Macroeconomic News and Exchange Rates: Evidence of Unstable Effect

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Abstract

Although the link between macroeconomic news announcements and exchange rates is well documented in recent literature, this connection may be unstable. By using a broad set of macroeconomic news announcements and high frequency forex data for the Euro/Dollar, Pound/Dollar and Yen/Dollar from Nov 1, 2004 to Mar 31, 2014, we obtain two major findings with regards to this instability. First, many macroeconomic news announcements exhibit unstable effects with certain patterns in foreign exchange rates. These news effects may change in magnitude and even in their sign over time, over business cycles and crises within distinctive contexts. This finding is robust because the results are obtained by applying a Two-Regime Smooth Transition Regression Model, a Breakpoints Regression Model, and an Efficient Test of Parameter Instability which are all consistent with each other. Second, when we explore the source of this instability, we find that global risks and the reaction by central bank monetary policy to these risks to be possible factors causing this instability.

Key words: *smooth transition regression model, breakpoints regression model, efficient estimation, unstable macroeconomic news effects, high frequency data, exchange rate, global risk, central bank monetary policy*

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1. Introduction

Macroeconomic fundamental news and exchange rates are linked in recent literature by Andersen et al. (2003), Bauwen, Ben Omrane & Giot (2005), Dominguez and Panthaki (2006) and others. Some researchers also investigate the effects of macroeconomic news instability on exchange rates by using qualitative tools such as a survey of foreign exchange traders (Cheung and Chinn (2001)) or applying quantitative methods such as the parameter instability test made by Rossi (2006). Moreover, there is empirical evidence of unstable macroeconomic news effects such as state dependent effects on return (Fatum et al., 2012), asymmetric macroeconomic news effects on volatility (Laakkonen & Lanne, 2009), and sign switching effects on returns (Ben Omrane & Savaser, 2013). Using high frequency intraday data including the three major currencies and a new extensive and refined set of macroeconomic news involving US, UK, Europe and Japan, we extend the literature by analyzing the unstable effect of macroeconomic news on exchange rates. To the best of our knowledge, no papers exist on the unstable response of exchange rate returns and volatility to news, over time, states and specific economic contexts.

There are many questions with regards to unstable news effects. Are all macroeconomic news unstable in foreign exchange markets? If not, which categories of news are unstable? What patterns does unstable news follow? What is the determinant of the instability? Does the instability exist in both high frequency returns and volatility?

The confusion raised by unstable news effects in foreign exchange markets makes understanding this instability critical, because some scholars question the existence of this link. Bacchetta & Wincoop (2004, 2006 and 2011) provide a possible theoretical explanation: they argue that the relationship between macroeconomic fundamentals and exchange rates is highly unstable due to rational "scapegoat" effects. Here, "scapegoat" means that news related to macroeconomic fundamentals are always blamed instead of the change in unobservable factors (Bacchetta & Wincoop, 2004), implying that news is disconnected from the exchange rate. However, we show that this link, though unstable, does exist under the assumption of two-regime shifts, multiple structural breaks and continuous variation over time.

We focus on the unstable relationship between macroeconomic fundamentals and exchange rates with the following objectives. 1) We implement smooth transition regressions (Teräsvirta,

1994) to estimate logistic transition functions and examine the unstable volatility response to macroeconomic news announcements. Logistic functions involve the probabilities of being in a given state of the economy (expansion or recession). This method is more efficient than the implementation of a predetermined indicator function based on dates announced by NBER (The National Bureau of Economic Research). 2) We focus on US and European crises in order to investigate the sensitivity of macroeconomic news effects to their specific economic contexts. Macroeconomic news impact could be contingent on the economic context of the announcement time. For example, an increase of US Existing home sales could depreciate the dollar during a US crisis since the news content indicates an increase in mortgage demands. 3) We compare news effects on exchange rates during US and European crises and investigate any sign changes. The same news could have diverse effects in separate crises since they were triggered in different economic settings. 4) We study the time varying impact of macroeconomic news on both foreign exchange returns and volatility using breakpoint regressions (Bai and Perron, 1998) and estimate response parameter paths using an efficient estimation method (Muller and Patalas, 2010). News effects become unstable when they diverge from the constant overall effect. However, it could be time varying for a short or long period of time. 5) We investigate the determinants of macroeconomic news effects instability using some economic fundamentals to decompose the time varying effect.

With regard to the source of the macroeconomic news effects' instability, we choose the measures of global risk, order flow and federal fund rates as three possible factors suggested from recent literature (Goldberg & Grisse, 2013). It is natural to choose global risk and order flow since current literature presents empirical evidence of a time varying response of news to economic conditions in the foreign exchange market (Fatum et al., 2012) and the role of order flow as a key determinant in exchange rates (Lyons, 2001). The policy rate decision is motivated by basic economic models including interest rate parity and Taylor-rules for central bank monetary policy. (Gürkaynak et al., 2005)

Our work contributes to the current literature from three perspectives: 1) We find empirical evidence of macroeconomic news instability over time, states of economy, and crisis contexts. Specifically, macroeconomic news effects are sensitive to time, business cycles (expansion and recession), and the economic context (deficits vs mortgage crisis). 2) We find the main reasons

of instability are directly related to global risk and central bank monetary policy. 3) Using an STR model, we find a significant difference between economic transition periods given by economic institutions such as NBER and CEPR (Centre for Economic Policy Research).

The remainder of the paper is organized as follows. Section 2 provides literature review. Section 3 explains the empirical model applied in the paper. Section 4 introduces our data set and its analysis. Section 5 and 6 present the empirical results and conclusion.

2. Literature Review

Andersen et al. (2003) use the 5-min conditional mean return response of a broad set of currency pairs such as Euro/Dollar, Pound/Dollar and Yen/Dollar related to US macroeconomic news. Bauwen, Ben Omrane & Giot (2005) document the news impact on Euro/Dollar volatility based on both scheduled and unscheduled news announcements and find that volatility increases in the 'pre-announcement periods', especially for scheduled news. Dominguez and Panthaki (2006) report that a fundamental news surprise can increase volatility immediately after the announcement in Euro/Dollar and Pound/Dollar. Faust et al. (2007), Love and Payne (2008), Love (2004) and Ben Omrane & Savaser (2013) all find significant news impact from their high frequency data sets. However, the link between macroeconomic fundamentals and exchange rates are unstable over time in foreign exchange markets. Cheung and Chinn (2001) conduct a survey on U.S. foreign exchange traders and find that the importance of a specific fundamental variable shifts over time. This time varying feature of parameters is also reported by Rossi (2006), who provides empirical evidence by running several kinds of tests on parameter instability.

Recent empirical literature on real-time news effects provide evidence of instability on both return and volatility in foreign exchange markets. While Andersen et al. (2007) find no significant asymmetrical news effects through different business cycles in foreign exchange markets, Faust et al. (2007) provide some limited evidence of asymmetry. Fatum et al. (2012) document a significant time varying response of Yen / dollar to Japan macroeconomic news over different economic conditions. Laakkonen & Lanne (2009) study news impact on foreign exchange volatility over different economic states by including a broader set of macroeconomic news from U.S. and Euro Zone countries. They show that the impact of good and bad news varies during expansion and recession periods by using a two-regime smooth transition regression (STR) model. Ben Omrane & Savaser (2013) compare US macroeconomic news impact on three major currencies during different business cycles. Their result is interesting because the parameters on several announcements switch their sign with a new business cycle. However, there are only a limited number of important macroeconomic news events that show an unstable relationship which leaves most of the other news events unexplained.

One possible theoretical reason for the instability of model parameters is provided through a series of papers by Bacchetta & Wincoop (2004, 2006 and 2011). They first derive a reduced version of a macroeconomic model linking fundamentals to exchange rates, and then impose time varying parameters on the model to find that exchange rates are determined by the expectation of these parameters rather than the parameters themselves (Bacchetta & Wincoop, 2011). They claim the relationship between fundamentals and exchange rates is highly unstable due to rational "scapegoat" effects. Here, "scapegoat" effects suggest that news related to macroeconomic fundamentals are always blamed instead of the change in the unobservable factors (Bacchetta & Wincoop, 2004).

Some other features of news also play important roles with regard to the return response in foreign exchange markets. The timeliness, precision and information content significantly influence the impacts of news effects (Andersen et al., 2003; Laakkonen & Lanne, 2013; Gilbert et al., 2010). More specifically, the more timely the announcement with respect to the reference date, the larger effect it has; the smaller the difference between the initial announcement and its later revision, the larger effect it has; the more content contained in the news for predicting the growth, inflation or central bank monetary policy, the larger effect it has. Regarding the features of some specific news, Neely & Dey (2010) provide informational reviews on some important US news which helps us interpret news effects in foreign exchange market.

One important feature on conditional volatility of the foreign exchange market is the intraday seasonality pattern. Neely (2011) reviews the relationship between news announcement effects intraday periodicity patterns and daily volatility patterns to recommend that intraday seasonality be controlled for in the methodology. In addition, Andersen & Bollerslev (1998) and Laakkonen (2007) introduce and evaluate filtering methods of intraday seasonality patterns.

Since we apply a wide range of models on parameter instability, we briefly review the related literature. There are two lines of research regarding the model with unstable parameters: "structural breaks" and "random coefficients". Under the assumption of structural breaks, Bai & Perron (1998) introduce a breakpoint regression model which can estimate the unknown break dates and the coefficients within each regime in a linear regression model. In addition, Teräsvirta (1994) introduce a Smooth Transition Regression Model which allows a smooth regime transition, as compared to an abrupt switch, by imposing a transition variable. Müller & Petalas

(2010) show that for a moderately time varying parameter, the parameter path can be inferred by an artificial linear and Gaussian model asymptotically without a large sample. However, Elliott & Müller (2006) introduce an efficient test called a quasi-local level test and argue that with respect to the test of parameter instability, the seemingly different assumptions "structural breaks" and "random coefficients" are not distinctive.

Recent literature also documents significant findings in foreign exchange markets during the recent global crises. Fratzscher (2009) documents a stunning sign switch effect from US macroeconomic news surprises on the dollar against many other currencies in daily returns, especially for countries with weak current account positions. This sign switch effect is consistent with the evidence in Ben Omrane & Savaser (2013) from their high frequency data set. Melvin & Taylor (2009) show important events happened during the US subprime crisis and suggest a financial stress index (FSI) to compare different crises over time. Regarding the Euro Zone crisis, Shambaugh (2012) separates this crisis into three parts: sovereign debt, banking and growth. High sovereign debt and weak banks reinforce each other and both lead to a growth problem.

3. Methodology

We first introduce the two-regime Smooth Transition Regression model, then discuss how to implement it on the return and volatility equations. Following that, we show the breakpoint regression model and the efficient test model. Finally, we introduce a method to estimate the time varying news coefficients efficiently, and show the regression equation on this additional analysis.

3.1 Two-Regime Smooth Transition Regression Model

We follow Laakkonen & Lanne (2009) to detect the regime transition by applying the two-regime smooth transition regression (STR) model on the data from Nov 1st, 2004 to Mar 31st, 2014. The STR model is introduced by Teräsvirta (1994)

$$\boldsymbol{y}_{t,n} = \emptyset' \boldsymbol{z}_{t,n} + \psi' \boldsymbol{z}_{t,n} G(t_{t,n}, \gamma, c) + \varepsilon_{t,n} \quad (1)$$

$$\text{With } G(t_{t,n}, \gamma, c) = (1 + \exp\{-\gamma \textstyle\prod_{k=1}^{K}(t_{t,n} - c_k)\})^{-1} \quad (2)$$

Where $\boldsymbol{y}_{t,n}$ is the log transform of filtered volatility on day *t* and interval *n* after filtering for intraday seasonality effects and daily ARCH effects; $\boldsymbol{z}_{t,n}$ denotes a vector with a constant and a consolidated macroeconomic news variable. Transition function $G(t_{t,n}, \gamma, c)$ is a logistic function, which is a function of the transition variable $t_{t,n}$, the threshold parameter c_k, slope parameter γ and transition type indicator *k*. The value of $G(t_{t,n}, \gamma, c)$ is between zero and one involving the probability of staying in the higher regime. When $G(t_{t,n}, \gamma, c)$ has a value close to 0, it means the state is most likely in the lower regime, otherwise, a value close to 1 means the state is likely in the higher regime. The common choice of k is either one or two. If *K* =1, this is a logistic STR1 model (LSTR1), then $\emptyset$ and $\emptyset$+ψ signify the macroeconomic news impact on exchange rate volatility in lower and higher regimes, respectively. A statistically significant ψ implies that the news effects are varying over expansion and recession. Appendix A.1 and A.2 explain how to construct a log filtered volatility $\boldsymbol{y}_{t,n}$, and the consolidated macroeconomic news variable $\boldsymbol{z}_{t,n}$. The transition variable $t_{t,n}$ will be explained in greater detail in the data section.

3.2 Model for Return and Volatility

We follow Andersen et al. (2003) and model the return and volatility response on the news surprise elements. Ideally, the coefficients of the news effects and the logistic transition function $\hat{G}_l(t_{t,n},\gamma,c)$ should be estimated at the same time. But this is not feasible due to a large work load to process the data. Alternatively, we apply a two-step approach by first estimating the logistic transition function, and then estimating the news effects by imposing the fitted value of the logistic transition function in the analysis regression equation. Next we introduce the analysis model on return and volatility respectively.

Our baseline analysis is on the effects of a news surprise element. Balduzzi, Elton and Green (2001) propose to measure the surprise element by first calculating the difference between the forecast and actual announced amount, and then dividing the difference by its standard deviation. This method removes the potential problem caused by different measurement units. So it is calculated by: $S_{k,t} = \frac{A_{k,t}-F_{k,t}}{\hat{\sigma}_k}$, where $A_{k,t}$ denotes the actual figure of news *k* at time *t*, $F_{k,t}$ denotes the forecast figure for the same announcement, $\hat{\sigma}_k$ is the sample standard deviation of the difference between actual and forecasts for news *k* through entire sample period.

Following Andersen et al. (2003), we model return response on the news surprise element while incorporating STR model:

$$R_{t,n} = \theta_0 + \theta_l \sum_{i=1}^{I} R_{t,n-i} + \sum_{k=1}^{K}\sum_{j=1}^{J} \beta_{k,j} S_{k,t,n-j} + \tau_1 Unsch_{t,n} + \tau_2 Int_{t,n} + \tau_3 Speak_{t,n}$$

$$+\{\theta'_0 + \sum_{k=1}^{K}\sum_{j=1}^{J} \beta'_{k,j} S_{k,t,n-j} + \tau'_1 Unsch_{t,n} + \tau'_2 Int_{t,n} + \tau'_3 Speak_{t,n}\}\hat{G}(t_{t,n},\gamma,c) + \epsilon_{t,n} \quad (3)$$

Where $S_{k,t,n-j}$ is the surprise element for news *k* at date t and j lagged interval n. *K* is the total number of macroeconomic news announcements. *I* is the total lagged term of return. *I*=4 and *J*=2 based on the Schwarz and Akaike information criteria. $\hat{G}(t_{t,n},\gamma,c)$ is the fitted value of the logistic transition function in equation (1), $\epsilon_{t,n}$ is the residual term. In addition, $Unsch_{t,n}$, $Int_{t,n}$, and $Speak_{t,n}$ are dummy variables controlling for three important events in the foreign exchange market. $Unsch_{t,n}$ is the dummy variable capturing the unscheduled important news announcements related to crisis, $Int_{t,n}$ is the central bank intervention dummy variable and $Speak_{t,n}$ is a 2x1 vector of dummy variables with related speeches made in the US and Euro

Zone Countries by important government and central bank officials such as the US president, the Federal Reserve Chairman and the President of the European Central Bank. These significant effects on exchange rates are documented in current literature as in Dominguez & Panthaki (2006), Bauwen, Ben Omrane & Giot (2005), and Beine, BOS & Laurent (2007).

During our nine year sample period, the literature documents two crises influencing the global economy: the US Crisis (Melvin & Taylor, 2009) and the Euro Zone Crisis (Shambaugh, 2012). To analyze the unstable effects for each crisis separately, we use the STR model on exchange rate returns and volatility in the following steps. First, we detect the regime transition of each crisis through the entire sample by assigning a corresponding transition variable. Then, we split the total sample into two sub-samples according to the estimates of the regime transition for each crisis. More specifically, since the US crisis started earlier than the Euro Zone crisis according to recent literature, we choose the end of the US crisis as a break point. We define the period from the beginning of our total sample and the ending of the US crisis as US subsample (US crisis related sample) and the following period as EU subsample (Euro Zone crisis related sample). Note that each subsample includes a regime transition between expansion and recession, making the recession the corresponding crisis. Lastly, we run the STR model within each subsample, to analyze the unstable effects without mixing the two crises together.

Equation (4) and (6) show the generalization of these steps.

$$R_{t,n} = \theta_i \sum_{i=1}^{I} R_{t,n-i} + \{\theta_0 + \sum_{k=1}^{K}\sum_{j=1}^{J} \beta_{k,j} S_{k,t,n-j} + \tau_1 Unsch_{t,n} + \tau_2 Int_{t,n} + \tau_3 Speak_{t,n}\} \sum_{l=1}^{2} D_l$$

$$+\{\theta'_0 + \sum_{k=1}^{K}\sum_{j=1}^{J} \beta'_{k,j} S_{k,t,n-j} + \tau'_1 Unsch_{t,n} + \tau'_2 Int_{t,n} + \tau'_3 Speak_{t,n}\} \sum_{l=1}^{2} \hat{G}_l(t_{t,n}, \gamma, c) * D_l + \epsilon_{t,n} \quad (4)$$

Where D_l is the indicator function in l th subsample. $\hat{G}_l(t_{t,n}, \gamma, c)$ is the fitted value of logistic transition function by using corresponding transition variables. For example, D_1 equals one within US subsample, and zero otherwise. $\hat{G}_1(t_{t,n}, \gamma, c)$ denotes the fitted value of a logistic transition function for the economic transition of the US, its value spans from zero to one, denoting the probability of the economy staying in higher regime (expansion). The interaction term $\hat{G}_l(t_{t,n}, \gamma, c) * D_l$ ensures that we only focus on the transition of US economy in the US subsample

when l =1, and of the Euorpean economy in European subsample when when l =2. Note that we assume the autoregressive terms are not distinctive over different subsamples[1].

To analyze the volatility response of news surprise, we follow Andersen & Bollerslev (1998) and model the residual term while incorporating the STR model:

$$|\epsilon_{t,n}| = \kappa_1 \frac{\hat{\sigma}_t}{\sqrt{N}} + \sum_{p=1}^{P}\left(\delta_{c,p} cos\left(\frac{2\pi p}{N} n\right) + \delta_{s,p} sin\left(\frac{2\pi p}{N} n\right)\right) + \sum_{d=1}^{3} \lambda'_d I_{d,t,n}$$

$$+ \omega_0 + \sum_{k=1}^{k}\sum_{j'=1}^{J'} \vartheta_{k,j'} \left|S_{k,t,n-j'}\right| + \tilde{\tau}_1 Unsch_{t,n} + \tilde{\tau}_2 Int_{t,n} + \tilde{\tau}_3 Speak_{t,n}$$

$$+ \left\{\omega'_0 + \sum_{k=1}^{K}\sum_{j\prime=1}^{J} \vartheta'_{k,j\prime} \left|S_{k,t,n-j\prime}\right| + \tilde{\tau}'_1 Unsch_{t,n} + \tilde{\tau}'_2 Int_{t,n} + \tilde{\tau}'_3 Speak_{t,n}\right\} \hat{G}(t_{t,n}, \gamma, c) + \chi_{t,n} \quad (5)$$

Where $\frac{\hat{\sigma}_t}{\sqrt{N}}$ stands for the daily ARCH effects described in appendix A.3, *N*=288 denotes the total number of 5-min intervals per day, I_d is the calendar effects such as the Japanese open, lunch and the US late summer effect, and the sinusoids are the Fourier Flexible form for the intraday seasonality pattern. *P*=4 based on the Schwarz and Akaike information criteria. Note that we assume the terms capturing intraday seasonality pattern are not distinctive over different subsamples for the same reasons described in return equation (4). Here, the value of *J'* denotes the length of volatility response to news announcements. We choose two hours to cover the volatility response for all the news according to recent literature (Laakkonen & Lanne, 2009), so *J'* =24. $\chi_{t,n}$ denotes the disturbance term. Similar to the return equation, we split the sample into two different subsamples, and generalize equation (5) to:

$$|\epsilon_{t,n}| = \kappa_1 \frac{\hat{\sigma}_t}{\sqrt{N}} + \sum_{p=1}^{P}\left(\delta_{c,p} cos\left(\frac{2\pi p}{N} n\right) + \delta_{s,p} sin\left(\frac{2\pi p}{N} n\right)\right) + \sum_{d=1}^{3} \lambda'_d I_{d,t,n}$$

$$+ \left\{\omega_0 + \sum_{k=1}^{k}\sum_{j'=1}^{J'} \vartheta_{k,j'} \left|S_{k,t,n-j'}\right| + \tilde{\tau}_1 Unsch_{t,n} + \tilde{\tau}_2 Int_{t,n} + \tilde{\tau}_3 Speak_{t,n}\right\} \sum_{l=1}^{2} D_l$$

$$+ \left\{\omega'_0 + \sum_{k=1}^{K}\sum_{j\prime=1}^{J} \vartheta'_{k,j\prime} \left|S_{k,t,n-j\prime}\right| + \tilde{\tau}'_1 Unsch_{t,n} + \tilde{\tau}'_2 Int_{t,n} + \tilde{\tau}'_3 Speak_{t,n}\right\} \sum_{l=1}^{2} \hat{G}_l(t_{t,n}, \gamma, c) * D_l + \chi_{t,n} \quad (6)$$

Where D_l and $\hat{G}_l(t_{t,n}, \gamma, c)$ are defined in the same fashion as equation (4).

Since the disturbance in equation (4) could be heteroskedastic, we apply the two-step weighted least squares approach to estimate the coefficients: First, we run an ordinary least square regression in equation (4) and obtain the residual terms to be used in volatility equation

[1] We relax this assumption and allow the autoregressive terms to be distinctive, and obtain robust results. Hence we keep this assumption to make the model parsimonious.

(6). After estimating the news effect in the volatility equation, we run weighted least squares by imposing the fitted value of the absolute disturbance term on the left hand side of equation (6) as the weight.

Note that there are 24 lags for $|S_{k,t,n-j'}|$ in equation (6), which is inefficient if we run the equation directly. Hence, we follow Andersen & Bollerslev (1998) and impose a third order polynomial structure for each news event to avoid such problems (see in Appendix A.4 for details).

3.3 Break Point Regression Model

There may be a concern about our restriction of only two-regimes. To relax this restriction, we follow Bai and Perron (1998) and model the breakpoint regression to allow for an unknown number of breaks without restricting the number of regimes in both the mean and volatility equations with respect to the analysis of unstable coefficients.

This model under the assumption that the news coefficients are unstable following "structural breaks", which means the news effects are stable within each sub period, but unstable over different sub periods. When we have the estimated unknown break dates, we can define the sub period accordingly and estimate the news coefficients within the corresponding period through ordinary least square methods.

Hence we model the mean and volatility equation as below:

$$R_{t_b} = \acute{\theta}_{0,b} + \acute{\theta}_{i,b}\sum_{i=1}^{I} R_{t_b-i} + \sum_{k=1}^{K}\sum_{j=1}^{J} \acute{\beta}_{k,j,1} S_{k,t_b-j'} + \tau_{1,b} Unsch_{t_b} + \tau_{2,b} Int_{t_b} + \tau_{3,b} Speak_{t_b} + \epsilon_{t_b} \quad (7)$$

$$|\epsilon_{t_b}| = \acute{\kappa}_1 \frac{\hat{\sigma}_t}{\sqrt{N}} + \sum_{p=1}^{P}\left(\acute{\delta}_{c,p} cos\left(\frac{2\pi p}{N} n\right) + \acute{\delta}_{s,p} sin\left(\frac{2\pi p}{N} n\right)\right) + \sum_{d=1}^{D} \acute{\lambda}'_d I_{d,t_b} + \acute{\omega}_{0,b} + \sum_{k=1}^{k}\sum_{j'=1}^{J'} \acute{\vartheta}_{k,j',b} |S_{k,t_b-j'}| + \acute{\tau}_{1,b} Unsch_{t_b} + \acute{\tau}_{2,b} Int_{t_b} + \acute{\tau}_{3,b} Speak_{t_b} + \chi_{t_b} \quad (8)$$

With $(t_b = T_{b-1} + 1, \dots, T_b)$, *b=1, 2… m+1*.

Where b denotes for bth sub period, $(T_1, \dots, T_b \dots, T_m)$ are the unknown breakpoints between each sub period. We follow the convention that $T_0 = 0$ and $T_{m+1} = T$, T equals the total number of 5-min intervals through our data set. t_b denotes for time frame started after the previous breakpoint $(T_{b-1} + 1)$, and ends at current breakpoint (T_b) . Here, all the coefficients such as

$\acute{\theta}_{0,b}, \acute{\beta}_{k,j,b}, \acute{\vartheta}_{k,j',b}$ amongst others with *(b=1,2,…,m+1)* are the corresponding coefficients within each sub period. Note that all the other settings are consistent to previous equation (4) to (6).

Equation (7) or (8) denotes a multiple linear regression system. If we use Δ_p to denote the vector of coefficients, and X_t denotes the vector of all independent variables, then we need to estimate the unknown coefficients $(\Delta_p, T_1, T_2, \dots, T_m)$, assuming $\Delta_p \neq \Delta_{p+1}$ $(p \leq m)$. The method of estimation is to minimize the sum of squared residuals: $\sum_{p=1}^{m+1} \sum_{t=T_{p-1}+1}^{T_p} [R_t - X'_t \Delta_p]^2$, if $\hat{\Delta}_p$ denotes the estimated coefficients, then

$$(\hat{T}_1, \hat{T}_2, \dots, \hat{T}_m) = argmin_{T_1, T_2, \dots, T_m} (\sum_{p=1}^{m+1} \sum_{t=T_{p-1}+1}^{T_p} [R_t - X'_t \hat{\Delta}_p]^2)$$

Thus, the break points estimates are the results of the optimizing equation, and the coefficients are the corresponding estimates through all *m+1* partitions $(T_1, T_2, \dots, T_m)$.

3.4 Analysis of Parameter Instability

Although the STR model and the Break Point Regression can show us whether the news are stable or not, an efficient test on the instability of the specific news coefficient can provide more solid evidence. Moreover, if we assume the coefficients are time varying, and estimate the parameter path, the analysis on how the coefficient evolves and why it is changing is of particular interest. Thus, we present an efficient test below and introduce a way to efficiently estimate the parameter path.

3.4.1 Efficient Test of Time Variation of Coefficients

There are two strands of literature discussing parameter instability which provide two possible models of time variation: "structural breaks" and "random coefficients". Elliott & Müller (2006) apply a quasi-local level efficient test on parameter instability and argue that: "when restricting the attention to efficient tests, the seemingly different approaches of 'structural breaks' and 'random coefficients' are in fact equivalent". Hence, we conduct the quasi-local level test at the very beginning.

Although these two possible methods are not distinctive regarding an efficient test, the underlying hypotheses are different. The null hypothesis is:

$$H_0: \ Y_t = X_t \rho + Z_t \delta + u_t$$

For "structural breaks", the alternative hypothesis is:

$$H_1: \quad Y_t = X_t\rho_b + Z_t\delta + u_t\,, \qquad (b=1,2,\ldots m)$$

For "random coefficients", the alternative hypothesis is:

$$H_2: \quad Y_t = X_t\rho_t + Z_t\delta + u_t$$

Where X_t is the vector of independent variables with suspected unstable coefficients; Z_t is the vector of independent variables with stable coefficients. In "structural breaks", $\rho_b \neq \rho_i$ when $b \neq i$, ρ_b denotes the coefficient in partition T_{b}. In "random coefficient", ρ_t is time varying and with a disturbance following a certain distribution. These models are a partially unstable coefficients model if Z_t exists and $\delta \neq 0$.

The quasi-local level test, denoted as $\widehat{qLL}$, is the most powerful instability test in a Gaussian unobserved component model (see the analysis made by Franzini and Harvey (1983) and Shively (1988)). The property of $\widehat{qLL}$ for an instability test is discussed in Elliott & Müller (2006). We list the steps to obtain the value of $\widehat{qLL}$:

1) Regress Y_t on $\{X_t, Z_t\}$ and obtain residual term $\{\hat{u}_t\}$.
2) Assuming u_t are uncorrelated, calculate long run $\hat{V}_x$ covariance matrix of $\{X_t u_t\}$.
3) Compute $\{\hat{E}_t\}=\{\hat{V}_x^{\,-1/2} X_t \hat{u}_t\}$, and let *i*th component of $\{\hat{E}_t\}$ denoted as $\{\hat{E}_{t,i}\}$, where *i*=1,2,…,k.
4) Let $\bar{r} = 1 - \frac{10}{T}$, for each $\{\hat{E}_{t,i}\}$, construct $\{\widehat{w}_{t,i}\}$, where $\widehat{w}_{1,i} = \hat{E}_{1,i}$, $\widehat{w}_{t,i} = \bar{r}\widehat{w}_{t-1,i} + \hat{E}_{t,i} - \hat{E}_{t-1,i}$.
5) Regress $\{\widehat{w}_{t,i}\}$ on $\{\bar{r}^t\}$ individually and sum over the residuals from *i*=1,…k.
6) Multiply the result obtained from (5) by $\bar{r}$ and then subtract $\sum_{i=1}^{k}\sum_{t=1}^{T}\left(\hat{E}_{t,i}\right)^2$.

To reject H_0, $\widehat{qLL}$ should be significantly negative. Table 1 contains the asymptotic critical value provided by Elliott & Müller (2006).

3.4.2 Continuous Instability: Time Varying News Coefficients

To better analyze how news effects evolve over time, we can estimate the parameter path by assuming the coefficients are continuously time varying with a Gaussian disturbance by applying the approach suggested by Müller & Petalas (2010).

First, we estimate the news effects in foreign exchange markets with a parsimonious specification in the mean and volatility equations:

$$R_{t'} = \sum_{k=1}^{K} \rho_{k,t'} S_{t'} + \pi_{t'} \quad (9)$$

$$|\hat{\epsilon}_{t'}| = \sum_{k=1}^{K} \rho'_{k,t'} |S_{t'}| + \pi'_{t'} \quad (10)$$

Where $t' = 1,2, \ldots . T$, denoting the t'th announcement for the news, and T is the total number of announcements. Our data spans nine years, so, T equals 108 and 36 for monthly and quarterly announcements respectively. $R_{t'}$ is 5-min return in the interval in which the t'th macroeconomic news announcement occurs; $S_{t'}$ is the t'th surprise element of news. $|\hat{\epsilon}_{t'}|$ is t'th disturbance volatility similar as $|\hat{\epsilon}_{t,n}|$ defined in equation (6), but only contain the observations for which the news is announced. $\pi_{t'}$ and $\pi'_{t'}$ are the residual terms capturing all the other effects in the corresponding equation; *K* is the number of news events announced at the same time. In our regressions, there are several pairs of news announced simultaneously such as Non-farm payroll and the unemployment rate. Next, we explain by estimating the coefficients in the mean equation as an example.

Müller & Petalas (2010) propose a way of minimizing the weighted average risk and maximizing the weighted average power over a broad set of possible parameter paths, where the weighting function is proportional to a Gaussian distribution process. Thus, we first assume that ρ_t is continuously time varying with a disturbance following a Gaussian process, as in Müller & Petalas (2010), the corresponding unstable coefficient series: $\{\rho_t\}_t^T = \{\rho + \varsigma_t\}_t^T$ where ς_t follow a Gaussian process. After a series of derivations based on the log-likelihood, we get a pseudo model:

$$\hat{\rho} = \rho + T^{-1/2} \hat{S}^{-1} \Theta_0$$

$$\hat{H}\hat{V}^{-1} S_t(\hat{\rho}) = \hat{S}^{-1} \varsigma_t + \Theta_t, t = 1, \ldots, T$$

With $\hat{\rho} \sim \mathrm{N}(\rho, \hat{S}/T)$ and $\Theta_t \sim \mathrm{N}(0, \hat{S}^{-1})$. $\hat{S}^{-1}$ is Fisher Information set. If the model is correctly specified, $\hat{V} - \hat{H} \xrightarrow{p} 0$ by the information matrix equality and $\hat{S}^{-1} - \hat{H} \xrightarrow{p} 0$.

Following the pseudo model above, we estimate a broad set of $\{\rho_t\}_t^T$ given a different standard deviation of the end point of the random walk weighting function that covers a wide

range for time variation and calculate the weighted average of the series of $\{\rho_t\}_t^T$ that minimizes the weighted average risk to obtain the estimated parameter path - $\{\widehat{\nabla}_t\}_{t=1}^T$. The weights are obtained from an expanded version of quasi-local level test statistics for each assumed standard deviation. The steps to obtain the parameter path are shown below:

1. For t=1,…,T, let $x_t \; and \; \tilde{y}_t$ be the first p elements of $\hat{H}^{-1}S_t(\hat{\rho}) \;\; \hat{H}\hat{V}^{-1}S_t(\hat{\rho})$.
2. For $h_i \in H = \{0, 5, 10, \dots, 50\}, i = 0, \dots, 10$, compute
   a. $r_i = 1 - \frac{h_i}{T}$, $z_{i,1} = x_1 \; and \; z_{i,t} = r_i z_{i,t-1} + x_t - \; x_{t-1}, t = 2, \dots, T$;
   b. The residuals $\{\tilde{z}_{i,t}\}_{t=1}^T$of a linear regression of $\{z_{i,t}\}_{t=1}^T$ on $\{{r_i}^{t-1} I_p\}_{t=1}^T$;
   c. $\bar{z}_{i,T} = \tilde{z}_{i,T}$, and $\bar{z}_{i,t} = r_i \bar{z}_{i,t+1} + \tilde{z}_{i,t} - \; \tilde{z}_{i,t+1}, t = 1, \dots, T-1$;
   d. $\{\widehat{\nabla}_t\}_{t=1}^T = \left\{\hat{\rho} + x_t - r_i \bar{z}_{i,t}\right\}_{t=1}^T$;
   e. QLL(h_i)=$\sum_{t=1}^T (r_i \bar{z}_{i,t} - x_t)' \, \tilde{y}_t$ and
      $\tilde{v}_i = \sqrt{\frac{T(1-{r_i}^2){r_i}^{T-1}}{1-{r_i}^{2T}}} \exp\left[-\frac{1}{2} QLL(h_i)\right] (set \; \tilde{v}_0 = 1)$
   f. $v_i = \tilde{v}_i / \sum_{j=0}^{10} \tilde{v}_j$.

Then the parameter path can be estimated by $\{\widehat{\nabla}_t\}_{t=1}^T = \{\sum_{i=0}^{10} v_i \, \widehat{\nabla}_{i,t}\}_{t=1}^T$. Here the statistic QLL(10) is equivalent to $\widehat{qLL}$ calculated in section 3.4.1.

To obtain the variances: $\Lambda_t = \sum_{i=0}^{10} v_i \{T^{-1} \hat{S}_\nabla \delta_t(h_i) + (\widehat{\nabla}_{i,t} - \widehat{\nabla}_t)(\widehat{\nabla}_{i,t} - \widehat{\nabla}_t)'\}$,

and $\delta_t(h) = \frac{h(1+e^{2h}+e^{\frac{2ht}{T}}+e^{2h\left(1-\frac{t}{T}\right)})}{2e^{2h}-2}$, where $\hat{S}_\nabla$ is the upper left p x p block of $\hat{S} = \hat{H}^{-1}\hat{V}\hat{H}^{-1}$ and $\delta_t(0) = 1$. Then we can obtain 95% equal tailed posterior probability interval for $\nabla_{t,j}$, the *j*-th component of ∇ at time t. Note that this posterior probability interval is not a confidence interval in the frequentist inference sense.

3.5 Source of Time Variation

Based on the estimates of the parameter path, we can analyze the source of variation by regressing the series of coefficients on the possible factors.

$$\widehat{\nabla}_{k,t} = \gamma_0 + \sum_q^3 \gamma_q \Gamma_{q,t} + \eta_t \tag{11}$$

$$\widehat{\nabla}'_{k,t} = \gamma_0 + \sum_q^3 \gamma'_q \Gamma_{q,t} + \eta'_t \tag{12}$$

Where $\widehat{\nabla}_{k,t}$ and $\widehat{\nabla}'_{k,t}$ is the series of time varying coefficients from previous section for news *k* at time *t* on return and volatility; $\Gamma_{q,t}$ is a possible influencing factor at time *t*, such as global risk, central bank monetary policy and order flow; η_t and η'_t are the residual parts at time *t* including the disturbance and any parts not captured by these three factors.

As an alternative way to determine the source, we can substitute $\widehat{\nabla}_{k,t}$ and $\widehat{\nabla}'_{k,t}$into equation (9) and (10) to analyze in both the mean and volatility equations:

$$R_{t'} = \sum_{k=1}^{K} \bar{\varphi}_k S_{t'} + \sum_{k=1}^{K} \sum_{q}^{3} \tilde{\varphi}_k S_{t'} \Gamma_{q,t} + \pi_{t'} \quad (13)$$

$$|\hat{\epsilon}_{t'}| = \sum_{k=1}^{K} \bar{\varphi}'_k |S_{t'}| + \sum_{k=1}^{K} \sum_{q}^{3} \tilde{\varphi}'_k |S_{t'}| \Gamma_{q,t} + \pi'_{t'} \quad (14)$$

Where $R_{t'}$, $S_{t'}$, $|\hat{\epsilon}_{t'}|$, $\Gamma_{q,t}$, $\pi_{t'}$, $\pi'_{t'}$, K are all defined as in equation (9) and (10). $\tilde{\varphi}_k$ and $\tilde{\varphi}'_k$ capture the joint effects for the interaction term between three factors and news surprise elements on return and volatility. $\bar{\varphi}_k$ and $\bar{\varphi}'_k$ are the constant components of the news effects.

4. Data

4.1 Description of Primary Data

Our primary data set spans more than nine years from Nov 1, 2004 to Mar 31, 2014[2] and contains two kinds of data: i) intraday 5-minute spot exchange rate returns for Euro/Dollar, Pound/Dollar and Yen/Dollar; ii) scheduled macroeconomic news announcements from US, UK, Japan and major Euro Zone countries including German, France, Italy, Spain, Portugal and Greece.

4.1.1 Exchange Rate Data

Our original high frequency exchange rate data set, supported by Hotspot FXi, includes tick-by-tick tradable quotes for best bid and best ask spot exchange rates and volume. Each quote is time stamped to seconds with three decimals in US Eastern Standard Time, daylight saving time adjusted, starting from 00:00:00.000 EST to 23:59:59.999 EST. Based on this definition, there are 288 5-minute intervals during the 24-hour foreign exchange market. If we take the first interval as an example, it can be expressed by [00:00:00.000, 00:05:00.000[which shows that the quote right after or on 00:00:00.000 is the first observation and the closest quote right before 00:05:00.000 is the last observation. After applying the filtering rules shown below for the treatment on outliers, we construct the price by taking the average of the best bid and ask ($\frac{(Ask+Bid)}{2}$), then calculate the difference of the log-price of the last observation between the last and current interval to get a continuously compounded return. Noting that the return calculated this way is very small, it is multiplied by 100 to give its percentage value. The notation is: $[\log(P_t) - \log(P_{t-1})] * 100$.

To minimize the disturbance from outliers and anomalies in our work, it is worthwhile to filter the original data. For anomalies, we first remove the data on weekends and ten important US statutory holidays[3] and those after 21:00 on Friday due to lower quoting activity. For outliers, we exclude returns from the first interval for each day because it contains overnight effects, especially for Monday morning. Our filtering rule is consistent with conventional treatment such

[2] The original data set ended in November, 2013, which was updated to March, 2014.

[3] The Ten US statutory holidays deleted are: New Year's Day, Martin Luther King's Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day

as Andersen & Bollerslev(1998), Bauwen, Ben Omrane & Giot (2005) etc. After all the filtering, we end up with 620,078 return observations for each pair. Table 2 presents descriptive statistics for the fitted quote data. It is obvious that the mean 5-minute return is almost zero, and the high kurtosis signifies that the return distributions are not normal. Note that some past literature contained too many zero return observations, but our sample has a comparatively small number of zero return observations (around 3% over three currency pairs).

4.1.2 Macroeconomic News

Our data set for scheduled macroeconomic news announcements is provided by Bloomberg, which lists all the economic news releases in its Economic Calendar (ECO) function with the date and time stamped to the minute. We incorporate the scheduled news from US, Japan, UK and Euro Zone major countries including Germany, France, Italy, Spain, Portugal and Greece because our research spans over nine years that includes both the US and the Euro Zone crisis. Some news are announced quarterly like GDP annualized QoQ Advance for US, but the majority are announced monthly like US Personal Income, US CPI MoM (change from last month), and the US unemployment rate. However, a minority of news is announced weekly such as US Continuing Claims.

The news announcement provides us with both actual figures and market forecasts which is the median value of the survey conducted for predicting the scheduled news figures on the Friday right before the announcement. To verify, we compare the most important US news data from Bloomberg with another agency, the International Money Market Services (MMS), from 2005 to 2009 and found that almost all the figures are the same. We do this because Balduzzi, Elton and Green (2001) show that most of MMS forecasts are unbiased and have information that is not out of date.

The forecast is important because we consider the surprise element rather than the actual figures, since exchange rates reflect future performance and only the difference between actual and forecast is relevant. Balduzzi, Elton and Green (2001) measure the surprise element by first calculating the difference between the forecast and the actual announced figure, and then dividing this difference by its standard deviation. This method removes the potential problem caused by different measurement units. It is calculated by:

$$S_{k,t} = \frac{A_{k,t} - F_{k,t}}{\hat{\sigma}_k}$$

Where $A_{k,t}$ denotes the actual figure of news k at time t, $F_{k,t}$ denotes the forecast figure for the same announcement, $\hat{\sigma}_k$ is the sample standard deviation of the difference between actual and forecast for news k throughout the entire sample.

- *Filtering Rules*

Similar to quote data, we need to filter the news before its analysis. There are two kinds of filters: first, we filter out news with too few observations such as announcements that only started a few years ago; second, we remove any news that have empirical problems such as multicollinearity or singularity matrix issues in regression equations. In the first round of filters, we also exclude news announcements that contain missing forecasts values, especially for those relatively unimportant or just recently created; then, we delete any news announcements if they covered less than 6 years[4]; lastly, we drop any news that are missing half of their announcements. For the second round, there are three criteria to filter the news: i) we calculate the correlation among simultaneous news announcements, and keep the most important one if the magnitude of correlation is more than 0.5; ii) we conduct the contemporaneous regression introduced in Andersen et al. (2003) by regressing each single news announcement on the corresponding 5 min return and only keep the news that have significant coefficients; iii) however, to avoid deleting important news in the previous step, we match the news with a return jump exceeding 0.2% but keep the news without significant coefficients in the contemporaneous regression.

Table 3 shows the summaries on the filtered data. The columns on left hand side named total, list the total frequencies of release and the number of news announcements for all the qualified news for each country in first filter round. In total, there are 31,520 observations from 375 different news categories. Not surprisingly, the US has the most news announcements and frequencies, followed by UK, Japan and German etc. The columns under "Smooth Transition Regression" and "Breakpoint Regression" show the filtered frequencies and news announcements from the second filter round. It should be noted that the number of valid news categories and frequencies for STR analysis are more than those for Breakpoint regression

[4] This is a subjective criteria based on the total length of US crisis and Euro Zone crisis obtained from STR model. The details are reported in empirical results section.

analysis. This is because there are more breaks for the breakpoint regression model, which makes the selection criteria more stringent in our case. Note that country column does not include Greece because all of its news is filtered out in the first round.

4.2 Highlights of News Special Features

4.2.1 The Association between Largest Return and News Announcement

Table 4 illustrates the association between the largest return jumps and macroeconomic news announcements. At least four major findings are worth mentioning. First, all of the largest return jumps shown in the table are associated with at least one macroeconomic news announcement, most of which are scheduled. Second, from the second, fifth and sixth largest return jumps, we find that the information regarding central bank intervention, unscheduled news and significant speeches are extremely important. This motivates us to control for these three effects in our analysis. Third, from the 12 largest return jumps, seven can be associated with the US crisis and three with the Euro Zone crisis. This confirms our plan to split the total sample into two parts with respect to these crises. Fourth, US news related to policy rates (Federal Open Market Committee Rate Decision – FOMC Rate Decision), unemployment (Unemployment Rate, Continuing Claims and Initial Jobless Claims) and payroll (Average Hourly Earning MOM Prod, Change in Nonfarm Payrolls, Unit Labor Costs) are frequently associated with these jumps.

4.2.2 Intraday Volatility Pattern

Andersen & Bollerslev (1998) characterize the DM/USD intraday volatility seasonality structure and state that there is significant periodicity in 5-min returns volatility because of the different trading times in the global 24-hour foreign exchange market. To have a more intuitional understanding, Figure 1 shows the intraday pattern for the three major currency pairs. Starting from midnight (00:00:00) EST, the volatility stays at a relatively low level because the most active markets in London and New York are closed, but after 2:00:00 EST, various European markets open, bringing a gradual rise in activity to reach a maximum level between 8:00:00 and 11:00:00 EST, at which point, both London and New York are open. When the European market closed, volatility descends gradually to its lowest level after 17:00:00 EST because only a few regional markets in Asia and Australia are open. Lastly, note that the spikes shown in Figure 1

can be attributed to the clustering of news releases for different countries. We will explain this feature next.

4.2.3 Announcement Clustering

Another apparent feature for Macroeconomic News Announcements is the clustering of releases. To provide a solid analysis, we summarize all the news announcements respectively from the US, Euro Zone Countries, UK and Japan, and display the result in Figure 2. The clustering of news announcements is remarkable. There are more than 4000 observations released at 08:30:00 EST in the US and at 04:30:00 EST in the UK. In contrast, Euro Zone news have more dispersion, because different Euro countries have their own clustered times. Japanese announcement times are more widely spread, but still concentrate mainly on a few fixed times. If we relate this concentration to the intraday volatility seen in Figure 1, the simultaneous jump of volatility is well explained. In general, the extreme spikes at 8:30 EST and 10:00 EST in all three major currency pairs can be attributed to the cluster of US announcements. Similarly, the moderate spikes from 2:00 EST to 4:40 EST and from 18:00 EST to 20:00 EST correspond to the clusters from UK/Euro countries and Japan respectively.

4.3 Additional Data

Besides the primary data set, we also needed some additional data for applying different models. For example, in equation (1) for the STR model, we need log filtered volatility, consolidated macroeconomic news variable and transition variable data; in equation (3) and (4) for the return and volatility model, we need daily exchange rates and the three major effects control variables data.

4.3.1 Additional Data for STR Model

In order to estimate the STR transition function, we need to discuss and show the findings for the three major components in equation (1) and (2): Log Filtered Volatility $\boldsymbol{y}_{t,n}$, Consolidated macroeconomic news variable $\boldsymbol{z}_{t,n}$ and the series of transition variable $t_{t,n}$.

- **Log Filtered Volatility**

Following the steps suggested in appendix A.1, we construct the log transformed filtered volatility data to estimate the regime transition pattern. To illustrate the necessity of choosing log

filtered volatility rather than absolute 5-min return, we plot the autocorrelation coefficients in Figure 3 with 1500 5-min intervals which contains five days since each day have 288 intervals. It shows that the filter eliminates the intraday periodicity pattern of the original absolute 5-min return, although significant autocorrelation still exists.

- **Consolidated Macroeconomic News Variable**

In the discussion of the consolidated macroeconomic news variable in appendix A.2, we suggest using a third order polynomial structure to construct a series that captures the total effects on volatility within two hours.

- **Transition Variable**

As mentioned in the methodology section, we need to estimate the regime transition for each crisis by imposing a corresponding transition variable. In recent literature regarding regime transition effects, macroeconomic news figures are widely used as business cycle indicators. McQueen & Roley (1993) define the state of the economy with industrial production. Andersen et al. (2007) apply unemployment figures, but Veredas (2006) suggests choosing the ISM (Institute for Supply Management) manufacturing index for US business cycles. The US ISM manufacturing index is a survey conducted on practitioners from over 300 manufacturing firms to identify the state of economy. The value of 50 means that half of the survey participants believe the economy is "better" and half think it is "worse", so an ISM higher than 50 denotes a "better" economic condition. We follow Veredas (2006) and choose ISM as transition variable for the US subprime crisis because this crisis had a major influence on economic fundamentals. Nevertheless, the European Sovereign Debt crisis differs from the US crisis because it only influenced some of Euro Zone countries like Italy, Spain, Portugal and Greece. Hence, to construct a more sensible indicator, we select 10-year interest rates from these four countries, and take the GDP weighed average as a transition variable for the Euro Zone crisis. Figure 4 plots two transition variables for the entire sample and implies that the two crises do not overlap. The US crisis starts in early 2008 and ends in mid 2009, but the Euro Zone crisis just starts at the end of 2009. Please check the empirical analysis section for a more rigorous analysis.

4.3.2 Additional Data for Return and Volatility Model

4.3.2.1 Daily Exchange Rate

Apart from intraday quote data, we include a broader range of daily spot exchange rate returns for the euro-dollar to construct the daily volatility component in the volatility equation. From the original data set, we search for the daily ending ask and bid price from Jan 1st, 1999 to March 31st, 2014 using the Bloomberg HP (Historical Price) function. The main reason for choosing Jan 1st, 1999 as the starting date is that the euro was first introduced to financial markets as an accounting currency. After this, we can calculate the daily continuous return by taking the log difference between concurrent midquotes of the bid ask spread.

4.3.2.2 Data for Three Major Effects

The past literature (Bauwen, Ben Omrane & Giot, 2005; Beine, BOS & Laurent, 2007) documents three major effects that should be controlled for in the forex market as we discussed in equation (3) and (4). They are Unscheduled News related to crises, Central Bank Intervention and Speeches made by important people. We now introduce these effects and show how to construct the corresponding data.

- ***Unscheduled News related to Crisis***

Since there are two kinds of major crises during our sample period, we construct unscheduled news by downloading the Financial Turmoil Timeline for both US and European Crises from Federal Reserve Bank of New York and European Central Bank respectively. The timeline highlights the date that important unscheduled News related to the crises are announced. So we construct a dummy data series that equals one for these intervals during the day and zero otherwise.

- ***Central Bank Intervention***

We download the daily central bank intervention information from the Bank of Japan (BOJ) since they announced several interventions in the forex market during our sample period. In addition, there is a wide range of coordinated interventions taken by G-7 countries on March 17th (EST) because of the uncertainty caused by the Japanese Earthquake. To obtain related information, we only download the data from Federal Reserve Bank of New York since G-7 interventions are taken on the same day.

To construct intervention data for the Bank of Japan, we create a dummy variable that denotes one during their common opening hours: 9:00 to 15:00 JST and zero otherwise. In addition, for Japanese earthquake intervention, we mark the entire operational hours starting from BOJ (March 17th 21:00 EST), and ending with the close of the North American foreign exchange market (March 18th, 17:00 EST).

- ***Important Speeches***

We obtain major speech information by downloading the news headlines from the Bloomberg Economic Calendar function (ECO) under speech sessions. The speeches are made by either country leaders like the US president or officers from central banks including Federal Reserve Bank, European Central Bank, Bank of England and Bank of Japan. Unlike the above two kinds of data, speeches are stamped to the minute, which means we construct the data series by denoting one in the corresponding 5 min interval rather than making the whole day a dummy variable.

5. Empirical Results

In this section, we first investigate the unstable macroeconomic news effects by using three distinctive methods: STR model, Breakpoint Regression model and the Efficient Test of Parameter Instability in section 5.1. Then we justify the pattern of instability in section 5.2 and explore the possible source of the variation in section 5.3.

5.1 Unstable News Effects

We start with the empirical results obtained from the two-regime STR model, and then relax the regime restriction by using a breakpoint regression model. Finally we conduct an efficient test of parameter instability by estimating the parameter path allowing for time varying unstable macroeconomic news effects.

5.1.1 Evidence from Smooth Transition Regression Model

As mentioned in section 3.2, we apply a two-step approach by first estimating the regime transition within the US and EU samples respectively, and then we impose the fitted value of the logistic transition function on the return and disturbance volatility regression equation.

5.1.1.1 Estimating the Logistic Transition Function in STR mode

Table 5 presents the parameter estimates in equation (1) and (2) for three currency pairs by imposing the ISM and GDP weighted average long term interest rate as transition variables for the US and Euro Zone crisis respectively. The large estimates of the slope parameter γ for the transition of the US and Euro Zone crisis indicates that the regime is almost switching. Except for the smaller value of slope parameters for the state transition in the EU sample on the Pound/Dollar implies a more moderate transition. Note that the LSTR Type in the EU sample on Yen/Dollar equals two, so there are two values estimated for c_k.

For a better understanding, Figure 5 plots the business cycle indication function for the US and EU samples in Panels A and B respectively according to the dates published by institutions such as NBER (The National Bureau of Economic Research) and CEPR (Centre for Economic Policy Research), along with fitted values of the transition function $\hat{G}(t_{t,n}, \gamma, c)$ over time in Euro/Dollar in Panels C and D.

The results from Figure 5 show that: 1) The crisis date estimated by the STR model for US starts from Jan of 2008 to Jul of 2009, which differs from the dates published by NBER by a few months. 2) The crisis dates for Europe defined by the STR model cover two periods. The first part before the end of 2009 overlaps the US crisis, implying the economy of Europe is affected by the US crisis, which is confirmed by the recession dates from the CEPR. However, the nature of this transition variable cannot reflect the economic context for the US crisis. If we focus on the second period which represents the Euro Zone crisis refering to the STR model, the crisis begins earlier than the date announced by the CEPR by almost a year. This is plausible because the CEPR define the business cycle according to economic output, but STR uses more updated data regarding long term interest rates, tracking the severity of sovereign debt problem more closely. According to Shambaugh (2012), the Euro Zone crisis contains three parts, with both the sovereign debt and weak banking problem leading to a growth problem. Therefore, we argue that the time lag can be attributed to a failure in detecting the government debt problem, thus showing the advantage of the STR model.

Base on the above findings, we choose to define the US sample from Nov 1, 2004 to the end of US crisis – Aug 3, 2009, with the rest as part of the EU sample. In the subsequent section, we analyze the macroeconomic news effect on return and volatility within each subsample.

5.1.1.2 STR Model vs Markov Regime Switch Model

The recent literature also documents another model widely applied for detecting a regime switch; the Markov Regime Switch regression (MS) model introduced by Hamilton (1991). This model estimates an unobservable state variable, assuming that the regime follows a first order Markov chain. One difference between STR and MS is that STR requires an observable state variable to serve as a transition variable.

We impose MS on the return and volatility model in section 3.2 but find that the regime switches are not related to the contexts of the crises, but instead to the state of the foreign exchange market and there are countless switches between higher and lower regimes. Therefore, it couldn't serve the purpose of detecting the crises with different contexts. Meanwhile, we apply the MS model on a first order autoregressive function for the transition variable of each crisis, and obtain qualitatively similar dates of regime switch. However, there is no literature supporting

the use of these two transition variable to detect regime change, so we only use this as a robustness check for the results of the STR model.

5.1.1.3 Results in STR Model

According to equation (1) and (2), the results from Table 5 can help us compare the consolidated news effects for expansions and recessions on exchange rate volatility. The estimates of ψ'_1 are significant for all the currency pairs for each transition variable except US crisis on Yen/Dollar, which means that most of the consolidated news effects are unstable over states of the economy. Here the consolidated news variable aggregates all the news announcements into one variable. Note that we impose the polynomial structure to the consolidated news, so the magnitudes are not the direct impacts on news. To get the direct impacts, we need to use ψ'_1 multiplied by the fitted value of the polynomial decay structure. See more details in appendix A.4.

Now we start to investigate the pattern of news effects instability by categorizing the type of effects into three patterns. The first interesting pattern is inspired by the sign switching effects documented in Ben Omrane & Savaser (2013), which show the sign of the coefficients of macroeconomic news changes over different business cycles. Table 6 presents all the news in our data exhibiting sign changes in either the US or European subsamples on return and volatility.

In the US subsample, the effects of US news regarding US housing market such as New Home Sales, Pending Home Sales MoM and Existing Home Sales experience change of sign with returns, which is consistent with the result from Ben Omrane & Savaser (2013). The possible reason for these sign switching effects can be attributed to the context of the US crisis. Since the US crisis is related to the mortgage (subprime crisis), a positive surprise of US housing market news (which is supposed to appreciate US Dollar in an expansion), now indicate a more severe mortgage problem, thus depreciating the US Dollar in this particular recession period. We define the effects that are closely related to the specific context of a crisis as context-specific effects. However, the context specific effects cannot explain all the sign switching effects on returns. McCauley & McGuire (2009) suggests another possible reason called safe-haven effects. When the US crisis become a global crisis, the uncertainty of the global economic future increases after negative US macroeconomic news is announced. In a chain effect, investors' risk

aversion is likely to increase, resulting in a sharp increase of the demand for safe assets such as US dollar denominated assets, which in turn appreciates the US dollar.

To extend the context specific effects, we conjecture that the context related to crises might lead to another pattern of instability, which means the news effects coefficients are significantly different over different crises. We define this as context dependent effects and present the news having this type of effect both on return and volatility in Table 7, noting that the news presented in Table 6 are excluded in this case. As we expect, there are a large number of categories of news exhibiting context dependent effects either on return or on volatility. The instability contains the change in magnitude of the impacts (increase, decrease or disappear). For example, GE Private Consumption QoQ, SP Retails Sales WDA YoY and EC Trade Balance SA show an increase, decrease and disappearance of the magnitude of news impact from US to Euro Zone crises.

To gain an overview of context dependent effects, we summarize the news with context dependent effects over all the news from equation (4) and (6) on return and volatility of three currency pairs in Table 8. The summary shows that 60%, 57% and 48% of valid news exhibit this pattern on return, and 19%, 20% and 27% on volatility, implying that this is a pronounced pattern.

Lastly, we categorize the rest of the news with unstable coefficients into general state dependent patterns presented in Table 9 on return and volatility. Due to a large number of news having this pattern, we only show the state dependent pattern in both US and EU samples in all currency pairs. It is interesting to find that the news related to US housing market only show state dependent pattern on Yen/Dollar instead of a sign switch. On the Euro/Dollar and Pound/Dollar, the news exhibiting a state dependent pattern are mainly related to the economic growth fundamental such as unemployment (US Unemployment Rate), Trade balance (US Net Long-term TIC Flows).

Similar to the context dependent pattern, we summarize the state dependent pattern in Table 10, noting that the sign switch pattern is a special case of state dependent pattern. Table 10 shows that there are at least 48% of news have state dependent effects over three currency pairs on return, and approximately 20% of news on volatility. Note that the percentage we obtained here is based on the filtered news, not all the news, so the magnitude of the percentage can reveal the significance of the particular pattern, not containing economic meaning.

5.1.1.4 Diagnostic Tests

According to Teräsvirta (1994), there are several diagnostic checks we need to conduct in order to make a robust conclusion. One important diagnostic test we apply here is the test of remaining autocorrelation. Laakkonen (2007) suggests that Fourier Flexible Form method is the best filtering method for intraday volatility periodicity after comparing three main stream filtering methods, but we still want to check the filtering results. Hence, we plot the autocorrelation coefficients of the residual terms of volatility equation (6) and the absolute returns for 1500 five minutes lags in figure 6. We find that although there still exists significant autocorrelation in the residual term, the intraday periodicity is well filtered by the control variables in equation (6), implying our results are not significantly interrupted by the intraday volatility seasonality.

To sum up, by applying a two-regime STR model, we find evidence of unstable news effects with respect to the states of economy and contexts related to a specific crisis with different magnitudes (increase, decrease or disappearance), or a change of sign. However, a limit of the STR model is that we consider only two regimes. What if there are more than two regimes? If there are more regimes, do the news effects remain unstable? To answer this question, we need to show the results of a breakpoint regression model.

5.1.2 Evidence from Breakpoint Regression Model

Relative to the STR model, the breakpoint regression model has following advantages: 1) it relaxes the restriction of two regimes; in fact, it does not restrict the number of regimes, and allows multiple structural breaks; 2) it can estimate the news effects and unknown break dates simultaneously, rather than from two separate steps in the STR model; 3) it does not require a corresponding transition variable.

Table 6 presents the results from the breakpoint regression model for news that has been shown in Table 6 for comparison. In total, there are six sub periods estimated from the model on return and volatility. We take the breaks on return as an example: starting from Nov 1, 2004, the six subsamples can be detected by the break dates: Jun 29, 2006; Jul 3, 2008; Dec 3, 2009; May 5, 2011 and Nov 4, 2012. Here, the third subsample overlaps with the US crisis detected in the

STR model, and the fourth and fifth overlap with Euro Zone crisis within a couple of month's discrepancy. Note that the sign switching effects detected from Table 6 on New Home Sales, and Existing Home Sales are also presented on Euro/Dollar and Pound/Dollar in Table 11. This implies that the relevance between the context of crisis and news is a possible reason for the sign switch pattern supported by both models.

In conclusion, the breakpoint regression model not only provides a robustness check for the unstable effects we detected from the STR model, but also shows that the news effects are unstable without a two-regime restriction. Next, we want to test whether the instability of the news effects is directly related to the timing of the shock (news announcement). But first, we need to conduct an efficient test on parameter instability, and use only the news with significant unstable effects to examine the timing issue.

5.1.3 The Efficient Test of Parameter Instability

To test parameter instability, we implement an efficient test introduced by Elliott & Müller (2006) for each single news announcement on return and volatility. They suggest using a quasi local level (QLL) test statistic to detect parameter instability rather than finding instability indirectly inferred from the STR model or Breakpoint regression model.

Table 12 presents the results for the test of single news announcements under the null hypothesis of a stable parameter. We keep only the news with significant statistics under the 5% level on Euro/Dollar from Table 14. Note that although some news exhibits instability on Euro/Dollar, they may not be unstable on the other two currency pairs. More specifically, about half of the news on Pound/Dollar show similar instability, but relatively few news on Yen/Dollar. Furthermore, the news having unstable effects over three currency pairs are primarily from US. More striking results come from the volatility effects. None of the news showing unstable effects on Euro/Dollar in Table 12 have unstable effects on Yen/Dollar.

This method adds value to our work because it tests the news effects instability for all the valid news from first round filter mentioned in section 4.2 regardless of the impact from the singular matrix problem on the STR model and breakpoints regression models. For example, the JP (Japan) Eco Watchers Survey Current contains only 47 observations and is filtered out by the second filter round due to the singularity problem in the STR and Breakpoint regression models,

but can be tested by the efficient test. Most European News are filtered out by the second round filter but now can be tested for parameter instability. Note that this test is more stringent because the number of news exhibiting significance is much less than what we find in the STR and breakpoint models. Moreover, the parameter instability test focuses more on the significance of the difference between the estimated local news coefficient and its estimate assuming constant news effects.

5.2 How News Effect Varies Over Time

To provide a deeper analysis of the unstable news effects, we plot the parameter path for news with a significant QLL test statistic on return and volatility and present the nine news announcements with the most significant QLL statistics on Euro/Dollar in Figure 4.

In panel A we find similar variations within the first and third rows respectively. For example, the US Trade Balance news surprise starts with highly negative effects in the early years of the sample period. As time progresses, this effect becomes weaker as the state of economy declines, and changes its sign at the end. A similar pattern can be found for US Net Long-term TIC Flows and US PCE Core MoM. In contrast to this gradual fading, the effect of news such as the US Consumer Confidence Index show a sudden increase during the US crisis but remain close to zero in the subsequent Euro Zone crisis. A similar pattern can be found for US Retail Sales Advance MoM, US Change in Nonfarm Payrolls and US Retail Sales Ex Auto. Comparing this to the results from the STR and breakpoint models, we find that the first and second patterns are qualitatively similar to the sign switch and state dependent respectively. Moreover, the sharp increase for US consumption news during the US crisis can be interpreted as a variant of context specific effects defined in section 5.1, which claims that the consumption news effects hold a reverse sign because of the contexts of the US crisis (related to mortgage). In addition, for the news with the most significant test rejections, their constant effects (assuming the news effects are stable) have been significantly biased at a certain time point. For example, if we assume US Consumer Confidence Index news effects are stable, the estimated result is significantly different from that obtained by the time varying method. More specifically, the constant estimates fall outside of the bound of the time varying parameter during US crisis period. Note that the bounds here are 95% posterior probability interval assuming equal tail, which is different from frequentist confidence intervals.

Panel A of Figure 7 is the news effects on the return Euro/Dollar and if we extend to the other two currency pairs, we find qualitatively similar result on Pound/Dollar, but significantly different on Yen/Dollar except for International Trade news such as US Trade Balance and US Net Long-term TIC Flows.

To explain this in greater detail, we plot the parameter path of the US consumer confidence index on Euro/Dollar return in Figure 5 along with the news effects obtained from the STR[5] and Breakpoint regression models. We first plot the constant news coefficients and the unstable coefficients from STR equation (4) in Panel A. Then we add unstable coefficients from breakpoint regression equation (7) in Panel B. At last, we add the time varying coefficients with 95% posterior equal tail interval in Panel C. There are several findings: 1) The results from STR, Breakpoint regression and time varying parameter path are consistent as they almost fall inside of the 95% equal tail posterior probability interval. The sharp increase of the news effects during the US crisis are captured by all three methods. 2) We can break down the news effects into three phases: in the first phase, there is no suspected crisis and the news effects are significantly negative, implying that a greater than expected release figure of US Consumer Confidence Index will appreciate the US dollar. In second phase, as US enter into a serious crisis, the news effect changes its sign to positive, implying a smaller than expected release figure will appreciate US dollar. Note that, at this time point, the local news effect obtained from the time varying method are significantly different from the effect assuming stability because it falls outside of the interval. In the third phase, the news effects gradually decline to a level close to zero, but do not return to the previous significant negative level. Perhaps by accident the constant news effect is also close to the more accurate estimates from the method allowing for time variation. 3) The estimates of news effects within the first two subsamples for the Breakpoint regression model are similar, implying that the first two subsamples estimated by the Breakpoint regression model are qualitatively similar to the US expansion estimated by STR model. Hence both methods are effective and reinforce each other's results.

[5] The news effect from STR under each subsample are $\beta_{k,j} + \beta'_{k,j}\hat{G}_l(t_{t,n}, \gamma, c)$ on return in equation (4) and $\vartheta_{k,j'} + \vartheta'_{k,j'}\hat{G}_l(t_{t,n}, \gamma, c)$ on volatility in equation (6)

5.3 The Source of Instability

To discover the source of the variation, we incorporate three major factors that could influence the news effect in current literature: global risks, central bank monetary policy and order flow. We follow convention by using the VIX index, Federal Fund Rate and Order flow as proxies. Following equations (11) and (13), we determine the effects of these three factors on the path of US Consumer Confidence Index effects on Euro/Dollar return and show the result in Table 14.

At least four findings are worth mentioning in Table 14. 1) Both of the analyses in equation (11) and (13) confirm that Global risks and Central Bank Monetary Policy are possible sources of variation. 2) The negative sign of intrinsic news effect (intercept) in panel A implies that a more than expected figure of US Consumer Confidence Index will appreciate US dollar. 3) The opposite sign between global risks (VIX) and intrinsic news effect (intercept) in panel A implies that global risk has the effect of offsetting the intrinsic news effect, and perhaps even changes the sign. 4) The same sign on Central Bank Monetary Policy (FFR) in panel A implies that central bank decisions reinforce the news intrinsic effects.

- **Decomposition of Time Variation**

From the results of Table 14, we can show the decomposition of the news effects and analyze how the news effects evolve over time.

Figure 6 plots the decomposition of the news effects path in a straight forward fashion. During the period from late 2004 to the late of 2007, the overall news effects are negative. Although the components of global risk have the opposite sign and offset the intrinsic effects, the central bank monetary policy reinforces the negative impact, and since the impact from order flow is not significant, the total news effects end up with negative sign.

During the period from late 2007 to mid 2010, risk has elevated to an abnormal level; this component leads the overall effects to be positive, which can be interpreted as a safe haven effect during the global crisis. Meanwhile, as the central bank keeps lowering the federal fund rate to stimulate the economy, the impact from this component finally disappears when it reaches its lower bound. Put differently, at the beginning of US crisis, risk weakens the news effect and leads to a gradual fade. After that, the US crisis gets worse and affects Europe, which in turn

triggers the safe haven effect, and increases the news effect to be positive. At last, when the world economy recovers from a US triggered global crisis and enters the Euro Zone crisis era, the moderate risk plays again the role of offsetting the intrinsic news effects. The close to zero total news effects are the comprehensive results from the cancellation between risk and intrinsic effects, and the absence of central bank monetary policy.

Overall, we perform a similar analysis for all the news exhibiting significant parameter instability in our sample and regress each parameter path on three factors to explore the source of variation. The coefficients of the measure of risk – VIX Index and central monetary policy – the Federal Fund Rate for important news on return are presented in Table 13. We also decompose the news effects for those with significant return and volatility time variation, and plot them in Figure 7 .

The results show that the source of the most of important news with time variation can be attributed to two factors – global risk and central bank monetary policy. Similar to what we found previously, the opposite sign between global risk (VIX) and intrinsic news effects (Intercept) can be found in most US news, implying that while moderate risk will force the investor to put less weight on news effects due to future uncertainty, a larger risk will trigger safe haven effects because of the flight to quality reaction. Similar findings can be found in European news but with opposite signs. Since we are considering the Euro, Pound and Yen against the US dollar, this negative association from European news to risk should be interpreted in the same fashion as the positive association from US news. Regarding the decomposition of news effects on volatility in Figure 10, we find the same source of variation as on return: global risks and central bank decisions.

- **Context Specific Effects**

Comparing news effects time variation during US and Euro Zone crises on some categories of news related to the context, we justify context specific effects in our sample. From Figure 7, the effects of news related to consumption (US Consumer Confidence Index), Housing market (US New Home Sales, Pending Home Sales MoM) and employment (US Change in Nonfarm Payrolls) present a sign switch only during the US crisis. More specifically, while these news effects show negative coefficients during the US expansion, they reverse their sign by showing a strong positive coefficient during the US recession, becoming weaker or even disappearing

during the European recession. This is because the context of US crisis are related to mortgages, and because the consumption and employment announcements contains more information content related to this context, the news effect has significant variation during this US crisis. Hence, we find that the context specific effects defined in section 5.1 can partially explain the different patterns of time varying news effects in both US and European crises.

6. Conclusion

In our study regarding the unstable feature of macroeconomic news effects in the foreign exchange market, using high-frequency data from Nov 1, 2004 to Mar 31, 2014 with 5-min windows, we document unstable news effects on both return and volatility in the foreign exchange market and reach similar conclusions by either allowing smooth economic transition, or by allowing different assumptions of parameter instability such as "structural breaks" or "continuous time varying". Second, the time variation in news effects show diverse patterns. For example, the magnitude of news effects may increase, decrease or disappear, and the sign of the effect may change, over time, business cycles and different contexts of the crises. Third, we investigate the sensitivity of macroeconomic news effects to the specific economic contexts, and find that the news related to those contexts are possibly contingent on the economic context of the announcement time. Fourth, through the analysis of the source of instability, we find that the economic conditions such as global risk and central bank rate decisions under which the news was announced, play an important role on the impact of the news effects. For example, risk can dissolve the news effect which in turn changes the magnitude of impacts, while the central bank policy can both dissolve and reinforce the effects. We interpret this as risk may force the investor to put less weight on news announcement due to the uncertainty of future economic conditions, while central bank policy may reflect the financial stability which in turn boosts or destroys investor confidence about the economic future.

Therefore, we demonstrate practical implications to finance practitioners that the effect of macroeconomic news announcements do exist. However, we should not rely only on the quality of the released figure to gauge its effects, but also consider the economic contexts in which the news was announced.

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Tables

Table1: Asymptotic Critical Values of Quasi Local Level Test - $\widehat{qLL}$

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1%	−11.05	−17.57	−23.42	−29.18	−35.09	−40.24	−45.85	−51.18	−56.46	−61.77
5%	−8.36	−14.32	−19.84	−25.28	−30.60	−35.74	−40.80	−46.18	−51.10	−56.14
10%	−7.14	−12.80	−18.07	−23.37	−28.55	−33.45	−38.49	−43.59	−48.78	−53.38

Notes: The table presents the statistics of quasi local level test for parameter instability. **1** to **10** denotes the number of independent variables in X_t shown in three equations in section 3.4.1. **1%, 5%, 10%** denotes the significance level. The critical Values of $\widehat{qLL}$ reported are drawn from the simulation results from the distribution of the random variable reported in P.919 of Elliott & Müller (2006).

Table 2: Descriptive Statistics for 5-min Returns

	EURUSD	**GBPUSD**	**JPYUSD**
Mean	0.000	0.000	-0.000
Standard deviation	0.039	0.040	0.043
Skewness	0.095	-0.162	-0.046
Kurtosis	17.301	22.455	70.947
Number of observation	620,078	620,078	620,078
Number of zero return observation	18,424	17,391	21,687
Autocorrelation of order 1	-0.019***	-0.027***	-0.036***
Autocorrelation of order 2	-0.005***	-0.006***	-0.011***

Notes: The returns are calculated by taking the log difference of ask-bid mid spread of the last observations between current interval and last interval. $[\log(P_t) - \log(P_{t-1})] * 100$ .EURUSD, GBPUSD and JPYUSD are the abbreviations of the currency pairs of Euro/Dollar, Pound/Dollar and Yen/Dollar. The 5-min returns are in percentage form. *** denotes the statistical significance of 1% level.

Table 3: News Announcement Filter

	Total		Smooth Transition Regression				Breakpoint Regression			
Country	**Freq**	**News**	**Freq**	**%**	**News**	**%**	**Freq**	**%**	**News**	**%**
EC	3564	44	1171	33%	15	34%	869	24%	10	23%
FR	2404	31	257	11%	3	10%	154	6%	2	6%
GE	3958	45	1051	27%	12	27%	1051	27%	12	27%
IT	2598	34	497	19%	7	21%	474	18%	6	18%
JP	4207	52	223	5%	2	4%	223	5%	2	4%
PO	355	8	89	25%	2	25%	64	18%	1	13%
SP	1255	17	310	25%	4	24%	310	25%	4	24%
UK	5301	64	1142	22%	12	19%	1038	20%	10	16%
US	7878	80	4286	54%	41	51%	3888	49%	35	44%
Total	**31520**	**375**	**9026**	**29%**	**98**	**26%**	**8071**	**26%**	**82**	**22%**

Notes: The table shows the summary of news after first and second round of data filtering. **Country** provide the countries name corresponding to the news categories: EC- Euro Zone aggregated news, FR-France, GE-German, IT-Italy, JP-Japan, PO-Portugal, SP-Spain, UK-United Kingdoms and US-United States. **Total** is the summary of news satisfying the first round of filter. "**Smooth Transition Regression**" and "**Breakpoint Regression**" show the summary of filtered news for each corresponding model after the second round of filter. **News** and **Freq** show the number of news categories and releases through entire sample period.

Table 4: Largest Returns in Euro/Dollar (EURUSD)

EURUSD	Date	Country	News Announcement	Type	GBPUSD	JPYUSD
1.126	3/18/2009	US	FOMC Rate Decision		0.620	1.360
1.084	11/30/2011		Coordinated central bank action to address pressures in global money markets	Central Bank Intervention	0.525	0.505
1.020	3/25/2009	US	New Home Sales		0.820	0.850
		US	New Home Sales MoM			
-0.992	11/7/2013	EC	ECB Announces Interest Rates		-0.061	-0.082
0.852	11/13/2008	US	Restructuring of the Fed's Financial Support to AIG	Unscheduled News	0.327	-0.409
0.814	12/18/2008	UK	Stannard of BNP Paribas Speaks on Currency Markets	Speech	0.222	-0.150
0.763	1/12/2005	US	Trade Balance		0.580	0.740
0.727	2/20/2009		Stocks Drop Around the World; Stoxx 600 Falls to 6-Year Low	Unscheduled News	0.443	0.704
0.712	12/16/2008	US	FOMC Rate Decision		0.500	0.590
-0.700	10/22/2008	US	Treasury's McCormick Speaks In Hong Kong About Mark	Speech	-0.504	0.165
0.696	1/4/2008	US	Avg Hourly Earning MOM Prod		0.360	0.829
		US	Avg Hourly Earning YOY Prod			
		US	Avg Weekly Hours Production			
		US	Change in Manufact. Payrolls			
		US	Change in Nonfarm Payrolls			
		US	Unemployment Rate			
-0.669	5/5/2011	UK	BOE's Bailey Speaks at BSA Annual Conference	Speech	-0.120	0.010
		US	Continuing Claims			
		US	Initial Jobless Claims			
		US	Nonfarm Productivity			
		EC	Trichet Speaks at ECB Monthly News Conference in He	Speech		
		US	Unit Labor Costs			

Notes: The table shows the association between the largest return in Euro/Dollar and macroeconomic news announcement. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. We subjectively associate the largest return jump to the news announced within 15 minutes before the return jump. The return from Friday 21:00:00 EST through Sunday 23:59:59 EST are excluded. **Return** contains the largest 5 min return sorted by absolute value in Euro/Dollar in percentage form. **Country** shows the country name corresponding to the news announcement: US – United States; UK – United Kingdoms; EC – Euro Zone Aggregated. **News Announcement** present the news announced within 15 minutes before the return jump. All the suspected news that lead to the large jump are provided. **Types** contain the type of news such as Central Bank Intervention, Unscheduled News and Speeches made by important people except for scheduled macroeconomic news.

Table 5: Estimation Results of STR Model: Equations (1) and (2)

	ISM			GDPWA		
	EURUSD	**GBPUSD**	**JPYUSD**	**EURUSD**	**GBPUSD**	**JPYUSD**
γ	132.577 (66903442)	74.435 (16145)	60.014 (7533)	156.466*** (21.954)	3.053*** (0.154)	1690.5 (3372)
$\emptyset_0{}'$	-0.151*** (0.002)	-0.06*** (0.002)	-0.26*** (0.002)	-0.290*** (0.001)	-0.234*** (0.004)	-0.295*** (0.001)
$\emptyset_1{}'$	-0.081*** (0.002)	-0.082*** (0.002)	-0.08*** (0.002)	0.101*** (0.001)	0.132*** (0.005)	-0.093*** (0.001)
$\psi_0{}'$	18.943*** (0.503)	21.311*** (0.447)	27.718*** (0.495)	40.263*** (0.229)	46.587*** (0.934)	23.782*** (0.199)
$\psi_1{}'$	8.325*** (0.526)	5.41*** (0.469)	0.661 (0.517)	-20.505*** (0.302)	-26.744*** (1.045)	11.356*** (0.286)
LSTR Type	LSTR1	LSTR1	LSTR1	LSTR1	LSTR1	LSTR2
c_k	-4.126 (159646)	-4.126 (32.567)	-4.067 (34.682)	-0.673*** (0.001)	-0.956*** (0.026)	-0.679 (0.000)	2.815 (0.002)

Notes: Table presents the parameter estimations in equation (1) and (2) f by using ISM and GDP weighted average long term interest rate as transition variable respectively. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. ISM (Institute of Supply Management) is manufacturing index for US business cycles. GDPWA is GDP weighted average over four Euro Zone countries that involve in Sovereign debt crisis: Italy, Spain, Portugal and Greece. The number in bracket are the standard errors. *** denotes the figures statistically significant at 1% level. **LSTR Type** is defined in equation (2). K=1 and 2 for LSTR1 and LSTR2 model. This explains why there are two values of c_k in JPYUSD in the right column.

Table 6: Sign Switch Effects Estimated in Equations (4) and (6)

		US Sample			EU Sample		
Selected News	**CN**	**Expansion**	**Recession**	**P_diff**	**Expansion**	**Recession**	**P_diff**
Panel A: EURUSD Return							
ECB Announces Interest Rates	EC	-0.024***	0.033***	0.000			
Industrial Production MoM	US	-0.052***	0.018***	0.000			
New Home Sales	US	-0.033***	0.095***	0.000			
Pending Home Sales MoM	US	-0.052***	0.032***	0.000			
Existing Home Sales	US	-0.063***	0.045***	0.000	0.061***	-0.02***	0.000
Construction Spending MoM	US	-0.028**	0.025***	0.000			
Durables Ex Transportation	US	-0.097***	0.013**	0.000			
Consumer Confidence Index	US	-0.055***	0.068***	0.000			
Housing Starts	US	-0.016**	0.034***	0.000			
Philadel Fed Business Outlook	US	-0.045***	0.042***	0.000			
Initial Jobless Claims	US	0.029***	-0.043***	0.000			
Change in Nonfarm Payrolls	US	-0.219***	0.033***	0.000			
GDP Annualized QoQ - Advan	US				0.239**	-0.182***	0.000
Nonfarm Productivity - Prelim	US				0.034***	-0.165***	0.000
FOMC Rate Decision	US				-0.101***	0.049***	0.000
Panel B: EURUSD Volatility							
Retail Price Index	UK	0.617**	-0.897**	0.001			
Panel C: JPYUSD Return							
Business Inventories	US	-0.019***	0.051***	0.000			
CPI Ex Food and Energy MoM	US	-0.061***	0.068***	0.000			
Import Price Index MoM	US				-0.064	0.06***	0.000
Panel D: JPYUSD Volatility							
GDP SA QoQ - Final	EC	-0.166**	1.217***	0.000			
RPI Ex Mort Int.Payments (YoY)	UK	2.682***	-3.606***	0.000			

Notes: The table presents selected macroeconomic news that have sign switch effects over expansion and recessions in either Sample US or Sample EU from STR model. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. Sample US and Sample EU denotes US and Euro Zone crisis related subsample. **P_diff** presents the P value of $\beta'_{k,j}$ in equation (4) and $\vartheta'_{k,j}$, in equation (6) which is the difference between the coefficients in expansion and recession. A significant value of $\beta'_{k,j}$ or $\vartheta'_{k,j}$, signify that the coefficients are statistically different over expansion and recession. **CN** contains the corresponding country name of the Macroeconomic News: US - United States, EC- Euro Zone Aggregate; UK - United Kingdoms; GE – German. *, **, *** denotes statistical significance at 10%, 5% and 1% level.

Table 6: Sign Switch Effects Estimated in Equations (4) and (6)

		US Sample			EU Sample		
Selected News	**CN**	**Expansion**	**Recession**	**P_diff**	**Expansion**	**Recession**	**P_diff**
Panel E: GBPUSD Return							
Total Bus Inv QoQ - Prelim	UK	-0.149***	0.166***	0.000			
RPI Ex Mort Int.Payments	UK	0.055***	-0.186***	0.000			
Industrial Production MoM	US	-0.043***	0.012***	0.000			
New Home Sales	US	-0.03***	0.064***	0.000			
Pending Home Sales MoM	US	-0.053***	0.044***	0.000			
Existing Home Sales	US	-0.051***	0.092***	0.000	0.136***	-0.02**	0.000
Durables Ex Transportation	US	-0.064***	0.014**	0.000			
Consumer Confidence Index	US	-0.027**	0.052***	0.000			
ISM Manufacturing	US	-0.059***	0.027***	0.000	0.105***	-0.034***	0.002
Philadel Fed Business Outlook	US	-0.026**	0.017***	0.002			
Initial Jobless Claims	US	0.024***	-0.047***	0.000	-0.079***	0.014***	0.000
Change in Nonfarm Payrolls	US	-0.182***	0.053***	0.000			
Unemployment Rate	US	0.082***	-0.037***	0.000			
Industrial Production WDA YoY	IT				-0.09**	0.026**	0.024
RPI MoM	UK				0.615***	-0.257***	0.000
Nonfarm Productivity - Prelim	US				0.095**	-0.046**	0.027
Panel F: GBPUSD Volatility							
CPI MoM	SP	-0.158**	0.69**	0.008			
GDP SA QoQ - Final	EC				2.616***	-0.544**	0.001
ECB Announces Interest Rates	EC				-0.896**	0.272***	0.008

Notes: The table presents selected macroeconomic news that have sign switch effects over expansion and recessions in either Sample US or Sample EU from STR model. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. Sample US and Sample EU denotes US and Euro Zone crisis related subsample. **P_diff** presents the P value of $\beta'_{k,j}$ in equation (4) and $\vartheta'_{k,j}$, in equation (6) which is the difference between the coefficients in expansion and recession. A significant value of $\beta'_{k,j}$ or $\vartheta'_{k,j}$, signify that the coefficients are statistically different over expansion and recession. **CN** contains the corresponding country name of the Macroeconomic News: US - United States, EC- Euro Zone Aggregate; UK - United Kingdoms; GE – German. *, **, *** denotes statistical significance at 10%, 5% and 1% level.

Table 7: Context Dependent Effects Estimated in Equations (4) and (6) (excluding Sign Switch)

		EUR			GBP			JPY		
Selected News	**CN**	**US crisis**	**EU crisis**	**PW**	**US crisis**	**EU crisis**	**PW**	**US crisis**	**EU crisis**	**PW**
Panel A: Return										
Trade Balance SA	EC	0.05***	-0.01	0.00	0.12***	0.00	0.00	0.03***	-0.01	0.00
Private Consum QoQ	GE	-0.07	0.13***	0.00	-0.11***	0.05	0.00	0.14***	-0.01	0.00
Housing Starts YoY	JP	0.04	-0.01	0.04	0.12***	0.01	0.00	-0.14***	-0.01	0.00
Retail Sales WDA YoY	SP	0.06***	0.02**	0.00	0.13***	0.01	0.00	-0.09***	0.00	0.00
CPI MoM	UK	0.02	-0.02	0.01	0.12***	0.16***	0.03	-0.04***	0.01	0.01
BOE Bank Rate	UK	0.03***	-0.01	0.00	-0.01	0.04***	0.00	-0.31***	0.01	0.00
Avg Wkly Hours Prod	US	-0.05***	0.14***	0.00	-0.07***	0.11	0.02	0.15***	0.06	0.01
Core PCE QoQ - Prelim	US	-0.13***	-0.03	0.00	-0.09***	0.03	0.00	0.25***	0.06***	0.00
ISM Non-Manf. Comp	US	0.01	-0.04***	0.00	0.01	-0.03***	0.00	-0.02***	-0.12***	0.00
ISM Milwaukee	US	-0.1***	-0.02***	0.00	-0.27***	0.01	0.00	0.07***	-0.03***	0.00
U of M Conf.- Prelim	US	-0.05***	-0.01	0.00	-0.07***	-0.01	0.00	0.00	-0.03***	0.02
ADP Employ Change	US	-0.01	-0.05***	0.00	0.01	-0.05***	0.00	-0.11***	-0.17***	0.00
Min of FOMC Meeting	US	0.05***	-0.03***	0.00	0.1***	-0.03	0.00	0.1***	-0.07***	0.00
Panel B: Volatility										
ZEW Survey Exp	EC	-1.29	-0.8	0.02	2.28	0.28	0.050	-1.69	0.47	0.05
Private Consum QoQ	GE	-1.65***	-0.19	0.00	-3.21***	-1.27***	0.020	-7.4***	0.06	0.01
CPI MoM	PO	-2.69***	1.53	0.00	-1.98***	0.00	0.000	-8.09***	-1.31	0.00
Core PCE QoQ - Prelim	US	0.76	-0.14	0.05	1.13**	-0.18	0.010	0.93***	-0.06	0.01

Notes: The table presents selected macroeconomic news that are unstable over different contexts of crises in all three currency pairs excluding those presented in sign switch effects in Table 6 on the return and volatility (Equation 4). EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. **PW** presents the P value of Wald equivalence test for the news coefficients during recession period from different subsamples, more specifically, US and Euro Zone crisis. Only the news with significance of at least 5% level are presented. **CN** presents the corresponding country name of the news: EC - Euro Zone Aggregate; GE - German; US – United States; FR - France; IT - Italy; JP - Japan; SP - Spain.*, **, *** denotes statistical significance at 10%, 5% and 1% level within the corresponding crisis.

Table 8: Summary of Context Dependent News Effects Estimated in Equations (4) and (6)

		EURUSD		GBPUSD		JPYUSD	
Country	**Total**	**CD**	**%**	**CD**	**%**	**CD**	**%**
Panel A: Return							
EC	15	6	40%	8	53%	6	40%
FR	3	3	100%	2	67%	0	0%
GE	12	8	67%	4	33%	1	8%
IT	7	3	43%	2	29%	1	14%
JP	2	1	50%	1	50%	1	50%
PO	2	1	50%	1	50%	0	0%
SP	4	2	50%	2	50%	1	25%
UK	12	6	50%	12	100%	6	50%
US	42	29	69%	24	57%	32	76%
Total	99	59	60%	56	57%	48	48%
Panel B: Volatility							
EC	15	3	20%	1	7%	3	20%
FR	3	1	33%	0	0%	1	33%
GE	12	2	17%	4	33%	2	17%
IT	7	1	14%	3	43%	1	14%
JP	2	0	0%	1	50%	0	0%
PO	2	1	50%	1	50%	1	50%
SP	4	0	0%	0	0%	1	25%
UK	12	0	0%	2	17%	2	17%
US	42	11	26%	8	19%	16	38%
Total	99	19	19%	20	20%	27	27%

Notes: the table shows the summary of news that have significant context dependent effects in three currencies. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. **Country** provide the countries name corresponding to the news: EC- Euro Zone aggregated news, FR-France, GE-German, IT-Italy, JP-Japan, PO-Portugal, SP-Spain, UK-United Kingdoms and US-United States. Panel A and B contains the context dependent news information on 5 min return and volatility respectively. **Total** shows the number of category of news. **CD** stands for the number of context dependent news. The criteria to justify the context dependent effects is according to the PW – p value of equivalence test mentioned from Table 7. If the p value is statistically significant at least 5% level, we count the news as context dependent news.

Table 9: State Dependent Effects Estimated in Equations (4) and (6) (excluding Sign Switch and Context Dependent Effects)

		US Sample			EU Sample		
Selected News	**CN**	**Expansion**	**Recession**	**P_diff**	**Expansion**	**Recession**	**P_diff**
Panel A: EURUSD Return							
Labour Costs YoY	EC	-0.029	0.033***	0.001	-0.068	0.031	0.012
Industrial Production WDA YoY	IT	0	0.023***	0.047	-0.014	0.03***	0.032
Factory Orders	US	-0.03***	0.003	0.000	-0.066***	-0.011	0.000
ISM Manufacturing	US	-0.072***	0.004	0.000	0.014	-0.018***	0.028
Unemployment Rate	US	0.12***	0.03***	0.000	0.125***	-0.002	0.000
Net Long-term TIC Flows	US	-0.06***	-0.028***	0.002	-0.012	0.022***	0.016
Panel B: GBPUSD Return							
Labour Costs YoY	EC	-0.036**	0.015	0.010	-0.198**	-0.001	0.027
GDP QoQ - Advance	UK	0.316***	0.146***	0.002	0.413***	0.176***	0.000
Retail Price Index	UK	-0.017	0.076***	0.003	-0.254	0.184***	0.008
GDP Annualized QoQ - Advance	US	-0.161***	-0.002	0.000	0.318	-0.142***	0.012
Construction Spending MoM	US	-0.034**	-0.003	0.050	0.162***	0.001	0.002
Factory Orders	US	-0.027***	0.005	0.001	-0.104***	-0.005	0.015
Panel C: JPYUSD Return							
GDP Annualized QoQ - Advance	US	-0.135***	-0.09***	0.045	-0.954***	-0.181***	0.000
GDP Annualized QoQ - Prelim	US	-0.034	0.314***	0.000	0.03	-0.067***	0.011
Wholesale Inventories MoM	US	0.017**	0.048***	0.011	-0.066***	0.013	0.000
New Home Sales	US	-0.067***	0.017	0.000	-0.21***	-0.092***	0.000
Pending Home Sales MoM	US	-0.06***	-0.098***	0.029	-0.048***	-0.005	0.000
Housing Starts	US	-0.031***	-0.102***	0.000	-0.019	-0.124***	0.025
Unemployment Rate	US	0.257***	-0.015	0.000	-0.027	0.12***	0.000

Notes: The table presents the macroeconomic news that are unstable over different state of economy in both US and EU samples excluding those presented in sign switch effects (Table 7) and context dependent effects (Table 8&9) from STR Model on return and volatility. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. Sample US and Sample EU denotes US and Euro Zone crisis related subsample. **P_diff** presents the P value of $\beta'_{k,j}$ in equation (4) on return and $\vartheta'_{k,j}$, in equation (6) on volatility which are the difference between the coefficients in expansion and recession. A significant value of $\beta'_{k,j}$ or $\vartheta'_{k,j}$, signify that the coefficients are statistically different over expansion and recession. **CN** presents the corresponding country of the news: EC - Euro Zone Aggregate; GE - German; US – United States; FR - France; IT - Italy; JP - Japan; SP - Spain; UK - United Kingdoms. *, **, *** denotes statistically significance at 10%, 5%, 1%.

Table 9: State Dependent Effects excluding Sign Switch and Context Dependent Effects Detected by STR Model in Equation (4) and (6)

		US Sample			EU Sample		
Selected News	**CN**	**Expansion**	**Recession**	**P_diff**	**Expansion**	**Recession**	**P_diff**
Panel D: EURUSD Volatility							
Household Cons QoQ - Prelim	EC	-0.394	-3.238**	0.028	-2.175**	-2.175	0.030
ECB Announces Interest Rates	EC	0.25***	0.877***	0.045	0.146	0.146***	0.005
Factory Orders WDA YoY - Prelim	GE	-0.306	0.939	0.027	-1.506	-1.506	0.028
GDP WDA QoQ - Prelim	IT	-0.328***	0.475	0.036	-1.218	-1.218***	0.002
GDP Annualized QoQ - Advance	US	0.458***	0.076	0.048	2.76***	2.76***	0.000
Panel E: GBPUSD Volatility							
ZEW Survey Current Situation	GE	0.055	1.575**	0.027	4.368**	0.011	0.018
ZEW Survey Expectations	GE	0.383	-4.682**	0.014	-3.253**	0.051	0.015
GDP Annualized QoQ - Advance	US	0.435***	-0.062	0.044	3.403**	-0.103	0.038
Panel F: JPYUSD Volatility							
GDP SA QoQ - Prelim	GE	0.337	1.985***	0.003	-0.695**	0.5	0.012
Nonfarm Productivity - Final	US	-0.201	0.716**	0.023	0.424	-0.563***	0.004
Unemployment Rate	US	0.252***	1.109***	0.000	-0.09	0.263**	0.028

Notes: The table presents selected macroeconomic news that are unstable over different state of economy in both US and EU samples excluding those presented in sign switch effects (Table 7) and context dependent effects (Table 8&9) from STR Model on return and volatility. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. Sample US and Sample EU denotes US and Euro Zone crisis related subsample. **P_diff** presents the P value of $\beta'_{k,j}$ in equation (4) on return and $\vartheta'_{k,j}$, in equation (6) on volatility which are the difference between the coefficients in expansion and recession. A significant value of $\beta'_{k,j}$ or $\vartheta'_{k,j}$, signify that the coefficients are statistically different over expansion and recession. **CN** presents the corresponding country of the news: EC - Euro Zone Aggregate; GE - German; US – United States; FR - France; IT - Italy; JP - Japan; SP - Spain; UK - United Kingdoms. *, **, *** denotes statistically significance at 10%, 5%, 1%.

Table 10: Summary of State Dependent News Effects Estimated in Equations (4) and (6) (including sign switch)

		EURUSD				GBPUSD				JPYUSD			
		US Sample		EU Sample		US Sample		EU Sample		US Sample		EU Sample	
Country	Total Sample	SD	%	SD	%	SD	%	SD	%	SD	%	SD	%
Panel A: Return													
EC	15	7	47%	3	20%	9	60%	3	20%	7	47%	3	20%
FR	3	1	33%	0	0%	2	67%	1	33%	1	33%	0	0%
GE	12	2	17%	0	0%	5	42%	1	8%	2	17%	0	0%
IT	7	3	43%	1	14%	3	43%	1	14%	3	43%	1	14%
JP	2	0	0%	0	0%	1	50%	0	0%	0	0%	0	0%
PO	2	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
SP	4	0	0%	0	0%	2	50%	1	25%	0	0%	0	0%
UK	12	5	42%	2	17%	10	83%	5	42%	5	42%	2	17%
US	42	30	71%	17	40%	31	74%	10	24%	30	71%	17	40%
Total	99	48	48%	23	23%	63	64%	22	22%	48	48%	23	23%
Panel A: Volatility													
EC	15	3	20%	9	60%	1	7%	4	27%	3	20%	3	20%
FR	3	0	0%	0	0%	1	33%	0	0%	2	67%	0	0%
GE	12	3	25%	5	42%	3	25%	2	17%	2	17%	1	8%
IT	7	1	14%	2	29%	2	29%	0	0%	0	0%	0	0%
JP	2	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
PO	2	1	50%	0	0%	1	50%	0	0%	1	50%	0	0%
SP	4	0	0%	2	50%	1	25%	0	0%	0	0%	0	0%
UK	12	2	17%	4	33%	1	8%	1	8%	3	25%	0	0%
US	42	6	14%	6	14%	9	21%	4	10%	13	31%	3	7%
Total	99	16	16%	28	28%	19	19%	11	11%	24	24%	7	7%

Notes: the table shows the summary of news that have significant state dependent news effects through each sample period in three currencies (sign switch effects included). EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively. **US Sample** and **EU Sample** denotes US and Euro Zone crisis related subsample, and present the number and percentage of category of filtered news out of total number of news. **Country** provide the countries name corresponding to the news: EC- Euro Zone aggregated news, FR-France, GE-German, IT-Italy, JP-Japan, PO-Portugal, SP-Spain, UK-United Kingdoms and US-United States. Panel A and B contains the unstable news information on 5 min return and volatility respectively. **SD** stands for the number of state dependent news. The criteria to justify the unstable effects is according to the P_Diff mentioned from Table 6 and Table 9.

Table 11: Unstable Effects Estimated by Breakpoint regression Model: Equation (7)

		Estimated Break Periods						
Selected News	**CN**	**BS1**	**BS2**	**BS3**	**BS4**	**BS5**	**BS6**	**PW**
Panel A: on return of EURUSD								
ECB Anoun. Interest Rates	EC	-0.03***	-0.02***	0.02	0.00	-0.03***	-0.02	0.00
Industrial Production MoM	US	-0.01	-0.04***	0.00	-0.01	0.00	-0.01	0.01
New Home Sales	US	-0.03***	-0.04***	0.1***	-0.01	-0.04	-0.07***	0.00
Pending Home Sales MoM	US	-0.04	-0.03**	0.01	-0.01	0.00	-0.02	0.07
Existing Home Sales	US	-0.04***	-0.1***	0.04***	-0.02***	0.02	-0.03	0.00
Construc. Spending MoM	US	0.00	-0.05***	0.03***	0.03***	0.00	-0.01	0.00
Durables Ex Transportation	US	-0.08***	-0.08***	-0.01	-0.01	0.00	-0.05***	0.00
Consumer Confidence Index	US	-0.05***	-0.06***	0.07***	0.03***	0.01	-0.02**	0.00
Housing Starts	US	0.00	-0.03***	0.01	-0.1***	0.03	-0.07***	0.00
Philadel Fed Bus. Outlook	US	-0.05***	-0.06***	0.04***	-0.02**	0.01	-0.07***	0.00
Initial Jobless Claims	US	0.03***	0.05***	-0.02***	0.02***	-0.04***	0.02***	0.00
Change in Nonfarm Payrolls	US	-0.19***	-0.22***	0.08***	-0.1***	-0.06***	-0.31***	0.00
GDP Annualized QoQ – Adv	US	-0.13***	-0.26***	-0.01	-0.09***	-0.07	-0.11***	0.00
Nonfarm Prod - Prelim	US	-0.03	-0.01	0.00	-0.06***	-0.31***	0.14***	0.00
FOMC Rate Decision	US	-0.01	0.1***	0.02**	0.13***	0.00	-0.08***	0.00
Panel B: on volatility of EURUSD								
Retail Price Index	UK	-	-	-	-	-	-	-
Panel C: on return of JPYUSD								
Business Inventories	US	0.01	-0.04***	0.02**	-0.02**	0***	0.00	0.00
CPI Ex Food and Energy MoM	US	-0.07***	0.02**	-0.07***	-0.04***	-0.05***	0.00	0.00
Import Price Index MoM	US	-0.02**	0.04***	-0.05***	0.05***	0.01**	0.00	0.00
Panel D: on volatility of JPYUSD								
GDP SA QoQ - Final	EC	-	-	-	-	-	-	-
RPI Ex Mort Int.Pay. (YoY)	UK	2.18**	2.31**	-2.7***	-0.85	-0.61	0.00	0.00

Notes: The table presents selected macroeconomic news with unstable effects over different structural break subsamples estimated by breakpoint regression model on the return and volatility at 5% significance level. Since there are too many unstable news, we select the same category of news presented in Table 6 (sign switch). **CN** provide the countries name corresponding to the news. **BS i** denotes ***i*** th Structural Break Subsample. **PW** show the p value of Wald coefficients equality test under the null hypothesis making all of the coefficients from each subsample equal (H_0: $\hat{\beta}_{k,j,1} = \hat{\beta}_{k,j,2} = \hat{\beta}_{k,j,3} = \hat{\beta}_{k,j,4} = \hat{\beta}_{k,j,5} = \hat{\beta}_{k,j,6}$). If there is "-" in the cell, it means the news are eliminated during the estimation of breakpoint regression model. This is because the news lead to the singular matrix problem within one subsample period due to fewer announcement during sub period. *, **, *** denote statistical significance of the coefficient at 10%, 5% and 1% respectively within each subsample.

Table 11: Unstable Effects Detected by Breakpoint regression Model in Equation (7)

		Estimated Break Periods						
Selected News	**CN**	**BS1**	**BS2**	**BS3**	**BS4**	**BS5**	**BS6**	**PW**
Panel E: on return of GBPUSD								
Total Bus Inv QoQ - Prelim	UK	-	-	-	-	-	-	-
RPI Ex Mort Int.Pay (YoY)	UK	0.01	0.04	-0.03	0.04	0.06	0.25***	0.00
Industrial Production MoM	US	-0.02	-0.05***	0.00	-0.02	0.01	-0.01	0.00
New Home Sales	US	-0.03***	-0.03***	0.09***	0.01	0.07	-0.04***	0.00
Pending Home Sales MoM	US	-0.05**	-0.03**	0.03***	0.01	0.00	-0.03**	0.00
Existing Home Sales	US	-0.03**	-0.07***	0.11***	-0.02***	0.02**	-0.02	0.00
Durables Ex Transportation	US	-0.06***	-0.06***	0.00	0.00	-0.01	-0.04***	0.00
Consumer Confidence Index	US	-0.04***	-0.03***	0.06***	0.00	0.02***	-0.03***	0.00
ISM Manufacturing	US	-0.04***	-0.08***	0.04***	-0.04***	0.02	-0.08***	0.00
Philadel Fed Business Outlook	US	-0.02**	-0.03***	0.01	0.00	0.01	-0.05***	0.00
Initial Jobless Claims	US	0.02***	0.04***	-0.02***	0.01***	-0.01**	0.02***	0.00
Change in Nonfarm Payrolls	US	-0.19***	-0.12***	0.08***	-0.07***	-0.08***	-0.28***	0.00
Unemployment Rate	US	0.11***	0.19***	-0.05***	0.00	-0.01	-0.02	0.00
Industrial Prod WDA YoY	IT	0.01	0.01	0.02**	0.00	0.03***	-0.01	0.25
RPI MoM	UK	0.03	0.02	0.05***	-0.1***	-0.07	-0.18***	0.00
Nonfarm Productivity - Prelim	US	-0.02	-0.01	0.00	-0.02	-0.04	0.06	0.31
Panel F: on volatility of GBPUSD								
CPI MoM	SP	-0.08	0.38**	0.28**	0.49***	0.04	0.00	0.00
GDP SA QoQ - Final	EC	-	-	-	-	-	-	-
ECB Announces Interest Rates	EC	0.05	-0.02	0.07	0.13***	0.2***	0.00	0.02

Notes: The table presents selected macroeconomic news with unstable effects over different structural break subsamples estimated by breakpoint regression model on the return and volatility at 5% significance level. Since there are too many unstable news, we select the same category of news presented in Table 6. **CN** provide the countries name corresponding to the news. **BS i** denotes ***i*** th Structural Break Subsample. **PW** show the p value of Wald coefficients equality test under the null hypothesis making all of the coefficients from each subsample equal (H_0: $\acute{\beta}_{k,j,1} = \acute{\beta}_{k,j,2} = \acute{\beta}_{k,j,3} = \acute{\beta}_{k,j,4} = \acute{\beta}_{k,j,5} = \acute{\beta}_{k,j,6}$). *, **, *** denote statistical significance of the coefficient at 10%, 5% and 1% respectively within each sub period.

Table 12: Efficient Test of Parameter Instability

			EURUSD		GBPUSD		JPYUSD	
Selected News	**CN**	**Freq**	**QLL**	**Sig**	**QLL**	**Sig**	**QLL**	**Sig**
Panel A: on return								
Consumer Confidence Index	US	112	-18.00	***	-15.9	***	-7.02	
Trade Balance	US	112	-17.10	***	-20.3	***	-14.92	***
Eco Watchers Survey Current	JP	49	-14.05	***	-9.7	**	-3.78	
Retail Sales Ex Auto MoM	US	111	-12.78	***	-12.2	***	-6.38	
Change in Nonfarm Payrolls	US	112	-11.85	***	-15.5	***	-9.62	**
Net Long-term TIC Flows	US	106	-11.65	***	-11.3	***	-10.05	**
Retail Sales Advance MoM	US	111	-11.04	**	-11.5	***	-4.15	
Industrial Production NSA YoY	IT	66	-10.30	**	-5.1		-4.45	
PCE Core MoM	US	104	-10.19	**	-9.7	**	-3.73	
ZEW Survey Current Situation	GE	111	-9.89	**	-5.6		-7.29	*
Philadelphia Fed Business Outlook	US	112	-9.77	**	-9.3	**	-5.52	
PPI MoM	FR	98	-9.73	**	-3.9		-1.20	
Annualized Housing Starts	JP	65	-9.38	**	-5.2		-3.76	
Factory Orders MoM - Preliminary	GE	107	-9.36	**	-2.5		-3.75	
Durables Ex Transportation	US	110	-9.30	**	-11.4	***	-8.67	**
PPI YoY	FR	101	-9.19	**	-3.2		-1.52	
Avg Earnings ex bonus 3M/YoY	UK	57	-9.09	**	-3.0		-5.83	
Index of Services 3M/3M	UK	79	-9.06	**	-3.4		-3.39	
Jobless Rate	JP	100	-8.79	**	-10.0	**	-3.50	
Natl CPI Ex Food, Energy YoY	JP	77	-8.74	**	-6.5			
CPI NIC incl. tobacco YoY - Final	IT	87	-8.71	**	-5.5		-8.69	**
Richmond Fed Manufact. Index	US	100	-8.53	**	-9.3	**	-3.28	
Panel B: on Volatility								
CPI NIC incl. tobacco YoY - Prelim	IT	105	-10.21	**	-4.56		-4.24	
Public Finances (PSNCR)	UK	105	-9.91	**	-3.97		-3.91	
Unemployment Rate	US	112	-8.88	**	-9.83	**	-2.78	
CPI EU Harmonised MoM - Prelim	FR	109	-8.20	*	-5.68		-5.32	
Factory Orders MoM - Prelim	GE	107	-8.09	*	-2.87		-5.61	
RPI MoM	UK	110	-8.04	*	-9.58	**	-3.22	
RPI YoY	UK	111	-7.74	*	-9.98	**	-4.16	
Total Busi Investment QoQ - Prelim	US	110	-7.71	*	-4.61		-4.01	
Industrial Production SA MoM	EC	108	-7.46	*	-7.59	*	-5.86	

Notes: The table presents the efficient test of parameter instability for selected news with significant QLL statistics at 5% level on return and 10% level on volatility. **CN** provide the countries name corresponding to the news. **QLL** denotes the statistics of Quasi Local Level test which is introduced in section 3.4.1. *, ** and *** denotes significance at 10%, 5% and 1% level according to table 1.**Freq** show the total announcements of each category of news. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively.

Table 13: Source of News Effects Time Variation

		EURUSD		GBPUSD		JPYUSD	
Selected News	**CN**	**VIX**	**FFR**	**VIX**	**FFR**	**VIX**	**FFR**
Panel A: Return							
Consumer Confidence Index	US	0.003***	-0.965***	0.003***	-0.579***	-0.001***	-0.255***
Trade Balance	US	0.001**	-1.611***	0.001**	-1.476***	0.000	-1.813***
Eco Watchers Survey Current	JP	0.00***	0.115*	0.00***	0.064	0.000	0.033***
Retail Sales Ex Auto MoM	US	0.002***	-0.996***	0.002***	-1.12***	0.001***	0.606***
Change in Nonfarm Payrolls	US	0.005***	-0.656**	0.006***	-0.448	0.003***	2.074***
Net Long-term TIC Flows	US	0.000	-1.099***	0.00***	-0.888***	0.000	-0.825***
Retail Sales Advance MoM	US	0.002***	-0.929***	0.002***	-1.022***	0.00***	0.292***
Industrial Production NSA YoY	IT	0.00***	-0.44***	0.00***	-0.149***	0.000	0.065***
PCE Core MoM	US	-0.001***	-0.722***	0.00***	-0.505***	0.00***	0.042***
Panel B: Volatility							
CPI NIC incl. tobacco YoY - Prelim	IT	0.00***	0.194**	0.000	-0.037***	0.00**	0.035***
Public Finances (PSNCR)	UK	0.00***	0.15***	0.00**	0.071***	0.00***	-0.004
Unemployment Rate	US	0.002***	0.666***	0.002***	0.685***	0.00**	-0.16***
CPI EU Harmonised MoM - Prelim	FR	0.00***	-0.075***	0.00***	-0.018**	0.00*	0.071***
Factory Orders MoM – Prelim	GE	0.00***	-0.219***	0.00***	-0.036***	0.000	-0.092***
RPI MoM	UK	0.00**	0.008	0.00***	0.635***	0.000	-0.013***
RPI YoY	UK	0.00**	0.028*	0.00***	0.69***	0.000	-0.01***
Total Busi Investment QoQ - Prelim	US	0.00***	0.159***	0.00***	0.121***	0.00***	0.042***
Industrial Production SA MoM	EC	0.00***	0.157***	0.00***	0.166***	0.000	-0.03*

The table shows nine news coefficients with most significant QLL in EURUSD, estimated in equations (11) and (12) in panel A and B respectively. **CN** provide the countries name corresponding to the news. The variables: VIX, FFR and order flow proxy for three factors: Global risks condition, Central Bank Monetary Policy and the net amount of Order Flow. **Freq** show the total announcements of each category of news. *, ** and *** denotes significance at 10%, 5% and 1% level.

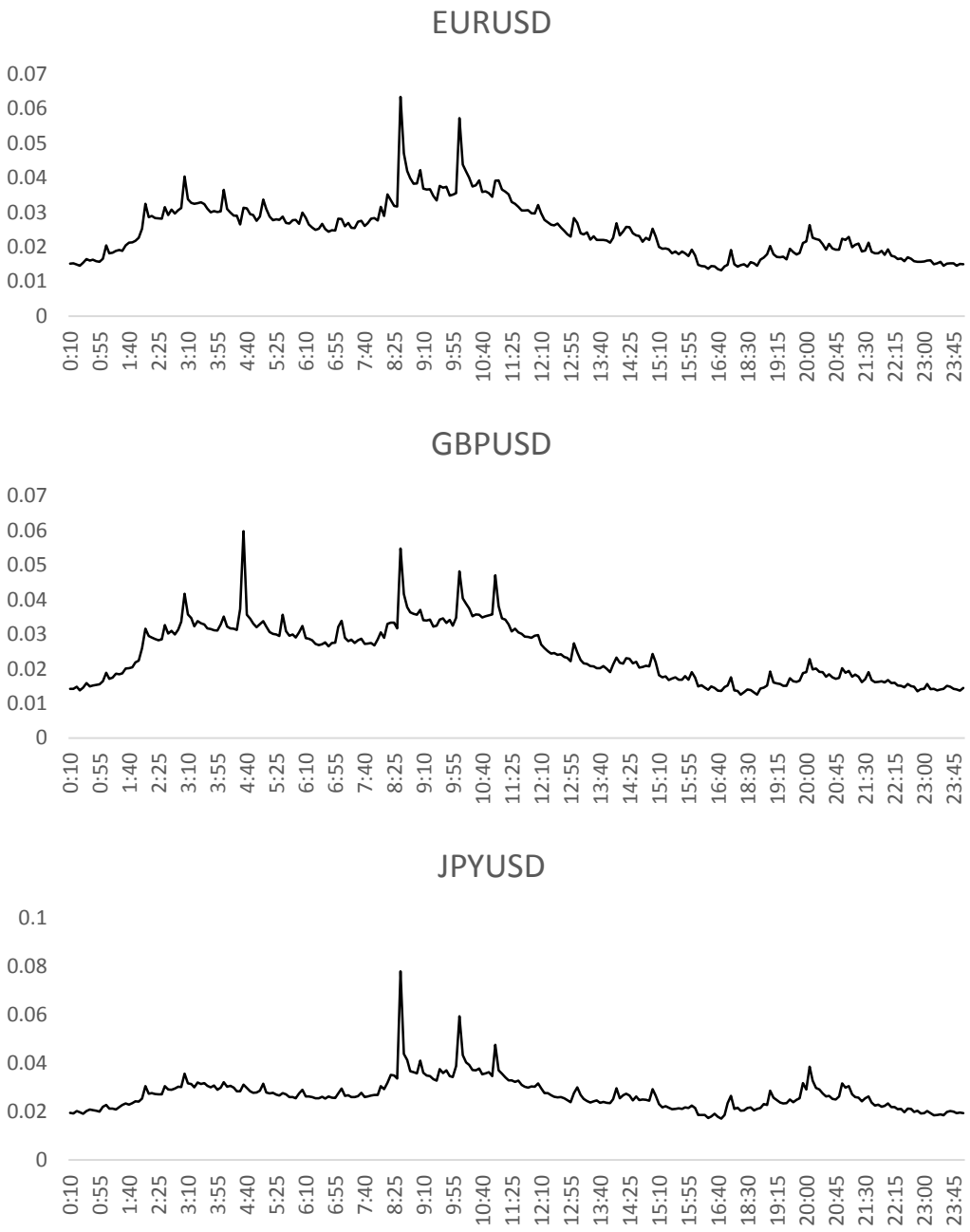
Table 14: Analysis of News Effect Time Variation for US Consumer Confidence Index Estimated in Equations (11) and (13)

	EURUSD		GBPUSD		JPYUSD	
Explanatory Variable	**Coefficient**	**P value**	**Coefficient**	**P value**	**Coefficient**	**P value**
Panel A: Parameter Path Regression: Equation 11						
Intercept	-0.039	0.000	-0.039	0.000	-0.048	0.000
VIX	0.003	0.000	0.003	0.000	-0.001	0.000
FFR	-0.965	0.000	-0.579	0.000	-0.255	0.000
Orderflow	-0.002	0.156	0.003	0.310	-0.006	0.000
R square	0.667		0.666		0.389	
Panel B: Interaction Factors: Equation 13						
Intercept	-0.018	0.046	-0.006	0.447	0.002	0.845
news	-0.031	0.149	-0.032	0.097	-0.023	0.295
*VIX	0.002	0.000	0.002	0.000	-0.001	0.027
*FFR	-1.929	0.001	-1.286	0.009	-0.953	0.103
*Orderflow	-0.007	0.131	0.015	0.238	0.019	0.104
R square	0.256		0.213		0.364	

Note: The table shows news coefficients estimated in equations (11) and (13) displayed in panel A and B respectively. The variables: VIX, FFR and order flow proxy for three factors: Global risks, Central Bank Monetary Policy and the net amount of Order Flow. Similarly, *VIX, *FFR and *order flow denotes the interaction term in equation (13) for each factor. EUSUSD, GBPUSD and JPYUSD denotes for Euro/Dollar, Pound/Dollar and Yen/Dollar respectively.

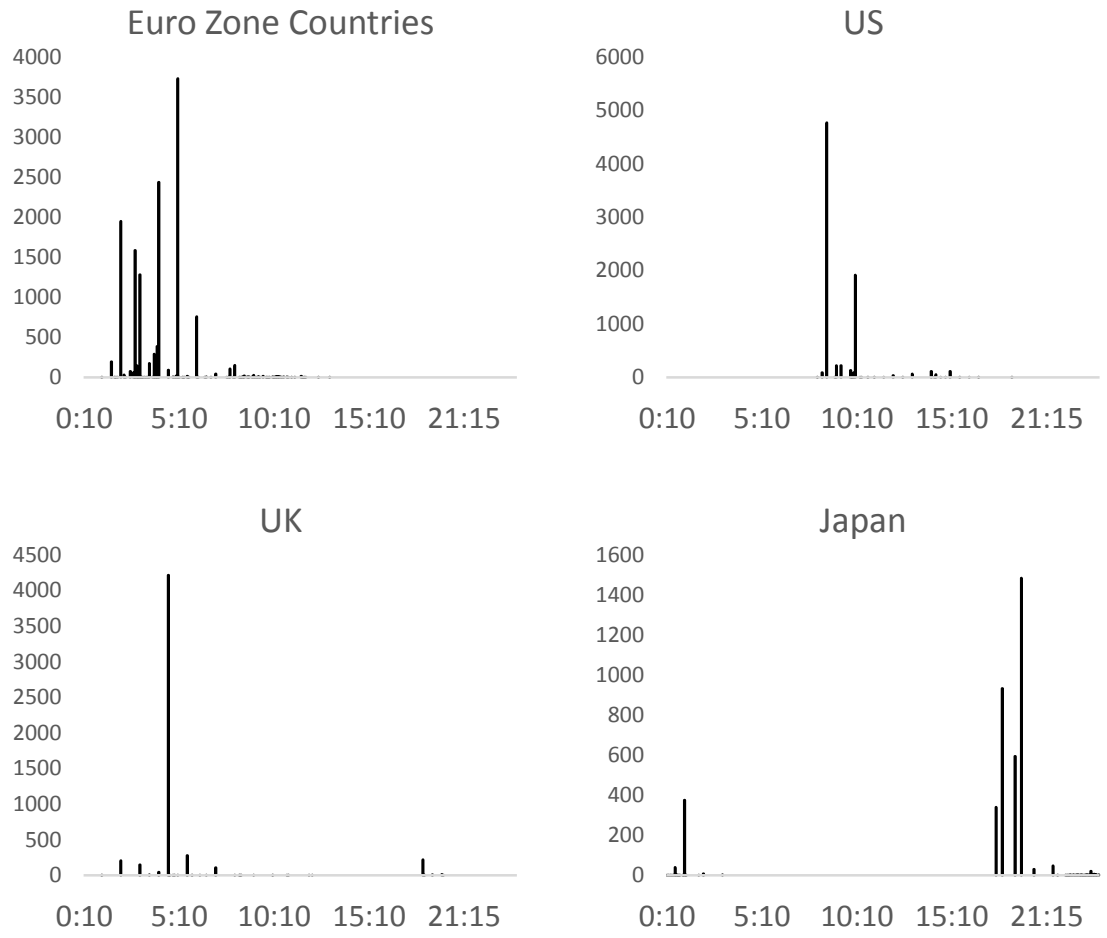
Figures

Figure 1 Intraday Volatility Seasonal Pattern



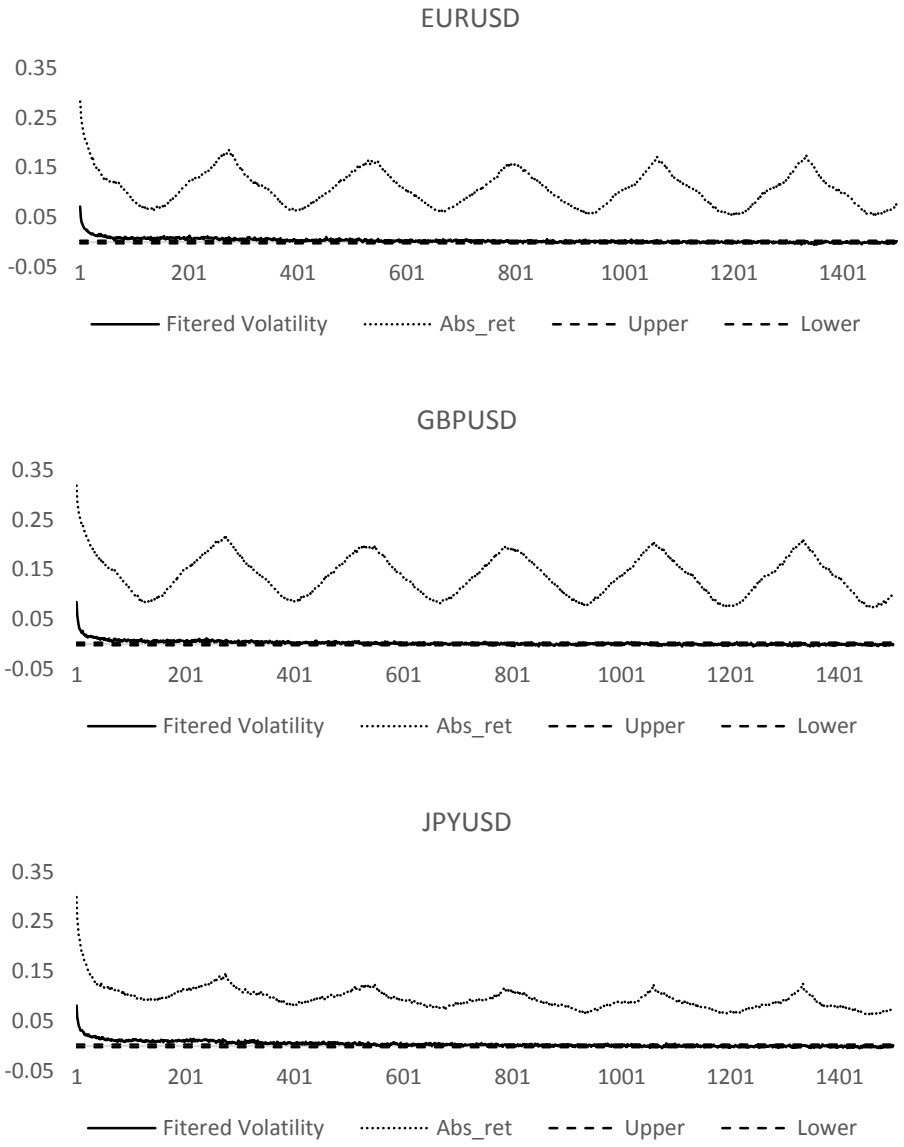
Notes: We calculate the average volatility for each 5-min interval by taking the average of absolute 5-min return through the entire sample for Euro/Dollar (EURUSD), Pound/Dollar (GBPUSD) and Yen/Dollar (JPYUSD). In total, we have 288 intervals before removing the outliers.

Figure 2 Announcement Clustering



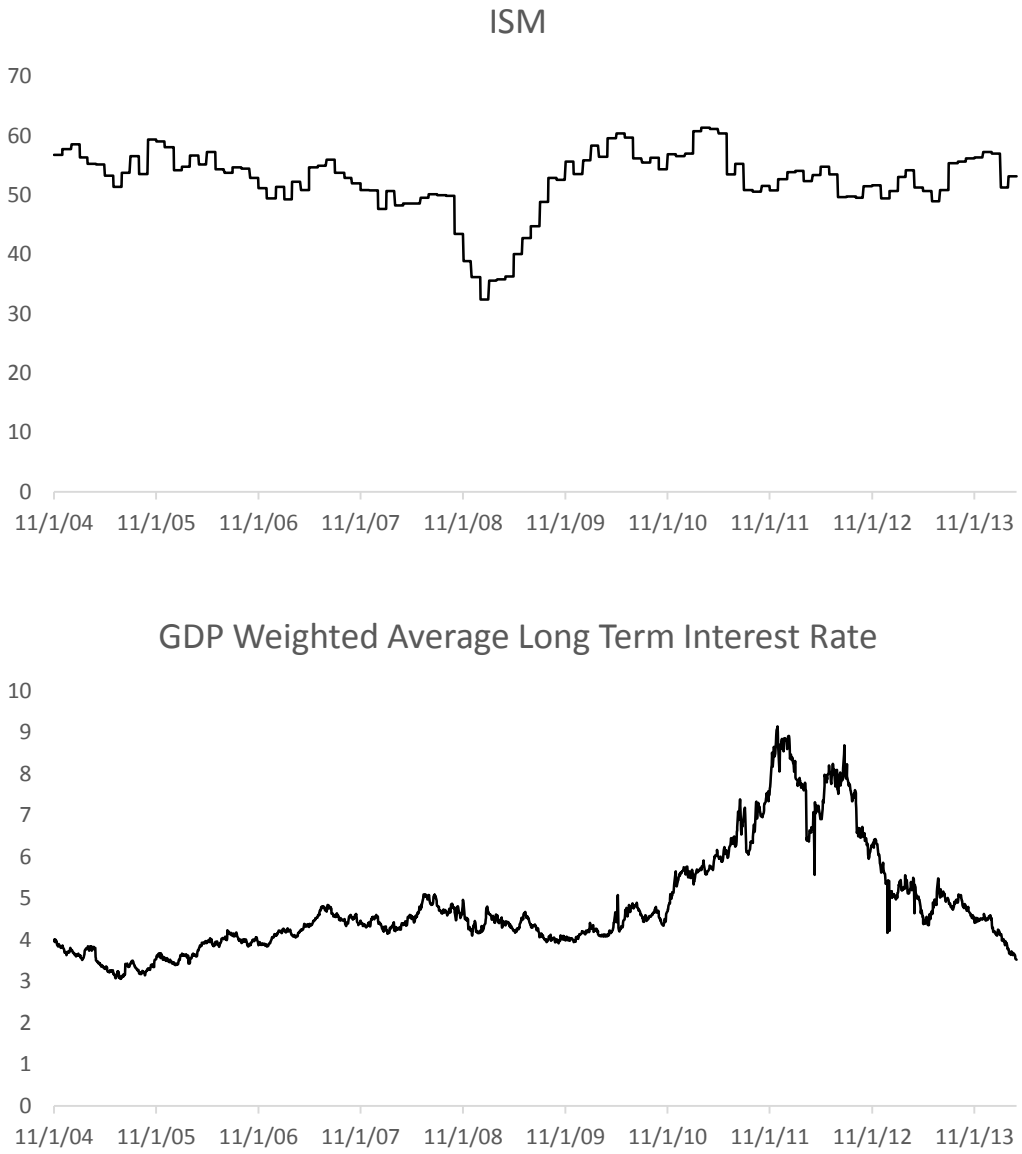
Notes: The figure plot the bar chart for the cumulated macroeconomic news announcements frequencies from Nov 1, 2004 to Oct 31, 2013. The news included here are the total number of valid news filtered by the first round of filtered introduced in section 4.1.2. The Vertical Axis is the number of announcements. The Horizontal Axis is the time a news announced stamped to minutes.

Figure 3: Autocorrelation Coefficients of Log Transformed Filtered Volatility



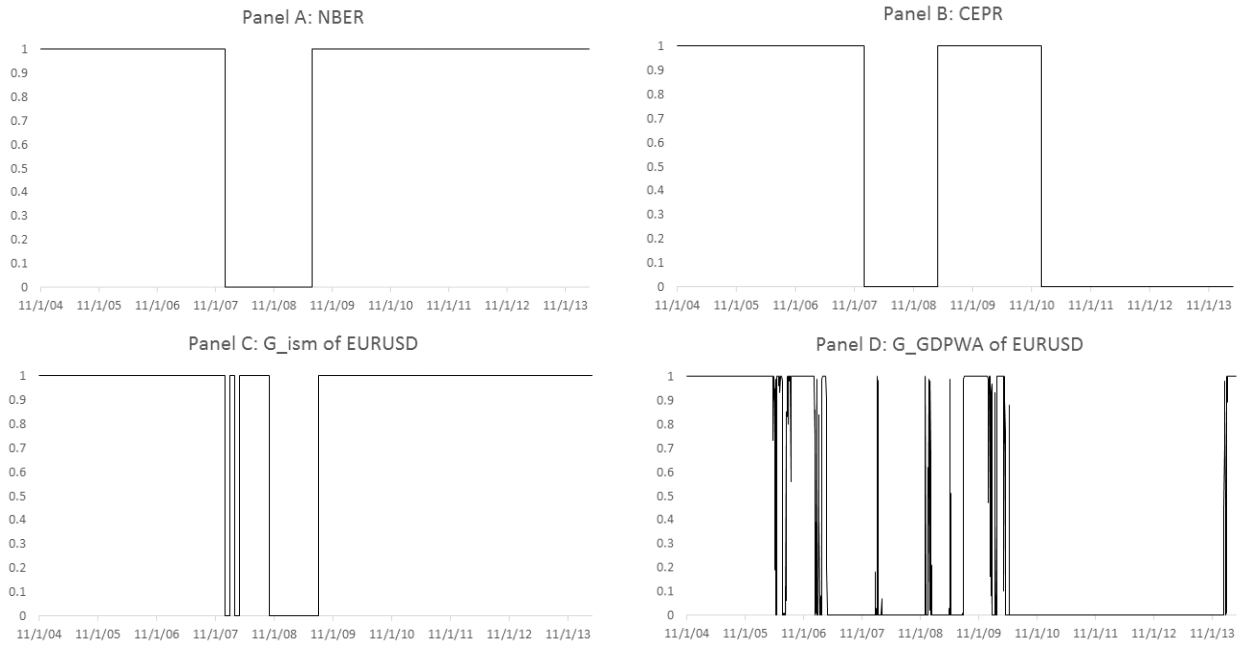
Notes: The figure shows the autocorrelation coefficients of the log transformed filtered volatility and original 5-min absolute returns for three currencies. The solid and dotted line denotes filtered and original volatility, and the dashed line provide the upper and lower bound constructed by Ljung-Box-Q statistic. Here the original volatility is calculated by taking the absolute value of 5-min return. In total, it shows 1500 5-min intervals which contains five day of correlogram since each day contain 288 intervals. Vertical axis shows the magnitude of autocorrelation coefficients.

Figure 4: Transition Variables



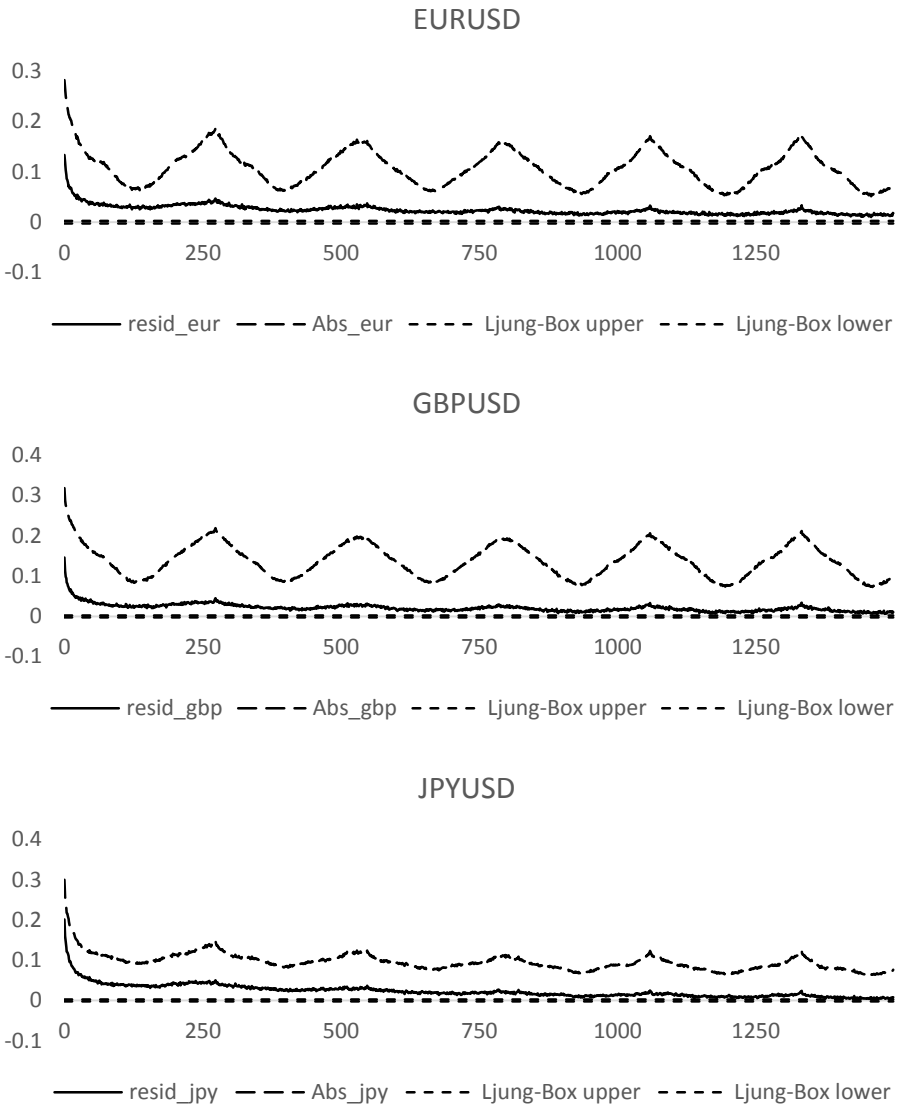
Notes: The figure plot the centered value of ISM and GDP Weighted Average Long Term Interest Rate. ISM (Institute of Supply Management) is manufacturing index for US business cycles. GDPWA is GDP weighted average over four Euro Zone countries that involve in Sovereign debt crisis: Italy, Spain, Portugal and Greece.

Figure 5: Transition Function vs Time



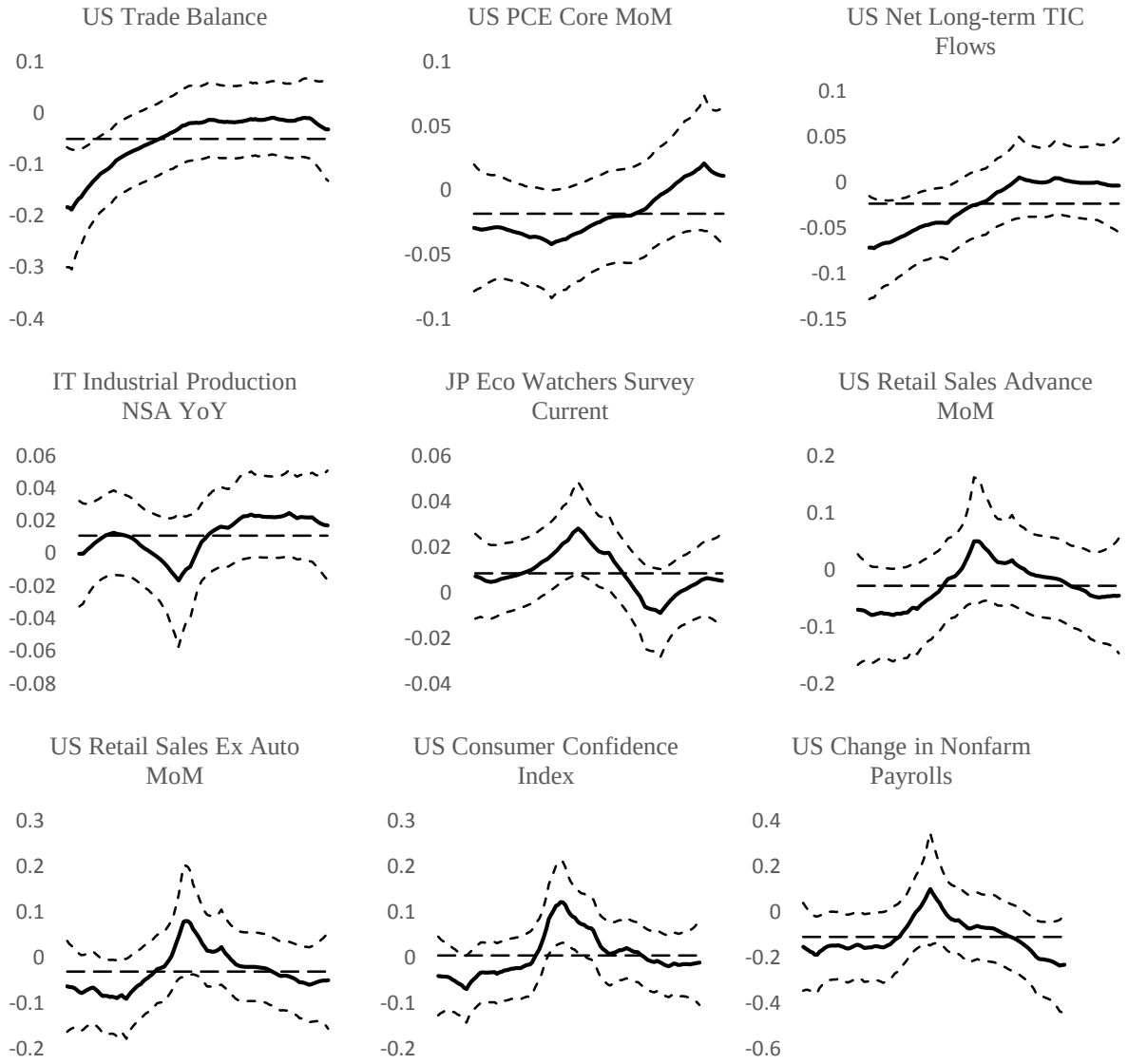
Notes: Table presents both the estimated economic transition for US and European economy from STR model and the predetermined indicative function NBER (The National Bureau of Economic Research) and CEPR (Centre for Economic Policy Research). Panel A & B show the graph plotting the indicative function according to the dates announced by NBER and CEPR regarding business cycle switching for US and Europe. Value of one and zero denotes expansion and recession respectively. Panel C & D illustrate the economic transition base on the fitted value of logistic transition function $G(t_{t,n}, \gamma, c)$ for US and Europe with corresponding transition variable: ISM and GDPWA. ISM (Institute of Supply Management) is manufacturing index for US business cycles. GDPWA is GDP weighted average over four Euro Zone countries that involve in Sovereign debt crisis: Italy, Spain, Portugal and Greece.

Figure 6: Autocorrelation Coefficients of Residual Term of Volatility Equation



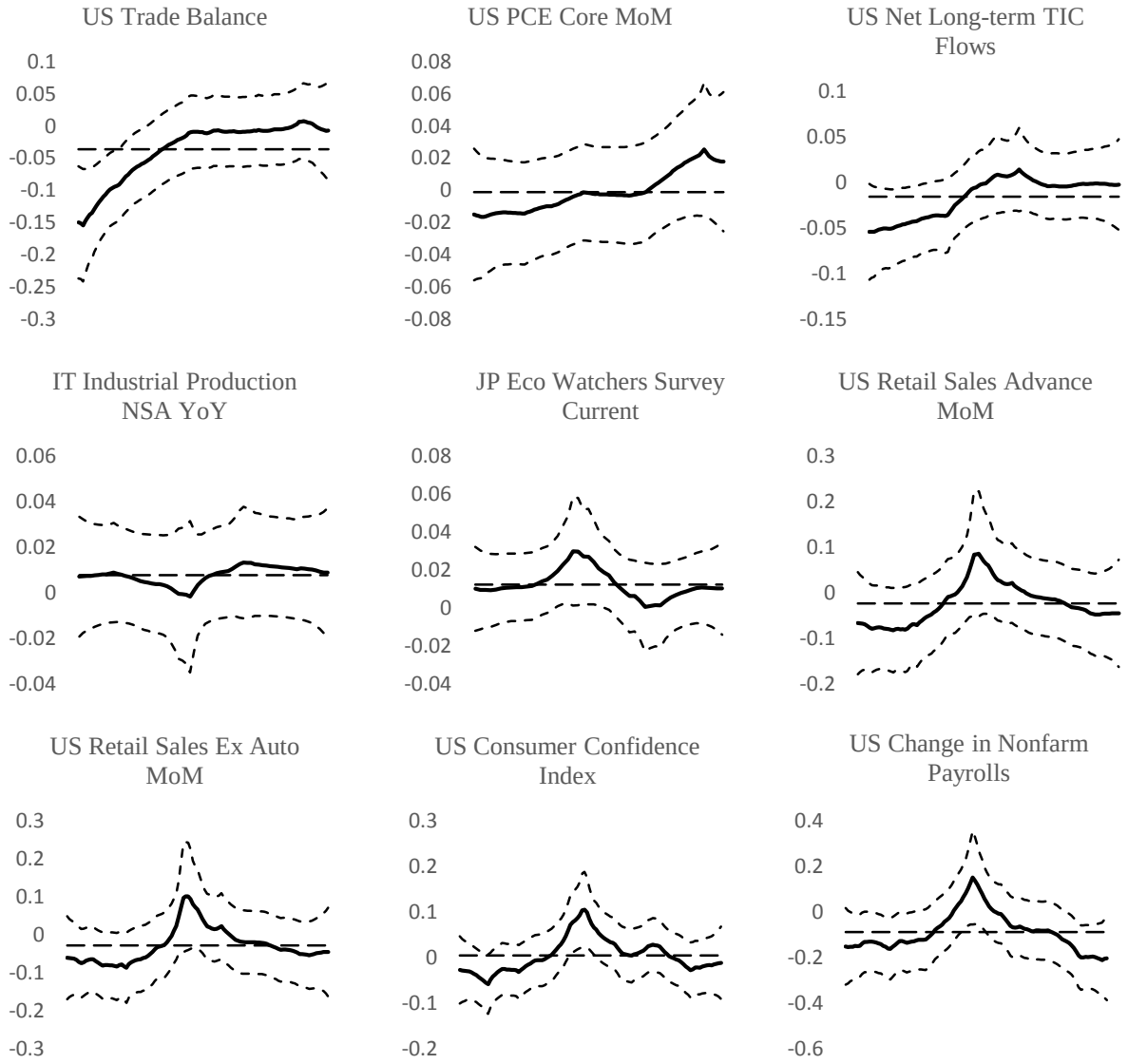
Notes: The figure shows the autocorrelation coefficients of the residual term in volatility equation (6) and original 5-min absolute returns for three currencies. The solid and dotted line denotes residual and absolute return respectively, and the dashed line provide the upper and lower bound constructed by Ljung-Box-Q statistic. In total, it shows 1500 5-min intervals which contains five days of correlogram since each day contain 288 intervals. Vertical axis shows the magnitude of autocorrelation coefficients.

Figure 7: Panel A - Parameter Path Estimates: EURUSD Return (Equation 9)



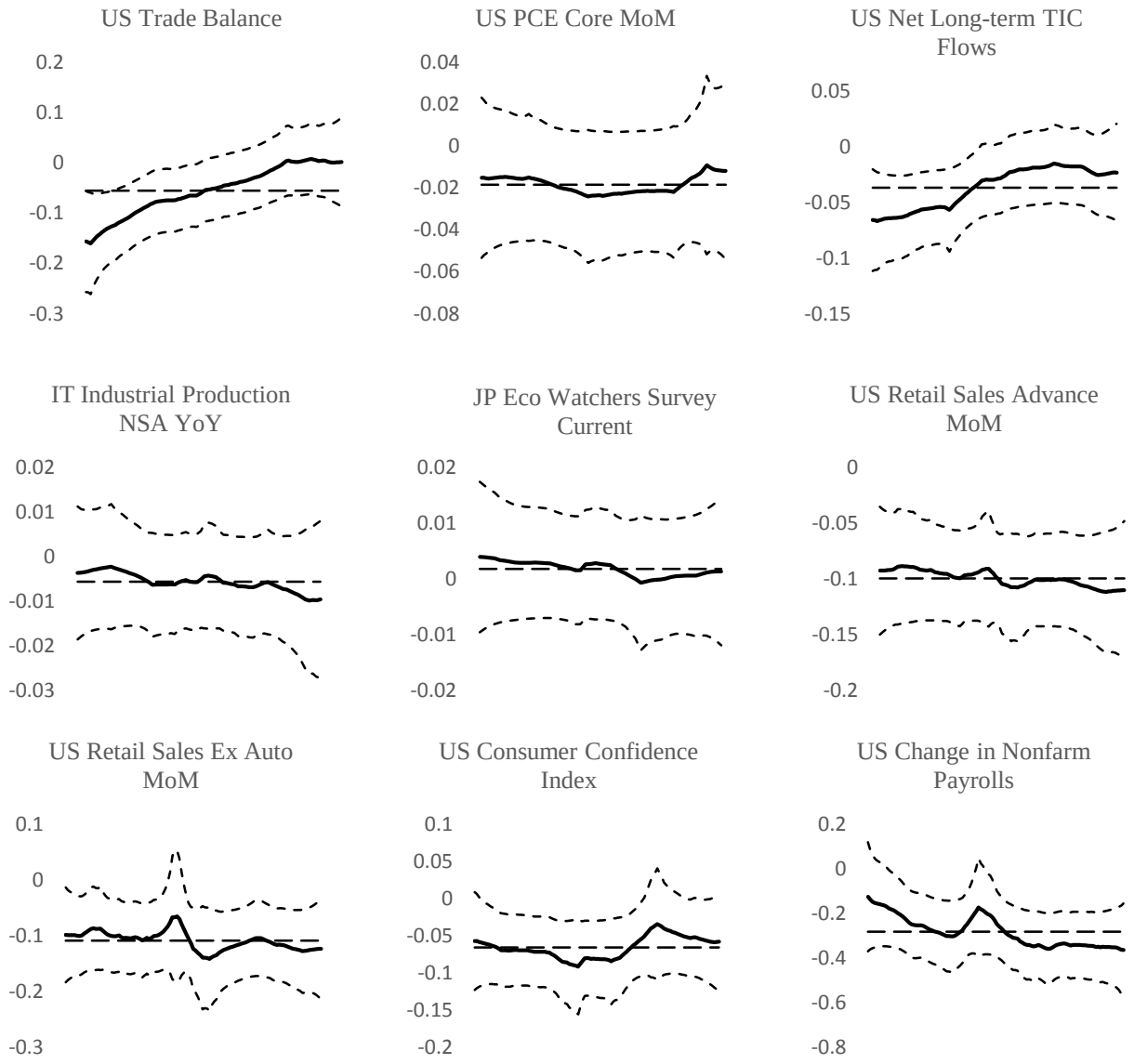
Notes: The graph represents the nine time varying news parameter path on return of Euro/Dollar with the most significant quasi local level test statistics. The parameter path are obtained by applying the method in section 3.4.2. The solid line is the parameter path; the dash line is the bound of 95% posterior probability interval with equal tail, which is not confidence interval in theory of frequentist; the long dashed line is the parameter estimates assuming constant news effects. Noted that some news are announced at the same time, for example, the change in nonfarm payrolls are announced at the same time with unemployment rate. In this case, we show path by assuming the other news being constant, because it is similar if we relax the assumption.

Figure 7: Panel B - Parameter Path Estimates: GBPUSD Return (Equation 9)



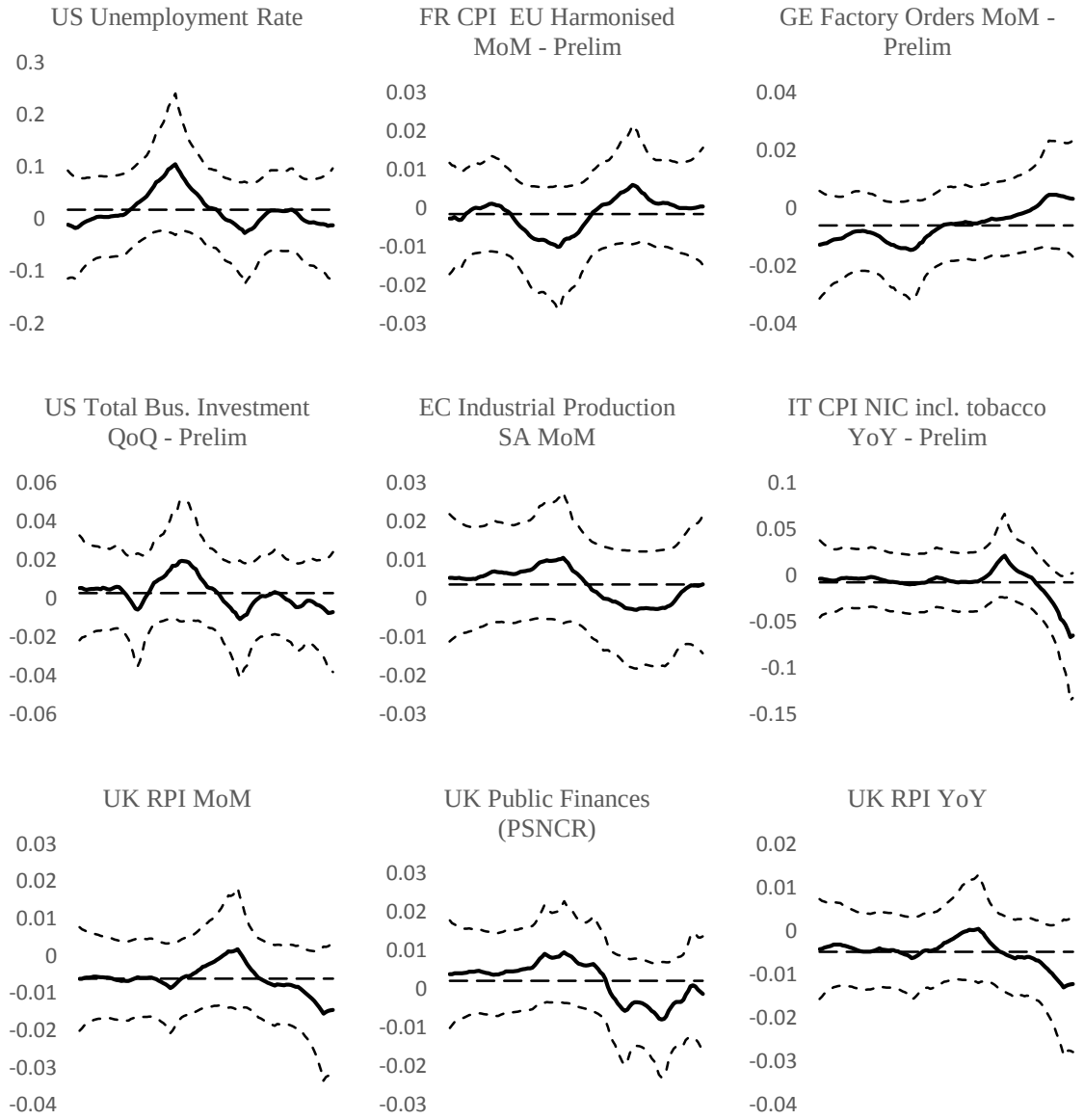
Notes: The graph represents the nine time varying news parameter path on return of Pound/Dollar with the most significant quasi local level test statistics. The parameter path are obtained by applying the method in section 3.4.2. The solid line is the parameter path; the dash line is the bound of 95% posterior probability interval with equal tail, which is not confidence interval in theory of frequentist; the long dashed line is the parameter estimates assuming constant news effects. Noted that some news are announced at the same time, for example, the change in nonfarm payrolls are announced at the same time with unemployment rate. In this case, we show path by assuming the other news being constant, because it is similar if we relax the assumption.

Figure 7: Panel C - Parameter Path Estimates: JPYUSD Return (Equation 9)



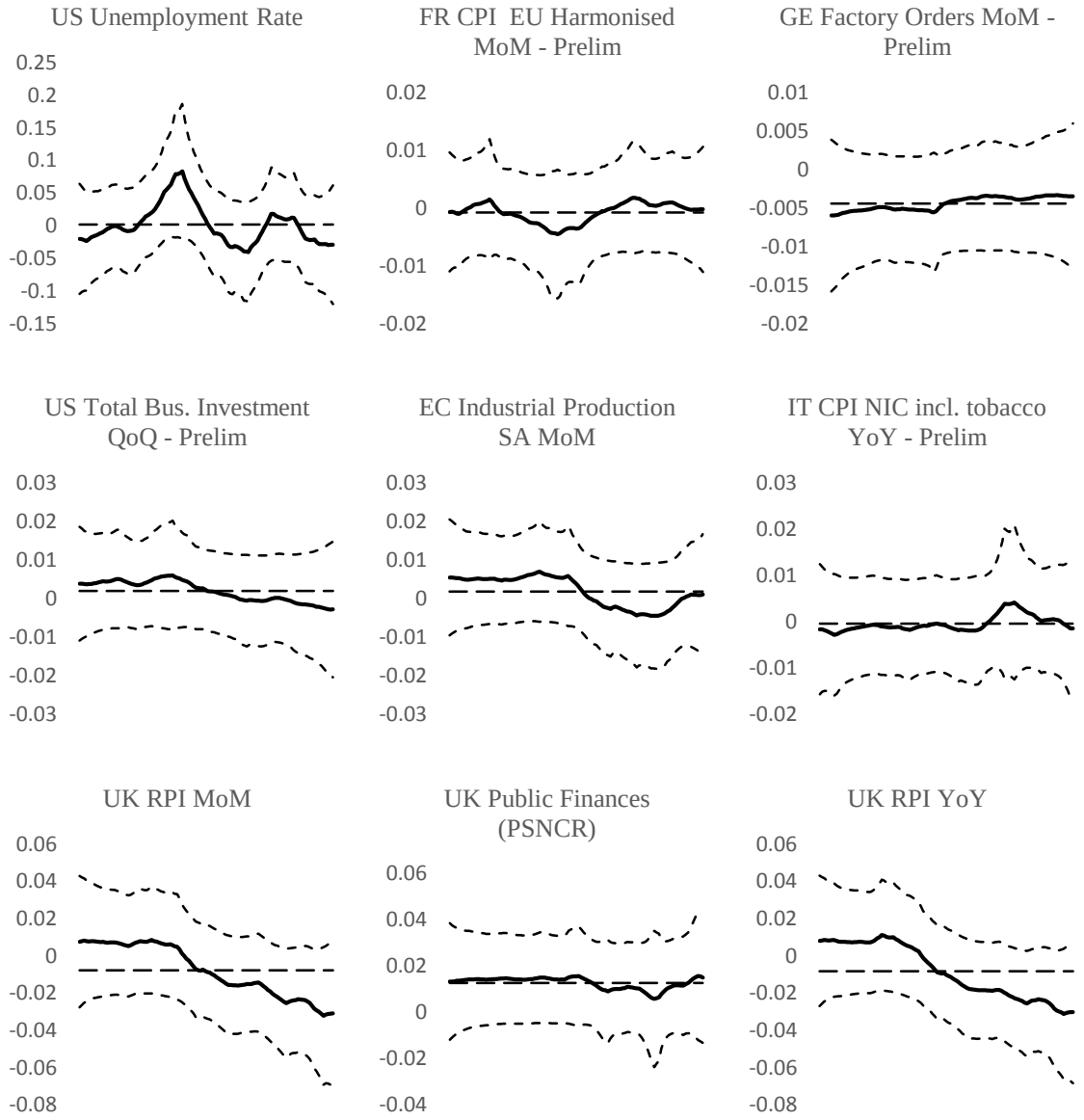
Notes: The graph represents the nine time varying news parameter path on return of Yen/Dollar with the most significant quasi local level test statistics. The parameter path are obtained by applying the method in section 3.4.2. The solid line is the parameter path; the dash line is the bound of 95% posterior probability interval with equal tail, which is not confidence interval in theory of frequentist; the long dashed line is the parameter estimates assuming constant news effects. Noted that some news are announced at the same time, for example, the change in nonfarm payrolls are announced at the same time with unemployment rate. In this case, we show path by assuming the other news being constant, because it is similar if we relax the assumption.

Figure 7: Panel D - Parameter Path Estimates: EURUSD Volatility (Equation 10)



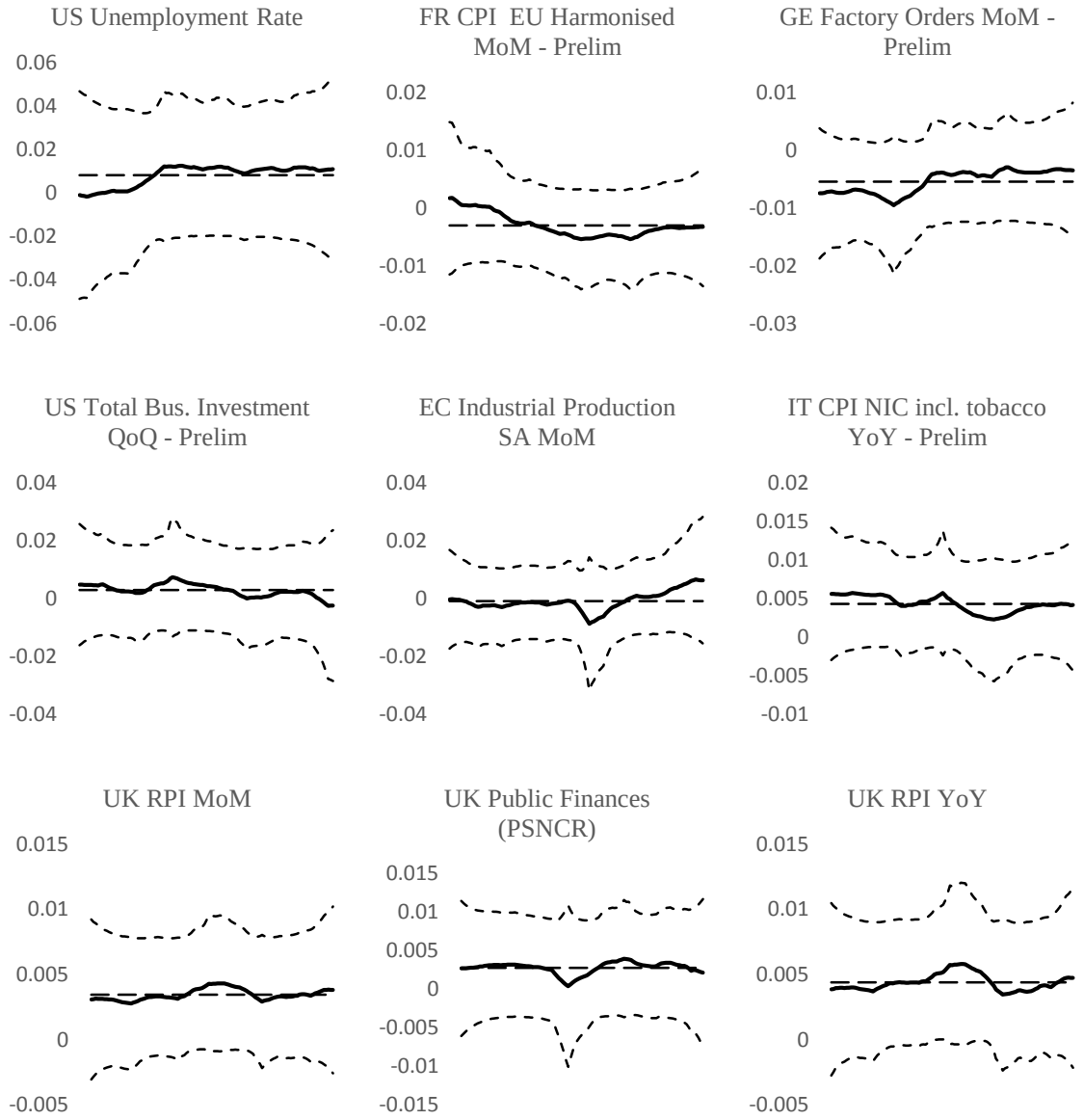
Notes: The graph represents the nine time varying news parameter path on volatility of Euro/Dollar with the most significant quasi local level test statistics. The parameter path are obtained by applying the method in section 3.4.2. The solid line is the parameter path; the dash line is the bound of 95% posterior probability interval with equal tail, which is not confidence interval in theory of frequentist; the long dashed line is the parameter estimates assuming constant news effects. Noted that some news are announced at the same time, for example, the change in nonfarm payrolls are announced at the same time with unemployment rate. In this case, we show path by assuming the other news being constant, because it is similar if we relax the assumption.

Figure 7: Panel E - Parameter Path Estimates: GBPUSD Volatility (Equation 10)



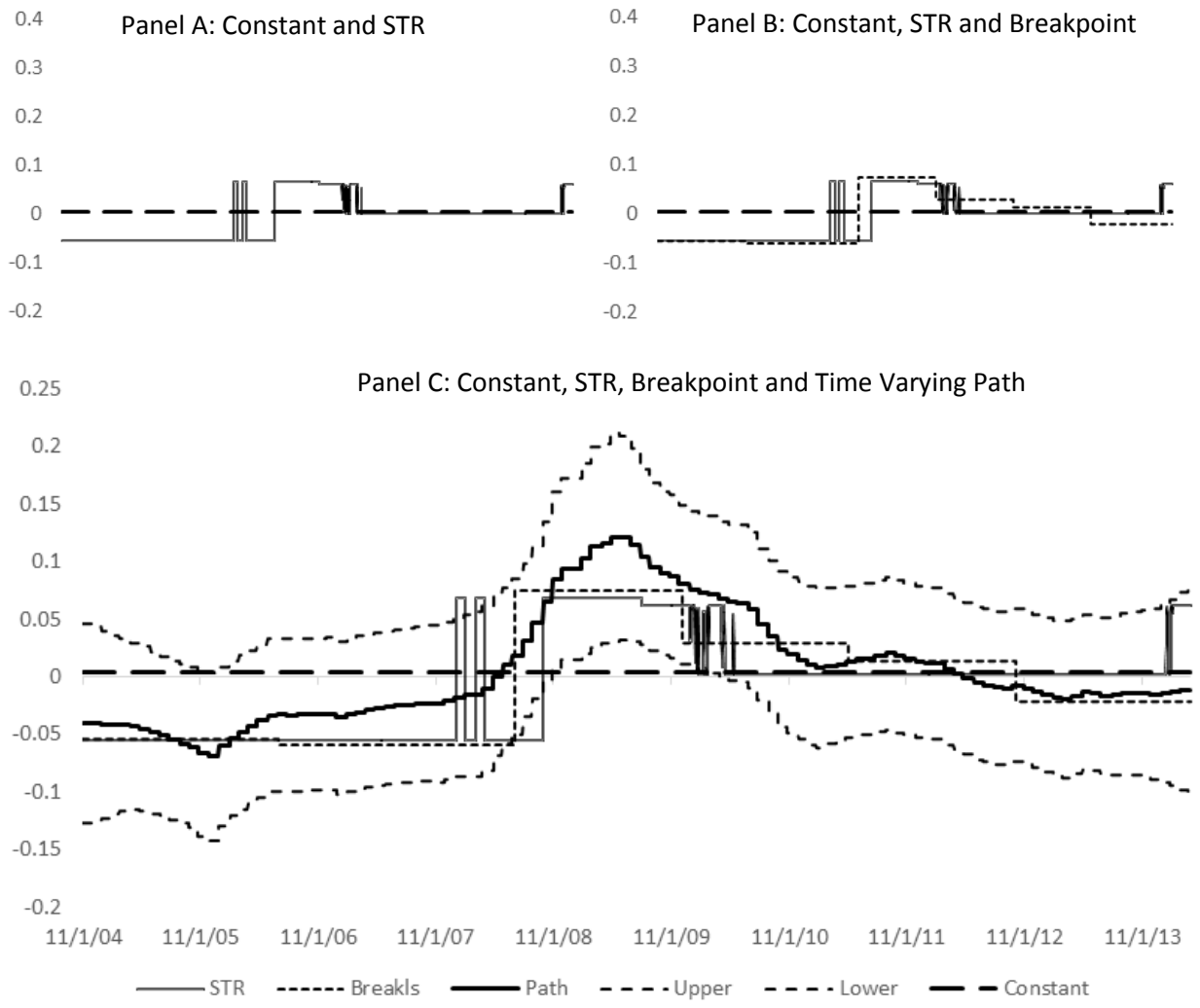
Notes: The graph represents the nine time varying news parameter path on volatility of Pound/Dollar with the most significant quasi local level test statistics. The parameter path are obtained by applying the method in section 3.4.2. The solid line is the parameter path; the dash line is the bound of 95% posterior probability interval with equal tail, which is not confidence interval in theory of frequentist; the long dashed line is the parameter estimates assuming constant news effects. Noted that some news are announced at the same time, for example, the change in nonfarm payrolls are announced at the same time with unemployment rate. In this case, we show path by assuming the other news being constant, because it is similar if we relax the assumption.

Figure 7: Panel F - Parameter Path Estimates: JPYUSD Volatility (Equation 10)



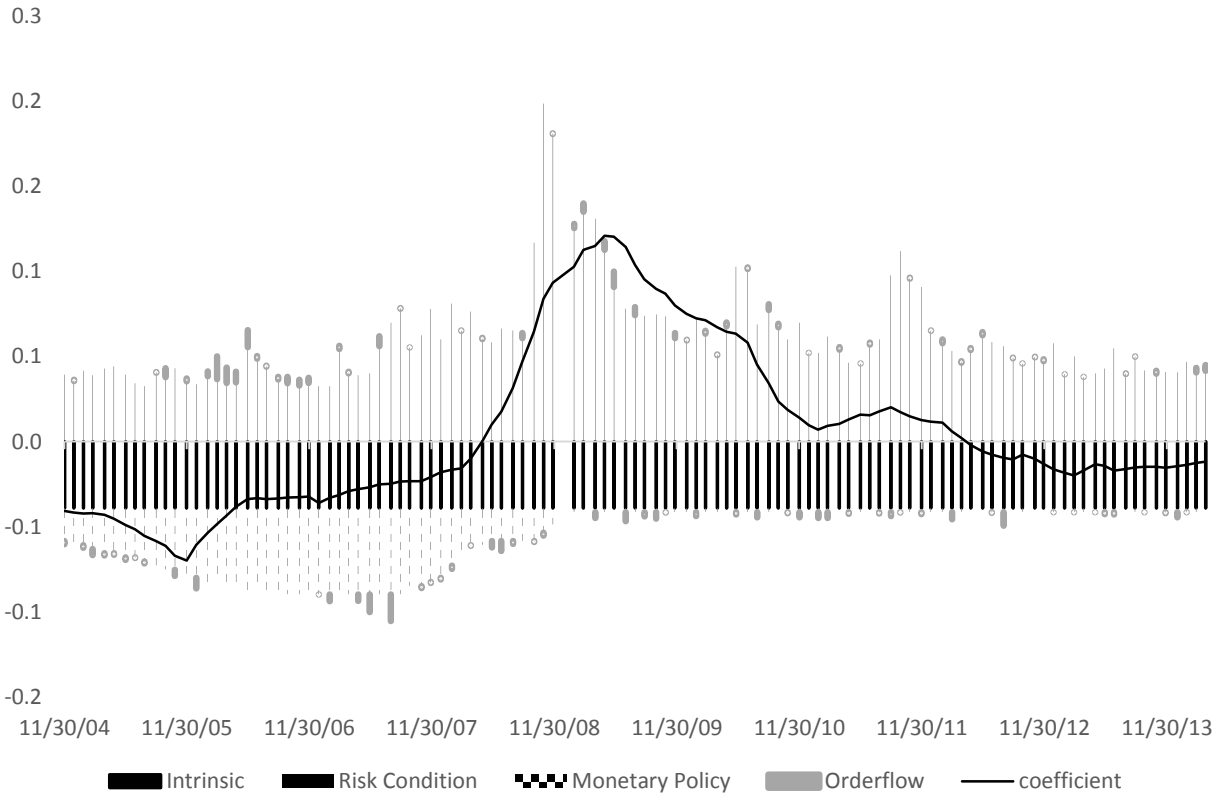
Notes: The graph represents the nine time varying news parameter path on volatility of Yen/Dollar with the most significant quasi local level test statistics. The parameter path are obtained by applying the method in section 3.4.2. The solid line is the parameter path; the dash line is the bound of 95% posterior probability interval with equal tail, which is not confidence interval in theory of frequentist; the long dashed line is the parameter estimates assuming constant news effects. Noted that some news are announced at the same time, for example, the change in nonfarm payrolls are announced at the same time with unemployment rate. In this case, we show path by assuming the other news being constant, because it is similar if we relax the assumption.

Figure 8: Parameter Path of US Consumer Confidence Index on EURUSD Return



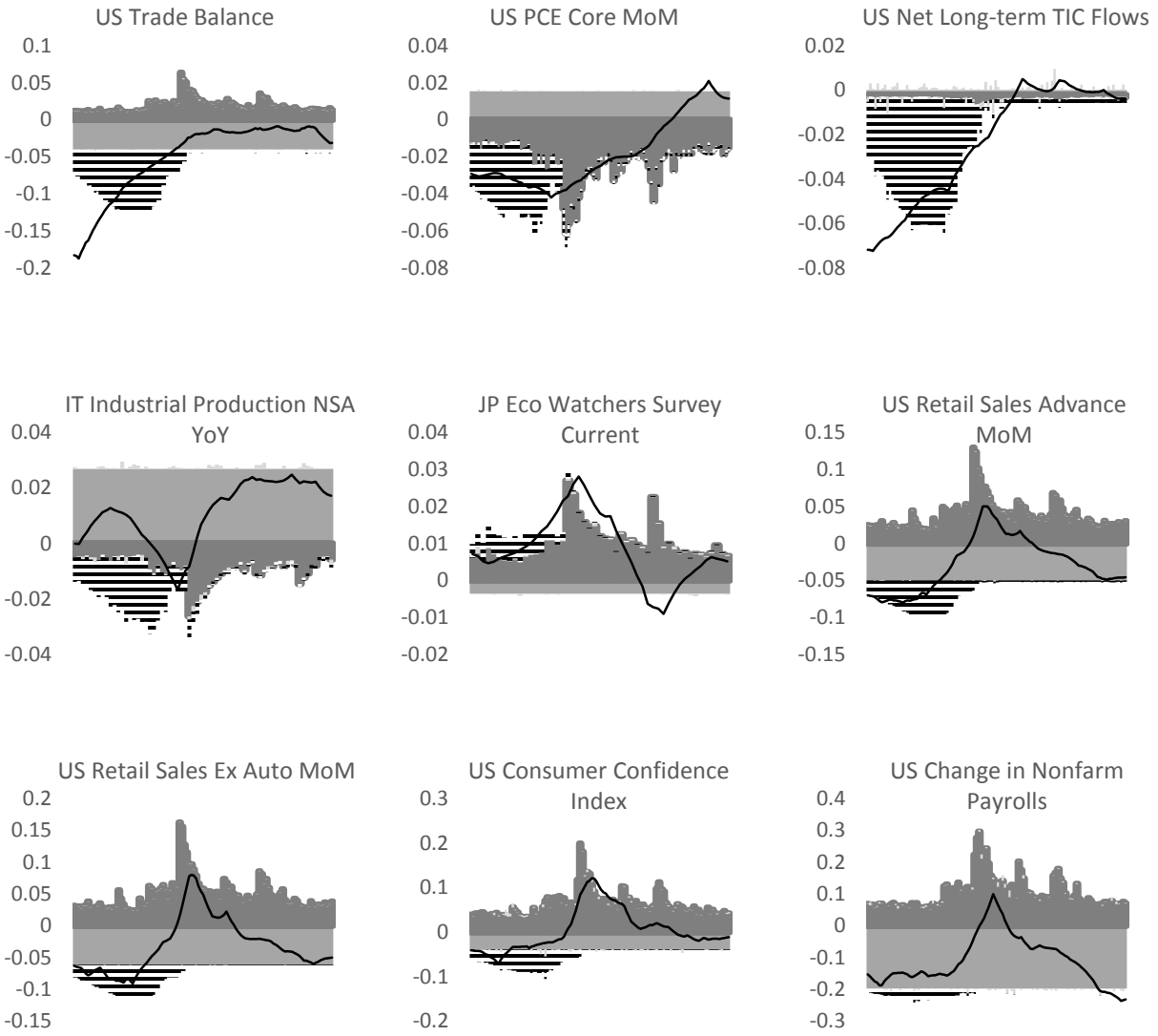
Notes: The graph plot the path of time varying effects of US consumer confidence Index on the return of Euro/Dollar over time according to the method introduced in section 3.4 associated with the results from STR and Breakpoint regression. Panel A contains the news parameters assuming constant effects and unstable parameters obtained from STR in equation (4). Panel B added the unstable effects obtained from Breakpoint regression model (7). Panel C added the time varying coefficients from efficient estimation method. Bold solid line denotes the path of the news effects; The upper and lower dash line show the interval of 95% posterior probability with equal tail of time varying news parameter path; slim solid line denotes the news effects from STR model; dotted line denotes the news effects obtained from Breakpoint regression model.; the long dashed line show the estimates of the news effects assuming constant effects. The analysis based on the news effect on 5-min return.

Figure 9: Decomposition of the effects of US Consumer Confidence Index on EURUSD Return



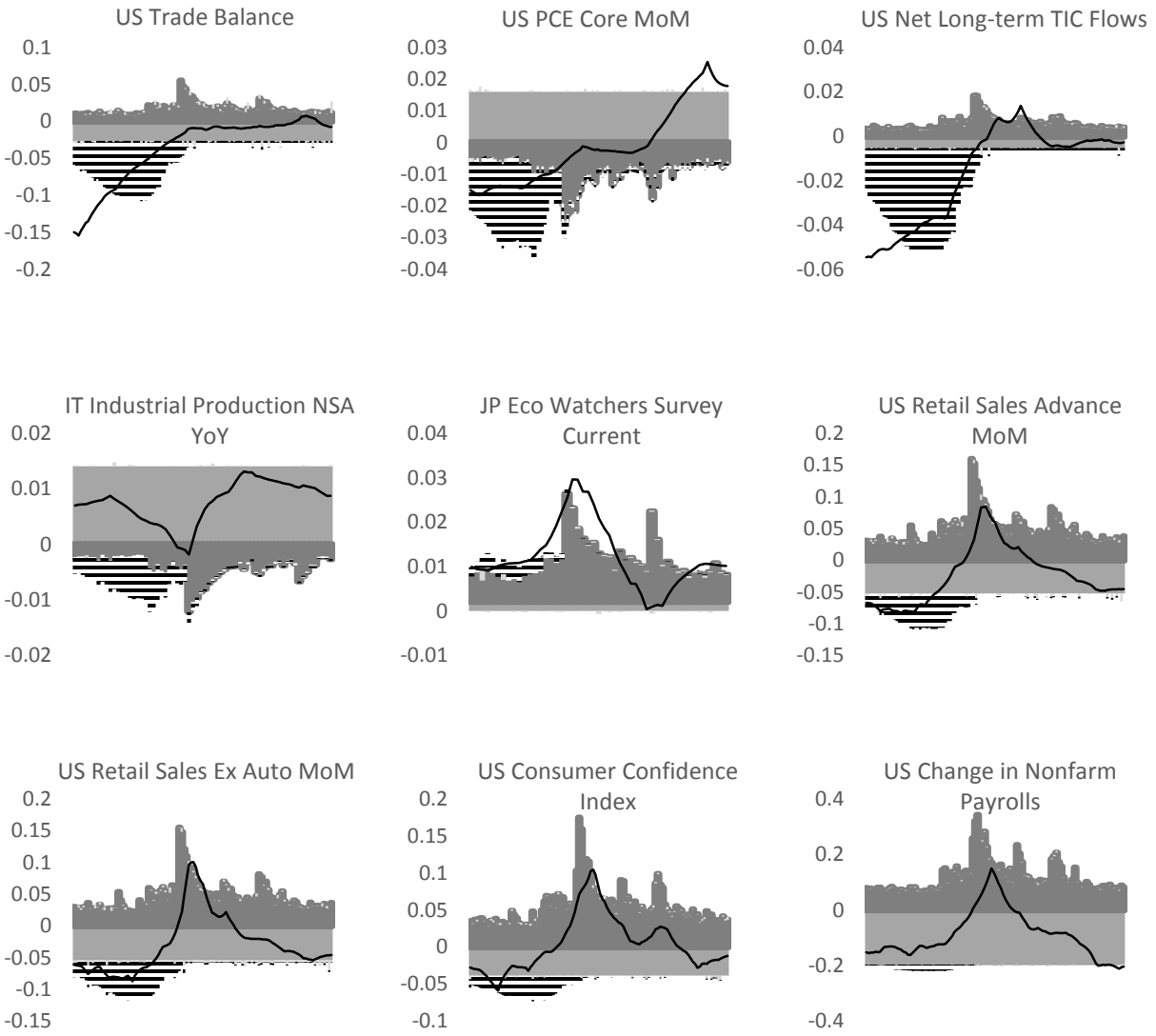
Notes: The graph decompose the news effects parameter path of US Consumer Confidence Index into four parts: Intrinsic news effect (Intercept), Risk Condition effect (VIX index), Policy Rate effect (Federal Fund Rate, FFR) and Order Flow effect according to Table 15. The solid line is the parameter path of US Consumer Confidence Index. Note that the coefficient of order flow is insignificant in Table 15, so it could not be found in the figure.

Figure 10: Panel A - Decomposition of Unstable News on EURUSD Return



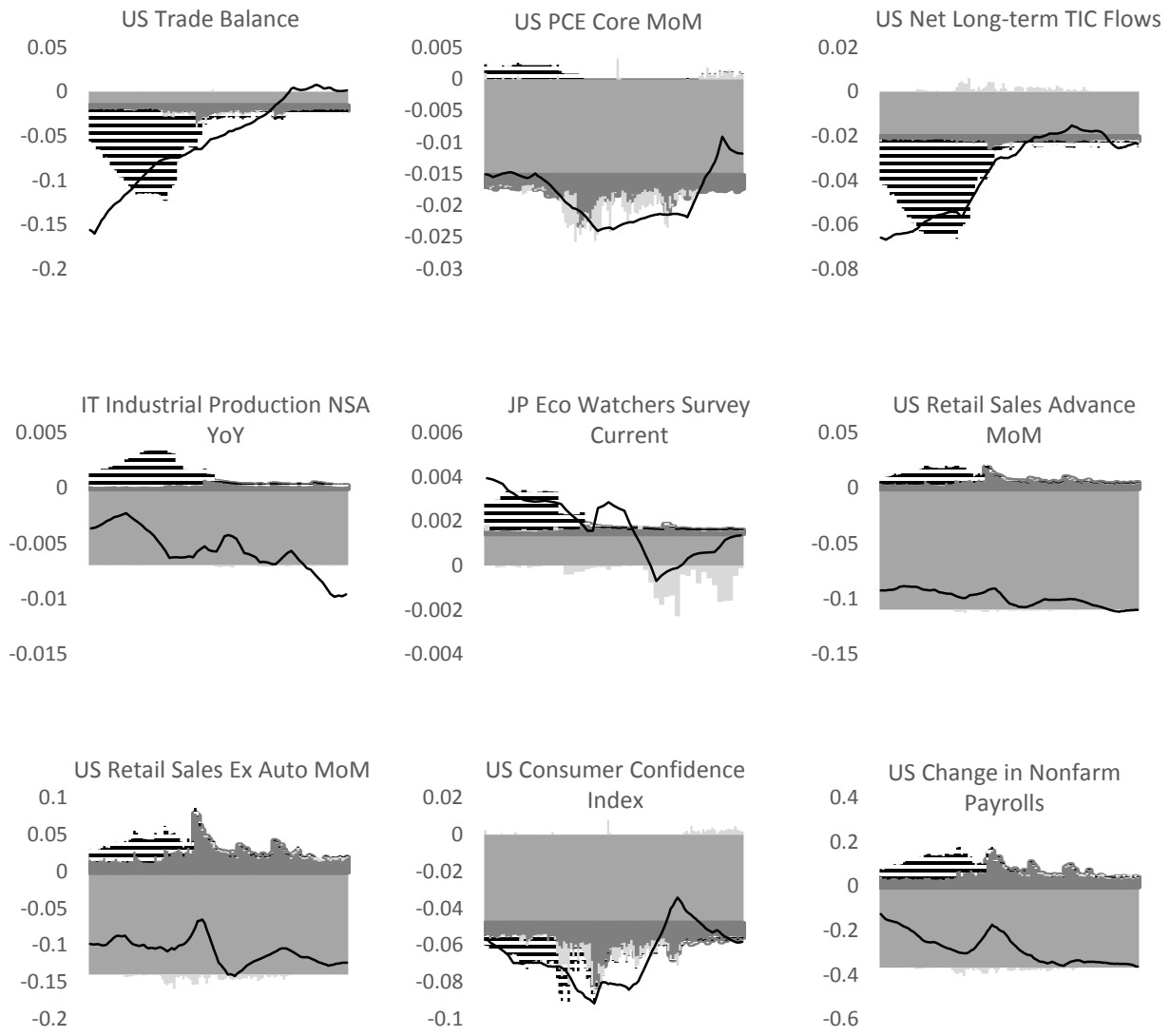
Notes: The graphs decompose the news parameter path for unstable effects on return of Euro/Dollar into four parts: news constant effect (Intercept), global risk effect (VIX index), central bank monetary policy effect (Federal Fund Rate, FFR) and Order Flow effect. Same as in Figure 9, the solid line is the parameter path of corresponding news effects. The lighter grey bar denotes for the component explained by central bank monetary policy. The dark grey bar and moderate grey bar denotes for the component explained by global risk and news constant effects.

Figure 10: Panel B - - Decomposition of Unstable News on GBPUSD Return



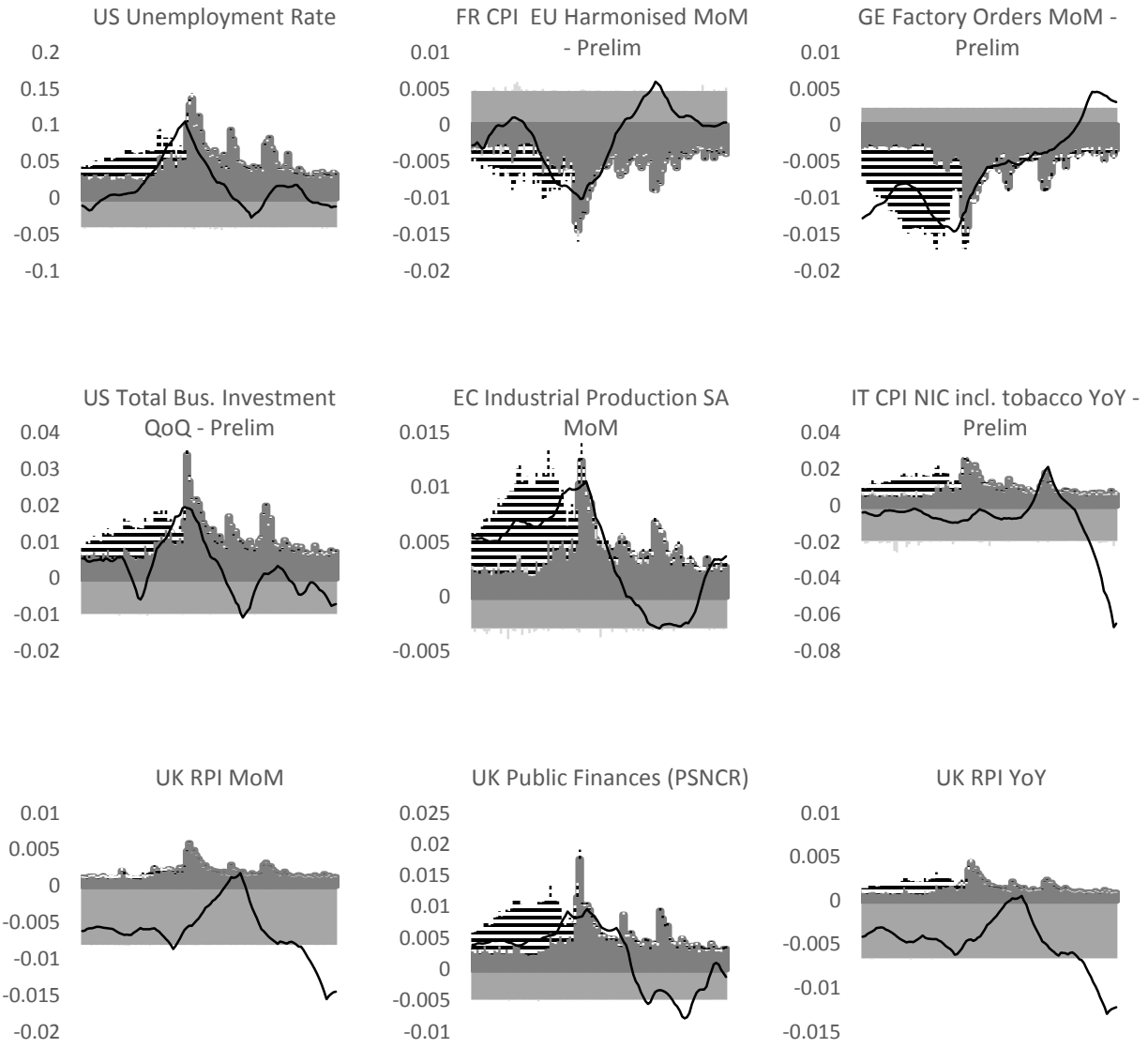
Notes: The graphs decompose the news parameter path for unstable effects on return of Pound/Dollar into four parts: news constant effect (Intercept), global risk effect (VIX index), central bank monetary policy effect (Federal Fund Rate, FFR) and Order Flow effect. Same as in Figure 9, the solid line is the parameter path of corresponding news effects. The lighter grey bar denotes for the component explained by central bank monetary policy. The dark grey bar and moderate grey bar denotes for the component explained by global risk and news constant effects.

Figure 10: Panel C - - Decomposition of Unstable News on JPYUSD Return



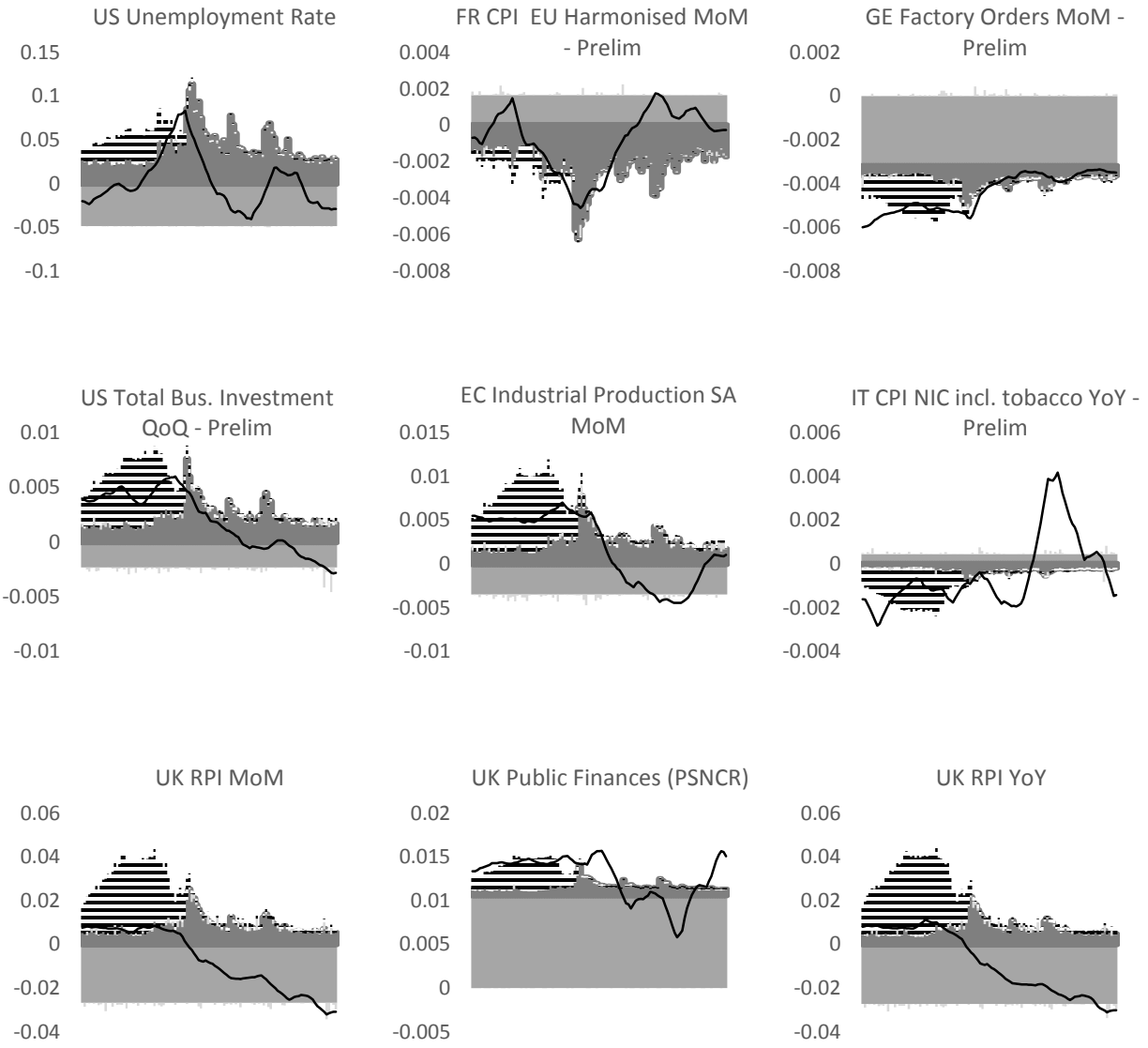
Notes: The graphs decompose the news parameter path for unstable effects on return of Yen/Dollar into four parts: news constant effect (Intercept), global risk effect (VIX index), central bank monetary policy effect (Federal Fund Rate, FFR) and Order Flow effect. Same as in Figure 9, the solid line is the parameter path of corresponding news effects. The lighter grey bar denotes for the component explained by central bank monetary policy. The dark grey bar and moderate grey bar denotes for the component explained by global risk and news constant effects.

Figure 10: Panel D - Decomposition of Unstable News on EURUSD Volatility



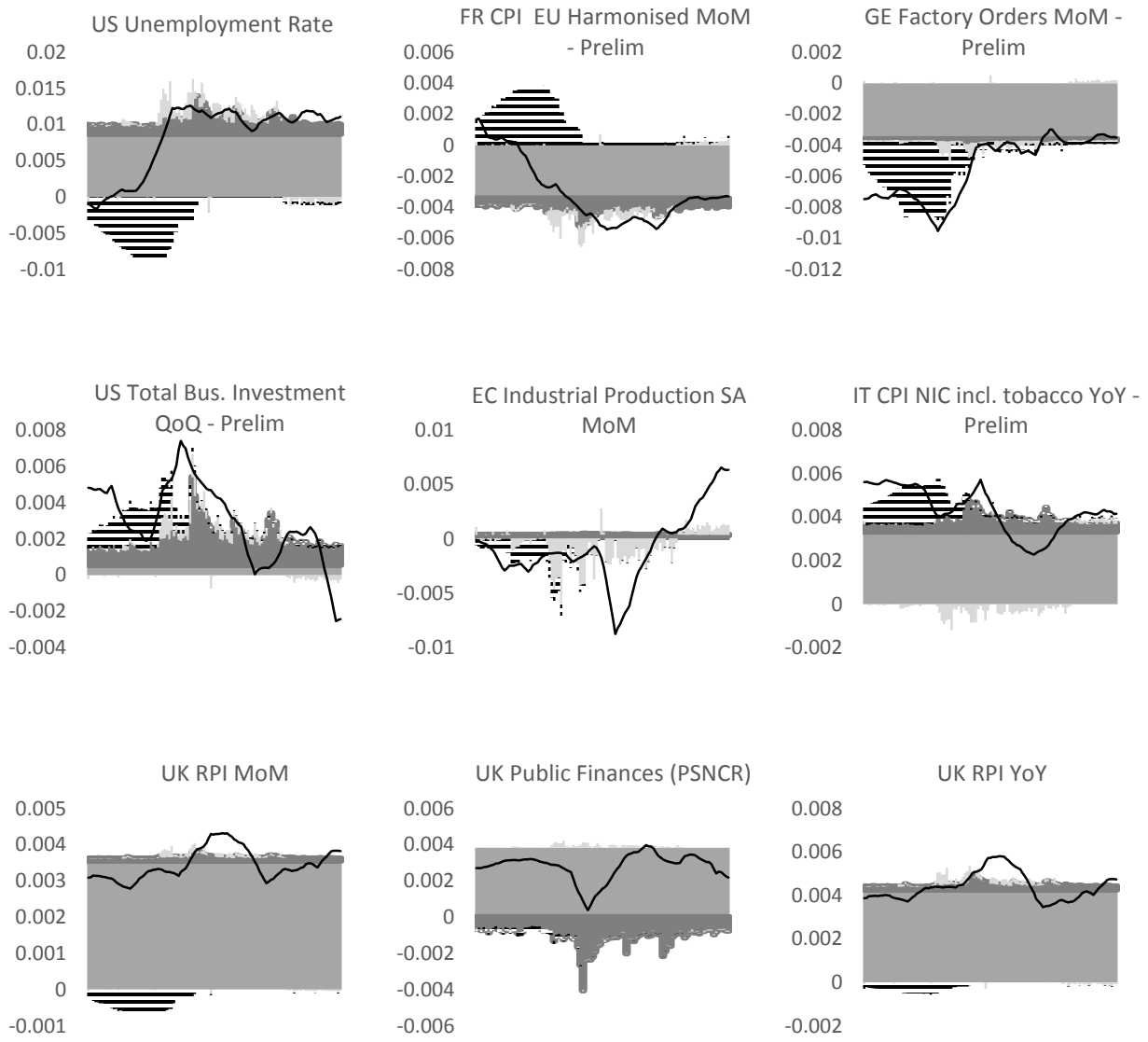
Notes: The graphs decompose the news parameter path for unstable effects on volatility of Euro/Dollar into four parts: news constant effect (Intercept), global risk effect (VIX index), central bank decision effect (Federal Fund Rate, FFR) and Order Flow effect. Same as in Figure 9, the solid line is the parameter path of corresponding news effects. The lighter grey bar denotes for the component explained by central bank decision effects. The dark and moderate grey bar denotes for the component explained by global risk and news constant effects.

Figure 10: Panel E - Decomposition of Unstable News on GBPUSD Volatility



Notes: The graphs decompose the news parameter path for unstable effects on volatility of Pound/Dollar into four parts: news constant effect (Intercept), global risk effect (VIX index), central bank decision effect (Federal Fund Rate, FFR) and Order Flow effect. Same as in Figure 9, the solid line is the parameter path of corresponding news effects. The lighter grey bar denotes for the component explained by central bank decision effects. The dark and moderate grey bar denotes for the component explained by global risk and news constant effects.

Figure 10: Panel F - Decomposition of Unstable News on JPYUSD Volatility



Notes: The graphs decompose the news parameter path for unstable effects on volatility of Yen/Dollar into four parts: news constant effect (Intercept), global risk effect (VIX index), central bank decision effect (Federal Fund Rate, FFR) and Order Flow effect. Same as in Figure 9, the solid line is the parameter path of corresponding news effects. The lighter grey bar denotes for the component explained by central bank decision effects. The dark and moderate grey bar denotes for the component explained by global risk and news constant effects.

Appendix A: The Components of STR Model

A.1 Log Filtered Volatility

The log transformed filtered volatility $\boldsymbol{y}_{t,n}$ is calculated by a strategy first suggested by Andersen and Bollerslev (1998), then completed by Laakkonen and Lanne (2009). They decompose the 5-min exchange rate volatility into three parts: a daily ARCH effect, intraday seasonality effects and announcement effects. Here, the volatility is the absolute centered 5-min return, and the structure imposed is:

$$\left|R_{t,n} - \bar{R}\right| = \frac{\sigma_t}{\sqrt{288}} h_{t,n} \nu_{t,n}$$

Where $R_{t,n}$ is 5-min exchange rate return, $\bar{R}$ is the sample mean of $R_{t,n}$, σ_t denotes the AR(2)-GARCH(1,1) one day ahead daily volatility (see discussion in appendix A.3), 288 is the total number of 5-min intervals per day, $h_{t,n}$ denotes the intraday seasonality and $\nu_{t,n}$ contains the rest of the volatility including announcement effects. To decompose these three parts, we square and take natural logs on both sides of equation:

$$2Ln\frac{\left|R_{t,n}-\bar{R}\right|}{\sigma_t/\sqrt{288}} = 2Ln\left(h_{t,n}\right) + 2Ln\left(\nu_{t,n}\right)$$

In our study, for the log filtered volatility, we keep only the announcement portion, so we apply Fourier Flexible Form (FFF) regression to capture the intraday seasonality:

$$l_{t,n} = \mu + \beta_1 n + \beta_2 n^2 + \sum_{d=1}^{d} \lambda_j I_{d,t,n} + \sum_{p=1}^{P}\left(\delta_{c,p} cos\left(\frac{2\pi p}{288} n\right) + \delta_{s,p} sin\left(\frac{2\pi p}{288} n\right)\right) + u_{t,n} \quad (15)$$

With $l_{t,n} = 2Ln\frac{\left|R_{t,n}-\bar{R}\right|}{\sigma_t/\sqrt{288}}$

Where I_d is the dummy capturing intraday calendar effects such as the Japan lunch effect, Japan open market effects and US Late summer afternoon effects characterized by Andersen & Bollerslev (1998). n and n^2 are normalizing factors, the sinusoids denotes the Flexible Fourier Form that capture the intraday periodicity pattern. We choose p=4 according to Schwarz and Akaike information criteria. Laakkonen and Lanne (2009) report that the estimation of (15) should be taken weekly since the intraday seasonality pattern is time varying. After the estimation of equation (15), we calculate the intraday seasonal factor by:

$$s_{t,n} = \hat{h}_{t,n} / \bar{\hat{h}}_{t,n}$$

Where $s_{t,n}$ is the intraday seasonal factor, $\hat{h}_{t,n}$ is the fitted value obtained from $\hat{h}_{t,n} = \exp(\hat{l}_{t,n}/2)$, $\bar{\hat{h}}_{t,n}$ is the sample average of $\hat{h}_{t,n}$. From $s_{t,n}$, we can calculate the filtered 5-min return, $\tilde{R}_{t,n} = R_{t,n}/s_{t,n}$, and thus obtain the log transformed filtered volatility by: $\boldsymbol{y}_{t,n} = 2Ln\frac{|\tilde{R}_{t,n}-\bar{R}|}{\sigma_t/\sqrt{288}}$.

A.2 Consolidated Macroeconomic News Announcement

Here we assume each news announcement has similar impact on exchange rate volatility and therefore we combine all the news together as one vector. Andersen et al. (2003) report that the volatility response of the news disappear gradually within two hours and that there is a similar decay pattern for all the news. The pattern can be captured by third order polynomial structure:

$$\eta(j) = c_0(1-(j/J)^3) + c_1(1-(j/J)^2)\,j + \cdots + c_2(1-(j/J))\,j^2$$

Where j = 1,2,…25 is the number of interval after announcement. J=25 is the interval after two hours. C is the coefficient of the polynomial function, η(j) measure the effects of the announcement on volatility, so it is calculated by using the average volatility after j intervals minus the total sample average volatility. To fully capture the effects on volatility, we use the estimated η̂(j) replace the 25 intervals right after announcement and zero otherwise. The estimated polynomial decay structure for US crisis sample is provided in Figure 4, with (c_0, c_1, c_2) = (0.0552, -0.0105, 0.0007).

A.3 Daily ARCH Effects

Andersen & Bollerslev (1998) characterize the 5-min volatility into three part: daily ARCH, intraday seasonality and other. The ARCH model effectively the captures the daily exchange rate return and they claim that these daily ARCH effects still exist in 5-min intervals. Here we discuss how to characterize these daily ARCH effects.

From previous literature, the macroeconomic model fails to outperform random walk model (Meese & Rogoff, 1983a) for forecasting the level of spot exchange rates, so Andersen & Bollerslev (1998) conjecture the spot exchange rate follows an ito process:

$$d\log(\mathrm{P}_\tau) = \mu_\tau d\tau + \sigma_\tau dB_\tau \ ,$$

Where P_τ denotes the exchange rate level at time τ, μ_τ is the drift and B_τ is standard Brownian motion. Since the mean value of exchange rate return is close to zero, we can suppose μ_τ to be zero, then the 5-min volatility can be expressed as:

$$E\left(\left|R_{t,n} - \mu_\tau\right|\right) = \Delta * \sigma_{t+n/N} \ ,$$

Where $\Delta = \sqrt{2\pi/N}$ is a constant, N=288 is the total number of intervals. Therefore, we assume the daily level volatility is persistent throughout the day:

$$\hat{\sigma}_{t,n} = \hat{\sigma}_t/\sqrt{N},$$

Where $\hat{\sigma}_t$ is one day ahead volatility from AR(2) – GARCH(1,1) model. This is one of the explanatory variables standing for the daily ARCH effects in equation (6)

A.4 Polynomial Decay Structure of Response Pattern

Compared to return response, the impact of the news on volatility takes a longer time. This is the reason that we choose J' equals to 24 as long as two hours in model (6). However, considering the wider range of news from our data set, if we apply the traditional way to list the full range of J'th lag surprise term or pure news dummies, the parameter estimates will be inefficient. To avoid this problem, Andersen & Bollerslev (1998) propose a polynomial structural to capture the average news impact on volatility by the equation:

$$\eta(j) = \mathrm{c}_0 + \mathrm{c}_1 * j + \mathrm{c}_2 * j^2 + \cdots + \mathrm{c}_\mathrm{p} * j^p$$

Where j=1,2,…J denotes the length of event window, $\eta(j)$ signifies the average volatility j intervals after the news announcement subtracting the total sample average volatility. P denotes the order of polynomial which defines the accuracy of the specification. If p=J, it will capture the pattern exactly, whereas we prefer a lower order specification which allows a greater level of flexibility (Andersen & Bollerslev, 1998). In addition, we restrict $\eta(J)$=0 to show that the news impact was disappear smoothly after J intervals. Through some mathematical transformations, we obtained a reduced form which ensures $\eta(j)$=0 when j=J:

$$\eta(j) = \mathrm{c}_0(1 - (\mathrm{j}/\mathrm{J})^\mathrm{p}) + \ \mathrm{c}_1(1 - (\mathrm{j}/\mathrm{J})^{\mathrm{p}-1})\ \mathrm{j} + \cdots + \mathrm{c}_{\mathrm{p}-1}(1 - (\mathrm{j}/\mathrm{J}))\ \mathrm{j}^{\mathrm{p}-1}$$

Assuming one unique average volatility pattern for all the news, we impose the polynomial structure on each news surprise and pure news dummies, then we only need one parameter coefficient for each variable: $\vartheta_{k,j} = \xi_k * \eta(j)$, where $\vartheta_{k,j}$ is the response pattern for news k, and ξ_k is the specific factor loading for each different news. Therefore, the volatility response in interval j can be obtained by $\vartheta_{k,j}$, and the cumulated volatility response equals $\sum_{j=1}^{J} \vartheta_{k,j}$.

Appendix B: Description of the Macroeconomic News

In this appendix, we provide the brief introduction for macroeconomic news. Description is the introduction for the macroeconomic news. Usual Effect is the criteria to judge economic interpretation for news surprise. Advance/Preliminary/Final denotes Advance, Preliminary and Final report for a certain news that announced for several time with revision of the figures. SA/NSA means Seasonal Adjusted or Non Seasonal Adjusted figures. YoY, MoM, QoQ denotes the comparison between the current released figure and the previous figure Year over Year, Month over Month, Quarter over Quarter. WDA denotes for Weighted Density Approximation. The source are Bloomberg and www.Forexfactory.com.

Country	Macroeconomic News	Description	Usual Effect
US	ADP Employment Change	Estimated change in the number of employed people during the previous month, excluding the farming industry and government;	Actual > Forecast = Good for currency;
US	Avg Hourly Earning MOM Prod	Change in the price businesses pay for labor, excluding the farming industry;	Actual > Forecast = Good for currency;
US	Avg Weekly Hours Production	measures the aggregate number of hours	Actual > Forecast = Good for currency;
US	Business Inventories	Change in the total value of goods held in inventory by manufacturers, wholesalers, and retailers;	Actual < Forecast = Good for currency;
US	Change in Nonfarm Payrolls	Measures the number of employees on business payrolls. It is also sometimes referred to as establishment survey employment to distinguish it from the household survey measure of employment	Actual > Forecast = Good for currency;
US	Chicago Purchasing Manager	Level of a diffusion index based on surveyed purchasing managers in the Chicago area;	Actual > Forecast = Good for currency;
US	Construction Spending MoM	Change in the total amount builders spent on construction projects;	Actual > Forecast = Good for currency;
US	Consumer Confidence Index	Level of a composite index based on surveyed households;	Actual > Forecast = Good for currency;
US	Core PCE QoQ - Advance	Is defined as personal consumption expenditures (PCE) prices excluding food and energy prices.	Actual > Forecast = Good for currency;
US	Core PCE QoQ - Preliminary	Is defined as personal consumption expenditures (PCE) prices excluding food and energy prices.	Actual > Forecast = Good for currency;
US	CPI Ex Food and Energy MoM	CPI excluding Food and Energy part.	Actual > Forecast = Good for currency;

US	Durables Ex Transportation	Tracks the volume of new orders for duranble goods excluding transportation received during the reference period. Orders are typically based on a legal agreement between two parties in which the producer will deliver goods or services to the purchaser at a future date.	Actual > Forecast = Good for currency;
US	FOMC Rate Decision	A target interest rate set by federal reserve in its efforts to influence short-term interest rates as part of its monetary policy strategy.	Actual > Forecast = Good for currency;
US	Empire Manufacturing	Level of a diffusion index based on surveyed manufacturers in New York state;	Actual > Forecast = Good for currency;
US	Factory Orders	Change in the total value of new purchase orders placed with manufacturers;	Actual > Forecast = Good for currency;
US	Existing Home Sales	Annualized number of residential buildings that were sold during the previous month, excluding new construction;	Actual > Forecast = Good for currency;
US	GDP Annualized QoQ - Advance	Measures the final market value of all goods and services produced within a country. It is the most frequently used indicator of economic activity. The GDP by expenditure approach measures total final expenditures (at purchasers' prices), including exports less imports. This concept is adjusted for inflation.	Actual > Forecast = Good for currency;
US	GDP Annualized QoQ - Preliminary	Measures the final market value of all goods and services produced within a country. It is the most frequently used indicator of economic activity. The GDP by expenditure approach measures total final expenditures (at purchasers' prices), including exports less imports. This concept is adjusted for inflation.	Actual > Forecast = Good for currency;
US	Housing Starts	Annualized number of new residential buildings that began construction during the previous month;	Actual > Forecast = Good for currency;
US	IBD/TIPP Economic Optimism	Level of a diffusion index based on surveyed consumers;	Actual > Forecast = Good for currency;
US	Import Price Index MoM	Change in the price of imported goods and services purchased domestically;	Actual > Forecast = Good for currency;
US	Industrial Production MoM	Change in the total inflation-adjusted value of output produced by manufacturers, mines, and utilities;	Actual > Forecast = Good for currency;

US	Initial Jobless Claims	Track the number of people who have filed jobless claims for the first time during the specified period with the appropriate government labor office. This number represents an inflow of people receiving unemployment benefits	Actual < Forecast = Good for currency;
US	ISM Manufacturing	Level of a diffusion index based on surveyed purchasing managers in the manufacturing industry;	Actual > Forecast = Good for currency;
US	ISM Milwaukee	ISM data issued by NAPM-Milwaukee	Actual > Forecast = Good for currency;
US	ISM Non-Manf. Composite	ISM release for Non-Manufacturing industry	Actual > Forecast = Good for currency;
US	Net Long-term TIC Flows	Difference in value between foreign long-term securities purchased by US citizens and US long-term securities purchased by foreigners during the reported period;	Actual > Forecast = Good for currency;
US	Minutes of FOMC Meeting	Meeting Minutes for FOMC meeting	More hawkish than expected = Good for currency;
US	NAHB Housing Market Index	Level of a diffusion index based on surveyed home builders;	Actual > Forecast = Good for currency;
US	New Home Sales	Annualized number of new single-family homes that were sold during the previous month;	Actual > Forecast = Good for currency;
US	Nonfarm Productivity - Final	Tracks the total output that can be produced with a given input of labor. Generally it is measured by dividing total real gross domestic product by either total employment or total hours worked.	Actual > Forecast = Good for currency;
US	Nonfarm Productivity - Preliminary	Tracks the total output that can be produced with a given input of labor. Generally it is measured by dividing total real gross domestic product by either total employment or total hours worked.	Actual > Forecast = Good for currency;
US	PCE Core MoM	Change in the price of goods and services purchased by consumers, excluding food and energy;	Actual > Forecast = Good for currency;
US	Pending Home Sales MoM	Change in the number of homes under contract to be sold but still awaiting the closing transaction, excluding new construction;	Actual > Forecast = Good for currency;
US	Personal Consumption - Preliminary	The personal Consumption part in GDP	Actual > Forecast = Good for currency;
US	Personal Spending	Change in the inflation-adjusted value of all expenditures by consumers;	Actual > Forecast = Good for currency;
US	Philadelphia Fed Business Outlook	This survey, conducted on a monthly basis by the Federal Reserve Bank of Philadelphia, tracks sentiment among manufacturers in the Philadelphia Fed's district which includes Eastern Pennsylvania, Southern New Jersey and Delaware.	Actual > Forecast = Good for currency;

US	PPI Ex Food and Energy MoM	Producer prices ex food and energy are a measure of the change in the price of goods as they leave their place of production excluding food and energy (i.e. prices received by domestic producers for their outputs either on the domestic or foreign market).	Actual > Forecast = Good for currency;
US	PPI MoM	Change in the price of finished goods and services sold by producers;	Actual > Forecast = Good for currency;
US	Retail Sales Ex Auto MoM	Change in the total value of sales at the retail level;	Actual > Forecast = Good for currency;
US	Trade Balance	Difference in value between imported and exported goods and services during the reported month;	Actual > Forecast = Good for currency;
US	Unemployment Rate	Percentage of the total work force that is unemployed and actively seeking employment during the previous month;	Actual < Forecast = Good for currency;
US	Univ. of Michigan Confidence - Preliminary	Consumer Confidence Index Issued by Thomson Reuters/University of Michigan	Actual > Forecast = Good for currency;
US	Wholesale Inventories MoM	Change in the total value of goods held in inventory by wholesalers;	Actual < Forecast = Good for currency;
UK	Bank of England Bank Rate	A target interest rate set by federal reserve in its efforts to influence short-term interest rates as part of its monetary policy strategy.	Actual > Forecast = Good for currency;
UK	CPI Core YoY	Change in the price of goods and services purchased by consumers, excluding the volatile food, energy, alcohol, and tobacco items;	Actual > Forecast = Good for currency;
UK	CPI MoM	Consumer prices (CPI) are a measure of prices paid by consumers for a market basket of consumer goods and services. The yearly (or monthly) growth rates represent the inflation rate.	Actual > Forecast = Good for currency;
UK	GDP QoQ - Advance	Gross domestic product (GDP) measures the final market value of all goods and services produced within a country. It is the most frequently used indicator of economic activity. The GDP by expenditure approach measures total final expenditures (at purchasers' prices), including exports less imports. This concept is adjusted for inflation.	Actual > Forecast = Good for currency;
UK	Industrial Production MoM	Change in the total inflation-adjusted value of output produced by manufacturers, mines, and utilities;	Actual > Forecast = Good for currency;
UK	Nationwide House PX MoM	Change in the selling price of homes with mortgages backed by Nationwide;	Actual > Forecast = Good for currency;

UK	Retail Price Index	The retail price index is a measure of inflation that tracks changes in retail prices paid by households for a market basket of goods and services. The yearly (or monthly) growth rates represent the inflation rate.	Actual > Forecast = Good for currency;
UK	Retail Sales Ex Auto YoY	This concept is the Retail Price Index excluding Auto part	Actual > Forecast = Good for currency;
UK	RPI Ex Mort Int.Payments (YoY)	This concept is the retail price index issued by UK Office for National Statistics, excluding the mrogage payment	Actual > Forecast = Good for currency;
UK	RPI MoM	Change in the price of goods and services purchased by consumers for the purpose of consumption;	Actual > Forecast = Good for currency;
UK	Total Business Investment QoQ - Preliminary	Change in the total inflation-adjusted value of capital investments made by businesses and the government;	Actual > Forecast = Good for currency;
UK	Visible Trade Balance GBP/Mn	This concept is the part of trade balance in physical goods	Actual > Forecast = Good for currency;
SP	CPI EU Harmonised YoY - Final	The harmonised index of consumer prices (HICP), used primarily within the European Union, is a measure of prices paid by consumers for a market basket of goods and services. It is calculated using the same methodology across countries to allow for comparable measures of inflation. The yearly (or monthly) growth rates represent the inflation rate.	Actual > Forecast = Good for currency;
SP	CPI MoM	Change in the price of goods and services purchased by consumers;	Actual > Forecast = Good for currency;
SP	Retail Sales WDA YoY	Retail sales (also referred to as retail trade) tracks the resale of new and used goods to the general public, for personal or household consumption. This concept is based on the volume of goods sold.	Actual > Forecast = Good for currency;
SP	Unemployment Rate	Percentage of the total work force that is unemployed and actively seeking employment during the previous month;	Actual < Forecast = Good for currency;
PO	CPI MoM	Consumer prices (CPI) are a measure of prices paid by consumers for a market basket of consumer goods and services. The yearly (or monthly) growth rates represent the inflation rate.	Actual > Forecast = Good for currency;
PO	GDP YoY - Final	Gross domestic product (GDP) measures the final market value of all goods and services produced within a country. It is the most frequently used indicator of economic activity. The GDP by expenditure approach measures total final expenditures (at purchasers' prices), including exports less imports. This concept is adjusted for inflation.	Actual > Forecast = Good for currency;

JP	GDP Nominal SA QoQ - Preliminary	Gross domestic product (GDP) measures the final market value of all goods and services produced within a country. It is the most frequently used indicator of economic activity. The GDP by expenditure approach measures total final expenditures (at purchasers' prices), including exports less imports. This concept is not adjusted for inflation.	Actual > Forecast = Good for currency;
JP	Housing Starts YoY	Change in the number of new residential buildings that began construction;	Actual > Forecast = Good for currency;
JP	Retail Trade YoY	Retail sales (also referred to as retail trade) tracks the resale of new and used goods to the general public, for personal or household consumption. This concept is based on the value of goods sold.	Actual > Forecast = Good for currency;
IT	Business Confidence	Tracks the general state of the economy as it relates to businesses. It can include broad economy-wide conditions or specific economic conditions of a particular industry.	Actual > Forecast = Good for currency;
IT	GDP WDA QoQ - Final	Change in the inflation-adjusted value of all goods and services produced by the economy;	Actual > Forecast = Good for currency;
IT	GDP WDA QoQ - Preliminary	Gross domestic product (GDP) measures the final market value of all goods and services produced within a country. It is the most frequently used indicator of economic activity. The GDP by expenditure approach measures total final expenditures (at purchasers' prices), including exports less imports. This concept is adjusted for inflation.	Actual > Forecast = Good for currency;
IT	Industrial Production WDA YoY	Change in the total inflation-adjusted value of output produced by manufacturers, mines, and utilities;	Actual > Forecast = Good for currency;
IT	Retail Sales MoM	Change in the total value of sales at the retail level;	Actual > Forecast = Good for currency;
IT	Total investments	Total investiment part in GDP	Actual > Forecast = Good for currency;
IT	Trade Balance Total	Difference in value between imported and exported goods and services during the reported month;	Actual > Forecast = Good for currency;
IT	Unemployment Rate Quarterly	Percentage of total work force that is unemployed and actively seeking employment during the previous quarter;	Actual < Forecast = Good for currency;
GE	Construction Investment QoQ	The construction investment part in GDP	Actual > Forecast = Good for currency;
GE	Exports QoQ	The export part in GDP	Actual > Forecast = Good for currency;
GE	Factory Orders WDA YoY - Preliminary	Change in the total value of new purchase orders placed with manufacturers;	Actual > Forecast = Good for currency;
GE	GDP SA QoQ - Preliminary	Change in the inflation-adjusted value of all goods and services produced by the economy;	Actual > Forecast = Good for currency;

GE	IFO Business Climate	Level of a composite index based on surveyed manufacturers, builders, wholesalers, and retailers;	Actual > Forecast = Good for currency;
GE	Imports QoQ	Change in the price of imported goods purchased domestically;	Actual > Forecast = Good for currency;
GE	Industrial Production SA MoM - Preliminary	Change in the total inflation-adjusted value of output produced by manufacturers, mines, and utilities;	Actual > Forecast = Good for currency;
GE	PPI MoM	Change in the price of goods sold by manufacturers;	Actual > Forecast = Good for currency;
GE	Private Consumption QoQ	Private consumption part in GDP	Actual > Forecast = Good for currency;
GE	Retail Sales MoM	Change in the total value of inflation-adjusted sales at the retail level, excluding automobiles and gas stations;	Actual > Forecast = Good for currency;
GE	Unemployment Rate	Change in the number of unemployed people during the previous month;	Actual < Forecast = Good for currency;
GE	ZEW Survey Current Situation	The ZEW economic current situation arising out of the ZEW Financial Market Survey as the net percentage of positive and negative responses of the respondents on the question of economic growth in current	Actual > Forecast = Good for currency;
GE	ZEW Survey Expectations	The ZEW economic expectations arising out of the ZEW Financial Market Survey as the net percentage of positive and negative responses of the respondents on the question of economic growth in 6 months	Actual > Forecast = Good for currency;
FR	Consumer Spending (MoM)	Change in the inflation-adjusted value of all goods expenditures by consumers;	Actual > Forecast = Good for currency;
FR	Own-Company Production Outlook	This concept tracks business sentiment within the industry sector. The results are based on a survey conducted among a representative sample of businesses in industry.	Actual > Forecast = Good for currency;
FR	PPI MoM	Producer prices (output) are a measure of the change in the price of goods as they leave their place of production (i.e. prices received by domestic producers for their outputs either on the domestic or foreign market).	Actual > Forecast = Good for currency;
EC	Business Climate Indicator	This concept tracks the general state of the economy as it relates to businesses. It can include broad economy-wide conditions or specific economic conditions of a particular industry.	Actual > Forecast = Good for currency;
EC	CPI Core YoY - Final	Change in the price of goods and services purchased by consumers, excluding food, energy, alcohol, and tobacco;	Actual > Forecast = Good for currency;
EC	CPI Estimate YoY	The flash HICP is an early estimate of the harmonised index of consumer prices (HICP) that is generally released within the same month (e.g. June data released within the month of June)	Actual > Forecast = Good for currency;

EC	ECB Announces Interest Rates	A target interest rate set by federal reserve in its efforts to influence short-term interest rates as part of its monetary policy strategy.	Actual > Forecast = Good for currency;
EC	GDP SA QoQ - Final	Change in the inflation-adjusted value of all goods and services produced by the economy;	Actual > Forecast = Good for currency;
EC	Govt Expend QoQ - Preliminary	Government expenditure part in GDP	Actual > Forecast = Good for currency;
EC	Gross Fix Cap QoQ - Final	Eurozone Gross Fixed Capital Formation part in GDP	Actual > Forecast = Good for currency;
EC	Gross Fix Cap QoQ - Preliminary	Eurozone Gross Fixed Capital Formation part in GDP	Actual > Forecast = Good for currency;
EC	Household Cons QoQ - Preliminary	Household consumption Expenditure in GDP	Actual > Forecast = Good for currency;
EC	Industrial New Orders SA (MoM)	New orders in eurozone manufacturing industries	Actual > Forecast = Good for currency;
EC	Industrial Production SA MoM	Change in the total inflation-adjusted value of output produced by manufacturers, mines, and utilities;	Actual > Forecast = Good for currency;
EC	Labour Costs YoY	The employment cost index measures changes in employee compensation costs (or labor costs). These costs include both direct costs (such as wages, bonuses or in kind benefits) as well as indirect costs (such as social security contributions, training costs, medical benefits, taxes, etc.)	Actual > Forecast = Good for currency;
EC	PMI Manufacturing - Preliminary	Level of a diffusion index based on surveyed purchasing managers in the manufacturing industry;	Actual > Forecast = Good for currency;
EC	Retail Sales MoM	Change in the total value of inflation-adjusted sales at the retail level;	Actual > Forecast = Good for currency;
EC	Trade Balance SA	Difference in value between imported and exported goods and services during the reported month;	Actual > Forecast = Good for currency;
EC	ZEW Survey Expectations	The ZEW economic expectations arising out of the ZEW Financial Market Survey as the net percentage of positive and negative responses of the respondents on the question of economic growth in 6 months	Actual > Forecast = Good for currency;