Do macroeconomic announcements affect the foreign exchange markets?

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Abstract

In this paper, we study the explanation power of the macroeconomic news for the foreign exchange fluctuation. We define three measurements of the news deviations, then use Kalman filter and maximum likelihood method to extract several dynamic factors from 27 noisy and sparsely observed macroeconomic news deviations. In particular, 2 factor and 3 factor systems are investigated. We further input the news factors as independent variables in our VECM analysis. The fitted results show that the news factors' contribution is limited. The out of sample prediction yields the same conclusion. VECM yields better RMSE and MAE than the comparing groups, but the improvements are insignificant.

Key words: macroeconomic news release; VECM; dynamic factors; news deviations; Kalman filter; Maximize likelihood; predict foreign exchang;

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1 Introduction

This paper is an empirical study on the effect of macroeconomic news release on foreign exchange markets. It is well known that the macro variables sometimes influence the domestic currency value. But the direction and magnitude of the impacts are quite difficult to tell.

Scholars use various approaches to explain foreign exchange flutuations and predict foreign exchange rates. Most began with the interest rate approach. Clarida and Taylor applied vector error correction model (VECM) to analyze ther term structure of forward exchange premiums in 1997 and 2003. They got satisfactory forecast of spot exchange rates. They worked on a horizon of spot rate longer than 1 month. In contrast, Chaboud and Weight (2003) started with an extremely short horizon. They focused on the intradaily data and found that the UIRP only worked on the scale of several minutes. Some researches have been done on the relationship between currency spot returns and news surprises. Sen Dong (2006) used two news index and term structure to explain the exchange rate movements. Simpson, Ramchander and Chaudhry (2005) evaluated more news factors and ran a VECM to test their effect on the exchange rates. In this paper we address the question of whether we can get a better forecast for tomorrow's foreign exchangerate by applying a VECM with the organized news surprise factors to analyze the daily exchange rates.

In the United States, the market absorbs several news releases each week, sometimes many surprises in a single day. These news release have different effects on macroeconomics and drive the domestic currency value in different directions. In order to reduce noise, many researchers only focus on several important variables such as gross domestic product (GDP), consumer price index (CPI) and federal rates. While we agree all the different variables are not equally important, they each contains some information others don't. For example, while both consumer price index (CPI) and consumer price index core (CPI core) measure the retail prices in the urban area, the latter excludes the most fluctuating food and energy prices. Some scholars prefer the CPI core for its stableness. That means they have to give up the price fluctuations from the food and energy categories, which are critical when the crude oil price is highly volatile.

The news announcements can be roughly allocated into two categories. Some are released at higher frequencies but only track certain parts of the economy, such as the durable goods orders, business inventories and initial claims. Some others are released at lower frequencies but give a better picture for the activity of the whole economy, such as the RGDP SAAR, index of leading indicators. The former reveal only part of the economic activities and sometimes provide conflicting information. The later are ideal but their delayed release timing and the redundant information compromise their performance in the foreign exchange analysis.

Besides these inherent information and noise problems, there are some empirical reasons that disallow us from using all the regularly released macroeconomic indicators as independent variables in the model.

Firstly, some pairs of indicators, such as the CPI and CPI core are highly correlated. Secondly, the macroeconomic variables are released at different frequencies. Most indicators are published monthly; others are released quarterly or weekly. It is hard to align these time series. Even in the monthly released data group, some are published in the beginning of month and some are released near the end of the month. It is insufficient to coarsely treat them as providing macroeconomic information for the same month. The way to solve this problem is to align the data in a daily time series. We can clearly identify news release may affect a special day's foreign exchange spot return.

We use Kalman filter to treat the noise problem. Our procedure is firstly extracting a handful dynamic factors to represent the 27 macroeconomic announcements. In the second step, we fit the spot rates and forward rates on the extracted factors, to obtain the parameters for the model. Finally, we generate the out-of-sample prediction with the model, and compare the prediction errors from our model with the random walk and forward premium models.

Because many macroeconomic news release contains similar information. We classify the news into several categories and use Kalman Filter to extract the useful signal only. Based on UIRP and PPP, we classify the variables into the following categories: inflation factor, growth factor and interest rate factor. As for the relationship between the extracted news factors and the foreign exchange rates, we try the vector error correction model (VECM) to describe this nonstationary process.

The rest of the paper is organized as the following: section 2 reviews the explanations on the foreign exchange movements, discusses the prior academic literature on the relationship between macroeconomic news and currency market. Section 3 discusses the data, and shows the explanation power from the individual news. Section 4 describes the methodology we used to extract the dynamic factors, and the way we classify the news release. Section 5 tests the fitting ratio of the Kalman filter. Section 6 apply the extracted factors to fit the currency market. Section 7 tries to use our fitted model to forecast the spot rates and compares it with other models. Section 8 concludes.

2 Previous work

Exchange rate economics is characterized by a bunch of puzzles. The most famous puzzle is the uncovered interest rate parity (UIRP). UIRP argues that if domestic interest rate is higher than the foreign interest rate, the domestic currency will depreciate and the foreign currency will appreciate. As described by the following model:

$$s_{t+1} - s_t = \alpha + \beta(i - i^*) + \varepsilon \tag{1}$$

Here, i and i^* denote, respectively, the domestic and foreign interest rate on a one-period zero coupon bond. Ideally, α should be close to 0 and β should be close to 1. However, numerous empirical researches showed that α is indeed close to 0 but β goes to negative. This means that the high-yield currency appreciates rather than depreciates. That is the UIRP called as forward premium puzzle. The forward premium puzzle is now well documented and researchers provided many ways trying to solve it or explain it.

Many economists began from explaining the forward premium puzzle and ended up in out-of-sample forecasting. The most cited method is the vector error correction model (VECM) first incorporated by Clarida and Taylor (1997). They compared their forecast error term with the vector autoregression (VAR) model, random walk model, forward premium regression and forward rate. They found VECM almost beat all the other four methods in root-mean square error (RMSE) and mean absolute error (MAE) measurement.

Another important branch of studies try to analyze the forward premium puzzle in extremely long term or extremely short horizons. Lothian and Wu (2002) tested the uncovered interest rate parity in a period of two centuries. Because the wide application of computers, it is easier to access the intra-day foreign exchange rates and interest rates today. More and more works focus on the extremely short horizons. For example, Chaboud and Weight (2003) studied the exchange rates around a particular point in time (17:00 New York time) and their conclusion is that UIRP works, but just OK for several minutes. Some works try to relate the forward premium (or sometimes just the foreign exchange itself) with the interest rates term structure. These models make some valuable contribution too. For instance, Ahn (2004); Backus, Foresi and Telmer (2001); Backus, Foresi, Mozumdar and Wu (2001); Inci and Lu (2004); Piazzesi (2003).

There are relatively fewer works specializing on the macroeconomics news only. Lu and Wu (2005) used extended kalman filter to extract two dynamic factors from 17 macroeconomic releases, then related these two factors to the daily term structure of interest rates under the no arbitrage assumption. They found that the inflation factors had large and positive impacts on interest rates. Moreover, the extracted two dynamic factors can explain more than 76% daily variation in LIBOR and swap rates of all maturities.

Another important research was done by Simpson, Ramchander and Chaudhry (2005). They evaluated 23 news releases and classified the news releases in more detailed categories. To my knowledge, they first used inflation, growth, domestic demand and interest categories to classify the news announcements. They applied VECM with all 23 news variables to build their model. They found that the exchange rates failed to respond to the economy growth indicators.

Sen Dong (2006) applied CPI, industrial production index and term structure to explain the exchange rate movements and found "that the correlation between the model-implied exchange rate changes and the data is over 60%."[1]

3 Data description and the measurement of deviations

3.1 Data description: news announcements

We collect the consensus estimates of 27 macroeconomic announcements provided by Money Market Services (MMS). All of these 27 variables have a time spread of more than 10 years. The starting dates of these variables vary from Jan. 1980 to Sep. 1991. The ending dates from Nov, 2004 to Mar, 2005. Unfortunately, we have no macroeconomic news data from foreign countries. We choose the common sample from Nov. 2nd, 1993 to Jun. 1st, 2004 to extract the dynamic unobserved variables, and leave the last 5 months from Jun. 2nd, 2004 to Nov. 17th, 2004 for out of sample test.

As we know, the announcement itself doesn't make any difference if it has been fully anticipated already. In other words, surprises or deviations are more important for our model building. How to measure the diversities then? We tried 3 different ways in our work.

The first measurement is used by most economists. We define the *surprise* as the standardized difference between the announced and the expected indicators, represented by:

$$Surprise_i = (Actual_i - survey_i)/\sigma_{1i} \tag{2}$$

Here both $Actual_i$ and $survey_i$ come from MMS. The former is the announcement itself; the later is produced by MMS. The MMS surveys are obtained from estimates of approximately 40 academics and practitioners. They are interviewed 1 week before the news release, and the median value of the estimates are taken as the survey. They are believed to be unbiased estimates of the forthcoming announcements. σ_{1i} is the standard deviation of the

[1] Sen Dong, 2006, "Macro Variables Do Drive Exchange Rate Movements: Evidence from a No-Arbitrage Model", P31

whole *ith* announcement's differences between actual and forecast. We call this measurement *surprise*. It describes the pure surprise away from the market's expectation.

Following Lu and Wu (2005), we define

$$AwayH_i = (Actual_i - mean_i)/\sigma_{2i} \tag{3}$$

σ_{2i} here is the sample standard deviation of the data.

We define the *change* from last actual release divided by the standard deviation of the changes, as

$$Change_i = (Actual_i - Actual_{i-1})/\sigma_{3i} \tag{4}$$

Table 1 lists the 3 measurements for all the 27 macroeconomic announcements. Because the announcements have different release schedule and different frequency, as I noted in the introduction part, we aligned them in a daily time series. To fulfill this purpose, we generate a date series which includes all the business date from Nov. 2nd, 1993 to Jun. 1st, 2004, and insert all the macroeconomic announcements into their corresponding dates. All the other dates without news release have value 0 indicating that there are no surprises or no deviations on these days.

Out of the 27 announcements, 23 variables are released monthly. GDP and GDP price index are released quarterly[2]. Initial claims announces are announced weekly. Federal Open Market Committee (FOMC) has a regular meeting every 6 weeks, so the target fed funds rate is releases every 6 weeks[3]. Comparing the summary for the three measurements listed in table 1, we find *surprise* beats the other two measurements: it has smaller mean and standard deviation than the other two measurements.

3.2 Data description: foreign exchange spot rates and forward rates

[2]Both GDP and GDP price index have three scheduled releases in each quarter: preliminary, revised and final reading. Actually, these two announcements have monthly releases and I include them all.

[3]I include all the special cases such as fed had 3 continuous meeting from Oct. to the end of 2001.

For the foreign exchange rates part, the spot rates and overnight forward rates in daily frequency are obtained from the Bloomberg system, which were collected by Bloomberg as the average of the inter-bank quotes during the New York trading hours. We choose United States Dollar (USD) as the domestic currency, and study 4 important foreign currencies as my objects: Australia Dollar (AUD), Canada Dollar (CAD), British Bound (GBP) and Japanese Yen (JPY). We didn't include the very important European currencies such as the Deutsche Mark (DEM) and French Franc (CHF), because after entering the euro currency system, their behavior is somewhat inconsistent. These four currencies have different beginning dates: AUD starts from sep. 3rd, 1996; CAD begins from Aug. 19th, 1999; GBP and JPY have longer observations, they start from Nov, 4th, 1993. Similar to the news data treatment, we choose Jun. 1st, 2004 as the in sample end date, and leave Jun. 2nd, 2004 to Nov. 17th, 2004 for the out of sample test.

Table 2 lists summary of these 4 currencies. Because we take USD as domestic currency, we invert the original GBP and AUD data. The first two rows are statistic summary of spot rates and forward rates respectively. The third row is for the spot return which is defined as $S_t - S_{t-1}$[4].

For all these four currencies, we can see they have similar means and standard deviation in spot rates and forward rates. AUD has a higher standard deviation compared with the other three currencies. JPY is also quite volatile.

3.3 The explanation power from the individual news

Now we have both macroeconomic news and the foreign exchange rates. If news is critical to the foreign exchange rates, the spot rates will have a significant jump when the macroeconomic variables deviates from their normal course. We align the spot return ($s_{t+1} - s_t$) with each single news ($newsDeviation_t$)[5], and run 27 OLS models for each currency under each measurement. Table 3 report the results of the four currencies. Each table has 3 panels.

[4] All rates are written in the natural logarithum terms.

[5] The newsDeviation here represents the three measurements respectively. I run $27news \times 4currencies \times 3measurements = 324$ OLS regressions in total.

The first panel uses *surprise* as the independent variable, panel 2 and panel 3 use *AwayH* and *Change* as independent variables respectively. In each panel, we list the coefficient, the t value, adjusted R square and the numbers of observations. Because the news are announced at different frequencies, the number of observations vary. Even in the same announcement regressions, the 3 different measurements have different observation numbers. For example, fed funds rates has less *surprise* observations than *AwayH* and *change*. In general, *AwayH* has more observations than the other two measurements.

Let us begin from the AUD. Theoretically, *surprise* should have the best predicting power in such short horizon returns. However, we find only one news *surprise* has a significant coefficient on the spot return and all the adjusted R square are weak. Personal consumption expenditures seems critical to the AUD spot returns. It is significant with all three measurements. *AwayH* has the most significant coefficient to the spot returns for CPI, durable goods orders and personal consumption expenditures. For the *change* observations, two annoucement are more important: CPI and personal consumption expenditures.

surprise has worse performance for CAD. None is significant to the foreign exchange rates under 95% confidence intervals. Three variables are significant in 90% confidence intervals: business inventories, goods and services trade balance and nonfarm payrolls. RGDP is significant in both the *AwayH* observations and the *change* observations.

surprise has better performance for GBP spot returns. Housing starts and nonfarm payrolls are significant here. In fact, these two variables have good performance under all three measurements, among which *change* has the most significant coefficients to the spot returns. Besides the two common variables I got under the other two measurements, initial claims, RGDP and civilian unemployment rate are also significant.

Industrial production and civilian unemployment rate are significant under *survey* observations in the JPY analysis. Only GDP price index is significant in *AwayH* observations. Industrial production has good performance under *change* observations.

In conclusion, our OLS tests shows no evidence for the relationship between news announcements and the foreign exchange rates. There may be two reasons for this result.

Firstly, many announcements are released on the same day, for instance GDP and GDP price index announced together. So are the CPI, CPI core, PPI and PPI core. It is difficult to tell which news announcement is contributing to the fluctuation. Secondly, some news are not 'new' when they are released. For instance, the index of leading indicators is released in the third Thursday each month, after the announcements of capacity utilization, industrial production, CPI, PPI, etc. Market already has good expectation for these indicators by the time they are released. Actually, none of these "less important announcements" provides a significant effect to the foreign exchange rates as can be seen from the OLS reports on all the four currencies.

4 Model to extract systematic factors

4.1 Using dynamic Kalman filter to extract the news factor

There are so many macroeconomic announcements every month. The foreign exchange market always expects something everyday, domestic or foreign. Every macroeconomic variable has its special effects and some common factors with other published announcements. If we can combine these indicators by some reasonable model, we can draw a clearer picture of the economy and analyze the foreign exchange movement in a more robust way.

In this part, we extract the dynamic factors with Kalman filter and maximum likelihood, following the method used by Lu and Wu (2005).

The state equation is

$$dX_t = -\alpha X_t dt + dW_t \tag{5}$$

Here $X \in \mathbb{R}^n$denotes the n dimensional state vector, they represent the systematic state of the economy. For example, if we want to extract 2 factors such as inflation and growth effect of the economy, X is a 2 dimensional state vector. To simplify the question, we assume that the state vector X follows a $VAR(1)$ dynamics

$$X_t = e^{-\kappa \triangle t} X_{t-1} + \sqrt{I \triangle t} \varepsilon_t \tag{6}$$

Here ε_t denotes an $(n \times 1)$ independent and identically distributed standard normal random vector. $\triangle t$ denotes the discrete time interval. Because we use daily data, $\triangle t = 1/252$. I is an $(n \times n)$ identity matrix. κ is an $(n \times n)$ unknown matrix.

The measurement equation is

$$M_t = H X_t + e_t \tag{7}$$

Here $M \in \mathbb{R}^N$ denotes a N dimensional measurement vector. It represents N series of macroeconomic news deviations such as *surprises* of CPI, GDP or federal rate, etc. H is a $(N \times n)$ matrix of factor loading coefficients. e_t is a $(N \times 1)$ vector of measurement noises of the macroeconomic data series. The covariance matrix of the measurement errors is $R^M = E(e_t e_t^T)$. Following the prior works, we assume that the measurement errors are independent to the error terms in the state equation (6). And the measurement errors themselves are mutually independent. In other words, $R^M_{ii} = \sigma_i^2$, $i = 1, 2, 3, ..., N$ and $R^M_{ij} = 0$, if $i \neq j$.

Because X denotes the hidden state being estimated, I use $\overline{X_t}$ to represent the ex ante forecast value at time $(t-1)$, and $\widehat{X_t}$ is the ex post update. Similarly, because V is the covariance matrix of the hidden state, we define $\overline{V_t}$ the ex ante forecast of time t value calculated at time (t-1), and $\widehat{V_t}$ is the ex post update. A is the covariance matrix of macroeconomic measurement series M. In summary, all the ex ante forecast are,

$$\overline{X_t} = \Phi \widehat{X_{t-1}}; \tag{8}$$

$$\overline{V_t} = \Phi \widehat{V_{t-1}} \Phi^T + I \triangle t; \tag{9}$$

$$\overline{M_t} = H\overline{X}_t; \tag{10}$$

$$\overline{A_t} = H\overline{V_t}H^T + R^M; \tag{11}$$

The ex post filtering updates are,

$$\widehat{X_{t+1}} = \overline{X_{t+1}} + K_{t+1}(M_{t+1} - \overline{M_{t+1}}); \tag{12}$$

$$\widehat{V_{t+1}} = \overline{V_{t+1}} - K_{t+1}\overline{A_{t+1}}K_{t+1}^T; \tag{13}$$

While the Kalman gain is K_t,

$$K_t = \overline{V_t}H^T(\overline{A_t})^{-1}; \tag{14}$$

By combining the ex ante and ex post, we can use a recursive program to estimate the model. There are 5 unknown parameters: $\Theta \equiv \{\kappa, H, R^M, X_{0,}V_0\}$. Then we use maximize likelihood method to estimate these 5 parameters. The daily log likelihood function is:

$$L_t(\Theta) = -0.5\log|\overline{A_t}| - 0.5[(M_t - \overline{M_t})^T(\overline{A_t})^{-1}(M_t - \overline{M_t})]; \tag{15}$$

We sum all the daily log likelihood functions and maximize the result to estimate the unknow parameters.

$$\Theta = \arg\max_{\Theta}\sum_{t=0}^{T} L_t(\Theta); \tag{16}$$

4.2 Extract the invisible dynamic factors.

As described in section 1, most macroeconomic variables include more than one systematic factors. Different classification can determine different measurement equations and then extract different dynamic factors. We have 2 ways to define the dynamic factors.

Lu and Wu (2005) classified all the macroeconomic data series into two factors: real GDP growth and inflation. The first panel of table 4 follows this kind of loading. We analyze all the news in detail and use + to represent the positive effect to the spot returns; − represents negative effects. 0 represents no effect to the spot return. h1 represents the extracted growth factor and h2 the inflation factor.

Following this rule, some traditional indices have positive effect to h2. Such as GDP price index, CPI, CPI core, PPI and PPI core. The consumption indicators can change the aggregate demand then introduce higher inflation later. So Capacity Utilization, Consumer Confidence, Consumer Credit, Hourly Earnings, Personal Consumption Expenditures and Personal Income have pure positive effect on h2. Trade Balance measures the scale of international demand, also a positive indicator for h2. Higher treasury budget means the government demand is relatively small, therefore it should be a negative signal for h2. Apparently, RGDP SAAR, Business Inventories, Durable Goods Orders, Housing Starts, Industrial Production, Index of Leading Indicators, New Home Sales, Retail Sales Except Auto and Retail Sales should have pure positive effect on h1. Initial Claims and Civilian Unemployment Rate are negative signals for business cycle, therefore they should have negative effect on both h1 and h2. Higher construction spending always predicts a stronger growth, and it always companied by a presently lower interest rate and inflation rate.

We need to recognize that this loading is just an approximation. The economy is a very complex process. In other words, we cannot assume this allocation is perfect. For example, the fed funds rate is primarily an inflation indicator, the positive surprise in fed funds rate shall indicate a higher inflation risk. Therefore we assign a positive loading in its h2 loading and a 0 in its h1 loading. However, in many cases the higher fed rate increases the investment cost and is a bad news to real GDP growth. Another question is: under this loading system, some macroeconomic variables such as the trade balance can not be easily classified into these 2 dynamic factors. For this reason we introduce the 3-factor allocation methods.

In the second panel we insert an interest rate factor h3. h1 and h2 still represent growth and inflation respectively. Most textbooks claim that interest has the biggest and the most direct effect on foreign exchange rates. Many inflation indicators in two-dynamic-factor-classification can be replaced by interest rate factor here. Other pure inflation indices such as CPI, GDP price index belong to both the inflation and interest rate factors.

5 Extracting systematic factors from macroeconomic releases

Table 5 and table 6 list the estimation of the factor loading matrix H of 2 factors and 3 factors models. Each table reports all the three measurements of deviations, *surprises*, *AwayH* and *change* respectively.

Table 5 reports the estimates from 2 factors extraction. h1 represents the loading on growth and h2 on the inflation effects. rr_i is the variance of the estimation error for each macroeconomic variable.

$$rr_i = var(M_i - H_i \times X) \tag{17}$$

Here M_i represents the ith announced macro announcement. $(H_i \times X)$ is the estimation from the dynamic Kalman filter method.

FV is the forecasted percentage variance. We define it as

$$FV = 1 - \frac{rr_i}{rm_i} \tag{18}$$

rm here is the variance to the ith vector of *surprises*, *AwayH* or *change*. And its value is reported in the last column. FV indicates the quality of the forecast: the closer to 1, the better.

The first panel is the estimate for the parameters using survey *surprise*. All the parameters in h1 and h2 are significant. The estimate error variance is smaller than the original variance[6]. Most FVs are in the range between 0.9 and 1, except for the initial claims, trade balance, treasury budget and unemployment rate. The best fitting comes from CPI core, whose FV is 96.09%. And the worst fitting comes from initial claims, whose FV is 69.27%.

The results using $AwayH$ are report in panel 2. The performance is better than that with *surprise*. All the h1 and h2's are significant. FVs are improved in all 27 variables. Only the FV of initial claims does not exceed 90%. The lowest FV comes from initial claims (about 80%), while retail sales except auto has the best FV 98.69%.

In the last panel of table 5, we present the results estimated with the observation *change*. The fitting level beats that of surprises, but not as good as that of $AwayH$ in some variables. The best return comes from retail sales except auto (99.05%FV) and the worst comes from initial claims (78.5%FV). Initial claims, trade balance and unemployment rates have FV lower than 90%:.

Results for the 3 factors model from these 27 macroeconomic announcements are reported in table 6. The return from *surprise*, $AwayH$ and $Change$ observations are listed in panel 1, panel 2 and panel 3 respectively. The parameters under all these three measurements are significant. FV are fine except for some special variables such as initial claims. Note that capacity utilization shows an inconsistent behavior under this 3 factors system. For *surprise* observations, although its parameter is very significant (with a t-value of 999.82), its FV is very low, around 5%. Its performance is much better for the *change* observation. The FV is 41.6%. But the capacity utilization has a good FV under the $AwayH$ observations (94.6%).

Comparing the FVs in the 3 factors model with the corresponding numbers in 2 factors model, we note there are a little improvement for surprises and $AwayH$ observations, but that improvement is not significant. The FVs in Change observations for the 3-factor mode decreases compared with that of the 2-factor model. Considering the problem of capacity utilization, we recognize that the 3-factor extracting way is somewhat unstable.

[6] We have the results of t ratio, rr and rm. But we only report hs and FV in the attached table.

6 VECM with extracted news input

The dynamic Kalman Filter method generates not only the loading matrix H, but also the extracted dynamic factors Xs. Depends on which dynamic factors model we input, X has a dimension of $n \times 2$ and $n \times 3$. n is the observations number. In our analysis, we have 2760 in sample observations because we leave the last 121 business days for the out-of-sample tests.

There are many models describe the relationship between foreign exchange rates and forward rates. We make use of the classical vector error correction model (VECM) which was first introduced by Richard Clarida and Mark Taylor in 1997. VECM is an ideal model to help better understand the nature for any nonstationary process. It also improves the forecasting ability in a longer time horizon.

Many articles observe that the spot exchange rate possesses a unit root and can be write as:

$$s_t = x_t + \epsilon_t \tag{19}$$

Where s_t is the logarithm of the spot exchange rate, and ϵ_t is a stationary process with mean 0. x_t represents a unit root process which is assumed as a first order process:

$$x_t = x_{t-1} + e_t + \theta \tag{20}$$

Here θ is a constant and e_t is a stationary process. Compiling the formula together we get

$$s_t - s_{t-1} = \theta + e_t + \epsilon_t - \epsilon_{t-1} \tag{21}$$

Since θ is a constant and the later three items are stationary, we have shown that first difference of the logarithm of the spot exchange rate is stationary.

Then we build a vector y_t which includes the logarithm of both the spot exchange rates and the overnight forward rates:

$$y_t = [s_t, f_{t,1}]' \tag{22}$$

Moreover, y_t is a 2 dimension co-integrated vector. There exists an $2 \times r$ matrix α such that

$$z_t = \alpha' y_t \tag{23}$$

r is the number of co-intergrating relations, which we get from Johansen's trace test at 95% level.

Now the VECM form becomes:

$$\Delta y_t = \beta x_t + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + ... + \Gamma_k \Delta y_{t-k} + \gamma z_{t-1} + \varepsilon_t \tag{24}$$

Where Δ is the first difference operator, γ is a coefficients matrix which has dimension $2 \times r$. x_t is the extracted dynamic factors representing the effect of the macroeconomic deviations originating from the 27 macroeconomic variables.

6.1 lag checks

The number of lags to pick is critical in time series analysis. We need it to decide the k value for the VECM equation. Moreover, VECM requires Δy_t to be stationary, so we need to do a unit root test in addition to a cointergration test. Both of these tests require the lag as an input. We use the Akaike's Information Criterion(AIC) to measure the goodness of different VAR model with lags from 1 to 8. Table 7 reports the results of AIC. From the AIC value we obtain the smallest return for each currency. We found $k = 5$ for AUD and GBP, while $k = 6$ for CAD and JPY.

Because the lag check is very important to the following process, we use likelihood ratio (LR ratio) to double check this problem and report the results in table 8. Under 5% critia level, we find AUD and GBP reject lag 4 in favor of lag 5 as optimal lag length; while CAD and JPY rejected lag 5 in favor of lag 6 as their optimal lag length.

6.2 unit root test

Many literature suggested that s_t and f_t have unit roots. We employ the augmented Dickey - Fuller (ADF) test on the forward and spot rates for the unit root test.

Table 9 and table 10 reports the results of the unit root test. The critical value of ADF test in 1% level, 5% level and 10% level are –3.458, –2.871 and –2.594 respectively. We used two ways to run the ADF test: one with constant only, the other with both constant and a deterministic trend together. We run the ADF test to the currencies as well as to the extracted factors.

In the currencies part, we find that the unit root hypothesis can not be rejected in both the spot exchange rate levels and the forward rate levels. This result is consistent with the existing literature and confirms that both the spot and the forward exchange rates are nonstationary. The ADF test for the first differences of both spot and forward rates shows that the first differences are stationary. That is consistent with our proof in equation (21).

For the extracted dynamic news factors, we list the results for $surprise$, $AwayH$ and $change$ observations. Under each category, we have the tests from the 2 and 3 factors systems, all returns strongly reject the unit root hypothesis and suggest these series are stationary. Since all the dynamic factors are stationary we do not need to check their stationarity of their first differences.

6.3 VECM report

From table 11 to table 16 report the results of the dynamic macroeconomic factors included in VECM as seen in equation (24). Table 11 and table 12 lists the dynamic factors x generated from $surprise$ observations: table 11 has all the returns from the ΔS_t equation, table 12 reports the results from the ΔF_t equation. Table 13 and 14 report the result from the $AwayH$. Table 15 and 16 present that from the $change$ observations. Samely, we use table 13 and 15 report the results from the ΔS_t equations, table 14 and table 16 lists the results from the ΔF_t equations. In all these tables, we use lag $k = 5$ for AUD and GBP, while $k = 6$ for CAD and JPY.

We first discuss the results for the *surprise* measurement. We run three VECMs and report the coefficients, p-probabilities for each coefficient and adjusted R square. The three models are VECM without news, VECM with 2 factors news and VECM with 3 factors news.

Firstly, for all extracting methods and all currencies, spot return equations has better explaining power than the forward rate equations. The adjusted R square in the spot return equation is around 10% in all cases. In particular, CAD has the highest adjusted R square of 15%. And JPY has the lowest adjusted R square of 8%. One possible expanation is that the Canadian Dollar is more sensitive to the US macroeconomic information. The equations based on the forward rates only has an adjusted R square between -0.07% and 0.6%. Compared with the explaining power of OLS model, VECM is a good improvement.

Secondly, comparing the two news extract models for the same currency, we find there is no significant improvement in the adjusted R square when we extract the news surprises in more complex ways. Although GBP and JPY demonstrates a consistent improvement in the adjusted R square when we increase the number of news factors, the improvement is small and insignificant.

Thirdly, we use Johansen's trace test at 95% level to automatically find the cointergrating relationship and generate the cointegrating equation z_{t-1} automatically. We find all the coefficients of z_{t-1} items in spot return equation are significantly different from 0. This suggests that the spot return (and therefore the spot rates) adjust to past variation in the cointegrating relationship between s_t and f_t.

Fourthly, we take a close look at the effect of the news factors. The two factor system for AUD only has one significant news coefficient which represents the inflation factor. The P ratio is 2.5%. For JPY the P ratio is 8.5%. The inflation factor shows stable performance for all four currencies. When US has a higher inflation rate, the USD spot and forward rates tends to appreciate. This violates the PPP. The reason for this violation is that we are studying the daily spot returns while the PPP is known to work for longer horizons, at least longer than 1 year. The sign of coefficient to growth factor varies across four currencies.

The three-factor systems works poorly, the best P ratio is 12%. Specially, for the interest surprise x3, we find no significant coefficients in these four currencies.

We also studied the vector error correction model using the *AwayH* news observations. Here the spot returns also work much better than the forward return. The models with news factors show the similar R square with that of the simple VECM. We believe this is because the lagged spot returns and z contain most of the information in the regression. The improvement by inserting news variables is limited. In addition, we find that almost all the dynamic factors we generated from the news are insignificant.

The estimation result with *change* observation is presented in table 15 and table 16. The results are similar to the other two observations. The explanation power of the macroeconomic variables is also weak. Only the inflation factor has significant effect in 2 and 3 factor models for AUD spot return.

In summary, the most significant effect of the macroeconomic variables comes from the *surprise*, the standardized deviation of the differences between announcement and the median of the professional survey. This is consistent with the assumption that the market is rational. The market players have fair and open channels for all news, especially the macroeconomic indicators. The market has absorbed the possible deviations from the historical average or changes from last period gradually before the news is released. Therefore the real deviation from the market expectation affect the foreign exchange rates most.

7 Forecast spot exchange rates out-of-sample with VECM

It is well known that good fitting results for the in sample regression does not mean that the model can provide similar performance in the out of sample forecast. We want to test if the new macroeconomic information also has little effect on the future foreign exchange rates.

We use the root mean square error (RMSE) and the mean absolute error (MAE) as the criteria to measure the accuracy of the forecast. The compared groups are the alternative forecasts coming from VAR and random walk forecast. We follow the methods used by R

Clarida and M. Taylor in 1997. We take the historical standard deviation of the in sample spot return as the standard deviation of the random walk. The vector autoregression model is an unrestricted fourth order VAR. We update the forecast everyday. In other words, we only forecast one day not from day 1 to day 117.

The reason why we use the real yesterday spot and forward rates instead of the estimated rates is that we are investigating the effect of the macroeconomic news and using the real foreign exchange data can reduce the error that might be introduced by the estimated foreign exchange rates.

Table 17 reports the RMSE and MAE results from the prediction and that of the compared groups. We multiply all series by 1000 to increase the readability. The first row is for the simple VECM with spot rates and forward rates input only. Then we add in the 2-factor and 3-factor news systems extracted from the *surprise*, *AwayH* and *change* observations. To see the effect from news factors clearly, we average the extracted news factors and report the errors in next two rows[7]. Row 10 and row 11 are prediction errors from VAR(4) and random walk models.

Here are the findings:

The forecasting power of random walk model is very poor. In prior papers scholars believed that the random walk had the nearest predict to the foreign exchange rates. But my results show that it is the worst or second worst in the 11 models. Only VAR(4) for AUD has a a little larger RMSE than the random walk model.

We found that the 3-factor model based on *AwayH* observations have better performance comparing with the other VECM equations. It has the smallest MAE and RMSE in all the 11 models on CAD and GBP. For the models based on *surprise* observations, CAD has the smaller forecast error in the 2-factor equation than the simple VECM. It has the second smallest RMSE and smallest MAE in all 11 models. It is interesting note that although the 3 factors model for the three deviations have no special advantage in the VECM analysis, they have better performance in out-of-sample forecasts. Auctually, almost all the 3-factor

[7]For example, in 2-factor news system, we average the Xs got from surprise, AwayH and change to make the new X1, X2 vectors.

models have lower forecast errors than the comparable 2-factor models. Our averaged news factors input didn't show better RMSE or MAE than the other models.

8 Conclusion

In this paper we try to track the news effects on the foreign exchange fluctuations. We align the daily foreign currency spot rates with 27 news deviations. Because the original announcements are on different scales for different news. We use standardized news deviations as our inputs. In addition to the popular news *surprise*, we use two new deviations here: *AwayH* and *change*. We ran a series of simple OLS regressions on spot returns. The independent variable is every single news deviation. There are 3×27 regressions for the three deviations and the 27 news annoucement. Only a few news variables have significant coefficient in the regressions.

Since there are noises in each news release and redundant information in the variables, we applied Kalman filter to filter the news deviations and use maximize likelihood to estimate the unknown parameters. We used 2 different loading matrix which we call them 2-factor system and 3-factor system.

We checked the loading effect and found the results are satisfactory. Most news variables have a forecast percentage variance (FV) higher than 90%. Only the 3-factor system when using the *surprise* observations gave an extremely low FV 5% for capacity utilization announcement. FV for the *change* observations is 41.6%. This shows that the 3-factor system is unstable.

We used the vector error correction model (VECM) with the extracted news deviations factors to analyze the foreign exchange spot and forward rates. However, comparing the results with and without news input, we find the improvements coming from the news are limited. Not only the adjusted R square has little improvement, but also most coefficients of the news factors are insignificant.

Finally we ran out-of-sample tests on the VECM equations. The comparing groups are VAR(4) and random walk. We used a dynamic daily updated method to predict next day foreign exchange rate, compared with the out-of-sample real foreign exchange rate. Disappointingly, news implied VECM equations do not outperform the simple VECM equation. But all the VECM forecast errors beat the comparing groups.

In conclusion, we have shown that news has no critical effect to the foreign exchange daily spot returns. The news surprises have some effect on the spot returns but not as large as speculators would like. These results raise the following issues for further empirical and theoretical research.

First, we only analyzed the US domestic news announcements. If we have access to the important releases from the foreign countries, the model will be more interesting.

Secondly, our news surprises only focus on the regularly released macroeconomic indice. It is well known that other shocks affect foreign exchange market as well. For instance, the domestic stock market crash and crude oil price fluctuation could also significantly affect foreign exchange rates. It would be very interesting to study the relationship between foreign exchange market and the commodity markets.

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Table 1: Summary statistics for news deviations

Data are aligned in daily series. The sample period is from Nov. 2nd, 1993 to Jun. 1st, 2004. explanation of the news variables: FedRate - fed funds rate(current period); Claims - initial claims (thousands); RGDP - RGDP SAAR (chained after 2Q1995); GDPPI - GDP price index SAAR; BusInv - business inventories (%change); Capacity - capacity utilizaion(%); ConfidnC - consumer confidence (%); Construct - construction spending (%change); CPI - consumer price index (%change); CPIXFE - CPI core (%change); Credit - consumer credit ($bn, monthly change); DurGds - durable goods orders (%change); Tbalance - goods and services trade balance ($billion); HrEarn - hourly earnings (%change after Dec. 1989); Hstarts - housing starts (millions of units); IndProd - industrial production (%change); Leaders - index of leading indicators (%change); NewHome - new home sales (K's); Nonfarm - nonfarm payrolls (K's); PCE - personal consumption expenditures (%change); PersInc - personal income (%change); PPI - producer price index (%change); PPIXFE - PPI core (%change); RSXauto - retail sales except auto(%change); RetSls - retail sales (%change); TBudget - treasury budget ($B); unemp - civilian unemployment rate.

		Panel1	surpr.		Panel2	AwayH		Panel3	Change	
	freq.	Obs	Mean	SDV	Obs	Mean	SDV	Obs	Mean	SDV
FedRate	6W	2760	0.000	0.010	2760	0.002	0.106	2760	0.000	0.028
Claims	w	2760	-0.001	0.170	2760	-0.028	0.432	2760	0.000	0.200
RGDP	Q	2760	0.004	0.063	2760	0.005	0.220	2760	0.000	0.160
GDPPI	Q	2760	-0.003	0.115	2760	-0.008	0.205	2760	0.001	0.145
BusInv	W	2760	0.004	0.134	2760	0.000	0.217	2760	0.000	0.225
Capacity	M	2760	0.000	0.020	2760	0.004	0.232	2760	-0.001	0.032
ConfidnC	M	2760	0.001	0.042	2760	0.015	0.185	2760	0.000	0.051
Construct	M	2760	0.006	0.213	2760	0.002	0.219	2760	0.001	0.268
CPI	M	2760	-0.006	0.140	2760	-0.002	0.215	2760	0.000	0.290
CPIXFE	M	2760	-0.004	0.178	2760	-0.006	0.181	2760	0.001	0.256
Credit	M	2760	0.007	0.200	2760	0.011	0.205	2760	0.000	0.263
DurGds	M	2760	0.000	0.165	2760	-0.002	0.200	2760	-0.001	0.341
Tbalance	M	2760	-0.001	0.030	2760	-0.004	0.192	2760	-0.001	0.039
HrEarn	M	2760	0.001	0.192	2760	0.002	0.204	2760	0.000	0.327
Hstarts	M	2760	0.004	0.071	2760	0.011	0.169	2760	0.001	0.087
IndProd	M	2760	0.003	0.124	2760	0.001	0.222	2760	0.000	0.274
Leaders	M	2760	0.003	0.090	2760	-0.001	0.182	2760	-0.001	0.238
NewHome	M	2760	0.004	0.066	2760	0.009	0.168	2760	0.001	0.079
Nonfarm	M	2760	-0.003	0.147	2760	0.003	0.223	2760	0.000	0.234
PCE	M	2760	0.002	0.098	2760	0.000	0.216	2760	0.000	0.362
PersInc	M	2760	0.004	0.119	2760	0.001	0.191	2760	0.000	0.293
PPI	M	2760	-0.004	0.167	2760	-0.001	0.221	2760	0.000	0.296
PPIXFE	M	2760	-0.006	0.199	2760	-0.002	0.213	2760	0.000	0.342
RSXauto	M	2760	-0.001	0.155	2760	0.001	0.228	2760	0.000	0.385
RetSls	M	2760	-0.002	0.180	2760	0.002	0.212	2760	-0.001	0.346
TBudget	M	2760	0.000	0.028	2760	0.004	0.228	2760	0.000	0.360
unemp	M	2760	-0.002	0.032	2760	-0.016	0.177	2760	0.000	0.035

Table 2: Summary statistics for foreign exchange rates

We report the statistics summary of spot rates, forward rates, spot return and forward premium for the 4 currencies respectively. The sample period is from Nov. 2nd, 1993 to Jun. 1st, 2004, in daily data. Spot and forward rates are in natural logarithm. Spot return (SR) is defined by $(\ln S_t - \ln S_{t-1}) \times 1000$.

		obs	mean	STD	min	max
AUD	spot	1802	0.463525	0.133866	0.2009	0.7255
	forward	1802	0.463203	0.133683	0.2031	0.7242
	sr	1802	0.025033	7.217598	-48.2481	44.4865
CAD	spot	1189	0.379565	0.070393	0.1755	0.4778
	forward	1189	0.379283	0.070347	0.1762	0.4776
	sr	1189	-0.15646	4.431678	-17.4905	15.8897
GBP	spot	2515	-0.45856	0.065394	-0.6442	-0.317
	forward	2515	-0.45893	0.065305	-0.6443	-0.3168
	sr	2515	-0.11289	4.882065	-19.9674	21.9074
JPY	spot	2374	4.727774	0.104639	4.3959	4.9914
	forward	2374	4.72749	0.104631	4.3894	4.992
	sr	2374	-0.18178	7.215082	-56.3021	32.399

Table 3: The explanation power from the individual news

We run simple OLS on individual news release only. The independent variable is the individual news deviation released on day t and the dependent variable is spot return defined by $(\ln S_{t+1} - \ln S_t)$. We report the beta, t-ratio, adjusted R square and the observation numbers here. Panel 1 has the surprise as independent variable, panel 2 use AwayH and Panel 3 use Change as independent variables respectively.

aud	Panel1	Surprise			Panel 2	AwayH			Panel 3	Change		
	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs
FedRate	-23.294	-1.338	0.154	10	-0.602	-0.430	-0.103	33	-3.150	-0.594	-0.097	33
Claims	-0.937	-1.303	0.001	530	-0.124	-0.438	-0.001	547	0.218	0.355	-0.001	532
RGDP	0.704	0.385	-0.003	116	0.477	0.921	0.005	124	-0.211	-0.293	-0.004	117
GDPPI	0.094	0.095	0.000	93	0.523	0.940	0.005	124	0.455	0.572	0.003	92
BusInv	1.263	1.571	0.022	106	0.214	0.406	-0.007	127	0.062	0.122	-0.007	108
Capacity	-0.052	-0.009	-0.001	113	0.560	1.184	0.010	127	-3.396	-1.072	0.006	112
ConfidnC	5.936	1.875	0.001	126	-0.256	-0.353	-0.026	126	4.610	1.760	-0.002	126
Construct	-0.122	-0.201	-0.028	125	-0.128	-0.217	-0.028	125	0.126	0.259	-0.024	122
CPI	1.594	1.462	0.026	79	1.605	2.658	0.053	127	1.217	2.522	0.060	96
CPIXFE	0.998	1.277	0.022	73	1.193	1.635	0.020	127	0.182	0.338	0.001	84
Credit	-0.877	-1.137	0.005	126	-1.236	-1.656	0.016	127	-0.240	-0.408	-0.005	127
DurGds	-1.288	-1.856	0.019	107	-1.140	-1.997	0.022	107	-0.313	-0.917	-0.007	106
Tbalance	3.430	0.754	0.002	124	-0.414	-0.560	0.002	127	1.836	0.503	0.001	124
HrEarn	-0.457	-0.646	-0.035	98	-0.408	-0.635	-0.024	127	0.462	1.133	-0.016	104
Hstarts	0.146	0.088	-0.020	121	-1.094	-1.601	0.002	126	0.355	0.257	-0.023	117
IndProd	1.005	1.083	0.009	109	0.117	0.235	-0.001	127	0.067	0.167	0.000	118
Leaders	1.381	1.002	-0.012	81	0.834	1.342	0.001	128	0.536	1.142	-0.039	106
NewHome	-1.161	-0.641	0.001	127	0.066	0.094	-0.002	127	-1.197	-0.785	0.002	125
Nonfarm	1.523	1.704	-0.008	127	0.506	0.853	-0.026	127	0.286	0.504	-0.029	127
PCE	2.402	2.289	0.001	94	1.508	3.023	0.016	125	0.708	2.323	-0.037	108
PersInc	0.660	0.682	-0.067	96	0.386	0.662	-0.052	125	-0.024	-0.062	-0.048	105
PPI	-0.880	-1.361	0.015	107	-0.792	-1.711	0.016	127	-0.484	-1.433	0.011	117
PPIXFE	-0.687	-1.542	0.013	98	-0.714	-1.478	0.010	127	-0.300	-1.003	0.000	106
RSXauto	0.667	0.956	0.008	114	0.563	1.191	0.011	127	0.157	0.572	0.002	125
RetSls	-0.090	-0.143	-0.002	108	-0.096	-0.187	0.000	127	-0.202	-0.633	0.003	118
TBudget	3.138	0.672	-0.006	124	-0.442	-0.771	-0.005	127	-0.169	-0.464	-0.008	127
unemp	3.374	0.784	-0.013	90	0.406	0.551	-0.024	127	1.321	0.357	-0.036	96

(To be continued of table 3_ CAD)

CAD	Panel1	Surprise			Panel 2	AwayH			Panel 3	Change		
	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs
FedRate	9.8813	1.2793	0.0879	10	0.0304	0.041	-0.117	33	2.2355	0.8012	-0.0951	33
Claims	-0.1541	-0.3579	-0.0001	530	-0.2377	-1.3879	0.0024	547	0.1979	0.5326	-0.0013	532
RGDP	-1.2607	-1.0982	0.0034	116	-0.7164	-2.1709	0.0242	124	-1.1284	-2.5417	0.0487	117
GDPPI	0.2686	0.4283	-0.0006	93	0.2013	0.5589	-0.0086	124	0.1752	0.3554	-0.0028	92
BusInv	0.9351	1.9193	0.0209	106	0.1483	0.4848	-0.0251	127	0.4146	1.3743	-0.0062	108
Capacity	-1.2574	-0.3532	0.0009	113	0.2915	0.9755	0.0075	127	-0.2443	-0.1129	-0.0006	112
ConfidnC	0.5677	0.3705	-0.0052	126	-0.0004	-0.0013	-0.0063	126	-0.112	-0.0884	-0.0063	126
Construct	0.2862	0.7805	0.0048	125	0.2505	0.703	0.0039	125	0.4449	1.5253	0.0188	122
CPI	0.6141	0.9802	0.0092	79	0.2938	0.8375	0.0037	127	0.0634	0.2552	0.0006	96
CPIXFE	-0.228	-0.5855	0.0047	73	-0.2169	-0.5198	0.0003	127	-0.3529	-1.225	0.0178	84
Credit	-0.1197	-0.2984	-0.0012	126	-0.0285	-0.0731	-0.0017	127	0.0296	0.0973	-0.0017	127
DurGds	-0.0576	-0.1624	-0.0183	107	-0.3188	-1.0823	-0.0113	107	-0.1383	-0.8047	-0.0124	106
Tbalance	4.6227	1.9076	0.018	124	0.4476	1.1382	-0.0053	127	3.4844	1.8172	0.0103	124
HrEarn	0.2343	0.5558	-0.0223	98	0.0501	0.1299	-0.0395	127	-0.0782	-0.3212	-0.0338	104
Hstarts	0.3815	0.3895	-0.0002	121	0.1508	0.3702	-0.0017	126	-0.3338	-0.4168	0.0005	117
IndProd	-0.5967	-1.034	0.0083	109	-0.1965	-0.6275	0.0031	127	-0.255	-1.0249	0.0075	118
Leaders	0.7606	0.8862	-0.0124	81	0.2784	0.6941	-0.0249	128	-0.1026	-0.3239	-0.0123	106
NewHome	-1.3943	-1.1271	-0.0054	127	-0.3478	-0.7186	-0.0114	127	-0.736	-0.7063	-0.0153	125
Nonfarm	0.9984	1.8869	-0.0055	127	0.0449	0.1271	-0.0338	127	0.3854	1.1503	-0.0232	127
PCE	1.0758	1.4811	0.0215	94	-0.0719	-0.2202	-0.0054	125	-0.1939	-1.0086	-0.0036	108
PersInc	-0.0033	-0.0056	0	96	0.2986	0.8125	-0.0005	125	0.2889	1.2041	0.0007	105
PPI	-0.2523	-0.5614	0.0019	107	-0.1753	-0.5219	-0.0008	127	-0.2116	-0.8239	0.0034	117
PPIXFE	0.078	0.1996	-0.0029	98	0.2575	0.7441	0.0005	127	-0.035	-0.1645	-0.0016	106
RSXauto	0.2846	0.684	-0.0169	114	0.1468	0.5169	-0.013	127	0.0747	0.4429	-0.016	125
RetSls	0.4385	1.217	0.0083	108	0.2836	0.9309	-0.0082	127	0.0502	0.273	-0.0092	118
TBudget	2.8813	1.3584	0.0145	124	0.0286	0.1092	-0.0002	127	-0.0362	-0.2173	0.0001	127
unemp	1.7388	0.7662	-0.0336	90	0.3764	0.8532	-0.0335	127	1.6603	0.7427	-0.0329	96

(To be continued of table 3 _ GBP)

GBP	Panel1	Surprise			Panel 2	AwayH			Panel 3	Change		
	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs
FedRate	4.5978	0.478	-0.3343	10	1.0148	1.3096	0.0428	33	4.9321	1.7063	0.0756	33
Claims	0.4271	0.7501	-0.0236	530	0.0153	0.0684	-0.0219	547	1.0627	2.2003	-0.013	532
RGDP	3.3515	2.1213	0.0375	116	0.5989	1.2915	0.0134	124	1.4472	2.3313	0.0444	117
GDPPI	-0.2935	-0.3539	-0.0151	93	0.0575	0.1147	0.0001	124	0.1793	0.2687	-0.0112	92
BusInv	0.2214	0.3204	-0.0021	106	0.2688	0.6264	-0.0054	127	-0.0429	-0.0984	-0.0121	108
Capacity	-3.366	-0.7184	0.0025	113	0.6438	1.6628	0.0195	127	-1.9811	-0.7112	0.0003	112
ConfidnC	-0.7917	-0.3853	-0.0084	126	0.4172	0.9009	-0.0031	126	-0.4115	-0.2423	-0.0091	126
Construct	-0.0872	-0.2066	-0.0156	125	0.2306	0.5632	-0.0134	125	0.4353	1.3032	-0.0032	122
CPI	0.5017	0.6591	0.0043	79	0.7153	1.6253	0.0175	127	0.2987	0.8481	0.0072	96
CPIXFE	0.2199	0.3887	0.002	73	0.2046	0.3876	-0.0019	127	-0.0866	-0.2211	-0.0006	84
Credit	-0.4116	-0.8075	-0.0041	126	-0.4659	-0.9405	-0.0023	127	-0.3056	-0.7901	-0.0043	127
DurGds	0.2674	0.5464	-0.0927	107	0.2946	0.7272	-0.0954	107	0.0197	0.0825	-0.1041	106
Tbalance	5.1878	1.7095	0.0178	124	-0.1909	-0.3945	-0.0065	127	2.9327	1.2374	0.0031	124
HrEarn	0.0258	0.0485	-0.0474	98	-0.1413	-0.2823	-0.0126	127	-0.3256	-1.0149	-0.0166	104
Hstarts	-2.9866	-2.4144	0.04	121	-1.4647	-2.8057	0.054	126	-2.0612	-1.9503	0.0277	117
IndProd	-0.4482	-0.6049	0.0009	109	0.0393	0.096	-0.002	127	-0.2972	-0.902	0.0056	118
Leaders	1.51	1.3444	-0.0223	81	0.2864	0.5183	-0.0014	128	-0.3906	-1.0369	0.0101	106
NewHome	-2.5236	-1.7074	0.0131	127	-0.2558	-0.4389	-0.0082	127	-1.3677	-1.0898	-0.0013	125
Nonfarm	2.8376	4.3522	0.1212	127	2.1458	5.1272	0.1636	127	1.064	2.4829	0.0363	127
PCE	0.5537	0.5575	-0.0165	94	0.4364	0.9683	-0.0377	125	0.0316	0.1173	-0.038	108
PersInc	-0.167	-0.1988	-0.0759	96	-0.418	-0.8209	-0.0399	125	0.0286	0.0881	-0.018	105
PPI	0.5502	0.9038	-0.0101	107	0.5966	1.3383	-0.0098	127	0.6091	1.8287	0.0086	117
PPIXFE	-0.5486	-1.0643	0.0019	98	-0.6783	-1.4695	-0.0051	127	-0.1871	-0.6688	-0.01	106
RSXauto	0.363	0.5505	-0.0171	114	-0.1361	-0.313	-0.0081	127	0.005	0.0195	-0.0081	125
RetSls	0.0414	0.0734	-0.0293	108	0.1293	0.2765	-0.0083	127	-0.0153	-0.0528	-0.0083	118
TBudget	2.7658	0.83	-0.0141	124	0.3216	0.7808	-0.0166	127	0.0983	0.3746	-0.0204	127
unemp	-5.9554	-1.8423	0.015	90	-0.1545	-0.2676	-0.0153	127	-6.9099	-2.387	0.032	96

(To be continued of Table 3 _ JPY)

JPY	Panel1	Surprise			Panel 2	AwayH			Panel 3	Change		
	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs	b	t	$\overline{R^2}$	obs
FedRate	10.7552	1.1512	-0.0706	10	-0.3429	-0.2684	-0.0001	33	7.8111	1.6781	0.0787	33
Claims	-0.6905	-0.859	-0.0027	530	0.2988	0.9303	-0.0054	547	-0.2552	-0.3672	-0.0078	532
RGDP	0.9018	0.4232	0.0014	116	-0.6825	-1.1473	0.0103	124	-0.1017	-0.1212	0.0001	117
GDPPI	-0.6367	-0.6519	-0.0046	93	1.4024	2.2308	0.0386	124	0.0615	0.0774	-0.0083	92
BusInv	-0.2039	-0.2072	-0.0003	106	-0.267	-0.3615	-0.0004	127	0.1698	0.2353	0.0004	108
Capacity	11.3606	1.4876	0.0185	113	0.4146	0.6638	-0.0001	127	0.863	0.1876	-0.0142	112
ConfidnC	-0.4631	-0.1768	-0.0451	126	-0.6924	-1.1764	-0.034	126	-0.6428	-0.2973	-0.0447	126
Construct	0.8878	1.3945	0.015	125	0.6566	1.0585	0.0085	125	0.032	0.0626	-0.0003	122
CPI	1.2063	1.1917	0.0145	79	0.7552	1.1934	-0.001	127	0.5418	1.165	0.0011	96
CPIXFE	0.7351	0.9581	0.0008	73	0.5814	0.7713	-0.0076	127	-0.0442	-0.0799	-0.0045	84
Credit	0.3009	0.3198	-0.0016	126	0.5124	0.5604	0.0002	127	0.1921	0.2691	-0.0017	127
DurGds	-0.0901	-0.1284	-0.0013	107	-0.1676	-0.288	-0.0003	107	-0.4301	-1.2636	0.0137	106
Tbalance	2.3939	0.5353	0.0023	124	0.4274	0.6112	0.0028	127	1.0549	0.3085	0.0006	124
HrEarn	1.1876	1.7616	-0.0281	98	0.9464	1.5127	-0.0427	127	0.484	1.1771	-0.0483	104
Hstarts	1.7442	1.0252	-0.0013	121	0.0146	0.0208	-0.0076	126	0.4229	0.2989	-0.0063	117
IndProd	2.4781	2.1034	0.0351	109	0.4976	0.7624	0.001	127	0.9721	2.0608	0.035	118
Leaders	1.1155	0.7486	-0.0383	81	-0.1385	-0.1746	-0.0051	128	-0.1881	-0.2985	-0.0013	106
NewHome	0.188	0.0846	0	127	-0.7098	-0.8205	0.0053	127	-0.8064	-0.431	0.0015	125
Nonfarm	0.8198	0.9368	-0.0523	127	0.9985	1.749	-0.0345	127	0.2537	0.4607	-0.0578	127
PCE	0.3444	0.2374	-0.0002	94	0.0716	0.1101	0.0001	125	0.0077	0.0198	-0.0001	108
PersInc	-1.2862	-1.056	0.0111	96	-1.3172	-1.8181	0.026	125	-0.6614	-1.3676	0.0169	105
PPI	0.3092	0.3565	-0.0038	107	0.3943	0.6277	0.001	127	0.3649	0.763	0.0047	117
PPIXFE	-0.294	-0.423	-0.0047	98	-0.2819	-0.4318	-0.0004	127	-0.0657	-0.1559	-0.0085	106
RSXauto	-0.2029	-0.2268	-0.0394	114	0.02	0.0339	-0.0225	127	0.0285	0.0816	-0.027	125
RetSls	0.3318	0.4506	-0.0078	108	0.4649	0.734	-0.0181	127	0.1731	0.4671	-0.0167	118
TBudget	0.6131	0.1491	-0.0002	124	-0.3399	-0.6679	0.0033	127	-0.2564	-0.793	0.0047	127
unemp	-9.6493	-2.3583	0.0076	90	-1.2494	-1.7402	-0.0421	127	-5.6185	-1.5317	-0.028	96

Table 4: Hypothesized relationship between macroeconomic factors and the announcements

We choose 2 different ways to load the information matrix. 2-factor loading system only includes growth (g) in h1 and inflation factors (inf) in h2; 3 factor system has a new interest rate factor (int) as h3, I use 0 represent no effect to the information matrix H, − means negative effect and + is a positive effect.

	Panel1	2fact.	Panel2	3fact	
	g	inf	g	inf	int
FedRate	0	+	0	0	+
Claims	−	−	−	−	0
RGDP	+	0	+	0	0
GDPPI	0	+	0	+	+
BusInv	−	0	0	−	0
Capacity	0	+	0	+	0
ConfidnC	0	+	0	+	+
Construct	+	−	+	0	−
CPI	0	+	0	+	+
CPIXFE	0	+	0	+	+
Credit	0	+	0	0	+
DurGds	+	0	+	0	+
Tbalance	0	+	0	0	+
HrEarn	0	+	0	+	+
Hstarts	+	0	+	0	+
IndProd	+	0	+	0	0
Leaders	+	0	+	0	0
NewHome	+	0	+	0	0
Nonfarm	+	+	+	+	+
PCE	0	+	0	0	+
PersInc	0	+	0	0	+
PPI	0	+	0	+	+
PPIXFE	0	+	0	+	+
RSXauto	+	0	+	0	0
RetSls	+	0	+	0	0
TBudget	0	−	0	0	−
unemp	−	−	−	−	−

Table 5: Extracting 2 systematic factors from macroeconomic news

We report the computed information matrix here. h1 is the growth factor and h2 is the inflation factor. fv is the forecasted percentage variance, defined by equation 18. Panel 1 reports the results from surprise, panel 2 is the results from AwayH and panel 3 has the results from change. This table is for the 2 systematic factors only.

2fact	Panel1	surprise		Panel2	AwayH		Panel3	change	
	growth	inf		growth	inf		growth	inf	
	h1	h2	fv	h1	h2	fv	h1	h2	fv
FedRate	0	2.906	0.9255	0	2.906	0.9853	0	2.906	0.9105
Claims	-1.3333	-1.0611	0.6927	-1.3333	-1.0611	0.8005	-1.3333	-1.0611	0.785
RGDP	0.3178	0	0.9264	0.3178	0	0.9548	0.3178	0	0.9578
GDPPI	0	0.9088	0.9466	0	0.9088	0.9548	0	0.9088	0.9674
BusInv	-3.2901	0	0.9359	-3.2901	0	0.9521	-3.2901	0	0.9552
Capacity	0	0.435	0.9289	0	0.435	0.9543	0	0.435	0.9556
ConfidnC	0	1.3423	0.9221	0	1.3423	0.951	0	1.3423	0.9396
Construct	3.2843	-0.2628	0.9283	3.2843	-0.2628	0.9539	3.2843	-0.2628	0.9532
CPI	0	2.0428	0.9573	0	2.0428	0.9584	0	2.0428	0.9685
CPIXFE	0	5.0711	0.9609	0	5.0711	0.9485	0	5.0711	0.9685
Credit	0	0.5007	0.9267	0	0.5007	0.952	0	0.5007	0.9548
DurGds	0.9631	0	0.9389	0.9631	0	0.9612	0.9631	0	0.9618
Tbalance	0	2.3584	0.8617	0	2.3584	0.9527	0	2.3584	0.8608
HrEarn	0	3.5043	0.958	0	3.5043	0.9641	0	3.5043	0.9715
Hstarts	1.3872	0	0.9303	1.3872	0	0.9542	1.3872	0	0.9536
IndProd	1.1908	0	0.9363	1.1908	0	0.9543	1.1908	0	0.9571
Leaders	0.8297	0	0.9523	0.8297	0	0.9541	0.8297	0	0.962
NewHome	2.0664	0	0.9133	2.0664	0	0.9495	2.0664	0	0.9314
Nonfarm	0.5553	0.2032	0.9261	0.5553	0.2032	0.954	0.5553	0.2032	0.9534
PCE	0	0.2367	0.9461	0	0.2367	0.9551	0	0.2367	0.9612
PersInc	0	1.7703	0.9419	0	1.7703	0.9542	0	1.7703	0.9618
PPI	0	0.6704	0.939	0	0.6704	0.955	0	0.6704	0.9584
PPIXFE	0	1.9937	0.9441	0	1.9937	0.9551	0	1.9937	0.9626
RSXauto	8.8745	0	0.9828	8.8745	0	0.9869	8.8745	0	0.9905
RetSls	0.8725	0	0.9419	0.8725	0	0.9575	0.8725	0	0.9609
TBudget	0	-2.2606	0.8612	0	-2.2606	0.955	0	-2.2606	0.9557
unemp	-1.1207	-2.0379	0.8694	-1.1207	-2.0379	0.9459	-1.1207	-2.0379	0.811

Table 6: Extracting 3 systematic factors from macroeconomic news

We report the computed information matrix here. h1 is the growth factor, h2 is the inflation factor and h3 is the interest rate loading.. fv is the forecasted percentage variance, defined by equation 18. Panel 1 reports the results from surprise, panel 2 is the results from AwayH and panel 3 has the results from change. The first table is for the 2 systematic factors only, and the next page we extract 3 systematic factors.

3fact	Panel1	Surprise			panel2	AwayH			Panel3	Change		
	growth	inf	interest		growth	inf	interest		growth	inf	interest	
	h1	h2	h3	fv	h1	h2	h3	fv	h1	h2	h3	fv
FedRate	0	0	3.2843	0.9834	0	0	3.2843	0.9949	0	0	3.2825	0.982
Claims	-1.3872	-0.9631	0	0.7029	-1.3872	-0.9631	0	0.8075	-1.3872	-0.9631	0	0.8097
RGDP	1.1908	0	0	0.927	1.1908	0	0	0.9561	1.1908	0	0	0.9587
GDPPI	0	0.8297	2.0664	0.9459	0	0.8297	2.0664	0.9527	0	0.8296	2.0663	0.9668
BusInv	0	-0.5553	0	0.9382	0	-0.5553	0	0.954	0	-0.5574	0	0.9612
Capacity	0	8.8745	0	0.0553	0	8.8745	0	0.9462	0	8.8677	0	0.416
ConfidnC	0	0.8725	1.1207	0.9218	0	0.8725	1.1207	0.9468	0	0.8724	1.1207	0.9466
Construct	2.906	0	-1.0611	0.9359	2.906	0	-1.0611	0.9594	2.9051	0	-1.0611	0.9605
CPI	0	0.9088	0.435	0.9542	0	0.9088	0.435	0.955	0	0.9087	0.4349	0.9664
CPIXFE	0	1.3423	0.2628	0.9606	0	1.3423	0.2628	0.9555	0	1.3423	0.2628	0.9718
Credit	0	0	2.0428	0.9286	0	0	2.0428	0.9523	0	0	2.0426	0.9558
DurGds	5.0711	0	0.5007	0.9496	5.0711	0	0.5007	0.9631	5.068	0	0.5007	0.9696
Tbalance	0	0	2.3584	0.919	0	0	2.3584	0.9536	0	0	2.3581	0.9399
HrEarn	0	3.5043	0.2032	0.9528	0	3.5043	0.2032	0.9601	0	3.503	0.2032	0.9685
Hstarts	0.2367	0	1.7703	0.9254	0.2367	0	1.7703	0.9484	0.2366	0	1.7703	0.9559
IndProd	0.6704	0	0	0.9386	0.6704	0	0	0.9556	0.6702	0	0	0.9586
Leaders	1.9937	0	0	0.951	1.9937	0	0	0.9532	1.9936	0	0	0.9618
NewHome	2.2606	0	0	0.9165	2.2606	0	0	0.949	2.2604	0	0	0.9448
Nonfarm	3.6337	2.0379	1.9515	0.9247	3.6337	2.0379	1.9515	0.9523	3.6328	2.0386	1.9526	0.9486
PCE	0	0	3.2898	0.9477	0	0	3.2898	0.9548	0	0	3.289	0.963
PersInc	0	0	0.3005	0.9434	0	0	0.3005	0.9551	0	0	0.3003	0.9623
PPI	0	0.9804	0.2011	0.9389	0	0.9804	0.2011	0.9548	0	0.9804	0.201	0.9585
PPIXFE	0	0.8549	1.2934	0.9436	0	0.8549	1.2934	0.9544	0	0.8549	1.2935	0.9628
RSXauto	0.3477	0	0	0.9359	0.3477	0	0	0.9549	0.3476	0	0	0.9556
RetSls	4.1171	0	0	0.9497	4.1171	0	0	0.9608	4.1152	0	0	0.9661
TBudget	0	0	-0.447	0.9289	0	0	-0.447	0.9541	0	0	-0.4467	0.9544
unemp	-1.2452	-1.6968	-0.3978	0.9236	-1.2452	-1.6968	-0.3978	0.9597	-1.2453	-1.6967	-0.3978	0.9225

Table 7 lag check for spot foreign exchange rates by AIC

We use the AIC to measure the goodness of different VAR model with lags from 1 to 8. The last row I indicate the lags we pick for each currency.

nlag	aud	cad	gbp	jpy
1	6.48	4.544	5.387	6.304
2	6.384	4.47	5.295	6.174
3	6.351	4.438	5.226	6.128
4	6.344	4.423	5.207	6.115
5	6.339	4.421	5.194	6.115
6	6.342	4.417	5.195	6.113
7	6.344	4.418	5.195	6.113
8	6.348	4.425	5.197	6.115
lag	5	6	5	6

Table 8: Lag check for spot foreign exchange rates by LR ratio

We apply LR ratio caculation to confirm the lag check results.

AUD	nlag	=	8	7	LR	statistic	=	2.0754	probability	=	0.7219
	nlag	=	7	6	LR	statistic	=	4.2076	probability	=	0.3786
	nlag	=	6	5	LR	statistic	=	3.7793	probability	=	0.4367
	nlag	=	5	4	LR	statistic	=	16.6505	probability	=	0.00226
	nlag	=	4	3	LR	statistic	=	18.5424	probability	=	0.000967
	nlag	=	3	2	LR	statistic	=	62.988	probability	=	6.83E-13
	nlag	=	2	1	LR	statistic	=	171.2934	probability	=	0
CAD	nlag	=	8	7	LR	statistic	=	1.2998	probability	=	0.8614
	nlag	=	7	6	LR	statistic	=	6.6439	probability	=	0.1559
	nlag	=	6	5	LR	statistic	=	12.8916	probability	=	0.01182
	nlag	=	5	4	LR	statistic	=	10.4881	probability	=	0.03296
	nlag	=	4	3	LR	statistic	=	23.8708	probability	=	8.48E-05
	nlag	=	3	2	LR	statistic	=	42.4035	probability	=	1.38E-08
	nlag	=	2	1	LR	statistic	=	87.3104	probability	=	0
gbp	nlag	=	8	7	LR	statistic	=	4.099	probability	=	0.3928
	nlag	=	7	6	LR	statistic	=	9.3066	probability	=	0.05388
	nlag	=	6	5	LR	statistic	=	5.9414	probability	=	0.2036
	nlag	=	5	4	LR	statistic	=	38.2847	probability	=	9.79E-08
	nlag	=	4	3	LR	statistic	=	51.3644	probability	=	1.87E-10
	nlag	=	3	2	LR	statistic	=	173.8289	probability	=	0
	nlag	=	2	1	LR	statistic	=	229.1571	probability	=	0
jpy	nlag	=	8	7	LR	statistic	=	2.3082	probability	=	0.6793
	nlag	=	7	6	LR	statistic	=	8.4998	probability	=	0.07489
	nlag	=	6	5	LR	statistic	=	12.2384	probability	=	0.01566
	nlag	=	5	4	LR	statistic	=	8.1377	probability	=	0.08666
	nlag	=	4	3	LR	statistic	=	36.5616	probability	=	2.22E-07
	nlag	=	3	2	LR	statistic	=	112.1308	probability	=	0
	nlag	=	2	1	LR	statistic	=	301.9676	probability	=	0

Table 9: Unit root test for spot and forward rates

This table we report the unit root test on the 4 currencies, in spot rates and forward rates. CO means constant only, CT is constant and trend together. We test the spot and forward rates both on level and on first difference. The critical value in 1% level is -3.458, 5% level is -2.871 and 10% level is -2.549.

	CO	CO	CT	CT
	level	first diff	level	first diff
aud spot	-1.6252	-47.3416	-0.8255	-47.3865
cad spot	-0.7812	-36.8793	-1.3118	-36.8762
gbp spot	-1.4459	-55.6642	-1.5017	-55.6597
jpy spot	-1.7809	-53.8378	-1.7925	-53.8298
aud forward	-1.6939	-48.0868	-0.9614	-48.1321
cad forward	-0.9438	-39.4659	-1.5398	-39.4621
gbp forward	-1.7465	-58.6377	-1.8074	-58.6313
jpy forward	-1.9022	-54.7558	-1.9164	-54.7478

Table 10: Unit root test for the extracted news factors

This table we report he unit root test on the extracted systematic factors. CO means constant only, CT is constant and trend together. The critical value value in 1% level is -3.458, 5% is -2.871 and 10% as -2.549. Because all the returns are significant, we only have the test on the levels.

	CO	CT	CO	CT	CO	CT
	surprise	surprise	AwayH	AwayH	change	change
x1_2fact	-37.7425	-37.7567	-43.3522	-43.3807	-44.5034	-44.4954
x2_2fact	-31.1442	-31.1416	-33.9803	-34.0025	-33.5577	-33.551
x1_-3fact	-36.6764	-36.6757	-36.692	-37.1557	-42.8493	-42.8478
x2_3fact	-40.255	-40.2605	-38.9243	-39.29	-47.6447	-47.6395
x3_3fact	-33.065	-33.0725	-43.7857	-44.1848	-39.944	-39.9621

Table 11: VECM with *surprise* news deviations: ΔS_t

We report the results of VECM in this table. We run 4 different equations here: without news, extracted 2-factor news and extracted 3-factor news. For each currency, we report the coeffiecients, P probability, adjusted R square and observation numbers. Table 11 is the results of ΔS_t..

panel 1	Var	AUD Δs_t	p	CAD Δs_t	p	GBP Δs_t	p	JPY Δs_t	p
Nonews	slag1	-0.2341	0.0766	-0.1116	0.5158	-0.1236	0.1132	-0.0285	0.8451
	slag2	-0.2148	0.0722	-0.1628	0.301	-0.1807	0.0112	-0.067	0.6204
	slag3	-0.1958	0.0592	-0.1493	0.2887	-0.1226	0.0501	-0.0645	0.6004
	slag4	-0.1288	0.124	-0.1582	0.1934	0.0118	0.8206	-0.0609	0.5727
	slag5	-0.1239	0.0314	-0.084	0.3934	-0.0342	0.3574	-0.081	0.3504
	slag6			-0.1249	0.0608			-0.0705	0.2365
	flag1	0.2791	0.0362	0.0853	0.6248	0.193	0.0133	0.0446	0.7615
	flag2	0.2155	0.0744	0.1797	0.2621	0.1743	0.0142	0.078	0.5678
	flag3	0.2154	0.0414	0.1566	0.2771	0.0936	0.1369	0.0685	0.5824
	flag4	0.1348	0.1168	0.151	0.2294	0.0313	0.5554	0.0653	0.5515
	flag5	0.0988	0.1065	0.132	0.2009	0.0345	0.3642	0.1013	0.2548
	flag6			0.1083	0.1351			0.0835	0.181
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	const	-0.0001	0.5705	0.0002	0.1352	0.0003	0.0154	0	0.8936
	Rbar	0.1176		0.1516		0.1037		0.0841	
panel 2	slag1	-0.2353	0.0746	-0.107	0.5336	-0.1265	0.1051	-0.0172	0.9063
2fact	slag2	-0.2093	0.0794	-0.1585	0.3141	-0.1827	0.0103	-0.0564	0.6767
	slag3	-0.1934	0.062	-0.1476	0.2944	-0.1241	0.0474	-0.0581	0.6368
	slag4	-0.1236	0.1396	-0.154	0.2059	0.0118	0.8206	-0.0575	0.594
	slag5	-0.1197	0.0374	-0.0795	0.4197	-0.0321	0.387	-0.0767	0.3767
	slag6			-0.1225	0.0667			-0.0691	0.246
	flag1	0.2773	0.0371	0.0801	0.6461	0.1937	0.0129	0.0314	0.8308
	flag2	0.2107	0.0807	0.1746	0.2763	0.1755	0.0135	0.0666	0.6259
	flag3	0.2117	0.0447	0.1559	0.2794	0.0956	0.1284	0.059	0.6357
	flag4	0.1296	0.1311	0.1464	0.2443	0.0312	0.557	0.0612	0.5766
	flag5	0.0975	0.1108	0.1278	0.2163	0.0334	0.3786	0.0964	0.2788
	flag6			0.1053	0.1471			0.0801	0.1995
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	g	-0.0074	0.6748	-0.0119	0.303	0.0036	0.7382	-0.0091	0.5966
	inf	0.0437	0.025	0.0091	0.515	0.0118	0.2642	0.0304	0.085
	const	-0.0001	0.5797	0.0002	0.127	0.0003	0.0148	0	0.9258
	rbar	0.1206		0.1508		0.1043		0.0848	

(To be continued of table 11 _ 3fact)

panel 3	Var	AUD Δs_t	p	CAD Δs_t	p	GBP Δs_t	p	JPY Δs_t	p
3fact	slag1	-0.2374	0.0726	-0.11	0.5232	-0.1275	0.1021	-0.0224	0.8777
	slag2	-0.2155	0.0713	-0.1623	0.3038	-0.1829	0.0102	-0.061	0.6518
	slag3	-0.2009	0.0531	-0.1489	0.2916	-0.1246	0.0463	-0.0612	0.6187
	slag4	-0.13	0.1207	-0.157	0.1983	0.0096	0.8538	-0.0597	0.5796
	slag5	-0.124	0.0312	-0.0815	0.4105	-0.0352	0.3437	-0.0791	0.3614
	slag6			-0.123	0.066			-0.0694	0.2436
	flag1	0.2792	0.0361	0.0833	0.6336	0.1959	0.0119	0.0361	0.8057
	flag2	0.2167	0.0731	0.1781	0.2679	0.1764	0.013	0.0711	0.6022
	flag3	0.22	0.0374	0.1566	0.2783	0.0964	0.1253	0.0613	0.6226
	flag4	0.1362	0.113	0.1509	0.2313	0.0328	0.536	0.0632	0.5639
	flag5	0.0998	0.103	0.1298	0.2108	0.0359	0.3448	0.0987	0.2664
	flag6			0.1057	0.1467			0.0813	0.1921
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	g	-0.021	0.4186	0.0022	0.9091	0.0128	0.404	-0.0108	0.6574
	inf	0.0718	0.1287	0.0154	0.6681	-0.0088	0.7274	0.051	0.217
	int	-0.0163	0.824	-0.0337	0.5201	0.0396	0.3295	0.026	0.6909
	const	-0.0001	0.5726	0.0002	0.1338	0.0003	0.0188	0	0.8527
	rbar	0.1187		0.1495		0.1052		0.0865	

Table 12: VECM with *surprise* news deviations: ΔF_t

We report the results of VECM in this table. We run 4 different equations here: without news, extracted 2-factor news and extracted 3-factor news. For each currency, we report the coeffiecients, P probability, adjusted R square and observation numbers. Table 12 is the return of ΔF_t.

panel 1	Var	AUD Δf_t	p	CAD Δf_t	p	GBP Δf_t	p	JPY Δf_t	p
Nonews	slag1	-0.2025	0.1524	-0.0807	0.6643	-0.021	0.8018	0.1253	0.4201
	slag2	-0.1359	0.2879	-0.1139	0.5038	-0.1766	0.0207	0.0705	0.6245
	slag3	-0.1642	0.1395	-0.1151	0.45	-0.0915	0.1727	0.0131	0.9204
	slag4	-0.1239	0.1668	-0.1209	0.3586	-0.0027	0.9618	-0.0306	0.7901
	slag5	-0.127	0.0394	-0.0744	0.4851	-0.0296	0.4575	-0.0682	0.4608
	slag6			-0.1163	0.107			-0.0339	0.5932
	flag1	0.2141	0.1333	-0.0121	0.9489	0.0877	0.2936	-0.1103	0.4813
	flag2	0.1349	0.2971	0.1244	0.4736	0.1396	0.0669	-0.0924	0.5254
	flag3	0.174	0.1238	0.1185	0.4475	0.0784	0.2448	-0.0122	0.9268
	flag4	0.138	0.1336	0.1112	0.4134	0.0474	0.4052	0.0338	0.7721
	flag5	0.1038	0.1136	0.1204	0.2812	0.0334	0.4127	0.0974	0.3039
	flag6			0.1109	0.1577			0.0478	0.4722
	z	0.0004	0.0198	0.0001	0.6968	0.0006	0	0	0.8451
	const	0.0002	0.3484	-0.0001	0.477	-0.0006	0	0	0.9175
	Rbar	0.0014		0.0018		0.0553		-0.0009	
panel 2	slag1	-0.2027	0.1515	-0.0785	0.6732	-0.0228	0.7854	0.1381	0.3743
2fact	slag2	-0.1294	0.3109	-0.1121	0.5113	-0.1778	0.0199	0.0823	0.5679
	slag3	-0.1608	0.1472	-0.1141	0.4546	-0.0925	0.168	0.0202	0.8778
	slag4	-0.1176	0.1893	-0.119	0.3669	-0.0027	0.9622	-0.027	0.8144
	slag5	-0.1223	0.0471	-0.0723	0.4984	-0.028	0.4822	-0.0633	0.4932
	slag6			-0.1149	0.1121			-0.0321	0.613
	flag1	0.2118	0.137	-0.0144	0.9393	0.0882	0.2911	-0.1252	0.4242
	flag2	0.1292	0.3169	0.1222	0.4819	0.1405	0.0653	-0.1052	0.4699
	flag3	0.1694	0.1335	0.118	0.4498	0.0796	0.2379	-0.023	0.8628
	flag4	0.1319	0.1512	0.1093	0.4222	0.0472	0.4072	0.0293	0.8019
	flag5	0.102	0.1194	0.1186	0.2896	0.0325	0.4248	0.092	0.3315
	flag6			0.1093	0.1649			0.0437	0.5109
	z	0.0004	0.021	0.0001	0.6994	0.0006	0	0	0.9206
	g	0.0005	0.978	-0.0052	0.6806	-0.003	0.7974	-0.0139	0.4453
	inf	0.0398	0.0562	0.0031	0.8395	0.0106	0.3508	0.0366	0.0518
	const	0.0002	0.3471	-0.0001	0.488	-0.0006	0	0	0.88
	Rbar	0.0046		0.0001		0.0549		0.0001	

(To be continued of Table 12 _ 3facter)

Panel 3	Var	AUD Δf_t	p	CAD Δf_t	p	GBP Δf_t	p	JPY Δf_t	p
3fact	slag1	-0.2059	0.146	-0.0858	0.6453	-0.0238	0.7757	0.1316	0.3965
	slag2	-0.1366	0.2858	-0.1196	0.4839	-0.1781	0.0197	0.0768	0.5935
	slag3	-0.1695	0.1274	-0.1129	0.4602	-0.093	0.1658	0.0167	0.8989
	slag4	-0.1251	0.1632	-0.1228	0.3527	-0.0038	0.9454	-0.0293	0.7986
	slag5	-0.1269	0.0395	-0.074	0.4899	-0.0303	0.4475	-0.0661	0.4739
	slag6			-0.1146	0.1137			-0.0327	0.6063
	flag1	0.2142	0.1332	-0.0049	0.9795	0.0895	0.2839	-0.1192	0.4463
	flag2	0.1358	0.2942	0.1321	0.4479	0.1411	0.0641	-0.0997	0.4931
	flag3	0.1788	0.1141	0.1176	0.4521	0.0803	0.2342	-0.0199	0.8805
	flag4	0.1395	0.1296	0.1135	0.4055	0.0481	0.3985	0.0316	0.7869
	flag5	0.1046	0.1107	0.1213	0.2801	0.0344	0.3991	0.0947	0.3172
	flag6			0.1084	0.1695			0.0455	0.4934
	z	0.0004	0.021	0.0001	0.689	0.0006	0	0	0.898
	g	-0.0215	0.4402	0.0133	0.5156	0.0048	0.7708	-0.011	0.6709
	inf	0.0782	0.1225	-0.0325	0.4028	-0.009	0.7383	0.0522	0.2359
	int	-0.0269	0.7323	0.0156	0.7829	0.0409	0.3477	0.0301	0.6652
	const	0.0002	0.3454	-0.0001	0.4708	-0.0006	0	0	0.9597

Table 13: VECM with $AwayH$ news deviations: ΔS_t

We report the results of VECM in this table. We run 4 different equations here: without news, extracted 2-factor news and extracted 3-factor news. For each currency, we report the coeffieecients, P probability, adjusted R square and observation numbers. Table 13 is the results of ΔS_t..

Panel1	Var	AUD Δs_t	p	CAD Δs_t	p	GBP Δs_t	p	JPY Δs_t	p
Nonews	slag1	-0.2341	0.0766	-0.1116	0.5158	-0.1236	0.1132	-0.0285	0.8451
	slag2	-0.2148	0.0722	-0.1628	0.301	-0.1807	0.0112	-0.067	0.6204
	slag3	-0.1958	0.0592	-0.1493	0.2887	-0.1226	0.0501	-0.0645	0.6004
	slag4	-0.1288	0.124	-0.1582	0.1934	0.0118	0.8206	-0.0609	0.5727
	slag5	-0.1239	0.0314	-0.084	0.3934	-0.0342	0.3574	-0.081	0.3504
	slag6			-0.1249	0.0608			-0.0705	0.2365
	flag1	0.2791	0.0362	0.0853	0.6248	0.193	0.0133	0.0446	0.7615
	flag2	0.2155	0.0744	0.1797	0.2621	0.1743	0.0142	0.078	0.5678
	flag3	0.2154	0.0414	0.1566	0.2771	0.0936	0.1369	0.0685	0.5824
	flag4	0.1348	0.1168	0.151	0.2294	0.0313	0.5554	0.0653	0.5515
	flag5	0.0988	0.1065	0.132	0.2009	0.0345	0.3642	0.1013	0.2548
	flag6			0.1083	0.1351			0.0835	0.181
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	const	-0.0001	0.5705	0.0002	0.1352	0.0003	0.0154	0	0.8936
	Rbar	0.1176		0.1516		0.1037		0.0841	
2fact	slag1	-0.2271	0.0858	-0.1118	0.5154	-0.1229	0.1152	-0.0208	0.8865
	slag2	-0.2032	0.0892	-0.1622	0.3033	-0.1797	0.0116	-0.0599	0.6584
	slag3	-0.1866	0.0723	-0.1488	0.2907	-0.1215	0.0523	-0.0589	0.633
	slag4	-0.1229	0.1426	-0.157	0.1974	0.0129	0.8051	-0.0581	0.5906
	slag5	-0.1187	0.0395	-0.0825	0.4022	-0.033	0.3746	-0.0787	0.3648
	slag6			-0.1237	0.0641			-0.0695	0.2437
	flag1	0.2703	0.0426	0.0851	0.6258	0.1908	0.0144	0.0359	0.8074
	flag2	0.2041	0.0915	0.1787	0.2653	0.1724	0.0153	0.0703	0.6074
	flag3	0.205	0.0525	0.1562	0.2786	0.0926	0.1412	0.0618	0.6201
	flag4	0.1269	0.1401	0.1487	0.237	0.0297	0.5763	0.0619	0.5725
	flag5	0.0942	0.1243	0.1299	0.2088	0.0329	0.3862	0.0981	0.2703
	flag6			0.1063	0.1439			0.0816	0.1912
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	g	-0.0056	0.6248	-0.0032	0.6634	-0.0012	0.8714	-0.0063	0.5798
	inf	0.0204	0.1017	0.0049	0.5831	0.0092	0.221	0.0144	0.2412
	const	-0.0001	0.4498	0.0002	0.1384	0.0003	0.0191	0	0.8334
	rbar	0.1184		0.1502		0.1039		0.0839	

(To be continued of Table 13 _ 3fact)

		Var	AUD Δs_t	p	CAD Δs_t	p	GBP Δs_t	p	JPY Δs_t
3fact	slag1	-0.2334	0.0774	-0.098	0.5692	-0.1247	0.1098	-0.0196	0.8932
	slag2	-0.2119	0.0762	-0.1551	0.325	-0.1813	0.0109	-0.0588	0.6636
	slag3	-0.1955	0.0598	-0.1443	0.3056	-0.1226	0.05	-0.0572	0.6421
	slag4	-0.1283	0.1257	-0.1485	0.2232	0.0099	0.8499	-0.0588	0.5855
	slag5	-0.121	0.0356	-0.0742	0.4525	-0.0358	0.3356	-0.0797	0.3581
	slag6			-0.1188	0.0761			-0.0692	0.2452
	flag1	0.2763	0.0381	0.0729	0.6764	0.1918	0.0138	0.033	0.8223
	flag2	0.2129	0.0782	0.1705	0.2884	0.1737	0.0145	0.0685	0.6161
	flag3	0.2135	0.0435	0.1539	0.2858	0.0948	0.1317	0.0597	0.6318
	flag4	0.1319	0.1251	0.1417	0.2605	0.0319	0.5471	0.0622	0.5707
	flag5	0.094	0.1249	0.1218	0.2398	0.0352	0.3544	0.0997	0.2624
	flag6			0.103	0.1565			0.0814	0.1923
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0009	0
	g	-0.0257	0.2033	-0.0177	0.218	0.0139	0.2481	-0.0202	0.2929
	inf	0.0408	0.0698	0.0119	0.4701	0.0039	0.7724	0.0406	0.0618
	int	-0.0035	0.8125	0.0084	0.3918	-0.0034	0.7091	-0.0005	0.9724
	const	-0.0001	0.4828	0.0002	0.1189	0.0003	0.0266	-0.0001	0.7262
	rbar	0.1184		0.151		0.1052		0.0857	

Table 14: VECM with $AwayH$ news deviations: ΔF_t

We report the results of VECM in this table. We run 4 different equations here: without news, extracted 2-factor news and extracted 3-factor news. For each currency, we report the coeffiecients, P probability, adjusted R square and observation numbers. Table 14 is the return of ΔF_t.

panel1	Var	AUD Δf_t	p	CAD Δf_t	p	GBP Δf_t	p	JPY Δf_t	p
Nonews	slag1	-0.2025	0.1524	-0.0807	0.6643	-0.021	0.8018	0.1253	0.4201
	slag2	-0.1359	0.2879	-0.1139	0.5038	-0.1766	0.0207	0.0705	0.6245
	slag3	-0.1642	0.1395	-0.1151	0.45	-0.0915	0.1727	0.0131	0.9204
	slag4	-0.1239	0.1668	-0.1209	0.3586	-0.0027	0.9618	-0.0306	0.7901
	slag5	-0.127	0.0394	-0.0744	0.4851	-0.0296	0.4575	-0.0682	0.4608
	slag6			-0.1163	0.107			-0.0339	0.5932
	flag1	0.2141	0.1333	-0.0121	0.9489	0.0877	0.2936	-0.1103	0.4813
	flag2	0.1349	0.2971	0.1244	0.4736	0.1396	0.0669	-0.0924	0.5254
	flag3	0.174	0.1238	0.1185	0.4475	0.0784	0.2448	-0.0122	0.9268
	flag4	0.138	0.1336	0.1112	0.4134	0.0474	0.4052	0.0338	0.7721
	flag5	0.1038	0.1136	0.1204	0.2812	0.0334	0.4127	0.0974	0.3039
	flag6			0.1109	0.1577			0.0478	0.4722
	z	0.0004	0.0198	0.0001	0.6968	0.0006	0	0	0.8451
	const	0.0002	0.3484	-0.0001	0.477	-0.0006	0	0	0.9175
	Rbar	0.0014		0.0018		0.0553		-0.0009	
panel2	slag1	-0.1956	0.1669	-0.0809	0.6641	-0.02	0.8107	0.1356	0.3833
2fact	slag2	-0.124	0.3327	-0.1146	0.5017	-0.1751	0.0218	0.0802	0.5782
	slag3	-0.1544	0.1649	-0.1156	0.4484	-0.0898	0.181	0.0208	0.8741
	slag4	-0.1168	0.1932	-0.122	0.3547	-0.0019	0.9727	-0.0268	0.8159
	slag5	-0.1215	0.049	-0.0757	0.4782	-0.0283	0.4782	-0.065	0.4821
	slag6			-0.1175	0.1043			-0.0325	0.6083
	flag1	0.2058	0.1492	-0.0117	0.9505	0.086	0.3033	-0.1221	0.4362
	flag2	0.1232	0.3414	0.1253	0.4707	0.138	0.0702	-0.1029	0.4798
	flag3	0.1631	0.1495	0.1189	0.4465	0.0764	0.2572	-0.0213	0.8728
	flag4	0.1295	0.1598	0.1131	0.4064	0.0456	0.4237	0.0292	0.8025
	flag5	0.0988	0.1321	0.1221	0.2753	0.0323	0.4279	0.0931	0.3261
	flag6			0.1128	0.1523			0.0453	0.496
	z	0.0004	0.0235	0.0001	0.6971	0.0006	0	0	0.8978
	g	-0.0006	0.9625	0.0029	0.7217	-0.0079	0.302	-0.0082	0.4985
	inf	0.0175	0.1892	-0.0037	0.7019	0.0108	0.179	0.0195	0.1374
	const	0.0001	0.4656	-0.0001	0.4772	-0.0006	0	0	0.9973
	rbar	0.0022		0		0.0552		-0.0007	

(To be continued of Table 14 _ 3fact)

panel3	Var	AUD Δf_t	p	CAD Δf_t	p	GBP Δf_t	p	JPY Δf_t	p
3fact	slag1	-0.201	0.156	-0.0789	0.6722	-0.0227	0.7863	0.1331	0.3918
	slag2	-0.1327	0.3	-0.1148	0.5014	-0.1779	0.0197	0.0781	0.5881
	slag3	-0.1631	0.1426	-0.115	0.4514	-0.0914	0.1728	0.0192	0.8836
	slag4	-0.1228	0.1713	-0.1171	0.3756	-0.0046	0.9347	-0.0284	0.8049
	slag5	-0.1253	0.0423	-0.0692	0.5183	-0.0317	0.4259	-0.066	0.4755
	slag6			-0.1115	0.1243			-0.0322	0.6124
	flag1	0.2114	0.1387	-0.0125	0.9475	0.087	0.2976	-0.1205	0.4419
	flag2	0.1319	0.3082	0.1264	0.4676	0.1396	0.0668	-0.1008	0.489
	flag3	0.1716	0.1298	0.1204	0.4412	0.0794	0.2385	-0.0199	0.881
	flag4	0.1354	0.1418	0.1085	0.4266	0.0479	0.3994	0.0305	0.7943
	flag5	0.1009	0.1242	0.1154	0.3041	0.0342	0.4008	0.0951	0.3159
	flag6			0.1069	0.1749			0.0452	0.4966
	z	0.0004	0.0217	0.0001	0.6957	0.0006	0	0	0.9216
	g	-0.0145	0.5023	-0.0016	0.9157	0.0095	0.4618	-0.0212	0.3004
	inf	0.022	0.3622	-0.0072	0.6857	0.0042	0.7664	0.0407	0.079
	int	0.0014	0.9276	0.0091	0.3915	0.0018	0.8547	-0.0056	0.7193
	const	0.0002	0.3982	-0.0001	0.4858	-0.0006	0	0	0.9603
	rbar	0.0006		-0.0004		0.0565		-0.0003	

Table 15: VECM with *Change* news deviations: ΔS_t

We report the results of VECM in this table. We run 4 different equations here: without news, extracted 2-factor news and extracted 3-factor news. For each currency, we report the coeffiecients, P probability, adjusted R square and observation numbers. Table 15 is the results of ΔS_t..

panel1	Var	AUD Δs_t	p	CAD Δs_t	p	GBP Δs_t	p	JPY Δs_t	p
Nonews	slag1	-0.2341	0.0766	-0.1116	0.5158	-0.1236	0.1132	-0.0285	0.8451
	slag2	-0.2148	0.0722	-0.1628	0.301	-0.1807	0.0112	-0.067	0.6204
	slag3	-0.1958	0.0592	-0.1493	0.2887	-0.1226	0.0501	-0.0645	0.6004
	slag4	-0.1288	0.124	-0.1582	0.1934	0.0118	0.8206	-0.0609	0.5727
	slag5	-0.1239	0.0314	-0.084	0.3934	-0.0342	0.3574	-0.081	0.3504
	slag6			-0.1249	0.0608			-0.0705	0.2365
	flag1	0.2791	0.0362	0.0853	0.6248	0.193	0.0133	0.0446	0.7615
	flag2	0.2155	0.0744	0.1797	0.2621	0.1743	0.0142	0.078	0.5678
	flag3	0.2154	0.0414	0.1566	0.2771	0.0936	0.1369	0.0685	0.5824
	flag4	0.1348	0.1168	0.151	0.2294	0.0313	0.5554	0.0653	0.5515
	flag5	0.0988	0.1065	0.132	0.2009	0.0345	0.3642	0.1013	0.2548
	flag6			0.1083	0.1351			0.0835	0.181
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	const	-0.0001	0.5705	0.0002	0.1352	0.0003	0.0154	0	0.8936
	Rbar	0.1176		0.1516		0.1037		0.0841	
Panel2	slag1	-0.2498	0.0585	-0.1091	0.5258	-0.1242	0.1114	-0.0283	0.8459
2fact	slag2	-0.2239	0.0604	-0.1622	0.3032	-0.1807	0.0111	-0.0667	0.6218
	slag3	-0.2026	0.0505	-0.1504	0.2859	-0.1223	0.0506	-0.0646	0.6002
	slag4	-0.1302	0.1194	-0.157	0.1975	0.0121	0.8164	-0.0625	0.5629
	slag5	-0.1186	0.0392	-0.0841	0.3935	-0.0328	0.3771	-0.0832	0.3378
	slag6			-0.1247	0.0619			-0.0721	0.2262
	flag1	0.2928	0.0278	0.0831	0.6339	0.1924	0.0135	0.0439	0.7655
	flag2	0.2247	0.0625	0.179	0.2646	0.1738	0.0145	0.0784	0.5658
	flag3	0.222	0.0353	0.1577	0.2744	0.0936	0.1368	0.0674	0.5887
	flag4	0.1377	0.1083	0.1495	0.2346	0.031	0.5598	0.067	0.5414
	flag5	0.0997	0.1029	0.132	0.2014	0.0336	0.3765	0.1033	0.2455
	flag6			0.1079	0.1374			0.0846	0.1755
	z	-0.0007	0.0001	-0.0006	0	-0.0005	0	-0.0008	0
	g	-0.0115	0.1363	-0.0036	0.4686	0.0005	0.9241	-0.0053	0.4802
	inf	0.0291	0.0047	0.003	0.6743	0.0068	0.2241	0.0116	0.2075
	const	-0.0001	0.6002	0.0002	0.1371	0.0003	0.0153	0	0.8966
	rbar	0.1212		0.1504		0.1042		0.084	

(To be continued of Table 15 _ 3 factors)

Panel3	Var	AUD Δs_t	p	CAD Δs_t	p	GBP Δs_t	p	JPY Δs_t	p
3fact	slag1	-0.2397	0.0697	-0.0951	0.5809	-0.123	0.1149	-0.0287	0.844
	slag2	-0.22	0.0654	-0.1498	0.3424	-0.1797	0.0116	-0.0675	0.6177
	slag3	-0.2044	0.0488	-0.133	0.3459	-0.1211	0.0532	-0.0637	0.6051
	slag4	-0.1314	0.1164	-0.143	0.2413	0.0128	0.8064	-0.0586	0.5875
	slag5	-0.1209	0.0358	-0.068	0.4923	-0.0337	0.3647	-0.0807	0.3522
	slag6			-0.1148	0.0863			-0.0708	0.2351
	flag1	0.2834	0.0334	0.0682	0.6963	0.1932	0.0132	0.0436	0.7669
	flag2	0.2205	0.0679	0.166	0.3015	0.1729	0.015	0.0791	0.5626
	flag3	0.2244	0.0337	0.1416	0.3268	0.0927	0.1407	0.0669	0.5911
	flag4	0.1386	0.1065	0.1359	0.2806	0.0307	0.5635	0.063	0.566
	flag5	0.0982	0.109	0.1165	0.2616	0.0342	0.3685	0.1006	0.2582
	flag6			0.0971	0.1827			0.0832	0.1826
	z	-0.0007	0	-0.0006	0	-0.0005	0	-0.0008	0
	g	-0.0267	0.0901	-0.0053	0.6378	0.0092	0.308	-0.0182	0.2097
	inf	0.0518	0.0626	-0.0084	0.6873	0.0004	0.978	0.0101	0.6587
	int	-0.0092	0.8112	-0.0004	0.9893	0.0015	0.941	0.0386	0.2557
	const	-0.0001	0.5941	0.0002	0.1316	0.0003	0.015	0	0.9036
	rbar	0.1189	0	0.1513	0	0.1039	0	0.0846	0

Table 16: VECM with *change* news deviations: ΔF_t

We report the results of VECM in this table. We run 4 different equations here: without news, extracted 2-factor news and extracted 3-factor news. For each currency, we report the coeffiecients, P probability, adjusted R square and observation numbers. Table 16 is the return of ΔF_t.

panel1	Var	AUD Δf_t	p	CAD Δf_t	p	GBP Δf_t	p	JPY Δf_t	p
Nonews	slag1	-0.2025	0.1524	-0.0807	0.6643	-0.021	0.8018	0.1253	0.4201
	slag2	-0.1359	0.2879	-0.1139	0.5038	-0.1766	0.0207	0.0705	0.6245
	slag3	-0.1642	0.1395	-0.1151	0.45	-0.0915	0.1727	0.0131	0.9204
	slag4	-0.1239	0.1668	-0.1209	0.3586	-0.0027	0.9618	-0.0306	0.7901
	slag5	-0.127	0.0394	-0.0744	0.4851	-0.0296	0.4575	-0.0682	0.4608
	slag6			-0.1163	0.107			-0.0339	0.5932
	flag1	0.2141	0.1333	-0.0121	0.9489	0.0877	0.2936	-0.1103	0.4813
	flag2	0.1349	0.2971	0.1244	0.4736	0.1396	0.0669	-0.0924	0.5254
	flag3	0.174	0.1238	0.1185	0.4475	0.0784	0.2448	-0.0122	0.9268
	flag4	0.138	0.1336	0.1112	0.4134	0.0474	0.4052	0.0338	0.7721
	flag5	0.1038	0.1136	0.1204	0.2812	0.0334	0.4127	0.0974	0.3039
	flag6			0.1109	0.1577			0.0478	0.4722
	z	0.0004	0.0198	0.0001	0.6968	0.0006	0	0	0.8451
	const	0.0002	0.3484	-0.0001	0.477	-0.0006	0	0	0.9175
	Rbar	0.0014		0.0018		0.0553		-0.0009	
Panel2	slag1	-0.2198	0.12	-0.0754	0.6857	-0.0212	0.7996	0.1252	0.4202
2fact	slag2	-0.1457	0.2539	-0.1105	0.5171	-0.1766	0.0207	0.0708	0.6235
	slag3	-0.1713	0.1223	-0.1116	0.4648	-0.0913	0.1734	0.013	0.9209
	slag4	-0.1251	0.1621	-0.1175	0.3729	-0.0026	0.9636	-0.0326	0.7769
	slag5	-0.121	0.0494	-0.0721	0.4991	-0.0287	0.4716	-0.0709	0.443
	slag6			-0.1138	0.1156			-0.0359	0.5712
	flag1	0.2291	0.1077	-0.0169	0.9288	0.0874	0.2955	-0.1111	0.4782
	flag2	0.1446	0.2626	0.1214	0.4846	0.1393	0.0675	-0.0918	0.5283
	flag3	0.1809	0.109	0.1153	0.4606	0.0784	0.2451	-0.0135	0.9188
	flag4	0.1411	0.1243	0.1081	0.4272	0.0472	0.4073	0.036	0.7578
	flag5	0.1045	0.1102	0.1183	0.2904	0.033	0.4175	0.1	0.2914
	flag6			0.1083	0.1685			0.0492	0.4594
	z	0.0005	0.014	0.0001	0.7118	0.0006	0	0	0.8451
	g	-0.0115	0.1634	-0.0014	0.7965	-0.0014	0.7897	-0.0063	0.4358
	inf	0.0313	0.0046	-0.0017	0.8233	0.0057	0.3426	0.0146	0.1365
	const	0.0002	0.3246	-0.0001	0.4876	-0.0006	0	0	0.914
	rbar	0.0057		0.0004		0.055		0.0002	

(To be continued of Table 16 _ 3factors)

Panel3	Var	AUD Δf_t	p	CAD Δf_t	p	GBP Δf_t	p	JPY Δf_t	p
3fact	slag1	-0.209	0.1397	-0.0675	0.7172	-0.0198	0.813	0.1238	0.4256
	slag2	-0.1414	0.2686	-0.1036	0.5438	-0.1749	0.022	0.0688	0.6329
	slag3	-0.1712	0.1234	-0.0938	0.5392	-0.0887	0.1864	0.0141	0.9144
	slag4	-0.1268	0.157	-0.1072	0.4168	-0.001	0.9853	-0.0273	0.8122
	slag5	-0.1259	0.0412	-0.0567	0.5966	-0.0293	0.4618	-0.0672	0.4672
	slag6			-0.1043	0.15			-0.0339	0.5935
	flag1	0.2194	0.124	-0.0238	0.8998	0.087	0.2976	-0.1104	0.481
	flag2	0.1403	0.2778	0.1168	0.5018	0.1374	0.0714	-0.0902	0.5354
	flag3	0.1818	0.108	0.0997	0.5235	0.0765	0.2567	-0.0137	0.9179
	flag4	0.1414	0.1242	0.0979	0.4729	0.046	0.4195	0.0306	0.7934
	flag5	0.1054	0.108	0.1035	0.3565	0.0329	0.4194	0.0959	0.3116
	flag6			0.0967	0.2202			0.0472	0.4782
	z	0.0004	0.0178	0	0.7743	0.0006	0	0	0.8372
	g	-0.025	0.1387	0.0029	0.8155	0.0079	0.4146	-0.0211	0.1735
	inf	0.0354	0.2355	-0.0369	0.1004	-0.0056	0.7105	0.0045	0.8518
	int	0.0199	0.6284	0.0212	0.4633	0.0129	0.5634	0.0561	0.1212
	const	0.0002	0.3163	-0.0001	0.5087	-0.0006	0	0	0.9051
	rbar	0.0023		0.0027		0.0555		0.0002	

Table 17: Compare the accuracy of different models

We use root mean square error (RMSE) and mean absolute error (MAE) as the criteria to measure the accuracy of the prediction models. Here we have VECM only, VECM with 2-factor and VECM with 3-factor extracted information from all 3 kinds of news deviations. In addition to the models we used in the prior works, we average the extracted news factors and report their results in average2 and average3 respectively. The comparing groups are VAR(4) and random walk. To increase the readablility of the errors, we multiply all series by 1000.

	AUD		CAD		GBP		JPY	
	RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE
nonews	0.0593	6.0364	0.0255	4.0142	0.0257	3.9075	0.0319	4.2688
s2	0.0606	6.0955	0.0253	4.0165	0.0259	3.9305	0.0324	4.2256
s3	0.0598	6.0984	0.0262	4.0406	0.026	3.9349	0.0319	4.2289
wu2	0.0595	6.0626	0.0254	4.009	0.0257	3.9086	0.0325	4.2851
wu3	0.061	6.1099	0.0247	3.937	0.0255	3.8775	0.033	4.3523
my2	0.0608	6.1222	0.0256	4.0277	0.0258	3.9211	0.0324	4.2821
my3	0.0606	6.2261	0.0262	4.0056	0.0257	3.8881	0.0327	4.2921
average2	0.0604	6.103	0.0259	4.0386	0.0257	3.9206	0.033	4.3402
average3	0.0604	6.1565	0.0251	3.9365	0.0255	3.8845	0.0333	4.3918
var(4)	3.1541	46.9724	2.0187	40.2298	0.182	10.789	0.797	24.5025
randWalk	3.1415	47.0324	2.0887	40.7922	0.2306	12.4722	0.9161	26.1223