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#### Article

## Foreign exchange markets, behavior of options volatility and bid-ask spread around macroeconomic announcements

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# Foreign exchange markets, behavior of options volatility and bid-ask spread around macroeconomic announcements

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#### GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

### Foreign exchange markets, behavior of options volatility and bid-ask spread around macroeconomic announcements

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economics & finance

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**Abstract:** The purpose of this study is to examine the role of options volatility and bid-ask spread as microstructural variables in determining whether the foreign exchange market's price formation process in response to macroeconomic announcements is characterised by changes in risk perception and transaction costs. The findings suggest that behavioural characteristics of market participants appear to trump macroeconomic considerations. The volatility indices and bid-ask spreads were found more sensitive to announcements than forex returns, which directly imply weak assimilation of common knowledge into exchange rates. The forex returns, bid-ask spread, and volatility indices demonstrated less vulnerability towards Chinese announcements than the USA, UK, Japan, and Euro. Moreover, findings distinctly signify the role of China as a global liquidity provider by reducing trading costs in the foreign exchange markets. The implications suggest that core macroeconomic models should incorporate agents' heterogeneous expectations based on risk perceptions than the order flow approach.

#### Subjects: Macroeconomics; Monetary Economics; International Finance

Keywords: Foreign exchange market; options volatility; macroeconomic announcements; VAR

JEL Classification: E02; C58; F31

#### 1. Introduction and background

The microstructure approach states that information content that is unrelated to macroeconomic announcements, like liquidity demands, hedging, and changing risk tolerance, may affect the exchange rate (M.D.D. Evans & Lyons, 2002a). Microstructure approaches enriched with order flow dynamics of exchange rates around fundamentals, but other determinants are understudied or uncovered (Abolaji Daniel Anifowose, 2018; Du et al., 2018; M.D.D. Evans & Lyons, 2002a, 2002b). However, the present study investigated the information content disclosed through the trade of hedging and changing risk tolerance through "options volatility" in particular and a liquidity component (bid-ask spread) to explain exchange rate dynamics around macroeconomic announcements which is the core novelty and contribution of this research.

This research's first contribution is using a novel component of options implied volatility to forecast exchange rate movements. This study hypothesized two possible ways to deal with market uncertainty; either market participants sell their underlying assets to avoid future uncertainty, which in turn induces order flow or hedge against future uncertainty via trading of options. This indicates that information content is preserved in private information with the market





participants exercised through the trade of assets or hedging through options. Hence, a rise in the trade of buying options demonstrates mounting volatility, influencing the underlying asset prices or currencies. However, this study considered options implied volatility which is the trademark of the Chicago Board of Options Exchange (CBOE), popularly known as the "fear gauge index" (Whaley, 2000). Presumably, options implied volatility considers the market's perceptions of risk or a gauge to measure short-term volatility. The second contribution of this research is using another variable of the bid-ask spread, which plays a substantial role in the valuation of market functioning and behavior and is an essential driving factor in immediate trade executions. The microstructure literature mentions the adjacent association of options implied volatility with market liquidity (bid-ask spread).

Do these options variables imply volatility and bid-ask forecast exchange rate dynamics directly or indirectly around macroeconomic announcements? It seems essential to employ macroeconomic announcements to explore the behavior of options implied volatility and bid-ask spread which is an essential contribution of this research. Moreover, this research includes emerging economies like China and the big four currencies, USD, EUR, JPY, and GBP. Earlier literature on the microstructure approach concentrated on exchange rates of mature markets. In this sense, it will be particularly more fascinating to compare the results applied to an emerging market, in which external factors exert significant influence on the development path of the domestic economy. The forex markets of transition economies may indicate different properties than the major currency markets. However, with the growing importance of China in the world economy, mounting complexity in financial liberalization and recent vulnerability of the CNY exchange rate.

The present study modernized the forecasting mechanism of foreign exchange with the introduction of micro variables, i.e., options implied volatility and transaction cost (bid-ask spread) around macroeconomic announcements of the USA, China, UK, Japan, and Euro area. The study examined whether options implied volatility and bid-ask spread characterize any part of the information to exchange rates in response to macroeconomic announcements, which, in particular, draw valuable information for monetary thinkers, financial markets, and market participants to anticipate the market direction and improve trading efficiency in foreign exchange markets.

The rest of this paper consists of the following sections; the second section discusses the data and methodology, while the third section sheds light on the results and discussions. The fourth section covers the conclusion of the study. Finally, the fifth section addresses the policy implications, limitations and future study directions.

#### 2. Literature review

The failure of conventional macroeconomic models to explain and forecast movements in exchange rates has given rise to two diverse dimensions of research: one concentrating on the implications of asset pricing through the standard present value approach and the other focused on the microstructure approach to the forex market (Flood & Taylor, 1996; J. J. Frankel & Rose, 1995; J. A. J. A. Frankel & Rose, 1994; Meese & Rogoff, 1983a, 1983b; Taylor, 1995). A later approach of microstructure literature of the forex markets attempted to clarify the mechanism inducing deviations from fundamentals (Flood & Taylor, 1996; R. K. R. K. Lyons, 2001; Taylor, 1995). Microstructure approach has taken into account short run dynamics of exchange rates.

Market participants interpret public information differently, which highlights the role of trading. However, one may conceive different information content; First, the information content is publicly available and evaluated similarly by most traders and also maps into prices directly and immediately as in traditional models. Second, information content is not common knowledge or common but is difficult to interpret (Glosten & Milgrom, 1985; Kyle, 1985; R. R. Lyons, 1995). In this case, it is considered as private and dispersed information and transmuted into prices via the trading process (M.D.D. Evans & Lyons, 2002a). Third, information content that is unrelated to macroeconomic announcements like liquidity demands, hedging, and changing risk tolerance may affect the exchange rate (M.D.D. Evans & Lyons, 2002a).Abolaji Daniel Anifowose (2018), Anifowose et al. (2018) and M.D.D. Evans and Lyons (2002a, 2002b) focused on the trading process and considered order flow as core determinant of exchange rate dynamics. However, trade of options (hedging instruments) and the role of transaction or trading cost have not explored yet which could drive valuable outcomes in forecasting exchange rate. The information content preserved in private information with the market participants exercised through the trade of assets or hedging through options as suggested by (Eberbach et al., 2021). Hence, a rise in the trade of buying options demonstrates mounting volatility, influencing the underlying assets or currencies.

Earlier literature evidence that the options implied volatility index significantly anticipates exchange rate (Cairns et al., 2007; Ishfaq, Qiong, Abbas et al., 2018; Ishfaq, Qiong, Rehman et al., 2018; Kang, Ki-Hong et al., 2014; Kang, Yun-Jung et al., 2014). Similarly, Du et al. (2018) reported that the transaction cost (bid-ask spread) play a substantial role in the valuation of market functioning and behavior, and essential driving factor in immediate trade executions. Earlier studies use ex-post and ex-ante foreign exchange risk measures to confirm that both options implied volatility and spread are interrelated and find that the risk measure is associated positively with the width of bid-ask spread (Black, 1989; Boothe, 1988; Glassman, 1987; Wei, 1991).

Previous studies have found that options volatility and bid-ask spread are linked to macroeconomic information (DeGennaro & Shrieves, 1997; Ederington & Lee, 1996; Ishfaq et al., 2017; Kim & Kim, 2004). However, the role of options volatility and transaction cost in aggregating expectations about macroeconomic fundamentals has not yet been studied in the literature. Table A1 summarizes the findings from the previous study to pave the way for the contribution of this study.

#### 3. Data and methodology

#### 3.1. Data

The daily frequency data conveys the rich structure of announcements effects. The dataset used in this study covers seven years' period from 16 March 2011<sup>1</sup> to 28 November 2017. The first stream of data includes exchange rates and bid-ask spread of currency pairs of USD/CNY, JPY/CNY, GBP/ CNY, and EUR/CNY at a daily frequency from a highly reliable database "Bloomberg."

The study also used five major options implied volatility indices of VIX, VXFXI, BPVIX, JYVIX, and EUVIX. The data source stems from the Chicago Board of Options Exchange (CBOE) official website. Options implied volatility defined as the market's expectation for the remaining life of the options (about 30 days), also known as "investor's fear-gauge index." In this study, Options implied volatility represents the expectations of the foreign exchange market (Whaley, 2000). A high value of Options implied volatility directs that participants expect the market will become more volatile and vice versa. However, Options implied volatility to be calculated for equity exchanges, exchange-traded funds (ETF), currencies, commodities, and so forth. This study considered options implied volatility of Euro Volatility Index (EUVIX), Japanese Yen Volatility Index (JYVIX), and British Pound Volatility Index (BPVIX), options volatility of S&P 500 index (VIX) and China ETF Volatility Index (VXFXI).

The study also considers the dummy variables of the macroeconomic announcements of the USA, China, UK, Euro area, and Japan over the sample on bi-weekly, monthly, and quarterly basis but varies on country basis. As this study uses novel variables of the microstructure approach, it seems necessary to investigate the impacts of all scheduled announcements in the sample, i.e., market participants know the hour and minute of their release in advance except for underlying information content and may react within a short time. The creation of dummy variables of announcements daily hypothesis that daily frequency intervals seem more appropriate to seize their effects on the exchange rate and volatility.

#### 3.2. Methodology

This section deals with the simple question of whether any part of the exchange rate is characterized through options implied volatility and bid-ask spread in response to the macroeconomic announcements. To inspect this question, it seems natural to explore bid-ask spread and options implied volatility contribution to the overall response to announcements simultaneously employing the Vector Autoregressive model (VAR), imposing a co-integrating vector in the absence of arbitrage. VAR model differs from univariate autoregressive models as these permit feedback to occur among the sample variables in the model. The model allow simultaneous effects of announcements on exchange rates, bid-ask spread, and options implied volatility simultaneously. VAR model seems distinct to explore direct or indirect effects among sample variables through feedback feature. To come up with robust results, the model motivations took from the paper (Chen & Gau, 2009). A comprehensive form of multivariate VAR model for our sample analysis presented below;

$\begin{bmatrix} \Delta P_{i,t} \\ \Delta S_{i,t} \\ \Delta VIX_{i,t} \\ \Delta VXFXI_t \end{bmatrix} = c +$	$\omega \begin{bmatrix} \Delta P_{i,t} \\ \Delta S_{i,t} \\ \Delta Vix_{i,t} \\ \Delta VXFXI_t \end{bmatrix} + \frac{1}{2}$	$\sum_{i=1}^{m} A_{i} \begin{bmatrix} \Delta P_{i,t-j} \\ \Delta S_{i,t-j} \\ \Delta Vix_{i,t-j} \\ \Delta VXFXI_{t-i} \end{bmatrix}$	$+B_iD_{i,t}+$	$\begin{bmatrix} e_{p,t} \\ e_{s,t} \\ e_{vix,i,t} \\ e_{vxfxi,t} \end{bmatrix}$
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Where  $\Delta P_{i,t}$ ,  $\Delta S_{i,t}$ ,  $\Delta VIX_{i,t}$  and  $\Delta VXFXI_t$  represent the change in the exchange rate, bid-ask spread, and options volatility indices for *i* series (VIX, BPVIX, JYVIX, EUVIX and VXFXI) in time *t*, respectively. The China ETF Volatility Index (VXFXI) remains influential in all four exchange rate parities of the CNY. The dummy variable of macroeconomic announcements of the USA, China, UK, Japan and Euro area turn  $D_{i,t}$ =1 on the release date and takes the form  $D_{i,t}$ =0 otherwise, for the country *i* in time *t*, respectively.

The literature also analyze the effect of public announcements shocks on exchange rate volatility (Andersen & Bollerslev, 1998). They find that dummy variable announcement effects are significant than ARCH effects. The impact of announcements are represented by  $B_i$  matrix. In addition, the coefficient  $A_i$  symbols for the lead-lag linkages among sample variables and helps in removing the problem of autocorrelation. The coefficient  $\omega$  in the 4 × 4 matrix quantify the impact of spread, VIX, and VXFXI on price movements of exchange rates and others contemporaneously.

The lag lengths are chosen by engaging Akaike Information Criteria (AIC). While evaluating the influence of macroeconomic announcements on foreign exchange markets, the primal should be both home country and foreign country's economic decisions. For this, the study hypothesized, for instance, when examining USD/CNY behavior, Chinese and the US announcements naturally have a stronger influence on the exchange rate.

#### 4. Empirical analysis

#### 4.1. Descriptive statistics

Table 1 reports summary statistics for the exchange rate returns, bid-ask spread, and volatility indices. The level diagrams exhibit that exchange rates and VIX indices remained volatile and contained a trend. However, the returns are generated by the difference of log price times 100 to make a stationary series for further analysis. The mean values of FX and VIX returns are negative. The mean values of bid-ask spreads are positive except EUR/CNY spread. VIX exhibited the highest standard deviation (market volatility of SPX), which means the highest price change. The positive values of skewness in VIX also show increased volatile) and positive skewness (positive returns). This positive skewness is associated with the appreciation trend in later periods of USD/CNY parity, as shown in the level series of exchange rates (Figure 1). Most sample exchange rates exhibit negative skewness due to the depreciation trend in CNY exchange rates, which is observable in (Figure 1). However, the bid-ask spread is highly volatile and comprises positive skewness.

I able 1. Descriptive std	ltistics												
	DLGBP_CNY	DLUSD_ CNY	DLJPY_CNY	DLEUR_CNY	DLBPVIX	DLVIX	DLVXFXI	DLEUVIX	XIV VIX	DLEUR_ SPREAD	DLGBP_ SPREAD	DLJPY_ SPREAD	DLUSD_ SPREAD
Mean	-0.009245	-0.00093	-0.019179	-0.005952	-0.1474	-0.14	-0.1065	-0.1252	-0.0522	-0.823921	0.207046	0.889181	1.120969
Median	-0.002158	0	-0.010648	-0.001786	-0.1632	-0.39	-0.4174	-0.1363	0	0	0	0	0
Maximum	2.853231	1.833421	3.896413	2.881229	37.127	40.10	36.5767	49.684	30.106	283.3213	415.8883	349.6508	460.517
Minimum	-7.52284	-0.834135	-3.404539	-2.440769	-43.869	-31.4	-18.513	-73.966	-28.010	-344.8222	-526.269	-298.7364	-460.517
Std. Dev.	0.54826	0.147853	0.601188	0.535336	4.5049	7.264	4.8532	5.6281	4.83727	59.62597	64.83873	65.64538	85.17367
Skewness	-1.53015	0.992646	0.014403	-0.053598	-0.5182	0.730	1.0862	-1.1799	0.2235	-0.240502	-0.249413	-0.189595	0.075856
Kurtosis	25.31967	22.55742	6.979688	5.401479	17.8811	7.235	8.3062	37.954	7.1849	6.97209	13.88985	6.453908	7.592672
Jarque-Bera	34808.31	26502.93	1086.274	396.315	15261.3	1376	2254.7	84175.9	1214.8	988.5486	7338.224	745.5239	1303.892
Probability	0	0	0	0	0	0	0	0	0	0	0	0	0
Obs.	1646	1646	1646	1646	1646	1646	1646	1646	1646	1482	1482	1482	1482
ADF	-39.63949	-39.57281	-38.30145	-39.58306	-36.201	-41.2	-38.802	-45.047	-39.961	-26.73815	-21.07626	-32.40546	-24.70596



Excess kurtosis coefficients have significant values, specifying that outliers may have arisen with a probability higher than a normal distribution. Accordingly, the Jarque-Bera test rejected the null hypothesis of the normal distribution for all sample returns at the 1% significance level. The lower panel of Table 1 reports the Augmented Dickey-Fuller test (ADF) results for a unit root. The significant estimates evidenced the absence of unit roots in the return series, implying that their mean returns are around zero. Moreover, the transformation of level series into return series removes the problem of multicollinearity employing the Variance Inflation Factor (VIF) test<sup>2</sup> and consistent (Ishfaq, Qiong, Abbas et al., 2018).

Table 2 reports the results of the Granger causality test in exchange rates, bid-ask spread, and VIX indices. Most estimates reject the null hypothesis that options volatility indices do not cause exchange rates and related bid-ask spread. Table 2 summarizes that the options volatility indices lead CNY exchange rates and hold a unidirectional relationship except for GBP/CNY parity in panel D, which shows that sample exchange rate and options volatility indices cause each other simultaneously. Second, options volatility indices and bid-ask have a bi-directional association and lead each other except EUR/CNY spread which does not affect options volatility indices in reverse. Finally, options volatility indices interlinked with each other.

#### 4.2. Empirical results

The present study hypothesized that market participants buy more options during uncertain circumstances to hedge against future adverse effects. The release of public announcements renders the foreign exchange market more volatile, hence push traders to hedge their investments through option contracts, which, in turn, spurs the options volatility. The Granger causality outcomes in Table 2 reveal that VIX indices lead to foreign exchange. However, our empirical analysis considered; whether VIX indexes and spread lead foreign exchange around announcements.

Table 3 contains BPVIX bears significant negative sign at a 3<sup>rd</sup> lag which causes an appreciation of sample exchange rate, while the positive coefficient of VXFXI reasons depreciation and partially consistent (Ishfaq, Qiong, Abbas et al., 2018). The lower panel of Table 5 presents aggregated announcement coefficients showing a significant impact on BPVIX and VXFIX on the day of release.

Figure 1. Exchange rates at level with extended data.

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Table 2. Pairwise gran	ger causality tests		
Panel A: USD/CNY, USD/CNY	Spread, VXFXI and VIX		
Null Hypothesis:	Obs.	<b>F-Statistic</b>	Prob.
VIX does not Granger Cause DLUSDCNY	1873	3.74963	0.0237
VXFXI does not Granger Cause USD_SPREAD	1874	3.19722	0.0411
VIX does not Granger Cause USD_SPREAD	1874	5.45527	0.0043
USD_SPREAD does not Granger Cause VIX		4.10976	0.0166
VIX does not Granger Cause VXFXI	1874	4.83589	0.0080
Panel B: JPY/CNY, JPY/CNY	Spread, JYVIX and VXFXI		
Null Hypothesis:	Obs.	<b>F-Statistic</b>	Prob.
VXFXI does not Granger Cause DLJPY_CNY	1873	3.33321	0.0359
JYVIX does not Granger Cause JPY_SPREAD	1874	11.8267	0.0000
JPY_SPREAD does not Granger Cause JYVIX		3.95795	0.0193
VXFXI does not Granger Cause JYVIX	1874	17.8353	0.0000
JYVIX does not Granger Cause VXFXI		3.74595	0.0238
Panel C: EUR/CNY, EUR/CNY	Spread, EUVIX and VXFXI		
Null Hypothesis:	Obs.	<b>F-Statistic</b>	Prob.
EUVIX does not Granger Cause DLEUR_CNY	1873	17.8188	0.0000
VXFXI does not Granger Cause DLEUR_CNY	1873	6.24757	0.0020
EUVIX does not Granger Cause EUR_SPREAD	1874	5.98848	0.0026
VXFXI does not Granger Cause EUR_SPREAD	1874	6.77471	0.0012
VXFXI does not Granger Cause EUVIX	1874	10.3387	0.0000
EUVIX does not Granger Cause VXFXI		5.53532	0.0040
Panel D: GBP/CNY, GBP/CNY	Spread, BPVIX and VXFXI		
Null Hypothesis:	Obs.	F-Statistic	Prob.
DLGBP_CNY does not Granger Cause GBP_SPREAD		2.59200	0.0751
BPVIX does not Granger Cause DLGBP_CNY	1873	4.95098	0.0072
DLGBP_CNY does not Granger Cause BPVIX		5.57793	0.0038
BPVIX does not Granger Cause GBP_SPREAD	1874	2.60365	0.0743
GBP_SPREAD does not Granger Cause BPVIX		4.87504	0.0077
VXFXI does not Granger Cause GBP SPREAD	1874	4.79792	0.0083

Note: Only significant outcomes are shown to conserve the space.

Table 3. USD/CNY,	, spread, VXFXI, VI	X and USA announc	ements	
	DLUSDCNY	DLUSD_SPREAD	DLVXFXI	DLVIX
DLUSDCNY(-1)	0.0996***	8.0511	0.4385	-0.6878
DLUSDCNY(-2)	-0.0475*	-8.7185	-1.1454	-0.4837
DLUSDCNY(-3)	0.0354	1.7829	1.0877	1.3476
DLUSDCNY(-4)	0.0198	-1.8334	-0.6838	-1.7871
DLUSDCNY(-5)	0.0696***	14.661	1.7586**	1.6939
DLUSDCNY(-6)	-0.0269	3.1333	0.5014	1.8199
DLUSD_SPREAD(-1)	0.0001	-0.5473***	0.0019	-0.0005
DLUSD_SPREAD(-2)	0.0001	-0.4342***	-0.0001	-0.0015
DLUSD_SPREAD(-3)	-0.0003	-0.2789***	0.0009	0.0005
DLUSD_SPREAD(-4)	-0.0001	-0.2315***	0.0015	-0.0009
DLUSD_SPREAD(-5)	-0.0000	-0.1663***	0.0004	-0.0020
DLUSD_SPREAD(-6)	-0.0000	-0.1069***	0.0019	-0.0004
DLVXFXI(-1)	-0.0001	0.0359	-0.0216	0.1091**
DLVXFXI(-2)	-0.0011	-0.0092	-0.0461	-0.0897*
DLVXFXI(-3)	0.0017	0.7396	-0.0401	-0.0590
DLVXFXI(-4)	-0.0005	-0.2961	-0.1192***	-0.0836
DLVXFXI(-5)	-0.0014	-0.0295	-0.0265	0.0780
DLVXFXI(-6)	-0.0022*	-0.6344	-0.0482	0.0476
DLVIX(-1)	0.0013*	0.3659	0.0584***	-0.0621*
DLVIX(-2)	0.0000	-0.1847	0.0047	-0.0221
DLVIX(-3)	-0.0006	-0.0634	0.0062	-0.0270
DLVIX(-4)	0.0008	0.4871	0.0256	-0.0050
DLVIX(-5)	0.0009	-0.1140	0.0151	-0.0712**
DLVIX(-6)	0.0008	0.3400	0.0270	-0.0576*
С	0.0026	-2.0317	-0.0044	0.0747
D	-0.0100	10.604***	-0.3086	-0.9668***
D(-1)	-0.0035	-0.2362	-0.1615	-0.6162*
D(1)	0.0030	1.4645	0.3986	0.5896
Consumer Confidence	-0.0402**	-8.7085	-1.1528**	-1.0355
Durable Goods Orders	0.0282	24.844***	0.8656	0.3862
Factory Orders	0.0082	-20.089**	-0.5099	-0.7400
GDP Annualized QOQ	-0.0204	-1.1049	-1.3288**	-0.9651
Housing Starts	-0.0248	2.6555	-1.4374**	-1.5744*
Personal Consumption	-0.0187	-0.6499	-1.4389**	-1.0045
Personal Income	-0.0484**	26.928***	1.2423**	0.9992
Unemployment Rate	0.0092	21.463**	-0.3973	-2.3990***
Total Net TIC Flows	-0.0090	2.1609	-1.4226**	-1.5230
R-squared	0.0369	0.2558	0.0393	0.0379

Note: An aggregate dummy variable of the US macroeconomic announcements is created to explore overall impact other than individual effects on the day of announcement (D), a day before the announcement D (-1) and a day after the announcement D (1). \*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively. Most of the insignificant announcements are not shown here to conserve space.

Table 4. USD/CNY,	, spread, VXFXI, VIX	K & Chinese announ	cements	
	DLUSDCNY	DLUSD_SPREAD	DLVXFXI	DLVIX
DLUSDCNY(-1)	0.0917***	8.7037	0.3272	-0.9316
DLUSDCNY(-2)	-0.0439	-7.1753	-0.9447	-0.1994
DLUSDCNY(-3)	0.0377	3.9349	0.9970	1.3415
DLUSDCNY(-4)	0.0176	-1.3537	-0.6923	-1.7564
DLUSDCNY(-5)	0.0659**	12.368	1.5476**	1.5992
DLUSDCNY(-6)	-0.0303	1.9045	0.2588	1.4468
DLUSD_SPREAD(-1)	0.0000	-0.5429***	0.0016	-0.0010
DLUSD_SPREAD(-2)	0.0001	-0.4306***	0.0001	-0.0015
DLUSD_SPREAD(-3)	-0.0000	-0.2834***	0.0007	0.0007
DLUSD_SPREAD(-4)	-0.0001	-0.2364***	0.0014	-0.0006
DLUSD_SPREAD(-5)	-0.0000	-0.1663***	0.0007	-0.0015
DLUSD_SPREAD(-6)	-0.0000	-0.1036***	0.0027	0.0005
DLVXFXI(-1)	-0.0003	-0.0811	-0.0308	0.0989*
DLVXFXI(-2)	-0.0010	0.0691	-0.0341	-0.0740
DLVXFXI(-3)	0.0015	0.6299	-0.0459	-0.0689
DLVXFXI(-4)	-0.0006	-0.1785	-0.1244***	-0.0876
DLVXFXI(-5)	-0.0015	0.0715	-0.0225	0.0925*
DLVXFXI(-6)	-0.0022**	-0.5272	-0.0423	0.0487
DLVIX(-1)	0.0013*	0.3675	0.0585***	-0.0603*
DLVIX(-2)	0.0000	-0.1911	0.0013	-0.0273
DLVIX(-3)	-0.0006	-0.0645	0.0056	-0.0276
DLVIX(-4)	0.0007	0.4220	0.0275	-0.0014
DLVIX(-5)	0.0010	-0.1650	0.0129	-0.0775**
DLVIX(-6)	0.0007	0.3015	0.0232	-0.0599*
С	0.0040	1.1998	-0.0705	-0.2219
D	-0.0050	-4.8745	-0.0881	0.3435
D(-1)	0.0120	-2.6731	-0.0751	0.2296
D(1)	0.0096	-4.0687	0.0166	0.3821
Balance of Trade	0.0138	-5.9686	0.3155	1.5161
Foreign Direct Investment	-0.0292	-0.8091	-1.0086*	-0.8404
Foreign Reserves	-0.0002	-17.8916	0.5956	0.8378
GDP (YOY)	-0.0564	-0.5093	-2.4882**	-3.5939*
Leading Index	-0.0653***	-20.401*	0.3386	2.0129*
Money Supply	0.0695	-10.7225	0.7072	-3.4812
Activity Index	0.0139	9.7783	-1.5816**	-1.4045
Non-Manufacturing Index	0.0057	6.1943	0.7139	-0.5267
Price Index	-0.0206	-10.549	-0.1955	0.2415
R-sauared	0.0379	0.2511	0.0380	0.0353

Note: An aggregate dummy variable of Chinese macroeconomic announcements is created to explore overall impact other than individual

effects on the day of announcement (D), a day before the announcement D(-1) and a day after the announcement D (1). \*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively.

Table 4 CNY exchange /CNY exchange rate, bid-ask spread, VXFXI, and VIX around the USA and Chinese announcements respectively. The study followed the hypothesis that announcements may have a direct impact on exchange rates or some part of private information perceived by the market participants and exercised through trading options hence affect the exchange rate indirectly through the movements in spread or VIX indices. The upper panel of both tables shows that VXFXI and VIX both influence the sample exchange rate significantly. The significant negative slope points appreciation of the sample of the exchange rate, while the positive coefficient of VIX implies deterioration.

The lower panel of Table 3 summarizes that spread and VIX index found sensitive to the public releases on the day of announcement of an aggregated dummy variable (D). The VIX index also shows sensitiveness to the release a day before the aggregated announcements (D-1). The widening spreads in response to unemployment rates and personal income are consistent with the earlier study (Rühl & Stein, 2013). The positive coefficient of spread around the US announcements reveals an asymmetry in information content and considers widespread as protection for loss to informed traders from noisy traders in low liquid markets which is consistent (Balduzzi et al., 2001; Kyle, 1985).

Most individual announcements significantly affect the spread of VXFXI and VIX on the day of release. The negative impact of announcements on options volatility points towards the resolution of uncertainty on the day of release. This result offers some support from earlier studies that the release of information content enclosed in scheduled macroeconomic announcements reduces the expectations of future volatility (DeGennaro & Shrieves, 1997; Ederington & Lee, 1996; Kim & Kim, 2004). The announcements of consumer confidence and personal income explain natural movements in the sample exchange rate. Other announcements seem to impact the exchange rate via VXFXI and VIX indirectly. Our study considers that the variable having a significant correlation with both announcements and exchange rates qualifies to encompass information content effectively and vice versa.

The estimates show that options volatility significantly correlates with both announcements and exchange rates, hence qualifies to assimilate private information content, unlike bid-ask spreads. Likewise, the role of order flow, these results support the importance of options volatility to analyze the movements in the exchange rate (Martin D. D. Evans & Lyons, 2005; Love, 2005; Love & Payne, 2008). The role of the money supply is too small and insignificant as money demand in China is mainly decided by other factors like expected inflation rate, income, and interest rate (Xiangsheng Dou, 2019). To best our knowledge, the present study is the first comprehensive study to explore the interaction of exchange rates, spread, and market volatility indices around announcements.

The lower panel of Table 4 bears significant negative sign at a 3<sup>rd</sup> lag which causes an appreciation of sample exchange rate, while the positive coefficient of VXFXI reasons depreciation and partially consistent (Ishfaq, Qiong, Abbas et al., 2018). The lower panel of Table 5 presents aggregated announcement coefficients showing a significant impact on BPVIX and VXFIX on the day of release. Table 4 reports that the effect of aggregated announcements of China has no role in explaining the dynamics of FX returns, spread, and VIX indices. However, directly and indirectly, individual announcements influence exchange rates via market volatility. The results indicated VXFXI and VIX lead price changes in the exchange rate. Additionally, the effects of the announcement of the leading index report a significant direct impact on the sample exchange rate. Other individual announcements display a substantial effect on the exchange rate. The results support our hypothesis that announcements affect exchange rate returns and market volatility.

The BPVIX bears significant negative sign at a 3<sup>rd</sup> lag which causes an appreciation of sample exchange rate, while the positive coefficient of VXFXI reasons depreciation and partially consistent

Table 5. GBP/CNY,	spread, BPVIX, VX	FXI & UK announce	ments	
	dlgbp_cny	dlgbp_spread	dlbpvix	dlvxfxi
DLGBP_CNY(-1)	0.0037	2.4770	-0.3632*	-0.3693*
DLGBP_CNY(-2)	-0.0286	2.9451	0.2420	0.1247
DLGBP_CNY(-3)	-0.0032	0.6268	-0.1427	-0.0123
DLGBP_CNY(-4)	-0.0281	3.9747*	-0.4592**	-0.0821
DLGBP_CNY(-5)	-0.0367	-0.8244	0.0928	0.0274
DLGBP_SPREAD(-1)	0.0002	-0.7346***	0.0001	-0.0008
DLGBP_SPREAD(-2)	0.0002	-0.5243***	0.0008	0.0013
DLGBP_SPREAD(-3)	0.0004	-0.4115***	0.0010	0.0037
DLGBP_SPREAD(-4)	0.0003	-0.2804***	0.0020	0.0033
DLGBP_SPREAD(-5)	0.0002	-0.1194***	-0.0001	0.0006
DLBPVIX(-1)	0.0030	0.2557	0.0507**	0.0432
DLBPVIX(-2)	-0.0007	0.1421	-0.0267	0.0168
DLBPVIX(-3)	-0.0052*	-0.0407	0.0207	0.0337
DLBPVIX(-4)	-0.0030	-0.0337	0.0168	-0.0648**
DLBPVIX(-5)	0.0051*	0.0324	0.0067	-0.0132
DLVXFXI(-1)	0.0010	-0.2510	0.0217	-0.0215
DLVXFXI(-2)	-0.0006	0.0283	-0.0089	0.0161
DLVXFXI(-3)	-0.0023	-0.0277	0.0047	-0.0505**
DLVXFXI(-4)	-0.0014	0.0336	-0.0583***	-0.0836***
DLVXFXI(-5)	0.0053**	-0.0297	-0.0116	-0.0250
С	-0.0155	-0.0697	0.1941	0.1881
D	0.0043	0.2700	-0.6717***	-0.7056***
D(-1)	0.0125	1.7966	-0.2097	-0.1570
D(1)	-0.0120	-2.5549	0.2501	0.2287
Bank of England Bank Rate	0.0037	2.4770	-0.3632*	-0.3693*
CPI (YOY)	-0.0286	2.9451	0.2420	0.1247
Imports & Exports	-0.0032	0.6268	-0.1427	-0.0123
GDP (YOY)	-0.0281	3.9747*	-0.4592**	-0.0821
Consumer Confidence	-0.0367	-0.8244	0.0928	0.0274
Unemployment Rate	0.0002	-0.7346***	0.0001	-0.0008
Industrial Production	0.0002	-0.5243***	0.0008	0.0013
Money Supply M4	0.0004	-0.4115***	0.0010	0.0037
Net Consumer Credit	0.0003	-0.2804***	0.0020	0.0033
Official Reserves Change	0.0002	-0.1194***	-0.0001	0.0006
Total Business Investment	0.0030	0.2557	0.0507**	0.0432
Trade Balance	-0.0007	0.1421	-0.0267	0.0168
Government Spending	-0.0052*	-0.0407	0.0207	0.0337
R-squared	-0.0030	-0.0337	0.0168	-0.0648**

Note: An aggregate dummy variable of UK macroeconomic announcements is created to explore overall impact other than individual

effects on the day of announcement (D), a day before the announcement D(-1) and a day after the announcement D (1). \*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively.

(Ishfaq, Qiong, Abbas et al., 2018). The lower panel of Table 5 presents aggregated announcement coefficients showing a significant impact on BPVIX and VXFIX on the day of release.

The effect of announcements of GDP, unemployment rate, and total business investment significant on FX returns. The rest of the announcements influenced FX returns via market volatility indices. Most announcements indicated the considerable impact on BPVIX and VXFXI but not on FX returns because the impact of announcements reflected in options volatility first, then impounded into FX returns via options volatility which is the market reaction to announcements. Tables 5 and 6 analyzed the dynamics of GBP/CNY returns, spread, BPVIX, VXFXI around the UK, and Chinese announcements separately. The upper panel of both Tables indicates that FX returns, BPVIX and VXFXI hold bi-directional association and lead each other to mark the market equilibrium as shown in the Granger causality test (Table 2, panel D).

The Chinese aggregated announcements denoted a significant impact on the day and a day after the announcement in Table 6. Particular changes in FX returns are explained by market volatility as announcements significantly affected BPVIX and VXFXI and are consistent with our hypothesis. The macroeconomic announcements from the UK and China significantly reduced the bid-ask spread in exchange rate markets, which implies that both economies play an essential role in providing liquidity and keeping markets active.

Tables 7 and 8 reports the association of EUR/CNY, bid-ask spread, EUVIX, VXFXI surrounding the Euro and Chinese announcements correspondingly. The upper panel of both tables displays a significant impact of EUVIX and VXFXI on FX returns. Both volatility indices contained significant negative coefficients pointing towards an appreciation of sample exchange rate and supportive (Ishfaq, Qiong, Abbas et al., 2018). The lower panel of Table 7 shows the substantial effect of aggregated Euro announcement on FX returns a day before the release of announcements D (–1). However, individual announcements exhibit insignificant coefficients to explain the dynamics of FX returns.

The individual announcements indicated a significant influence on the spread and both volatility indices that play a role to explore the movements in FX returns. The impact of aggregated Chinese announcements displayed a significant effect on EUVIX before the release in Table 8. The announcement of the balance of trade indicated a considerable coefficient to explain changes in FX returns. Other macroeconomic announcements leading index, New Year loans, and GDP influenced spread and VXFXI respectively hence play an essential role in intermediating information content into exchange rate via market volatility. Chinese announcements reduced the bid-ask spread, while the Current Account Balance of the Euro area raised spread during the sample period.

Tables 9 and 10 illustrate the results of JPY/CNY, spread, JYVIX, and VXFXI around Japanese and Chinese announcements accordingly. Chinese and Japanese volatility indexes significantly influence underlying exchange rates. The negative slope of JYVIX encourages appreciation while the positive slope of VXFXI urges deprecation and consistency (Ishfaq, Qiong, Abbas et al., 2018). Japanese announcements highlight the substantial impact on JYVIX which indicates increased volatility a day before and after the release of announcements in anticipation of macroeconomic announcements (Bauwens et al., 2005; Jones et al., 1998).

However, some part of the information makes significant revisions in the expectations of future volatility. The effects of GDP and PPI report substantial impact on both announcements on FX returns. Other individual announcements significantly influenced the spread of JYVIX and VXFXI to transmit information content in FX returns.

The sensitivity of spread coefficients to announcements find some support of liquidity and the presence of noisy traders, making the sample market less liquid. Table 10 describes that

Table 6. GBP/CNY,	spread, BPVIX, VX	(FXI & Chinese anno	ouncements	
	DLGBP_CNY	DLGBP_SPREAD	DLBPVIX	DLVXFXI
DLGBP_CNY(-1)	0.0040	2.4570	-0.3884*	-0.3593*
DLGBP_CNY(-2)	-0.0275	2.8510	0.2349	0.1466
DLGBP_CNY(-3)	-0.0029	0.6036	-0.1322	-0.0173
DLGBP_CNY(-4)	-0.0257	4.1203*	-0.4752**	-0.1084
DLGBP_CNY(-5)	-0.0351	-0.9036	0.1502	0.0693
DLGBP_SPREAD(-1)	0.0002	-0.7344***	0.0002	-0.0007
DLGBP_SPREAD(-2)	0.0002	-0.5229***	0.0008	0.0012
DLGBP_SPREAD(-3)	0.0004	-0.4108***	0.0011	0.0039
DLGBP_SPREAD(-4)	0.0003	-0.2810***	0.0020	0.0036
DLGBP_SPREAD(-5)	0.0002	-0.1199***	0.0000	0.0008
DLBPVIX(-1)	0.0032	0.2224	0.0476*	0.0446*
DLBPVIX(-2)	-0.0006	0.1535	-0.0295	0.0135
DLBPVIX(-3)	-0.0056*	-0.0178	0.0229	0.0361
DLBPVIX(-4)	-0.0027	-0.0208	0.0203	-0.0619**
DLBPVIX(-5)	-0.0056*	-0.0140	0.0218	0.0373
DLVXFXI(-1)	0.0008	-0.2613	0.0225	-0.0217
DLVXFXI(-2)	-0.0007	0.0286	-0.0094	0.0158
DLVXFXI(-3)	-0.0025	-0.0453	0.0023	-0.0510**
DLVXFXI(-4)	-0.0017	0.0629	-0.0675***	-0.0902***
DLVXFXI(-5)	0.0052**	-0.0040	-0.0159	-0.0233
С	-0.0260	0.1191	-0.2410	0.0889
D	0.0103	-1.2949	0.4788**	0.0124
D(-1)	-0.0171	1.4007	0.3552	-0.3958
D(1)	0.0527**	-1.4176	0.0137	-0.0320
Balance of Trade	0.0040	2.4570	-0.3884*	-0.3593*
Foreign Direct Investment	-0.0275	2.8510	0.2349	0.1466
Foreign Reserves	-0.0029	0.6036	-0.1322	-0.0173
GDP (YOY)	-0.0257	4.1203*	-0.4752**	-0.1084
Activity Index	-0.0351	-0.9036	0.1502	0.0693
Leading Index	0.0002	-0.7344***	0.0002	-0.0007
Money Supply	0.0002	-0.5229***	0.0008	0.0012
Manufacturing Index	0.0004	-0.4108***	0.0011	0.0039
New Year Loans	0.0003	-0.2810***	0.0020	0.0036
Price Index	0.0002	-0.1199***	0.0000	0.0008
Non-Manufacturing Index	0.0032	0.2224	0.0476*	0.0446*
R-squared	-0.0006	0.1535	-0.0295	0.0135

Note: An aggregate dummy variable of Chinese macroeconomic announcements is created to explore overall impact other than individual

effects on the day of announcement (D), a day before the announcement D(-1) and a day after the announcement D (1).

\*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively.

aggregated announcements of China have no impact on sample FX returns. Individual announcements affect spread, JYVIX, and VXFXI significantly, which, in turn, assist in examining the dynamics of FX returns.

Table 7. EUR/CNY,	, spread, EUVIX, V	KFXI & Euro annound	cements	
	DLEUR_CNY	DLEUR_SPREAD	DLEUVIX	DLVXFXI
DLEUR_CNY(-1)	-0.0100	0.5937	-0.0045	-0.2404
DLEUR_CNY(-2)	-0.0035	0.7821	0.2323	0.0932
DLEUR_SPREAD(-1)	-0.0001	-0.5220***	0.0028	-0.0004
DLEUR_SPREAD(-2)	0.0003	-0.2408***	0.0008	-0.0020
DLEUVIX(-1)	-0.0101***	-0.0527	-0.1656***	0.0523**
DLEUVIX(-2)	-0.0013	-0.2481	-0.0677***	0.0250
DLVXFXI(-1)	-0.0052**	0.4377	0.1072***	-0.0067
DLVXFXI(-2)	0.0046*	-0.0938	0.0144	0.0003
С	-0.0094	0.8861	0.1026	0.1114
D	-0.0029	-1.5598	-0.2672	-0.3446
D(-1)	-0.0493**	2.5576	0.2312	0.3725
D(1)	-0.0300	0.3545	0.2830	0.2582
Budget Balance	-0.0356	-8.0196	0.7330	0.1386
Consumer Confidence	-0.0176	-7.1607	-0.0317	-0.6350
CPI (YOY)	-0.0395	-1.0004	-0.0161	0.6468*
Current Account Balance	0.0541	15.389**	-0.8862	0.2377
Factory Orders (YOY)	-0.0378	-6.4974	-0.6013	0.1505
GDP (QOQ)	0.1026	7.2183	0.1552	-0.4918
Consumer Confidence	0.0891	-5.9303	0.1492	-0.4506
Industrial Production	-0.0494	3.4506	-1.6131**	-0.1249
Non-Farm Payrolls	-0.0790	-6.9513	-0.2773	0.1525
PPI (YOY)	-0.0024	-11.981*	1.2121*	0.0343
Retail Sales (YOY)	0.0070	-2.5970	-0.7436	-0.6236
Trade Balance	-0.0653	-3.4437	-1.1343*	-0.2818
Exports (MOM)	-0.0100	0.5937	-0.0045	-0.2404
R-squared	-0.0035	0.7821	0.2323	0.0932

Note: An aggregate dummy variable of Euro area macroeconomic announcements is created to explore overall impact other than individual effects on the day of announcement (D), a day before the announcement D(-1) and a day after the announcement D(1).

\*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively.

The study evidenced the behavioral aspects of market participants seem dominant over macro perspectives, which highlight the significance of microstructural approaches in anticipating asset prices, which is in line with the microstructural approach. One of the earlier studies supports our result which stated that risk perception slows down the process of economic growth (Marmolejo & Urquijo, 2011). The study evidenced the behavioral aspects of market participants seem dominant over macro perspectives, which highlight the significance of microstructural approaches in anticipating asset prices. Our study provides supportive evidence and recommends including heterogeneous expectations of agents in the core macroeconomic models, which are a crucial argument made in the recent developments on the macroeconomic perspective (Vines & Wills, 2018).

However, positive slopes of VXFXI and VIX point towards the depreciation of exchange rates. This devaluation in exchange rates might be linked with an economic backdrop in the stock market crash, a slowdown in real GDP growth rate, stubborn capital outflows from Chinese markets in

Table 8. EUR/CNY,	, spread, EUVIX, VX	FXI & Chinese anno	ouncements	
	DLEUR_CNY	DLEUR_SPREAD	DLEUVIX	DLVXFXI
DLEUR_CNY(-1)	-0.0102	0.6800	0.0016	-0.2520
DLEUR_CNY(-2)	-0.0034	0.5903	0.2260	0.1059
DLEUR_SPREAD(-1)	-0.0001	-0.5204***	0.0027	-0.0007
DLEUR_SPREAD(-2)	0.0003	-0.2377***	0.0008	-0.0020
DLEUVIX(-1)	-0.0103***	-0.0293	-0.1635***	0.0529**
DLEUVIX(-2)	-0.0013	-0.2775	-0.0594**	0.0282
DLVXFXI(-1)	-0.0055**	0.3984	0.1015***	-0.0106
DLVXFXI(-2)	0.0045*	-0.1045	0.0128	-0.0020
С	0.0045	0.7449	-0.0364	-0.0181
D	-0.0363	-2.8390	-0.0177	0.0555
D(-1)	-0.0223	0.6977	0.6163**	-0.3744
D(1)	0.0015	-3.2610	-0.1047	-0.0822
Balance of Trade	-0.1635***	-2.5355	-0.7511	0.3878
Foreign Direct Investment	0.0186	-1.1492	0.2055	-0.7732
Foreign Reserves	-0.0312	-0.9814	-0.2676	0.4980
GDP (YOY)	0.0305	0.3880	0.3795	-2.3801**
Activity Index	0.0468	5.4562	-0.0220	-0.0075
Leading Index	-0.0831	-13.515*	0.4592	0.5593
Money Supply	-0.0911	43.6859	0.9624	-0.5335
Manufacturing Index	-0.0740	1.6532	-0.5065	0.7962
New Year Loans	0.0802	-48.489*	-0.8793	0.3539
Price Index	-0.0582	-0.4096	0.7994	0.0498
Non-Manufacturing Index	-0.0740	1.6532	-0.5065	0.7962
R-squared	0.0247	0.2287	0.0309	0.0125

Note: An aggregate dummy variable of Chinese macroeconomic announcements is created to explore overall impact other than individual effects on the day of announcement (D), a day before the announcement D(-1) and a day after the announcement D(1).

\*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively

recent years, and controversies between the US and China in recent years (Peltier, 2015). The estimates evidenced the rise in volatility in Chinese financial markets that discouraged investor confidence and seek for "flight to safety" effect. The global risk aversion indicators of developed economies (BPVIX, EUVIX, and JYVIX) are considered as "safe heaven" during volatile regimes.<sup>3</sup> This designates implied volatility indices can play a substantial role in anticipating exchange rates. Investors should consider options volatility indices as a "fear-gauge index" during portfolio evaluation in foreign exchange markets. Our results are consistent with the previous literature (Cairns et al., 2007; Ishfaq, Qiong, Abbas et al., 2018; Kang, Ki-Hong et al., 2014; Kang, Yun-Jung et al., 2014).

Moreover, the volatility indices and bid-ask spreads were found more sensitive to announcements than forex returns, which directly imply weak assimilation of public information into exchange rates. This indicates that low or longer-term frequency announcements are unmatchable with China's high frequency and volatile exchange rate regimes. Although the forex markets of China are partially flexible, even then, the assimilation of public information seems poor. However, the high-frequency or comparatively matching frequency indicators seem more

Table 9. JPY/CNY, spread, JYVIX	K, VXFXI & Japanese announce	ements		
		DLJPY_SPREAD	סרואעוא	DLVXFXI
DLJPY_CNY(-1)	-0.0024	1.4699	-0.4022**	-0.1510
DLJPY_CNY(-2)	-0.0240	-0.6260	0.0238	-0.1323
DLJPY_CNY(-3)	0.0154	3.3680	0.0426	-0.1081
DLJPY_CNY(-4)	0.0261	1.3532	-0.0805	0.2824
DLJPY_CNY(-5)	0.0113	1.6051	-0.1845	-0.0039
DLJPY_SPREAD(-1)	0.0001	-0.5590***	0.0013	0.0035*
DLJPY_SPREAD(-2)	0.0000	-0.4640***	0.0030	0.0002
DLJPY_SPREAD(-3)	0.0000	-0.3375***	0.0074***	0.0034
DLJPY_SPREAD(-4)	0.0000	-0.3084***	0.0065***	0.0016
DLJPY_SPREAD(-5)	-0.0003	-0.1644***	0.0031	-0.0013
DLJYVIX(-1)	-0.0003	0.1192	-0.0855***	0.0293
DLJYVIX(-2)	-0.0051	-0.2925	-0.0877***	-0.0047
DLJYVIX(-3)	-0.0025	-0.1052	-0.1159***	-0.0496*
DLJYVIX(4)	-0.0044	-0.3238	-0.0442*	-0.0008
DLJYVIX(-5)	-0.0063**	-0.3774	-0.0477**	-0.0466*
DLVXFXI(-1)	0.0065**	0.0840	0.1458***	-0.0072
DLVXFXI(-2)	0.0031	0.1809	0.0546**	0.0113
DLVXFXI(-3)	0.0007	-0.3197	0.0237	-0.0386
DLVXFXI(-4)	-0.0034	0.5371*	-0.0106	-0.0747***
DLVXFXI(-5)	0.0032	0.1778	-0.0041	-0.0098
C	-0.0203	-1.8038	0.0557	-0.0028
D	0.0029	1.8184	0.2230	0.1376
D(-1)	-0.0224	0.9860	0.5027**	0.2409
D(1)	-0.0342	-3.5463	0.5214**	-0.0922
Current Account Balance	0.0786	16.775**	0.1401	1.411**
				(Continued)

	DLJPY_CNY	DLJPY_SPREAD	DLJYVIX	DLVXFXI
Capacity Utilization (MOM)	+++0.0-	32.806***	0.0024	-0.2007
Construction Orders	-0.1644	7.3877	-0.6073	-1.1887
Consumer Confidence Index	0.0693	-16.267***	0.5652	-0.7160
Exports (YOY)	-0.0382	6.0435	0.1105	-0.2075
GDP Annualized (QOQ)	-0.1734**	-0.5844	0.0525	$-1.4331^{**}$
Industrial Production	0.1341	-16.782*	-0.0348	0.4956
Leading Index	0.0351	1.3394	-0.3337	0.4879
Monetary Base (YOY)	0.0031	-1.3222	-0.3080	0.2449
CPI (YOY)	0.0024	30.931***	-0.7776	-0.1972
Official Reserve Assets	-0.0476	2.5508	-0.5812	-0.3416
Overall Household Spending	-0.0666	4.7533	-1.0323*	-0.4617
ΡΡΙ (ΥΟΥ)	0.1171*	-12.3610*	0.8042	0.5489
Retail Trade	-0.0058	-8.6180	0.1173	0.7886
Trade Balance	-0.0359	3.6396	0.1461	-0.0936
R-squared	0.0169	0.2884	0.0559	0.0301
Note: An aggregate dummy variable of announcement D(=1) and a day after t	<sup>5</sup> Japanese macroeconomic announceme he appoincement D(1)	ents is created to explore overall impact o	ther than individual effects on the day	of announcement (D), a day before the

winconcentent of 1) and a day area are announcentent of 1).

Table 10. JPY/CN	/, spread, JYVIX, V>	(FXI & Chinese anno	ouncements	
	DLJPY_CNY	DLJPY_SPREAD	DLJYVIX	DLVXFXI
DLJPY_CNY(-1)	-0.0022	1.5289	-0.3792**	-0.1467
DLJPY_CNY(-2)	-0.0234	-0.9277	0.0430	-0.1489
DLJPY_CNY(-3)	0.0159	3.2828	0.0298	-0.1091
DLJPY_CNY(-4)	0.0225	2.0748	-0.0930	0.2704
DLJPY_CNY(-5)	0.0133	2.0854	-0.1920	-0.0018
DLJPY_SPREAD(-1)	0.0001	-0.55754***	0.0016	0.0033*
DLJPY_SPREAD(-2)	-0.0001	-0.4671***	0.0033	0.0000
DLJPY_SPREAD(-3)	0.0000	-0.3421***	0.0078***	0.0033
DLJPY_SPREAD(-4)	0.0000	-0.3127***	0.0068***	0.0014
DLJPY_SPREAD(-5)	-0.0003	-0.1635***	0.0030	-0.0015
DLJYVIX(-1)	-0.0003	0.1696	-0.0862***	0.0318
DLJYVIX(-2)	-0.0053*	-0.2500	-0.0887***	-0.0071
DLJYVIX(-3)	-0.0027	-0.1198	-0.1178***	-0.0504**
DLJYVIX(-4)	-0.0045	-0.3534	-0.0434*	-0.0015
DLJYVIX(-5)	-0.0064**	-0.3360	-0.0504**	-0.0458*
DLVXFXI(-1)	0.0067**	-0.0386	0.1444***	-0.0112
DLVXFXI(-2)	0.0032	0.1397	0.0598**	0.0120
DLVXFXI(-3)	0.0009	-0.3634	0.0267	-0.0363
DLVXFXI(-4)	-0.0030	0.6021**	-0.0137	-0.0763***
DLVXFXI(-5)	0.0032	0.0698	0.0010	-0.0108
С	-0.0058	0.1033	-0.0829	0.0900
D	0.0095	-0.2301	0.0903	0.0872
D(-1)	-0.0376	2.0391	0.2656	-0.3789
D(1)	-0.0133	-1.2449	-0.1753	-0.0960
Balance of Trade	0.01514	4.4382	-0.7226	0.2927
Foreign Direct Investment	-0.0758	-2.5898	0.4142	-0.6161
Foreign Reserves	0.0604	-10.084	0.4778	0.6998
GDP (YOY)	0.0008	3.6758	-0.3384	-2.2933**
Leading Index	-0.0150	-20.036***	0.02425	0.6344
Money Supply	0.1577	24.3901	0.4111	0.1033
Manufacturing Index	-0.0675	-0.8430	0.2035	0.8142
New Year Loans	-0.0455	-22.197	0.0419	-0.2156
Non-Manufacturing Index	-0.0712	-1.2089	0.1955	0.8355
Activity Index	0.0270	12.379*	-0.3369	-1.0127*
Price Index	-0.0190	4.5560	0.9330*	0.13319
R-squared	0.0152	0.2785	0.0548	0.0293

Note: An aggregate dummy variable of Chinese macroeconomic announcements is created to explore overall impact other than individual effects on the day of announcement (D), a day before the announcement D(-1) and a day after the announcement D(1).

\*, \*\*, \*\*\* represent the level of significance at 10, 5, and 1% respectively.

appropriate to encompass the short-term effects. Our results support the microstructural approaches that information content influences the exchange rate through wide-ranging interpretations of public information.

The forex returns, bid-ask spread, and volatility indices demonstrated less vulnerability towards Chinese announcements as compared to the USA, UK, Japan, and Euro. However, China's announcements like GDP, FDI, leading index, foreign reserves, and activity index are more influential to volatility indices and bid-ask spreads. The release of announcements reduces the volatility in foreign exchange markets on the day of the announcement. This result offers some support from earlier studies that the release of information content enclosed in scheduled macroeconomic announcements reduces the uncertainty of future expectations (DeGennaro & Shrieves, 1997; Ederington & Lee, 1996; Ishfaq et al., 2017; Kim & Kim, 2004). The study also found that the US announcements containing asymmetric information widen the bid-ask spread and consider widespread as protection for loss to informed traders from noisy traders in low liquid markets which is consistent with earlier studies (Balduzzi et al., 2001; Kyle, 1985). The quick reversion of bid-ask spread in most samples can be attributed to the supremacy of informed traders. The spread consequences do not help to impound any part of information into exchange rates. However, bidask spread found sensitive to the release of macroeconomic announcements.

In contrast, announcements related to China and the UK keep foreign exchange markets liquid by reducing bid-ask spread to boost economic activity. These outcomes prove the subjective evidence that "Bernanke and China Send World Stocks Lower" by CNN on 20 June 2013. Likewise, the Bloomberg BusinessWeek headlines that "Copper Weakens for Second Day as China's Manufacturing Slows" on 30 April 2013. The volatility indices found more sensitive to announcements than forex returns and spreads, which implies weak assimilation of public information into exchange rates consistent with the microstructural approach. The return series of spread and volatility indices demonstrate less vulnerability towards Chinese announcements than the USA, UK, Japan, and Euro. However, the bid-ask spread outcomes do not help to impound any information into exchange rates. Options implied volatility represents investor behavior as a "fear gauge" for future uncertainty.

#### 5. Conclusion

The purpose of this study is to examine the role of options implied volatility and bid-ask spread as microstructural variables in the price formation process of foreign exchange markets in response to macroeconomic announcements. The findings of this study indicated that changes in one's perception of option implied volatility affect exchange rates and, more precisely, on the private portion of information content associated with announcements likewise order flow in previous literature. The findings indicate that behavioral characteristics of market participants appear to be more influential than macroeconomic perspectives, emphasizing the importance of microstructural approaches in anticipating asset prices, which is consistent with the microstructural approach.

The heterogeneous expectations of agents in core macroeconomic models demonstrated the increase in volatility in Chinese financial markets, which eroded investor confidence and induced a "flight to safety" response. Additionally, the findings demonstrated that US announcements containing asymmetric information increase the bid-ask spread and are widely regarded as a form of protection for informed traders against noisy traders in low-liquid markets. Finally, volatility indices and bid-ask spreads were more sensitive to macroeconomic announcements than forex returns, implying that public information is not directly incorporated into exchange rates.

#### 6. Policy implications, limitations and future study direction

The study recommends that monetary and financial institutions of China require gaining more confidence of global investors emerging as "safe heaven" during volatile regimes through transparent economic policy mechanisms and letting the natural forces of supply and demand to settle market equilibrium. Otherwise, the rising uncertainty in Chinese markets will put pressure on RMB's financial openness and internationalization. Monetary thinkers and investors should consider China's GDP, FDI, leading index, foreign reserves, and activity index while evaluating forex markets. Investors should also consider options implied volatility as a fear gauge index during portfolio evaluation. The limitations of this research include the non-availability of high-frequency data on the minute basis of options volatility and exchange rates which can explore more insights to support microstructure models. Therefore, prospective researchers can consider this limitation as a future study direction.

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#### Notes

- As CBOE started to calculate China Exchange Traded Fund's Volatility Index (VXFXI) since 16 March 2011 which is our core variable.
- 2. Variance Inflation Factor (VIF) is employed to authenticate results but not presented in the paper to conserve the space.
- 3. Chinese instability has appreciated the yen because Japanese fixed income is seen as "safe haven" in the face of global risk aversion.

https://www.investmentweek.co.uk/investmentweek/analysis/2426383/what-will-be-the-realimpact-of-chinas-slowdown-on-japan

#### **Disclosure statement**

No potential conflict of interest was reported by the author(s).

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Various Studies
from
Findings
Summarized
A1:
Table

Author (s)	Journal	Year	Objective	Model	Results
Xiangsheng Dou	Cogent Economics & Finance	2018	This study examine the determinants of China's money demand.	SVAR model	China's money demand is mainly decided by income, interest rate and expected inflation rate.
David Vines and Samuel Wills	Oxford Review of Economic Policy	2018	The objective is to rebuild a macroeconomic theory project covered under analytical assessment.	New Keynesian model	They documented that the behavioral equations in the model governing consumption, investment, and price setting, and also the insertion of a wedge between the interest rate set by policy-makers and that facing consumers and
Hirshleifer, D., & Sheng, J	Journal of Financial Economics	2021	How the arrival of macro- news affects the stock market's ability to incorporate the information in firm-level earnings announcements.	Regression Analysis	The sensitivity of announcement returns to earnings news is 17% stronger, and post-earnings announcement drift 71% weaker, on macro-news days.
Du, B., Fung, S., & Loveland, R.	Journal of Banking & Finance	2018	Informational role of equity options trading around Federal Open Market Committee (FOMC) announcements.	Regression Analysis	Information contained in option trades prior to FOMC rate change announcements predicts bank stock returns to a greater degree than does volatility spread prior to non- meeting days.
					(Continued)

(Continued)					
George J. Jiang, Guanzhong Pan	Journal of Futures Markets	2022	Examine the speculation or hedging under the scope of Options trading prior to FOMC announcements.	Regression Analysis	Informed traders use options to speculate on their private information for the upcoming FOMC announcements.
Jelena Eberbach, Marliese Uhrig-Homburg, Xiaoxiao Yu		2021	Identifying the information Processing in the Option Market around Earnings and Macroeconomic Announcements.	Regression Analysis	Earnings announcements coincide with macro releases, sophisticated option investors process private information more effectively.
Abolaji Daniel Anifowose & Izlin Ismail & Mohd Edil Abd Sukor,	Global Business Review	2018	The objective is to examine the currency Order Flow and Exchange Rate Determination under the scope of Empirical Evidence from the Malaysian Foreign Exchange Market.	Vector Autoregressive (VAR)	Currency order flow explains an important portion of the movements in the MVRâ€ USD exchange rate.
Andersen, T. G., & Bollerslev, T.	Journal of Finance	1998	Deutsche Mark-Dollar Volatility: Intraday Activity Patterns, Macroeconomic Announcements, and Longer Run Dependencies.	GARCH (1,1)	They documented an intraday volatility pattern is dominant.
Balduzzi, P., Elton, E. J., & Green, T. C.	Journal of Financial and Quantitative Analysis	2001	This Paper uses intraday data from the interdealer government bond market to investigate the effects of scheduled macroeconomic announcements on prices, trading volume, and bid-ask spreads.	Regression Analysis	They find that 17 public news releases, as measured by the surprise in the announced quantity, have a significant impact on the price.
Bauwens, L., Omrane, W. B., & Giot, P.	Journal of International Money and Finance	2005	Examine the news announcements, market activity and volatility in the euro/dollar FX market.	GARCH Model	Volatility increases in the pre- announcement periods, particularly before scheduled events.

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Ishfaq, M., Qiong, Z. B., & Abbas, G.	Mediterranean Journal of Social Sciences	2018	Examines the intertemporal association between CBOE market volatility indices (VIX), foreign exchange rates and respective bid-ask spread for four CNY exchange rate parities.	EGARCH (1,1)	Results report that negative slopes of EUVIX, BPVIX, and JVVIX imply a higher level of volatility, hence improves the underlying exchange rate through appreciation, while positive slopes of VXFXI deteriorates exchange rates during the sample period.
Boothe, P.	Economic Inquiry	1998	Documented the exchange rate risk and the bid-ask spread: A seven country comparison.	Regression Analysis	It provides empirical support for the theoretical prediction of a positive relationship between the level of uncertainty regarding future prices and current transaction costs.
Chen, Y., & Gau, YF.	Annual Conference of Taiwan Finance Association	2009	Impacts of News Announcements to Order Flow and Price Discovery in the Foreign Exchange Market.	Regression Analysis	They concluded a significant impact of news announcement on oredr flow and price discovery.
Munazza Jabeen, Abdul Rashid	Global Journal of Emerging Market Economies	2021	This article studies the effects of macroeconomic news announcements and order flow on exchange rates in Pakistan by considering both direct and indirect information channels during news announcements periods.	GARCH	The findings reveal that macroeconomic news directly, and indirectly affect Pak Rupee exchange rates. The results also show that the order flow drives fluctuations in Pak Rupee exchange rates indirating the role of trade signals and tradens in the exchange rate determination.

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Cairns, J., Ho, C., & McCauley, R.	BIS Quarterly Review	2007	Examine the exchange rates and global volatility under the implications for Asia- Pacific currencies.	Regression Analysis	They concluded that at times of heightened global equity and bond market volatility, high-yielding currencies tend to depreciate while low- yielding ones tend to serve as a "safe haven".
Yu-Lun Chen, Yin-Feng Gau	The Journal of Futures Markets	2022	Identifying the important role played by order flow in price discovery and in intermediating the exchange-rate reactions to macroeconomic news.	VAR	After considering the order flows of futures and spot markets, the futures market dominates price discovery when compared with the spot market, confirming that order flows have a permanent impact on prices, even more so in futures markets.
Ederington, L. H., & Lee, J. H.	Journal of Financial and Quantitative Analysis	1996	This study attempts to examine the scheduled macroeconomic announcement effects on the India VIX.	OLS and the EGARCH model	The information content of macroeconomic news on report day and day after does not have significant influences on India VIX, except MCIR.
Evans, M. D. D., & Lyons, R. K.	Journal of International Money and Finance	2002	The importance of information conveyed by order flow in major currencies for pricing minor currencies.	Regression Analysis	The model explains 45 to 78 percent of daily returns in all nine currencies. Moreover, its prediction that order flow in individual markets should be relevant for determining prices in other markets is borne out.

(Continued)

	Documented the order FlowRegression AnalysisThe model of daily deutsche mark/dollar log changes produces an R2 statistic above 60 percent. For the deutsche mark/dollar spot morket as a whole, we find that \$1 billion of net dollar purchases increases the deutsche mark price of a dollar by 0.5 percent.
(Continued)	Evans, M. D. D., & Lyons, R. K. Journal of Political Economy



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