority of it make no differentiation among various type of oil shocks, despite of their utmost importance in examining their impact on an economy. The earlier proponents of oil shocks are Kilian (2009) and Hamilton (2009). Hamilton (2009) divided oil shocks into demand side and supply side shocks, stemming from changes in aggregate demand and oil production, respectively. Kilian (2009) further separates demand side shocks into aggregate demand and oil specific demand shocks, both of which are related to uncertainty regarding the availability of oil in future.

3. Data description

Our data consists of percentage change in world crude oil production, real crude oil prices imported by the US, an indicator of global real economic activity and economic policy uncertainty (thereafter EPU) for sample countries. Data frequency for the variables is on monthly basis and ranges from January 1995 to December 2015. Real crude oil prices[1] are extracted in dollars per barrel. Author use US refiner acquisition cost for crude oil and further deflate it with US CPI. Data for world crude oil production (oil supply in millions barrel per day) and oil prices is collected from Energy Information Administration (EIA) database on monthly basis. An index for real global economic activity is sourced from Lutz Kilian website[2] as the data is similar to one used by Kilian and Park (2009).

EPU represents economic risk for any country because of an unclear, uncertain path of government policy that leads towards an escalating risk premium and causes delays in individuals as well as businesses spending until the uncertainty resolves. This EPU can also interchangeably refers towards fiscal or monetary policy uncertainty, uncertain electoral outcomes and/or regulatory or tax regime. Data for EPU is collected based on three main components. The first component deals with the newspaper coverage of economic uncertainty related to policy issues. Second component represents provision set for federal tax code for future years. Finally, disagreement among economic forecasters represents a proxy for uncertainty. I collect EPU data for our sampled economies. Among the selected countries, China, India and Japan represents major Asian economies whereas developed

[1] Cost of crude oil prices is extracted from http://www.eia.gov/petroleum/data.cfm#prices.
[2] http://www-personal.umich.edu/~lkilian/paperlinks.html

economy indices of US, UK and Europe (composite index) are also used for economic policy uncertainty. I also separately include other European countries to measure economic policy uncertainty. The selection of EPU indices is based on data availability.

[Insert Table 1 about here]

4. Empirical Methodology

I follow the methodology proposed by Kilian and Park (2009) and Basher et al. (2016) using two-stage approach by constructing "oil supply shocks", "aggregate demand shock" and "oil-specific demand shock". Our data consists of percentage change in world crude oil production, real crude oil prices imported by the US and an indicator of global real economic activity. Author then empirically assess the response of demand shock, supply shock and price shock in our sample markets with Markov Regime Switching framework. In a regression context, this means that oil supply shock, aggregate demand shock and oil-specific demand shock are supposed to be orthogonal variables. Such variables, if orthogonality holds (i.e. uncorrelated with other included and omitted regression variables) are included in second-stage analysis. In this way, regression coefficients also appear as unbiased estimates. Thus, the only effect of omitted variables is to increase the residual variance in second stage of Markov switching regression.

An introduction to Markov-switching models is presented in an earlier study by Hamilton (1994). The approach allows to explore regime-specific impacts instead of typical linear models with constant parameters. The Markov-switching model, therefore makes use of the regime-switching probabilities rather estimating separate linear models for each regime. It also captures potential nonlinearity or asymmetry in the process that drives adjustment of economic policy uncertainty to oil shocks . Markov-switching framework has been useful in cases where the adjustment seems to be mainly driven by exogenous events. There are numerous examples of such events in our sample period. For example, the Asian financial crisis in 1997-98, the dot-com bubble crisis in 2000, the terrorist attack on World Trade Center in 2001, the Iraq War in 2003, the Global Financial Crisis in 2007-08, OPEC oil production cuts in 2009, etc. These events had major impact on global oil markets including our sample of countries and therefore are considered as main exogenous events.

i. The identification of global oil shocks

The starting point of our analysis is a structural VAR (SVAR) model specified as:

$$A_0 y_t = A(L) y_{t-1} + \varepsilon_t \quad (1)$$

where y_t includes (i) world crude oil production (oil supply), (ii) global real economic activity and (iii) real crude oil prices for the US market, described further in the data section; ε_t denotes the vector of serially and mutually uncorrelated structural innovations that have an economic interpretation. Structural innovations are derived by imposing exclusion restrictions on A_0^{-1} in $e_t = A_0^{-1}\, \varepsilon_t$ where ϵ_t is a vector of errors in SVAR framework (Kilian and Park, 2009).

$$y_t = A_0^{-1} A(L) y_{t-1} + A_0^{-1} \varepsilon_t \quad (2)$$

The three above mentioned structural shocks are attributed as follows: ε_{1t} denotes shocks to global supply of crude oil (hereafter "oil supply shock"); ε_{2t} represents shocks to global demand (aggregate demand shock); and ε_{3t} captures an oil market specific demand shock (oil-specific demand shock). The identification of A_0^{-1} in Eq. (2) is achieved by imposing the following exclusion restrictions:

$$e_t = \begin{bmatrix} e_{1t}^{\Delta prod} \\ e_{2t}^{rea} \\ e_{3t}^{rpo} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t}^{oil\ supply\ shock} \\ \varepsilon_{2t}^{aggregate\ demand\ shock} \\ \varepsilon_{3t}^{oil-specific\ demand\ shock} \end{bmatrix}. \quad (3)$$

The identifying restriction in this structural model assumes that demand shocks do not respond to innovations in supply shocks in a single day and vice versa. First, changes in global oil shocks can impact the economic policies but may take some time. This is because international markets take some time for stocks to absorb and react to changes. Secondly, global oil shocks may require little economic and financial justification and are more prone to major exogenous events even before their rational impact on world equity and financial markets. Therefore, this restriction is plausible as any major exogenous event along high and low global prices for a day can shift the global oil shocks. To apply a structural VAR framework, Author select demand, supply and oil price values for generating subsequent shock. Although the application of unit root and co-integration is quite common in empirical VAR literature, I have not imposed these tests and followed the methodology of Kilian and Park (2009). Even in the absence of unit root and co-integration statistics, least squares test can be applied for consistent parameter estimates (Sims et al. 1990). Hamilton (1994) in his work also pointed out the disadvantages of imposing restrictions for co-integration. I plot time series for the generated supply shock, aggregate demand shock and oil specific demand shock over the sample period in Figure 1.

[Insert Figure 1 about here]

ii. Markov-switching

As a starting point and to provide some baseline results, a linear regression model is estimated for each stock market index.

$$\Delta pu_{i,t} = \beta_{0,i} + \beta_{1,i}\varepsilon_{i,t}^{demand} + \beta_{2,i}\varepsilon_{i,t}^{supply} + \beta_{3,i}\varepsilon_{i,t}^{oil} + \beta_{4,i}\Delta pu_{i,t-1} + u_{i,t} \quad (4)$$

Where $\Delta pu_{i,t}$ represents change in economic policy uncertainty index for country *i*. The oil shock variables are extracted from SVAR methodology described in the previous section i.e. global economic demand shock ($\varepsilon_{i,t}^{demand}$), oil supply shock ($\varepsilon_{i,t}^{supply}$) and oil demand shock ($\varepsilon_{i,t}^{price}$). Notice that it is assumed that oil shocks are pre-determined which is consistent with Kilian and Park (2009). A one period lag of change in policy uncertainty is included as an explanatory variable because this specification provides better regression fit and residual diagnostics compared to a model without lagged dependent variable.

To account for possible non-linear relationship between global oil shocks and economic policy uncertainty, Markov-switching model for Eq. (4) is specified as follows.

$$pu_{i,t} = \beta_{0,i,s_t} + \beta_{1,i,st}\varepsilon_{i,t}^{demand} + \beta_{2,i,st}\varepsilon_{i,t}^{supply} + \beta_{3,i,st}\varepsilon_{i,t}^{oil} + u_{i,t} \quad (5)$$

Markov-switching model considers the possibility that any impact of global oil shocks on policy uncertainty index is state (s_t) dependent. Transition probability from state l at a single period t to the state m at any period *t+1* depends on state *t* only. It is assumed that the stochastic regime generating process follows an ergodic, homogeneous, first-order Markov chain with a finite number of regimes (M) and constant transition probabilities.

$$p_{lm} = \Pr(s_{t+1} = ms_{t+1} = l)\,, plm \geq 0, \sum_{m}^{M} Plm = 1 \quad (6)$$

Author use two states for Markov-switching models with policy uncertainty index, state dependent volatility for error process and state dependent regression coefficients. As policy uncertainty is considered to exhibit volatility clustering, I allow volatility to vary across regimes. Two different assumptions about error terms are made for estimations i.e. normal and Student-t distribution. Since the Markov chain is unobservable, state specific probabilities are included in estimating the output. Markov-switching model with a good fit provides clear regime classification with smooth probabilities that are close to either zero or one. Ang and Bekaert (2002) use regime classification measure (RCM) for determining the accuracy of Markov-switching models, expression for which is presented below.

$$RCM(S) = 100S^2(1/T)\sum_{t=1}^{T}\prod_{i=1}^{s}\hat{p}_{j,t} \quad (7)$$

RCM statistic is estimated as average of the product of smoothed probabilities $\hat{p}$; where S presents number of regimes (states). Bernoulli distribution is followed for switching variable for which RCM provides variance estimation. Low RCM value provide perfect regime classification and comparatively higher value highlight the failure in detecting a regime classification. Therefore, lower RCM statistics are preferred over higher values. For similar reasons, RCM value close to zero with smooth probability near 1 is required to ensure significantly different regimes.

5. Analysis and discussion

Author extract oil supply shock, aggregate demand shock and oil specific demand shock from SVAR methodology presented in equation (2) and is estimated at 24 lags. For a good model fit, characteristic roots are within the unit circle with normal distribution of residuals. Table 1 presents descriptive statistics of oil supply shock, aggregate demand shock and oil specific demand shock along with the EPU indices of selected countries. Variance in EPU is maximum for France and England whereas minimum for US and Japan. Data is positively skewed for EPU indices of all the countries whereas negatively skewed for three oil shocks. Normality test highlight that neither oil shocks nor EPU data is normally distributed for selected countries.

[Insert Table 2 about here]

I further analyze time series properties of our variables by conducting unit root tests. Table 2 present results of Elliott, Rothenberg and Stock (1996) Dickey-Fuller unit root test (DF-GLS) and Kwiatkowski et al. (1992) unit root test (KPSS). Both these unit root tests are performed with 12 lags and are reported twice, once with a constant term and then with a trend. I choose lags for KPSS test for n sample size according to $\sqrt[4]{4 \times (\frac{n}{100})}$. We can see that oil supply shock and aggregate demand shock are stationary for both these tests except oil specific demand shock for DF-GLS test with constant. EPU is stationary for almost all selected countries at level however significance level of stationarity is variant. For Spain and Japan, results of DF-GLS and KPSS are different with constant term however both results converge towards similar conclusion of stationarity in the presence of trend.

[Insert Table 3 about here]

After DF-GLS and KPSS tests, I perform BDS test proposed by (Brock et al. 1987; Brock et al. 1996) for investigating the spatial dependence in EPU index. BDS test is used to detect the non-linear trend in time series and is performed by checking if increments to the series are independent and identically distributed (*iid*). The BDS test is asymptotically distributed as a standard normal under the null hypothesis of *iid* increments. This test is based on correlation integral which is a measure of the frequency with which the temporal patterns are repeated in the data series. For our sampled EPU indices, rejection of the null hypothesis of independent and identical distribution (*iid*) can be seen for most combinations of ε (epsilon value) and m (embedding dimension). Figure 2 highlight EPU indices of our sample countries with little evidence of linear structure also supported by the results of BDS test presented in Table 3.

[Insert Figure 2 about here]

To have first look at the impact of oil shocks on economic policy uncertainty index, author runs series of regressions as presented in equation (4) where EPU for all the countries act as a dependent variable on which author measure the effect of disintegrated oil shocks and lag values of EPU.

[Insert Table 4 about here]

Estimations in Table 4 provide baseline results indicating relationship between disintegrated oil shocks and economic policy uncertainty in the absence of any switching effects. R-squared values for our linear regression analysis ranges from 3.64 percent in case of US to 19.99 for French economy. I also include one period lagged value of economic policy uncertainty ranging from a low of -0.4318 (France) to a high of 0.9300 (Germany) highlighting high level of persistence in policy uncertainty measure. Oil specific demand shock have insignificant coefficient values for economic policy uncertainty of included countries except for Japan, where the value is significant suggesting its strong impact on Japanese economic policy uncertainty. Similar results are evident for both oil supply shock and aggregate demand shock with insignificant values suggesting no role of both supply side shock or aggregate demand side shock on economic policy uncertainty for selected economies. These insignificant results may be an outcome of the presence of non-linear relationship or the limitation of the linear regression to detect any inherited non-linear structure of the model.

[Insert Table 5 and Figure 3 about here]

To detect the presence of any non-linear relationship between economic policy uncertainty and disintegrated oil shocks, I present results of Markov regime switching model. Table 5 highlight the sensitivity of Indian, Spanish and Japanese economies to the global oil price shock. All the remaining countries do not respond to the oil price shock in any regime. These results highlight that global oil price changes attributable to oil supply shock have significant explanation for changes in the economic uncertainty for India, Spain and Japan in both, low volatile and the high volatile periods. These results also highlight the dependence of these economy on oil price shocks regardless of the magnitude of volatility that depends mainly on disintegrated oil shocks. Results indicate that a positive oil price shock reduces economic policy uncertainty for Indian, Spanish and Japanese economies, however these oil price shocks are insignificant in remaining countries for inducing any change. Oil supply shock fail to induce any change in either of the state. This suggests that oil supply shocks are not the driver of change in economic policy uncertainty for sampled countries. Finally, aggregate demand shocks are significant for only China and India in state 2 (high volatility regime). Coefficient value of aggregate demand shock is positive for China whereas negative for India. These findings suggest that economic policy uncertainty for China increases with a positive aggregate demand shock whereas economic policy uncertainty for India increases with a negative aggregate demand shock. These globally demand driven shocks would affect the economic policy uncertainty of India and China through change in the global oil prices. Comparing RCM values among sample countries, we can see that Markov regime switching model fits best for Japan with the lowest value of 35.22 whereas comparatively less fitted values are recorded for France, i.e. 83.31. Despite these differences, RCM values for every country are low indicating a good fit for Markov regime switching model. Goodness of our regime switching model is also confirmed by the expected duration of being in a particular state i.e. low Du1 and Du2 values for almost all the sample countries. In our case, however, low RCM value is confirmed by the lower Du1 and Du2 values for Japan. Based on smooth probability measure, each regime has high persistence value evident by the high constant probability values i.e. P_{11} and P_{22} respectively. Table 5 also reports sigma values for each country highlighting the magnitude of volatility (represented by the standard deviation) for each regime. High volatility regime is represented by high coefficient value of sigma whereas low coefficient value indicates low volatility regime. Values of sigma are significant and positive for each country in both the regimes. Our estimated values of sigma support the switching between low and high volatility regimes. For US, Italy, UK, Spain and Japan, the sigma value is greater in state 1 than the state 2 indicating more volatile behavior of state 1 in these economies. These results suggest that the first regime is volatile than the second one although the coefficient values are significant in both regimes. Author also reports lower difference in values across both regimes suggesting that US, Italy, UK, Spain and Japan have little volatility difference across different regimes thereby highlighting low distinction between the two regimes. The economic policy uncertainty for remaining countries i.e. China, India, Europe, France and Germany show more volatility in state 2 as compared to state 1. Except Germany, relative magnitude of low and high volatility regime is weak. In case of Germany, there is a strong distinction between low and high volatility regime, where unconditional variance in state 2 is almost twice as compared to state 1. Figure 3 confirms smooth probabilities of being in a low or high volatility state with stats of RCM. Small values of RCM correspond to a clear switching pattern between regimes. Our statistics of RCM suggest that the regime switching model is fitted best for Japan whereas less fitted for France.

i) Robustness check using student t distribution

I check the robustness of our analysis by changing the probability distribution of errors in Markov regime switching model using student *t* distribution. The use of student *t* distribution is suggested in regime switching models as it enhances different regimes stability. According to Klaassen (2002), large innovation in low volatility periods result in switching to high volatility regime because of a single outlier in an otherwise tranquil period. Evidence of the application of Markov regime switching framework with student *t* distribution can also be seen in the work of Hamilton and Susmel (1994).

[Insert Table 6 and Figure 4 about here]

Results of our robustness test are presented in Table 6 and are similar to our previous findings with Markov regime switching using normal distribution of errors. Markov regime switching model with student *t* distribution of errors fits best for Japan with the similar lowest value of 35.22 whereas comparatively less fitted values are recorded for France, i.e. 83.31. Impact of oil price shock on economic policy uncertainty remains similar except for the shift in regime of Spain from S1 to S2. Reason for this shift is associated to the persistence of being in a high volatility state that changes from S1 to S2 in regime switching with student *t* distribution. Global supply shock again has no effect on the economic policy uncertainty for any country in either of the state however similar results are reported for global demand shock in case of China and India in state 2 being the higher volatile regime. However, coefficient values of sigma are slightly different for Markov regime switching model with student *t* distribution from our previous results. France, UK and Japan exhibit more volatile behavior is state 1 whereas for remaining countries, S2 indicated more volatile behavior based on the magnitude of sigma coefficient. Again like previous results, we experience shifts in regime across countries however difference in unconditional variance across regimes is not high. Finally Figure 4 highlights and confirms the results of RCM in regime switching with student *t* distribution with a clear switching pattern between two regimes.

6. Conclusion

Current literature provides valuable insights about the impact of raising oil prices on different macro-economic variables. This is because of the importance of global oil prices in affecting any economy and an ever-increasing energy demand regardless of the economic status of any country. Any escalation in oil prices can induce either economic or macro-economic policy uncertainty of a country. Although current strand of literature deals with the behavior of different economies to oil price fluctuations, author aims at capturing non-linear behavior of oil using Markov regime switching model. This technique has the advantage of capturing non-linear behavior of oil prices that would be difficult to gauge with traditional non-linear models. To have a complete understanding of oil prices behavior on economic policy uncertainty, I introduced oil supply shock, aggregate demand shock and oil specific demand shocks. The effect of these shocks is captured by two regime states corresponding to low and high volatility state.

Findings of the paper that stem from our analysis are as follows. The application of Markov switching framework helps in identifying the non-linear structure of oil supply shock, aggregate demand shock, oil specific demand shock and their impact on the economic policy uncertainty of our sampled countries. The non-linear behavior of oil supply shock, aggregate demand shock, oil specific demand shock on economic policy uncertainty is also confirmed by their insignificant impact on EPU in a linear regression model whereas significant impact in Markov switching model. We witness more influencing and significant role of disintegrated structural oil shocks on EPU through Markov switching framework in at least one of the regimes thereby proving important role of oil shocks on economic policy uncertainty. Our application of Markov framework with two regimes extract its support from the application of Ang and Bekaert (2002) confirming that application of Markov regime switching model distinguishes well between two regimes. Our results highlight that Indian, Spain and Japanese economic policy uncertainty responds to the global oil price shocks. Indian EPU is sensitive to oil price shock in both the regimes whereas Spain and Japan respond to oil price shock in either one state or the other. Oil supply shock fail to induce change in any country however demand specific global oil shocks are significant only for China and India in high volatility state. Our paper has economic implication for policy makers during times of high global oil prices fluctuations. Oil shocks can also vary depending on the country's consumption of oil and their importing and exporting status. Furthermore, the developing and developed status of countries can also have different sensitivity levels to global oil shocks.

Being able to disintegrate oil shocks yields different results regarding their impact on economic policy uncertainty. This is supported by our results as I report different behavior of disintegrated oil shocks on the economic policy uncertainty for sampled countries. By disintegrating oil shocks and measuring their impact on economic policy uncertainty highlights its sensitivity to different shocks that significantly contribute to oil price changes. This can be of significant help for economists as identifying the structural causes of oil price fluctuations and then separately measuring their impact (by disintegrating them) on policy uncertainty can enhance the understanding about their relationship. This disintegration of oil shocks into supply side, aggregate demand and oil based demand shocks under varying regimes can further provide useful insights to economists and policy makers regarding the role of turbulent periods and extraneous variables on the relationship between these oil shocks and economic policy uncertainty. With significant increase in the financialization of oil commodities, international investors willing to consider both traditional assets and oil commodities in a portfolio can rebalance their portfolio based on the sensitivity of economic policy uncertainty to oil shocks because of their widely reported impact on equity market returns as well.

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Table 1: Descriptive Statistics

Statistic	Oil	Supply	Demand	China	India	US	Europe	France	Germany	Italy
Observations	252	252	252	252	252	252	252	252	252	252
Minimum	-0.293	-0.025	-0.077	9.067	20.580	57.203	47.694	11.287	28.434	31.986
Maximum	0.211	0.020	0.067	393.234	283.689	245.127	304.603	380.179	377.844	243.869
1st Quartile	-0.056	-0.004	-0.017	68.323	59.839	78.085	85.921	66.401	78.046	80.421
3rd Quartile	0.058	0.005	0.018	140.409	122.531	125.349	155.972	189.154	136.603	133.060
Mean	-0.001	0.000	0.000	112.534	96.634	105.829	124.652	133.594	114.684	109.741
Std. dev.	0.081	0.008	0.026	67.130	51.050	36.269	49.465	83.311	52.877	38.992
Skewness	-0.345	-0.366	-0.459	1.375	1.192	1.059	0.900	0.819	1.394	0.877
Kurtosis	0.245	0.665	-0.019	2.207	1.380	0.470	0.318	-0.164	2.989	0.836
Normtest.S	5.617*	10.265*	8.845*	130.536*	79.694*	49.389*	35.083*	28.468*	175.380*	39.614*

Notes: Oil denotes shock to global oil prices, Supply shows global oil supply shocks and Demand is the global economic activity shocks.

Table 2: Unit Root Statistics

Statistic	DF-GLS (c)	DF-GLS (t)	KPSS (μ)	KPSS (τ)
Oil	-2.225^{b}	-14.409	0.204	0.087
Supply	-0.467	-2.121^{b}	0.074	0.054
Demand	-3.111	-2.971^{b}	0.069	0.082
China	-2.550^{b}	-3.023^{b}	0.818	0.080
India	-1.210	-2.051	0.423^{c}	0.150^{b}
US	-1.692^{c}	-1.746	0.864	0.115^{c}
Europe	-3.169	-4.329	1.090	0.194^{b}
France	-1.164^{c}	-1.885	1.642	0.201^{b}
Germany	-5.528	-6.168	1.159	0.154^{b}
Italy	-2.490	-3.475	0.274	0.209^{b}
UK	-1.462	-1.804	1.397	0.221
Spain	-3.498	-3.740	0.097	0.091^{b}
Japan	-5.770	-5.777	0.152	0.149^{b}

Notes: Oil denotes shock to global oil prices, Supply shows global oil supply shocks and Demand is the global economic activity shocks. For ADF-GLS, critical values are -2.5743, -1.9421 and -1.6159 at 1, 5 and 10 percent respectively. With intercept and trend, critical values are -3.9974, -3.4290 and -3.1380 at 1, 5 and 10 percent respectively. For KPSS test, critical values are 0.7390, 0.4630 and 0.3470 at 1, 5 and 10 percent respectively. With intercept and trend, critical values are 0.2160, 0.1460 and 0.1190 at 1, 5 and 10 percent respectively.

Table 3: BDS Test Statistics for Policy Uncertainty

	m			
	1	2	3	4
China	0.0805	-0.0000	0.0545	0.0010
	(0.0000)	(0.0000)	(0.0000)	(0.0048)
	0.1350	-0.0000	0.0598	0.0019
	(0.0000)	(0.0014)	(0.0000)	(0.0189)
India	0.0670	0.0008	0.0641	0.0024
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	0.1177	0.0003	0.0768	0.0055
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
US	0.1285	0.0003	0.1352	0.0016
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	0.2152	0.0000	0.1738	0.0032
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Europe	0.1029	0.1029	0.1028	0.0006
	(0.0000)	(0.0000)	(0.0000)	(0.0065)
	0.1738	0.1738	0.1239	0.0039
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
France	0.0890	0.0000	0.1093	0.0039
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	0.1681	-0.0000	0.1379	0.0122
	(0.0000)	(0.0086)	(0.0000)	(0.0000)
Germany	0.0663	0.0000	0.0484	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.9391)
	0.1061	-0.0000	0.0543	0.0024
	(0.0000)	(0.0032)	(0.0000)	(0.0006)
Italy	0.0585	0.0077	0.0431	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.7013)
	0.0965	0.0007	0.0432	0.0002
	(0.0000)	(0.0000)	(0.0000)	(0.6481)
UK	0.1172	0.0001	0.1380	0.0137
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	0.2058	-0.0000	0.1900	0.0275
	(0.0000)	(0.0246)	(0.0000)	(0.0000)
Spain	0.0447	0.0004	0.0387	0.0069
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	0.0780	00000	0.0453	0.0137
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Japan	0.0433	0.0002	0.0309	-0.0003
	(0.0000)	(0.0000)	(0.0000)	(0.2504)
	0.0732	-0.0000	0.0310	0.0011
	(0.0000)	(0.0000)	(0.0000)	(0.0531)

Notes: In the above table, m denotes the embedding dimension of the BDS test.

Table 4: Linear Impact of Oil Shocks on Policy Uncertainty

	Constant	Oil	Supply	Demand	EPU (-1)	R-squared
China	-0.0025	-0.1282	8.3824	0.4785	-0.4000*	0.1701
	(-0.0718)	(-0.3049)	(1.8082)	(0.3563)	(-6.8335)	
India	-0.0064	-0.4373	-2.2581	-0.3319	-0.4236*	0.1862
	(-0.2389)	(-1.3341)	(-0.6233)	(-0.3165)	(-7.3101)	
US	0.0003	-0.0984	-1.2268	0.3821	-0.1724	0.0364
	(0.0278)	(-0.7879)	(-0.8927)	(0.9611)	(-2.7266)	
Europe	0.0003	-0.1129	0.9848	1.1187	-0.2956	0.0983
	(0.0185)	(-0.6175)	(0.4913)	(1.9441)	(-4.7629)	
France	0.0037	0.0770	1.1975	1.5954*	-0.4318*	0.1999
	(0.1525)	(0.2582)	(0.3655)	(1.6870)	(-7.5088)	
Germany	0.0002	-0.2299	-0.0875	1.3240	0.9300	0.1520
	(0.0064)	(-0.8057)	(-0.0278)	(1.4616)	(-6.4977)	
Italy	-0.0041	0.0533	-0.6581	0.9207	-0.4010*	0.1720
	(-0.2162)	(0.2301)	(-0.2571)	(1.2405)	(-6.8723)	
UK	0.0014	0.1307	2.9983	0.3163	-0.3100*	0.1031
	(0.0781)	(0.5735)	(1.2022)	(0.4399)	(-5.0400)	
Spain	0.0002	0.0847	0.6800	1.5216	-0.3098*	0.1068
	(0.0061)	(0.2445)	(0.1806)	(1.4011)	(-5.0117)	
Japan	-0.0019	-0.5374*	4.0401	-0.1377	-0.3819	0.1635
	(-0.1086)	(-2.3869)	(1.6319)	(-0.1921)	(-6.4606)	

Notes: Dependent variable is Economic Policy Uncertainty (EPU). Oil denotes shock to global oil prices, Supply shows global oil supply shocks and Demand is the global economic activity shocks. Values are parenthesis are corresponding t statistics. *, **, *** represent significance at 1, 5 and 10 percent, respectively

Table 5: Impact of Oil Shocks on Policy Uncertainty- Markov Switching Framework (Normal Distribution for Errors)

A. Estimated Coefficients

Country	State	Intercept	Prices	Supply	Demand	Sigma	LL	P11-C	P22-C
China	S1	0.8109*	0.0167	0.4598	-0.3265	3.5760*	1327.0600	3.3610	-2.3402
		(2.2968)	(-0.1084)	(1.2365)	(-0.6598)	(60.4919)		7.3760	-4.0854
	S2	0.9569*	0.0367	0.4695	0.7965*	4.1957*			
		(5.4653)	(0.2095)	(0.3265)	(1.9865)	(40.2568)			
India	S1	0.9568*	-0.5632*	0.3265	-0.6532	3.2067*	-1263.8580	2.9576	-2.3386
		(7.1235)	(-2.6532)	(0.3265)	(-0.6532)	(47.5308)		7.0709	-5.2165
	S2	0.1465*	-0.2689*	0.4598	-0.6598*	3.8816*			
		(8.2365)	(-3.6598)	(0.6598)	(-2.0364)	(48.4627)			
US	S1	0.1365*	-0.4863	0.9162	-0.6986	3.4478*	-1117.9530	2.8882	-3.2222
		(2.3598)	(-0.6904)	(0.5698)	(-0.7954)	(47.9000)		5.9149	-6.7856
	S2	0.6598*	-0.1668	0.1398	0.6598	2.4498*			
		(3.0659)	(-1.3545)	(0.3165)	(0.6598)	(33.8101)			
Europe	S1	0.2369*	-0.6532	-0.6532	-0.6321	3.0263*	-1222.8400	3.0447	-2.6939
		(5.5698)	(-1.6532)	(-0.6532)	(-0.4165)	(32.5840)		6.3475	-5.8643
	S2	0.5698*	-0.3565*	0.5462	0.1698	3.6541*			
		(8.2269)	(-5.7165)	(0.8698)	(0.6613)	(48.6139)			
France	S1	0.6598*	0.2365	-0.6598	-0.9865	3.4398*	-1336.4780	3.3848	-3.2070
		(5.2236)	(0.2365)	(-0.6598)	(-0.0978)	(51.2604)		6.4667	-5.6252
	S2	0.5698*	-0.3265	0.2365	0.9465	4.1839*			
		(6.2568)	(-1.3265)	(0.9865)	(0.6532)	(56.5556)			
Germany	S1	0.5369*	0.4496	-0.5698	-0.5684	53.1722*	-1257.8050	2.5950	-1.9888
		(5.0798)	(1.6593)	(-0.8798)	(-0.1332)	(8.5986)		5.2994	-3.1274
	S2	0.7798*	-0.6598	0.6161	0.3261	99.2691*			
		(5.6539)	(-0.3265)	(0.7986)	(1.6532)	(7.3717)			
Italy	S1	0.4498*	0.0879	0.3326	-0.4213	3.5427*	-1222.842	1.9821	-2.7808
		(4.3298)	(0.2303)	(0.6598)	(-0.3965)	(38.9027)		4.0665	-6.1779
	S2	0.2369*	-0.1987	0.2132	0.3665	3.1463*			
		(4.2998)	(-0.6598)	(0.5265)	(0.5642)	(41.7388)			
UK	S1	0.9865*	0.1698	0.9865	0.3265	4.2390*	-1291.7000	4.4840	-4.2698
		(3.2268)	(0.6598)	(0.3265)	(0.3265)	(59.3506)		4.3673	-5.8459
	S2	0.5987*	-0.4465	0.4598	-0.3653	3.2383*			
		(6.2654)	(-1.6598)	(0.0798)	(-0.2356)	(51.4927)			
Spain	S1	0.1698*	-0.3698*	0.6549	-0.1354	4.1136*	-1293.4630	2.4156	3.7945
		(5.5648)	(-1.9865)	(1.3265)	(-0.4465)	(37.7564)		-3.9285	-6.3092
	S2	0.6659*	-1.3265	1.3298	2.3265	3.5176*			
		(4.1336)	(0.2365)	(0.6598)	(0.3265)	(59.9985)			
Japan	S1	2.9968*	-0.8965*	0.1779	-0.5623	3.3600*	-1194.5970	2.1275	-2.2031
		(6.3659)	(-2.6532)	(0.4598)	(-0.4231)	(35.4314)		4.4280	-6.1187
	S2	0.4698*	-0.6598	0.1889	0.3265	2.8909*			
		(4.2365)	(-0.1326)	(0.4595)	(0.2335)	(34.4552)			

B. Expected Durations and Transition Probabilities

Country	P11	P12	P21	P22	DU1	DU2	RCM
China	0.9665	0.0335	0.0879	0.9122	29.8176	11.3836	67.1299
India	0.9506	0.0494	0.0880	0.9120	20.2514	11.3667	51.0502
US	0.9473	0.0527	0.0383	0.9617	18.9605	26.0830	36.2689
Europe	0.9545	0.0455	0.0633	0.9367	22.0030	15.7888	49.4654
France	0.9672	0.0328	0.0389	0.9611	30.5118	25.7056	83.3115
Germany	0.9304	0.0695	14.3972	8.3065	14.3972	8.3065	52.9803
Italy	0.8789	0.1211	0.0584	0.9416	8.2581	17.1323	38.9923
UK	0.9888	0.0112	0.0138	0.9862	89.5891	72.5085	80.7387

Spain	0.9180	0.0820	0.0193	0.9807	12.1956	51.8302	52.8722
Japan	0.8935	0.1065	0.0995	0.9005	9.3935	10.0530	35.2201

Notes: Dependent variable is policy uncertainty. Oil denotes shock to global oil prices, Supply shows global oil supply shocks and Demand is the global economic activity shocks. Sigma denotes standard deviation for each state. LL shows the maximized log likelihood value. Values in parenthesis are student's *t* statistics. [a], [b] and [c] denotes significance at 1, 5 and 10 percent respectively. Regime classification measure is denoted by RCM. Expected durations for being in state i is reported as Dui i.e., Du1 for state 1 and Du2 for state 2. Transition probabilities are reported as $\rho_{i,j}$.

Table 6: Impact of Oil Shocks on Policy Uncertainty- Markov Switching Framework (Student *t* Distribution for Errors)

A. Estimated Coefficients

Country	State	Intercept	Prices	Supply	Demand	Sigma	LL	P11-C	P22-C
China	S1	0.6532*	-0.3265	0.4565	-0.3598	3.5760*	-1327.063	3.3610	-2.3403
		(2.2365)	(-0.5632)	(1.2659)	(-0.4569)	(62.1413)		7.5686	-4.2141
	S2	0.2365*	0.6598	0.5963	0.7989*	4.1958*			
		(5.1565)	(0.2365)	(0.2653)	(2.6585)	(41.5244)			
India	S1	0.7986*	-0.5632*	0.2365	-3.5032	3.2067*	-1263.858	2.9576	-2.3386
		(6.2653)	(-9.5632)	(0.5986)	(-0.6351)	(48.7775)		7.2519	-5.3515
	S2	1.2365*	-0.5632*	0.4569	-0.2561*	3.8816*			
		(4.2636)	(-5.6598)	(1.2365)	(-2.1365)	(49.6721)			
US	S1	0.9865*	-0.1654*	0.1365	0.1254	2.4498*	-1117.953	3.2222	-2.8881
		(8.6986)	(-2.3265)	(1.2365)	(0.6532)	(34.6375)		6.9532	-6.0604
	S2	0.3265*	-0.3265	0.9563	-0.5632	3.4478*			
		(5.3652)	(-1.3265)	(1.6532)	(-0.1265)	(49.0784)			
Europe	S1	0.9532	-0.1546	-0.6323	-0.2232	3.0264	-1222.839	3.0444	-2.6939
		(0.4652)	(-0.2365)	(-0.2365)	(-0.5632)	(33.2466)		6.4855	-6.0024
	S2	0.3265	-0.3216	0.5321	0.1198	3.6541			
		(1.6532)	(-1.3256)	(0.8265)	(0.6543)	(49.8109)			
France	S1	2.3265*	-0.5698	0.2365	0.9765	4.1838*	-1336.478	3.2065	-3.3847
		(1.3265)	(-1.5698)	(0.3265)	(0.4653)	(57.9000)		5.7551	-6.6196
	S2	5.8653*	0.8965	-0.6598	-0.9865	3.4398*			
		(2.3265)	(0.2365)	(-1.6532)	(-0.1698)	(52.4775)			
Germany	S1	3.6532*	0.3265	-0.2365	0.2654	3.2332*	-1278.802	2.7404	-2.1377
		(0.5329)	(0.2365)	(-0.9865)	(0.3659)	(53.2063)		7.2446	-4.8622
	S2	8.6532*	-0.2654	0.6332	0.2135	3.9557*			
		(0.2232)	(-1.5698)	(0.8653)	(0.7701)	(50.6266)			
Italy	S1	0.6598	-0.5698	0.1235	0.3598	3.1463*	-1222.842	2.7807	-1.9821
		(0.3628)	(-0.9865)	(0.6532)	(0.5632)	(42.9313)		6.4254	-4.2718
	S2	0.6598	0.7998	0.3365	-0.1765	3.5427*			
		(1.3265)	(1.6589)	(0.5698)	(-0.1165)	(40.2335)			
UK	S1	0.2596	0.1565	0.6532	0.2651	4.2389*	-1291.692	4.2241	-4.4455
		(1.6598)	(0.1654)	(0.3256)	(0.8071)	(60.8037)		5.3699	-5.8443
	S2	0.2689	-0.5698	0.4598	-0.2565	3.2384*			
		(1.6588)	(-1.5698)	(0.2203)	(-1.2352)	(52.7859)			
Spain	S1	0.5985	-0.3569	-0.6532	0.2654	3.5197*	-1293.202	3.9810	-2.4333
		(0.5985)	(-1.5698)	(-0.2032)	(0.3325)	(62.0729)		6.4984	-3.9983
	S2	9.2654*	-0.9685*	0.1565	-0.1568	4.1177*			
		(2.6585)	(-5.6598)	(1.3202)	(-0.4665)	(38.5507)			
Japan	S1	7.2659*	0.5698*	0.1778	-0.5132	3.3600*	-1194.597	2.1277	-2.2032
		(3.2659)	(-5.6598)	(0.4798)	(-0.4798)	(36.6278)		4.5714	-6.2753
	S2	0.2685	-0.5698	0.1185	0.3798	2.8908*			
		(0.3598)	(1.2365)	(0.4971)	(0.6543)	(35.4348)			

B. Expected Durations and Transition Probabilities

Country	P11	P12	P21	P22	DU1	DU2	RCM
China	0.9665	0.0335	0.0878	0.9122	29.8182	11.3847	67.1300
India	0.9506	0.0494	0.0880	0.9120	20.2525	11.3670	51.0502
US	0.9617	0.0383	0.0527	0.9473	26.0820	18.9598	36.2689
Europe	0.9545	0.0455	0.0633	0.9367	21.9978	15.7893	49.4654
France	0.9611	0.0389	0.0328	0.9672	25.6933	30.5084	83.3115
Germany	0.8943	0.1057	0.0607	0.9393	9.4655	16.4836	52.6789
Italy	0.9416	0.0584	0.1211	0.8789	17.1309	8.2580	38.9923
UK	0.9856	0.0144	0.0116	0.9884	69.3154	86.2428	80.7387
Spain	0.9817	0.0183	0.0807	0.9193	54.5682	12.3965	52.8722
Japan	0.8936	0.1064	0.0995	0.9005	9.3955	10.0535	35.2201

Notes: Dependent variable is policy uncertainty. Oil denotes shock to global oil prices, Supply shows global oil supply shocks and Demand is the global economic activity shocks. Sigma denotes standard deviation for each state. LL shows the maximized log likelihood value. Values in parenthesis are student's *t* statistics. [a], [b] and [c] denotes significance at 1, 5 and 10 percent respectively. Regime classification measure is denoted by RCM. Expected durations for being in state i is reported as Dui i.e., Du1 for state 1 and Du2 for state 2. Transition probabilities are reported as $\rho_{i,j}$.

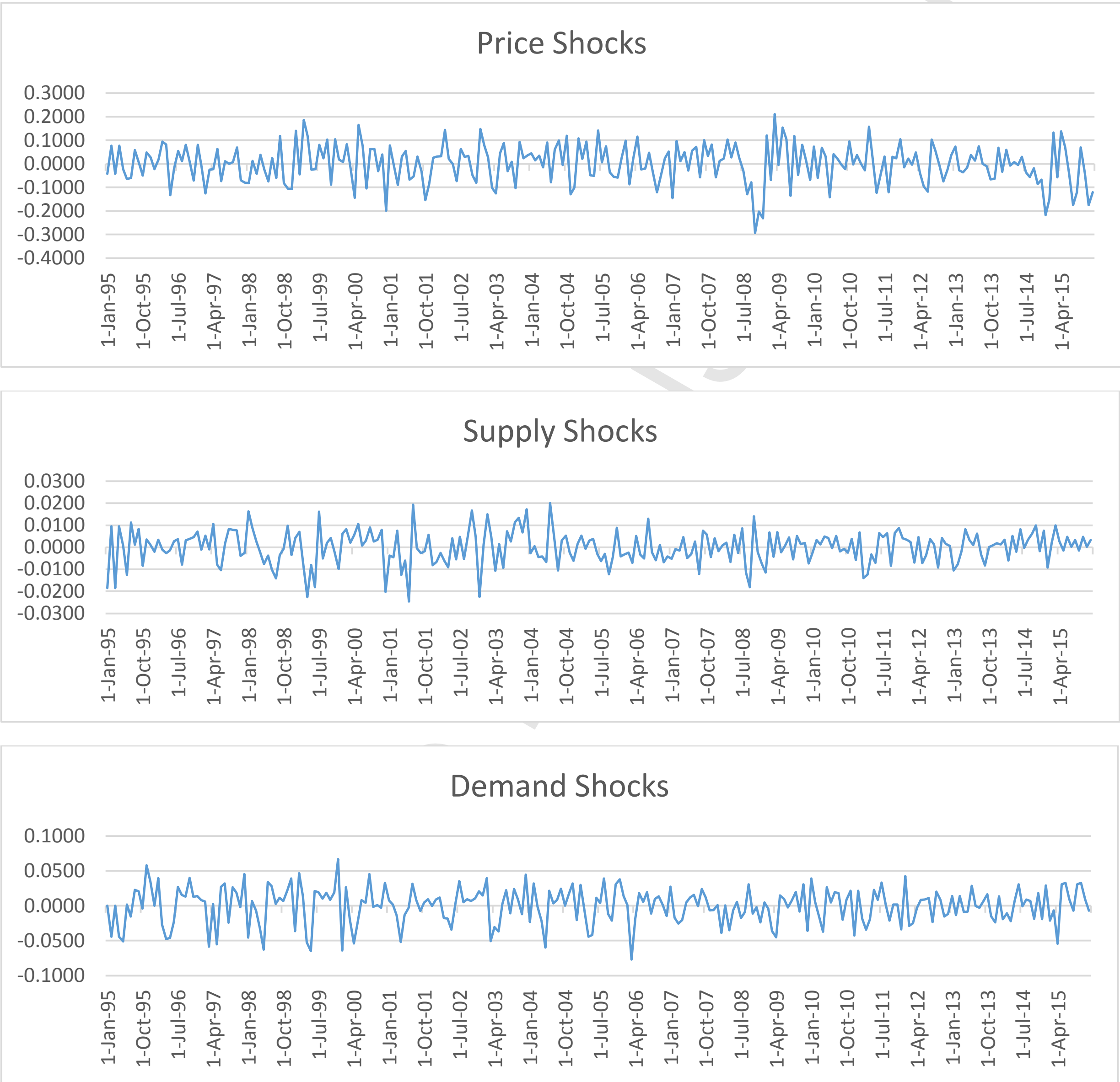
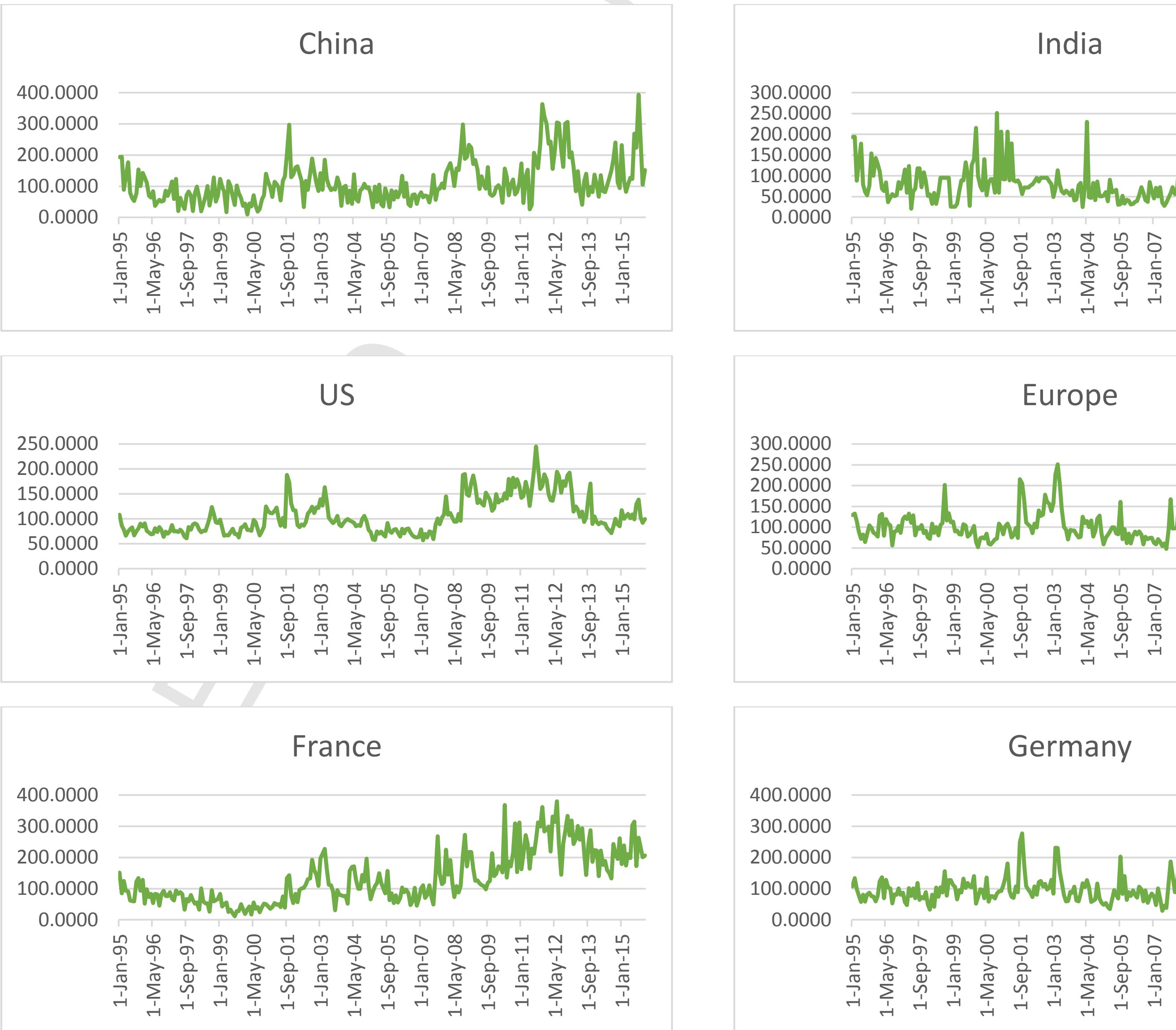


Figure 1: Global Oil price shocks, oil supply shocks and economic activity demand shocks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300.0000
200.0000
100.0000
0.0000
1-Jan-95
1-May-96
1-Sep-97
1-Jan-99
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1-Sep-01
1-Jan-03
1-May-04
1-Sep-05
1-Jan-07
1-May-08
1-Sep-09
1-Jan-11
1-May-12
1-Sep-13
1-Jan-15
India
300.0000
250.0000
200.0000
150.0000
100.0000
50.0000
0.0000
US
250.0000
200.0000
150.0000
100.0000
50.0000
0.0000
Europe
France
Germany

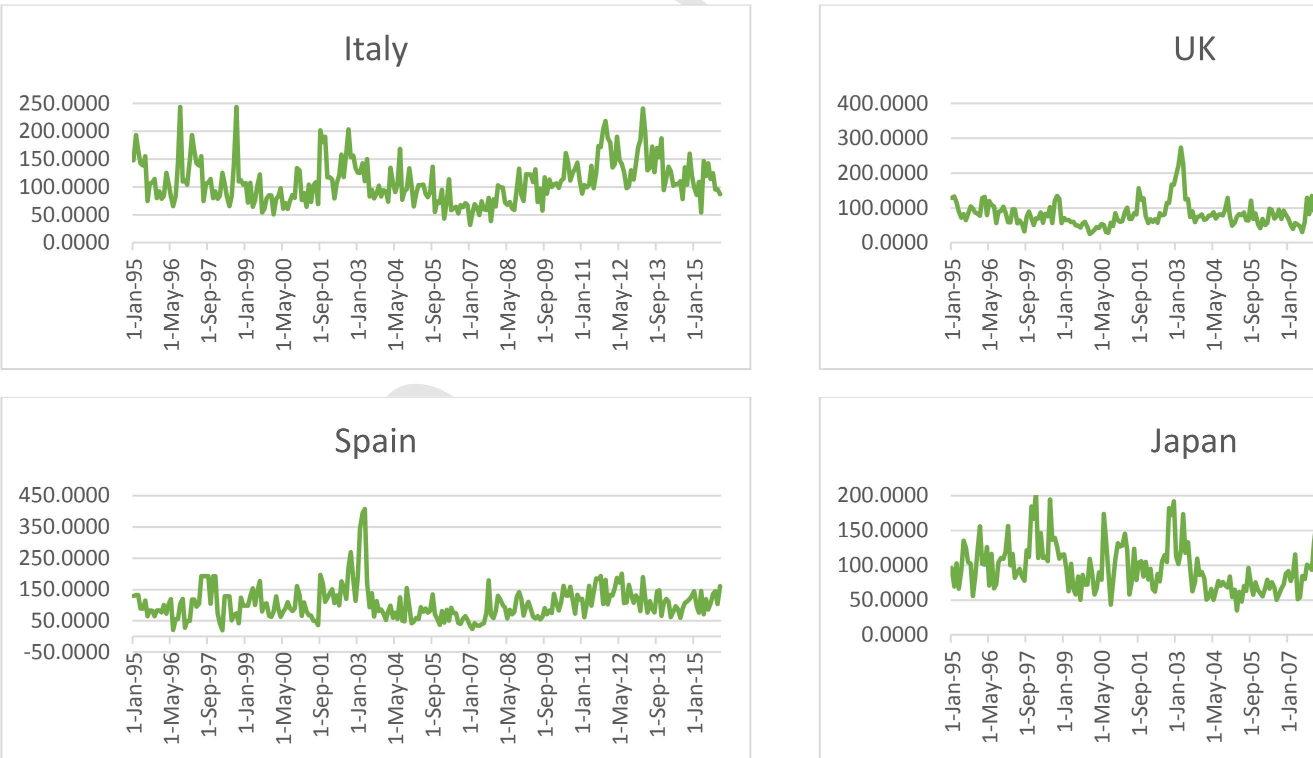
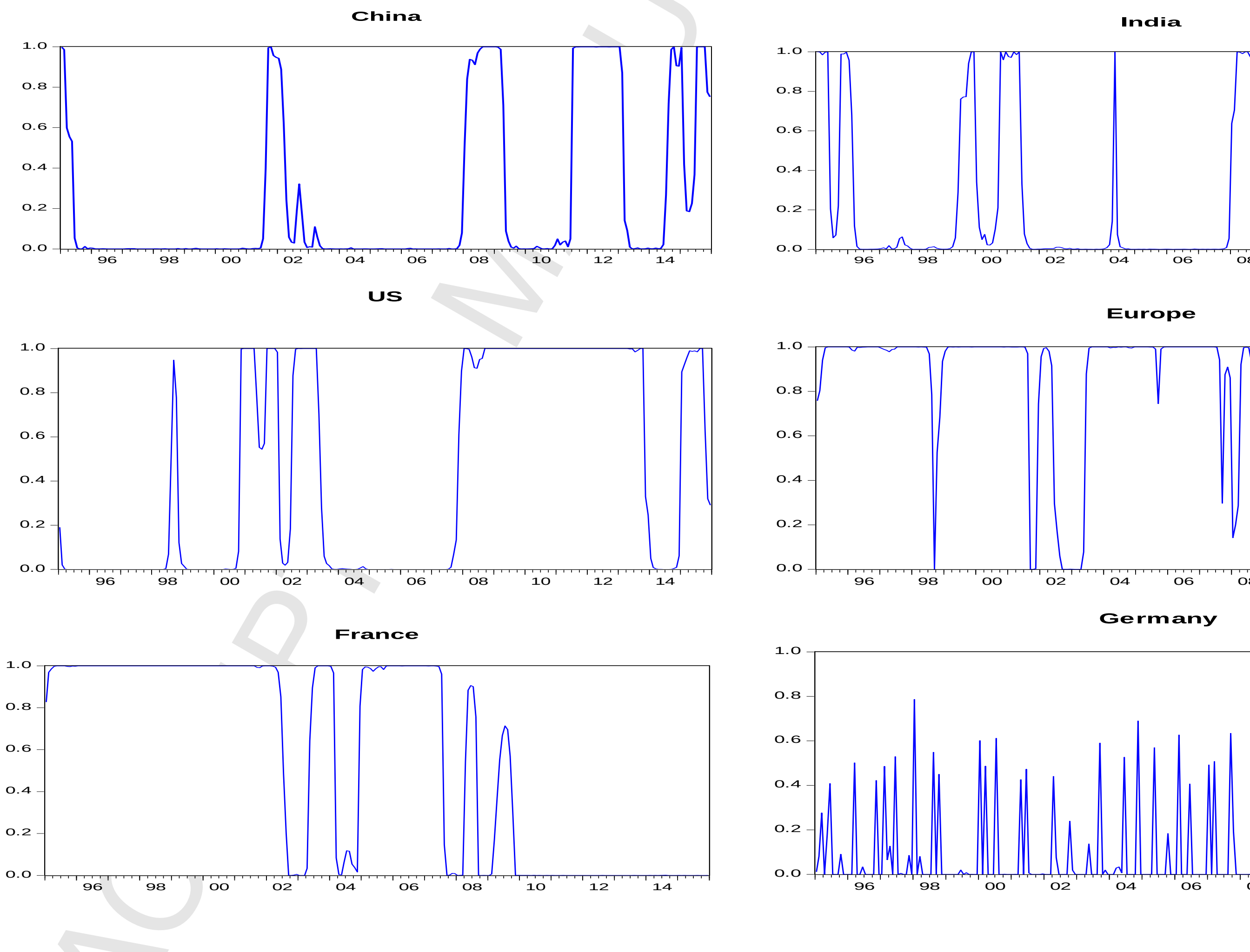


Figure 2: Policy uncertainty index


China
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0.8
0.6
0.4
0.2
0.0
96 98 00 02 04 06 08 10 12 14
India
US
Europe
France
Germany

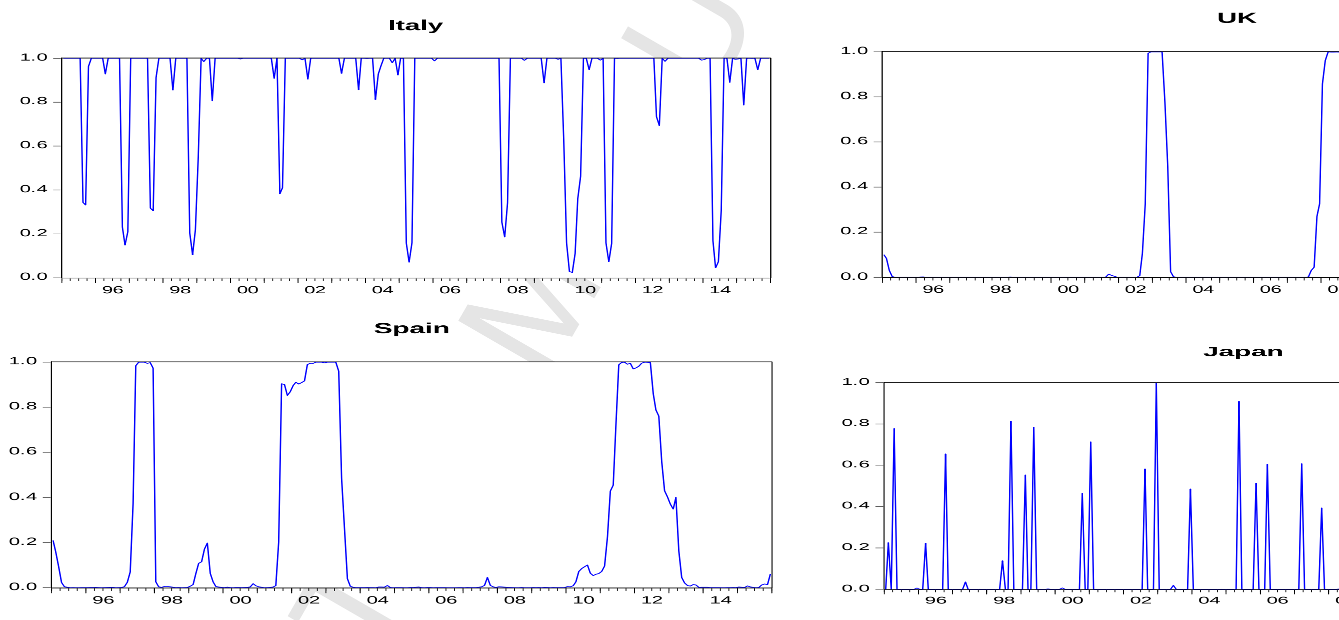
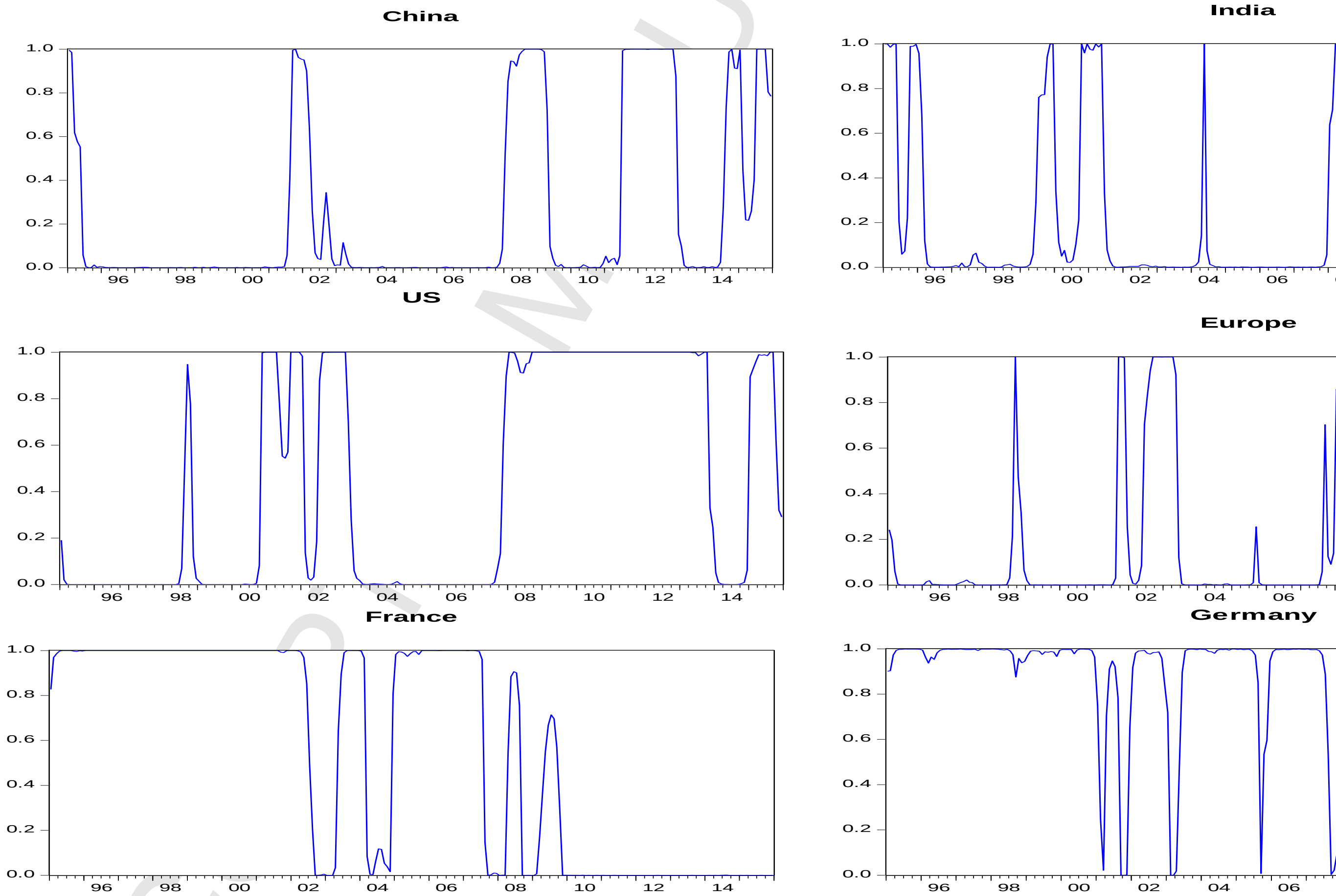


Figure 3: High volatility state (State 1 for all the countries) with smoothed probability (Normal distributio


China
India
US
Europe
France
Germany
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0.8
0.6
0.4
0.2
0.0
96
98
00
02
04
06
08
10
12
14

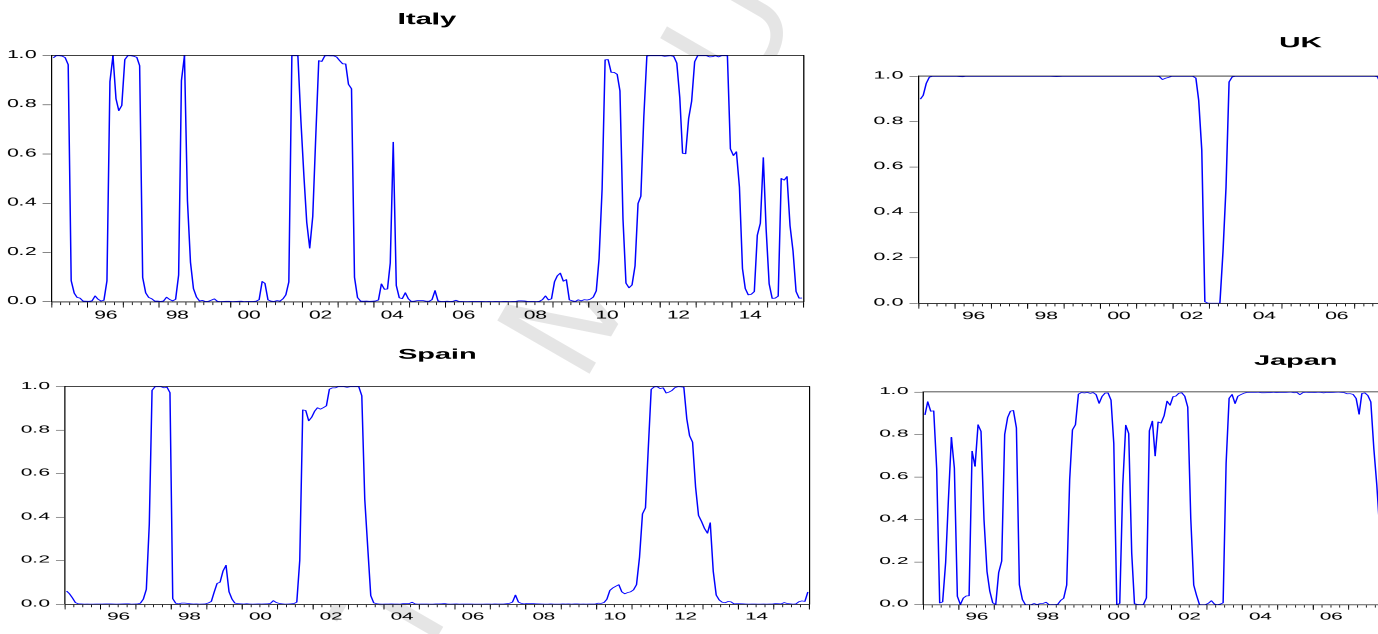

Figure 4: High volatility state (State 2 for all the countries) with smoothed probability (Student *t* distributio