Oral Intervention in China: Efficacy of Chinese Exchange Rate Communications

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Abstract

This paper analyses China's oral intervention and the efficacy of exchange rate communications by the Chinese monetary authorities. Applying the event study approach, we find that exchange rate communication could help the authorities to impact the Chinese exchange rate level moving in the desired direction. Also, China is responsive to international calls, particularly those from the US calling for the appreciation of the RMB exchange rate. But the response is moderately reluctant as the appreciation would occur after a delay of around two weeks. Finally, using the range-based variance model, confirmative evidence is found that successive, rather than solo, exchange rate communications can calm the exchange rate movement in terms of excess volatility.

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1. Introduction

Traditionally, monetary authorities have intervened directly in foreign exchange markets, impacting exchange rate levels and their fluctuations by actually trading currencies. In recent years, however, actual intervention has been supplemented or supplanted by oral

intervention, i.e. official communications via policy announcements or other means such as informal meetings with market participants intended to mitigate exchange rate trends by influencing market expectations (Fratzscher, 2006, 2008a, 2008b; Beine et al., 2009; Sakata and Takeda, 2013). For major economies like the US and EU member nations, there has been almost no direct market intervention by the authorities since the mid of 1990's; however, the frequency of oral interventions has increased.

In China, both actual and oral interventions are performed by Chinese monetary authorities, but in a secret way. However, we do know the occasions when the People's Bank of China (PBOC) makes statements directly to the foreign exchange market or talks to the state-owned banks. In recent years, the PBOC has announced that it will gradually reduce direct or "regular" interventions in the Chinese exchange market. But given PBOC's long standing of extensive intervention, this change is likely to be more form than substance.

China has been internationally noted for the extensity and sophistication of its foreign exchange interventions. Generally, three major forms can be identified for the Chinese intervention: (1) Direct sales or purchases of foreign currencies by PBOC in the marketplace. (2) Setting and adjusting of the official central parity rate and the range around which the daily trading prices are allowed to fluctuate. (3) PBOC's oral intervention in the form of policy briefing, moral persuasion, formal and informal meetings, and telephone conversations. The first two are regularly operated by the PBOC and the central bank's indication of a gradual reduction in regular interventions is likely to mean a possible change to engaging more in oral intervention.

Although many researchers have studied China's exchange rate policy and have been aware of intervention as a central feature of that policy, to date there has been very little

research attention directed toward China's oral intervention. This paper fills the gap in the foreign exchange intervention literature by considering the Chinese case.

Oral intervention as a policy tool has found to have mixed effects in existing literature. Recent studies have shown some progress in mitigating the problems in previous research. For example, the event study methodology has been applied in intervention studies, which is considered to be better at capturing the clustered property of interventions compared to time-series analysis (Fratzcher 2008a; Gnabo and Teiletche, 2009).

This paper follows the event study approach to explore China's oral intervention in foreign exchange to better our understanding of China's exchange rate. We focus on domestic as well as international aspects of China's exchange rate communication, China's response to international calls for exchange rate adjustment, particularly those form the USA, is considered.

We analyse the effects of oral intervention on the Chinese yuan/US dollar (CNY/USD) rate from 22 July 2005 to 22 July 2013. Four event window lengths, of 2, 5, 10 and 15 days, are deployed to check when the effects of oral intervention occur. Four dimensions - event, direction, reversal and smoothing - are investigated to test for the impacts of the events. We also employ more extensive tests in the empirical investigation. The event study approach that is commonly used in other similar research is based almost exclusively on the sign tests. In this research we extend the literature by employing the rank tests along with the sign tests, to check to what extent the communications may have the desired effects. We also compare the results of parametric and nonparametric tests, as the nonparametric tests may yield additional insights in the context of the event studies.

We find that exchange rate communications could help the Chinese central bank impact RMB exchange rate levels moving in desired directions. Based on the whole sample

results, while against the event criterion, exchange rate communications are not successful, in the reversal dimension, all the event window lengths under examination are significant. Finally, the longer the event window length is, the more significant the effects are in the four dimensions. We also test the effects of the international aspects of China's exchange rate communications, particularly in the case of the US calling for appreciation of the RMB exchange rate. As the events are significant in all dimensions, the results suggest that such calls can influence movements of the Chinese exchange rate, and hence by and large the Chinese authorities are responsive to American pressure for RMB appreciation. Finally, using the range-based variance model to get volatility, we find confirmative evidence of the effect of successive exchange rate communications on calming the exchange rate movement in terms of excess volatility.

The rest of the paper is organized as follows. Section 2 comprises a review of the literature on oral intervention. Section 3 introduces the forms of intervention in China with a focus on China's oral intervention. Section 4 explains the event study methodology; it defines the events, event windows and criteria, and describes the parametric and nonparametric tests. Section 5 discusses the estimation results. Section 6 offers concluding remarks.

2. Related Literature

In recent decades, exchange rate communication has become an increasingly important policy tool for monetary authorities (Fratzscher, 2006). Using reports issued by the newswire service Reuters News, Fratzscher (2006) analyses exchange rate communication on the basis of two sets of search criteria. They are used to extract all statements in which policy makers expressed a view about the domestic exchange rate. The search terms are the phrase 'exchange rate' or the name of the exchange rate, such as the US dollar for the United States,

and the title or name of relevant policy makers. Then, Fratzscher (2006) classifies the contents of the statements according to whether they support a stronger domestic currency or a weaker one, or are neutral:

$$IO_t = \begin{cases} +1 & if\ 'strengthening' oral\ statement; \\ 0 & if\ 'ambiguous' oral\ statement; \\ -1 & if\ 'weakening' oral\ statement; \end{cases} \quad (1)$$

Using the above classification process, Fratzscher (2006) identifies exchange rate communication in the Group of Three (G3), comprising the USA, Japan and the euro area, from 1990 to 2003. The findings show that from the mid-1990s the United States and the euro area has practically abandoned the use of actual purchases and sales in FX markets, and shifted to almost exclusive use of communication to affect exchange rate developments. The Japanese authorities, however, has intensified both actual intervention and exchange rate communication. The empirical results based on an EGARCH framework indicate that communication not only exhibits a significant contemporaneous effect on exchange rates, but also moves forward exchange rates in the desired direction up to a horizon of 6 months. Moreover, communication is found to reduce exchange rate volatility and uncertainty, whereas actual interventions tend to have the opposite effect. Overall, communication tends to be a fairly effective policy tool over the medium term.

In a subsequent study, Fratzscher (2008) investigates the channels through which communication works. Using the same data and search classification process as in his 2006 research, Fratzscher (2008) employs a standard asset-pricing framework. The research provides two key findings: first, G3 communication policies have constituted an effective policy tool in influencing exchange rates in the desired direction; second, communication has been effective independently of the stance and direction of the monetary policy and the occurrence of actual interventions. Meanwhile, the effects of communication are strongly

related to the degree of uncertainty and the positioning of participants in FX markets. Taken together, the results provide support for micro-based approaches to exchange rate modelling and are consistent with the argument that oral and actual interventions function through a coordination channel rather than a signalling channel.

One key question for Fratzscher (2008) is whether communication is successful in inducing a permanent, long-term effect on exchange rates. Still using the same data as in his 2006 research, Fratzscher (2008) employs an event study methodology based on four criteria - 'event', 'direction', 'reversal', and 'smoothing' - and nonparametric sign tests. The empirical findings for the success of interventions based on these criteria provide strong evidence for the medium- to long-term effectiveness of both oral interventions and actual interventions by G3 authorities since 1990. Then, Fratzscher (2008) attempts to gauge the channels through which these two types of interventions function. He tests hypotheses for the channels: if the portfolio balance channel is dominant, one would expect that oral interventions should have little or no effect on exchange rates; if the signalling channel is working, a close relationship between monetary policy and the effectiveness of interventions would be expected; if the coordination channel is relevant, interventions may be most effective in times of large market uncertainty or when exchange rates strongly deviate from fundamentals (Taylor, 2004).

In order to test the coordination channel, Fratzscher (2008) applies a formal test using odds ratios in a logit-model framework. The findings show that both oral and actual interventions are effective under large market uncertainty and when exchange rates deviate substantially from fundamentals. Fratzscher (2008) also finds that the success of communication and actual interventions is largely unrelated to monetary policy, thus suggesting that interventions function primarily through a coordination channel.

Using Dow Jones and Reuters press reports to identify oral interventions during 1989-2003 for the USD/DEM (the EUR/USD after 1999), and during 1991-2003 for the YEN/USD, Beine et al. (2009) assess how communication influences exchange rate levels and exchange rate volatility. They consider two types of communication: ex post communication includes all the official statements detected by market participants that are issued after direct interventions, while ex ante communication comprises statements issued at G7 meetings or potential future interventions issued by monetary authorities. The results indicate that oral intervention has effects on both exchange rate level and exchange rate volatility. Moreover, statements by monetary authorities on exchange rate policy can be a valuable complementary tool to actual exchange rate operations. The authors also conduct robustness checks for a range of factors: change in intervention regime, size of the intervention, the coordination channel, official statements as separate policy instruments, and the distinction between announced and unannounced interventions.

Sakata and Takeda (2013) attempt to complement Fratzscher's (2008) study, which examines only the effect of announcements made by main monetary authorities and does not exclude the possibility that other speakers may also influence the market. Using Reuters Japanese News, Sakata and Takeda (2013) collect statements by Japanese monetary authorities from 1 January 1995 to 31 May 2011. Then, following Fratzscher (2008), they regard oral intervention as an event, and define the success or failure of oral intervention by measuring whether it meets certain criteria. They use 'direction' as the criterion to analyse whether oral interventions can influence the exchange rate as the monetary authorities hope. In their study, Sakata and Takeda (2013) construct dummy variables based on 14 points (direction, specific rate, IA-announcement, suggestion, non-comment, watching, attitude, coordination, vice-minister, minister, MoF-member, BoJ, Japanese, International), and apply logit analysis to investigate what forms of oral intervention are most effective. Results from

this event study suggest that the market only responds to the statements made by main monetary authorities. In addition, Sakata and Takeda (2013) find that market participants give high credence to announcements that strike a decidedly positive or negative tone about the current exchange rate. Moreover, their results indicate that the effect of oral interventions depend on the speaker and the content; consequently, they provide policy implications.

Using Japanese data from April 1991 to September 2004, Bernal and Gnabo (2009) classify three types of intervention: actual intervention, oral intervention and confirmed intervention. Confirmed intervention is an actual intervention accompanied by an announcement either confirming its occurrence or clarifying its purpose. Bernal and Gnabo (2009) collect the oral and confirmed intervention information from the Factiva online database. They estimate an ordered probit model to test determinants of different types of interventions, and then use an event study approach to examine the effectiveness of the interventions. Their results indicate that the Japanese authorities tend to adopt stronger measures when the behaviour of the exchange rate becomes more unfavourable. This suggests that words and deeds are coordinated only in extreme cases. Overall, interventions are found to be moderately successful in correcting undesirable exchange rate developments, especially volatility of the exchange rate movements.

Fratzscher (2004) discusses three elements of foreign exchange interventions: exchange rate developments, monetary policy and the coordination of interventions. First, with regard to exchange rate developments, intervention focuses on arriving at a particular exchange rate level, decreasing deviations of the exchange rate from the desired level, or reducing volatility. Second, through the signalling channel, intervention seems closely associated with monetary policy. Third, in the international arena, monetary authorities have frequently coordinated their interventions across countries to increase the effectiveness on exchange rates (Bonser-Neal and Tanner, 1996; Beine et al., 2002). Fratzscher (2004)

conducts a logit analysis to test these three characteristics of Japanese actual and oral interventions. The results show that both actual and oral interventions follow a leaning-against-the-wind pattern, and are more frequent when exchange rate deviation and volatility are high. In addition, both actual and oral interventions are mostly consistent with and supportive of monetary policy changes. Furthermore, they are coordinated domestically and internationally.

The literature on China's intervention has not covered the oral type of intervention; nor has it used an event study approach. This paper aims to fill that critical void.

3. Foreign Exchange Interventions in China

Differing from the US, Japan and other mature economies, China operates foreign exchange intervention according to its own unique fashion. The Chinese monetary authorities intervene in the foreign exchange market secretly and the intervention takes a variety of forms. Specifically, quantity intervention takes place via purchase or sale of foreign currencies, price intervention is accomplished via setting the central parity rate for market trading and its allowed fluctuation band, while the authorities also engage in oral intervention through issuing government statements or other means of communication.

3.1.Forms of China's Intervention

Three forms of intervention used by China are as follows:

(1) The central bank (CB) intervenes by directly purchasing or selling foreign exchange in the marketplace. In the case of purchase intervention, the central bank trades foreign currencies with domestic notes; in selling intervention, it pours

foreign reserves into the market and so we term this type of intervention ‘quantity intervention’. As it involves the central bank participating in market transactions, it may be also called CB intervention,

(2) The central bank controls the level and growth of the RMB exchange rate by specifying the central parity rate (CPR) and the range around which the daily trading prices are allowed to fluctuate. We call this ‘price intervention’. It may also be termed as CPR intervention, since it involves the setting and adjustment of the central parity. Only rarely would the Chinese monetary authorities intervene through adjusting the interest rate or changing commercial banks’ required reserve rate.

(3) Intervention may also take place in the form of policy briefing, moral persuasion, formal and informal meetings, and telephone conversations. We call this oral intervention. It is straightforward for the Chinese central bank to effectuate this form of intervention by instructing or directing the attention of banks, especially the state-owned ones, which are dominant forces in the Chinese foreign exchange market, towards ‘things to note’.

In this paper, we choose to focus on the third type listed above, i.e. oral intervention, whereby in order to influence the RMB exchange rate against the dollar, the monetary authorities communicate with the foreign exchange market.

3.2.Measuring China’s Oral Intervention

In China’s foreign exchange market, oral intervention may be in the form of exchange rate communications by the domestic monetary authorities, but it may also have an

international dimension when the intervention takes place as a result of outside calls, such as appreciation pressure from American requests.

With regard to domestic communication, because the purpose of this paper is to measure the extent to which exchange rate communication could affect the foreign exchange market in the intended way, we choose to focus on statements by the relevant Chinese monetary authorities, including the PBOC, Ministry of Finance and State Administration of Foreign Exchange (SAFE), and exchange rate speeches by Chinese political and economic leaders such as China's President, Premier, and the PBOC governor. With regard to the exchange rate pressure coming from outside China, which is often calling for appreciation of the Chinese currency, we look at statements made during US-China presidential visits and Strategic and Economic Dialogue, and official statements on exchange rates by the US President, Secretary of the Treasury and senators.

To collect the data on domestic and foreign exchange rate communications we extract headline statements and speeches from the newswire service Reuters News, as this is the most likely source of information for market participants (Fratzscher, 2006 and 2008; Beine et al., 2009; Sakata and Takeda, 2013). Reuters US News is used for data on outside appreciation pressure, and Reuters Chinese News for information on domestic communication. In most cases, media reports from such sources are published within minutes of a policymaker's statement or speech, which allows us to conduct the empirical analysis using the data at daily frequency. For news about developments regarding China's foreign exchange market, we additionally use information from the official websites of the PBOC and SAFE.[1] Reports from these sources can be regarded as information released by the

[1] The People's Bank of China (PBOC) website is: http://www.pbc.gov.cn/, last accessed on 18 March 2015. The State Administration of Foreign Exchange (SAFE) website is: http://www.safe.gov.cn/, last accessed on 18 March 2015.

Chinese monetary authorities. On top of these, we use the newswire service of China.org.cn[2] as the official source of information from China's National People's Congress (NPC) and the Chinese People's Political Consultative Conference (CPPCC).

In seeking information about outside appreciation pressure we employ the following two search criteria: The first comprises the phrase 'exchange rate' or the name of the currency renminbi (RMB), or the Chinese yuan for the People's Republic of China, and the title or name of the US President, Treasury Secretary or senators. As shown in Table 1, during the sample period there was a change of US President, so we use both Bush and Obama as search terms, and there were four US Treasury Secretaries, so we use the names Snow, Paulson, Geithner and Lew in the search. Based on the first criterion, we discover indications of calls from the American side on the RMB exchange rate. The second criterion relates to the reports, news briefs or statements in relation to high level US-China bilateral meetings. This criterion comprises the name of the exchange rate, along with the name of the high level US-China bilateral meeting, such as presidential visits to and from the USA and the US-China Strategic and Economic Dialogue, which has taken place once every year since 2009.

Table 1

Names and periods of tenure for US presidents and treasury secretaries

US President		
Name:	George W. Bush	Barack Obama
Time:	Before 20/01/2009	After 21/01/2009

US Treasury Secretary				
Name:	John Snow	Henry Paulson	Timothy Geithner	Jack Lew
Time:	Before 30/06/2006	10/07/2006—20/01/2009	20/01/2009—25/01/2013	After 28/02/2013

[2] China.org.cn website is: http://www.china.org.cn/, last accessed on 18 March 2015.

For domestic communication, we choose Reuters Chinese News, the PBOC and SAFE websites, and China.org.cn as sources. As with Reuters US News, we use two search criteria for Reuters Chinese News. The first comprises the name of the Chinese exchange rate and the name of the Chinese President, Premier, or PBOC governor (see Table 2). The main purpose is to find speeches on the RMB exchange rate made by relevant authorities in China. The second criterion comprises the name of the exchange rate along with a phrase connoting a major economic or financial event in China, such as 'National Financial Work Conference', or 'Central Economic Work Conference', which issues statements about the Chinese exchange rate policy. Then, we use the PBOC and SAFE websites as sources for the China Monetary Policy Report and the Annual Report of the State Administration of Foreign Exchange, respectively. These documents report the evolution of China's exchange rate policy in a particular year and indicate official intentions for the future development of the policy. Finally, we use the newswire service China.org.cn to collect NPC and CPPCC statements relevant to the Chinese foreign exchange market.

Table 2

Names and periods of tenure for Chinese president, premier, and governor of the PBOC

	Chinese President		Premier		Governor of the PBOC
Name	Hu Jintao	Xi Jinping	Wen Jiabao	Li Keqiang	Zhou Xiaochuan
Tenure	Before 14/03/2013	After 14/03/2013	Before 15/03/2013	After 15/03/2013	22/07/2005-22/07/2013

Then, in order to provide a systematic classification of the meaning of statements and official speeches, we use the content analysis technique to extract relevant information (Holsti, 1969; Kassarjian, 1977). Given the high research interest in the extent to which communication of the views of domestic or US governments about the Chinese currency

would affect the RMB exchange rate, we have a classification of the media of the communication as follows:

$$IO_t = \begin{cases} 5 & US\ speech; \\ 4 & US-China\ meeting; \\ 3 & domestic\ meeting; \\ 2 & domestic\ speech; \\ 1 & domestic\ report. \end{cases} \quad (2)$$

where IO_t is the oral communication at time t. There are five channels through which oral intervention may take place. Domestic oral intervention occurs when a statement or speech is issued by the relevant authorities in China, usually at the PBOC or SAFE. Speeches by certain domestic officials, such as China's President, Premier or central bank governor, may also constitute intervention, since they are in a position to change the formulation of the Chinese exchange rate policy. Their speeches may send messages regarding their judgement on the current status of the RMB exchange rate or about possible changes they intend to make to the RMB exchange rate in the future. Domestic meeting intervention occurs when the content of meetings, such as those of the NPC or CPPCC, and the two central work conferences specified above, concerns the exchange rate. When statements issued during US-China presidential visits and Strategic and Economic Dialogue call for appreciation of the RMB exchange rate, this is defined as US-China meeting intervention. Finally, when the US speaks to China seeking appreciation of the yuan we term it US speech intervention as in some way and after some delay China may response to the call by changing the RMB exchange rate. While all US-China meetings and US speech interventions are concerned only with appreciating the RMB exchange rate, the other oral intervention types may have the tone of either appreciation or depreciation (± 1).

For example, according to media reports on 05/04/2006, before the US visit by the then Chinese President Hu Jintao, the then American Treasury Secretary John Snow claimed

that, while appreciation of the Chinese yuan could not be achieved immediately, the RMB should increase in that year. In another example, on 28/06/2010, President Obama expressed the hope that the Chinese yuan could appreciate more quickly. According to our classification, these two dates can be categorized as types 5 and 4 of oral intervention, respectively.

On 06/10/2006, the governor of the PBOC, Zhou Xiaochuan, indicated opposition to RMB appreciation, stating that it is essential to keep the RMB stable. Therefore, we mark that date as type 2 oral intervention. On 14/11/2006, the PBOC's Monetary Policy Report stated that the flexibility of the RMB exchange rate regime was increasing, and reform of the exchange rate regime was well underway. These developments would increase public anticipation that appreciation would be more likely to occur. Thus, we mark that date as type 1 of oral intervention.

One advantage of using the newswire service is that statements and official speeches are interpreted by experienced professionals. Because this paper intends to analyse the market reaction to communication that actually becomes available to market participants, we use Reuters News, a news provider with a good professional reputation for the quality of its services.

Table 3 shows the occurrence of the five types of oral intervention since 2005. There are some prominent features. Most importantly, we can identify distinct regimes of oral intervention over time. For instance, oral intervention happened less under the pegged exchange rate system: among the whole sample, the sub-period 2008/07/15-2010/06/22 saw the lowest number of oral interventions. This is because during that period central parity intervention was the main tool used by the central bank to influence the RMB exchange rate. With regard to domestic oral interventions and oral communications from the US, we find

that the largest numbers are for domestic and US speeches. This means that the main form of oral intervention is simply talking to the foreign exchange market.

Table 3

Number of exchange rate communications, 2005-2013

	Total	Domestic report	Domestic speech
2005/07/22-2013/07/22	362 (271&-91)	55 (37&-18)	138 (46&-92)
2005/07/22-2008/07/14	150 (117&-33)	20 (16&-4)	51 (14&-27)
2008/07/15-2010/06/22	84 (37&-47)	14 (3&-11)	37 (6&-31)
2010/06/23-2013/07/22	128 (88&-40)	21 (18&-3)	50 (16&-34)

	Domestic meeting	US-China meeting	US speech
2005/07/22-2013/07/22	18 (8&-10)	22	129
2005/07/22-2008/07/14	4 (2&-2)	17	58
2008/07/15-2010/06/22	5 (-5)	3	25
2010/06/23-2013/07/22	9 (6&-3)	2	46

Notes: Numbers in parentheses refer to the oral interventions for appreciation (with a positive sign +) and depreciation (with a negative sign -).

4. The Event Study Methodology

4.1.History of Event Study Methodology

Fama et al. (1969) were among the first to use the event study approach to finance research. Subsequently, Brow and Warner (1980 and 1985) elaborated the basics of the methodology (Binder, 1998). The approach starts with the identification of the event. Then, pre-event and post-event periods can be defined (Gnabo and Teiletche, 2009). Based on Fatum and Hutchinson (2006) and Morel and Teiletche (2008), the approach deployed in the

foreign exchange field uses Equation (2) below to test two null hypotheses regarding changes in the exchange rate returns in the pre- and post-event periods:

$$H_0^1: E\left(\Delta M_i^{post}\right) = 0$$

$$H_0^2: E\left(\Delta M_i^{post} - \Delta M_i^{pre}\right) = 0 \quad (3)$$

These two hypotheses were tested by Fatum and Hutchinson (2006) for exchange rate returns. ΔM_i^{post} and ΔM_i^{pre} are changes in the exchange rate movement of the pre- and post--event periods, respectively. The first null hypothesis (H_0^1) is used to test whether intervention events cause significant changes in exchange rate movements in the post-event period, and this corresponds to the direction test. The second null hypothesis (H_0^2) is used to determine whether pre-event changes in the exchange rate are significantly different from post-event changes, and it corresponds to the reversal test and smoothing test.

4.1.1. Event Studies in Advanced Countries

An event study framework is better suited to the study of sporadic and intense periods of official intervention than are standard time-series studies (Fatum and Hutchison, 2003). Fatum and Hutchison (2003) use the daily Bundesbank intervention and Fed intervention variables during the period from 1 September 1985 to 31 December 1995. Following Frankel (1994) and Humpage (1999), Fatum and Hutchison (2003) take the direction and smoothing criteria as the measure of success, and introduce a new criterion, 'reversal'. Using the nonparametric sign test and matched-sample test, they find strong evidence that sterilized intervention systemically affects the exchange rate in the short run. This means sterilized intervention may play a role in moving the exchange rate. The result is robust to changes in event window definitions over the short run and to controlling for central bank interest rate

changes during the event. However, because of the absence of more fundamental policy actions, their results should not be interpreted as a rationale for the longer-term management of exchange rates.

Payne and Vitale (2003) study the effects of Swiss National Bank (SNB) intervention operations using tick-by-tick transaction data between 1986 and 1995. The main contribution of their study is to extend the preliminary analysis of Fischer and Zurlinden (1999) by matching these data with indicative intra-day exchange rate quotes and newswire reports of central bank activity. Using an event study approach, Fischer and Zurlinden (1999) exactly quantified the effects of single intervention operations on the USD/CHF rate at a 15-minute sampling frequency. Their study focuses on the signalling hypothesis, which suggests that intervention operations are used by monetary authorities to convey information to FX markets and hence alter market expectations and exchange rates. Therefore, if central bank operations are informative, signed intervention should have a significant and permanent effect on the value of currencies. Fischer and Zurlinden's (1999) analysis suggests four important findings. First, SNB intervention operations have strong and persistent short-run effects on the USD/CHF. Second, SNB interventions are more effective in conditioning exchange rates when they are coordinated with other central banks. Third, interventions which are with-the-trend have stronger exchange rate impacts. Finally, the exchange rate can move in the direction of the intervention in the minutes before the actual intervention takes place.

Pierdzioch and Stadtmann (2003) use the event study methodology to analyse the effects of interventions conducted by the Swiss National Bank (SNB) during the period from 1986 through 1995. Like Fatum and Hutchison (2003), Pierdzioch and Stadtmann (2003) define the direction, smoothing and reversal criteria, and apply the nonparametric sign test and matched-sample test. They find some evidence that interventions by the SNB had an

impact on exchange rate dynamics. However, the significance of this effect depends on the direction of intervention. In general, evidence suggests that the SNB interventions to strengthen the Swiss franc were more effective than its interventions to weaken the Swiss franc. In addition, the results of the tests for the effects of the SNB interventions depend upon the length of the pre- and post-event windows analysed.

Using published official daily data on the Bank of Japan's intervention during the period from 1 April 1991 to 31 December 2000, Fatum and Hutchison (2006) apply an event study methodology to investigate the effects of intervention. They use the direction, smoothing and reversal criteria to examine the effects of the intervention episode, and employ two statistical tests: nonparametric sign test and matched-sample test. The nonparametric sign test verifies whether there is a change in direction or reversal of the exchange rate following an intervention event. The matched-sample test, which is identified with the smoothing criterion, verifies whether there is a significant shift in the exchange rate change between the pre- and the post-event periods. Pre- and post-event window lengths of 2, 5, 10 and 15 days are applied. According to the results of the nonparametric sign test and matched-sample test, Fatum and Hutchison (2006) find strong evidence that sterilized intervention systemically affects the exchange rate in the short run (less than one month). This result holds even when intervention is associated with (simultaneous) interest rate changes, whether or not intervention is 'secret', and against other robustness checks, such as controlling for endogeneity (when the central bank intervenes for multiple days during a single event).

Using an event study approach to test high-frequency (5-minute) euro-dollar exchange rates from 4 January 1999 to 17 May 2002, Jansen and Haan (2007) examine the effects of oral intervention. Focusing on direction, smoothing and volatility, they find that the effects of oral interventions are small and short-lived. Whether or not the verbal intervention is captured in the news report headline is the most important determinant of the effects. Oral

interventions which coincide with the release of macroeconomic data are less effective in changing the direction of the exchange rate, but do lead to lower exchange rate volatility. There is no difference between the effects of comments by European Central Bank Executive Board members and those of presidents of national central banks.

Fatum (2008) uses an event study methodology to analyse the effects of official, daily Bank of Canada intervention in the CAD/USD exchange rate over the 1995-1998 period. Like Fatum and Hutchison (2006), Fatum (2008) applies the nonparametric sign test and matched sample test to study the main dimensions of the effects, namely direction, smoothing, and volatility. He finds some evidence that during the period examined intervention was systematically associated with both a change in the direction and a smoothing of the exchange rate. This means that daily Bank of Canada intervention was effective for both the direction and smoothing criteria. However, the analysis does not find any significant effects of intervention in terms of reducing volatility of the CAD/USD exchange rate.

Fatum (2008) also takes into account the issue of currency co-movements. According to Eun and Lai (2004), the observed exchange rate movements might be driven by major currency factors. Therefore, Fatum (2008) uses the 'filtered' exchange rate to check for currency co-movements. The 'filtered' exchange rate is calculated as the difference between the % change in the 'raw' CAD/USD rate and an equally weighted average of the % change in the GBP/USD, DEM/USD and JPY/USD exchange rates. Fatum (2008) shows that the effects of intervention are weakened when the model is adjusted to capture the general currency co-movements against the USD.

Using Japanese data over 1992-2004 and an event study approach, Gnabo and Teiletche (2009) estimate the effect of different strategies on the USD/JPY exchange-rate risk-neutral density. Like Fratzscher (2004, 2006 and 2008), they find that communication

policy can play a significant role in the exchange rate policy. More generally, transparent policies (actual and oral interventions) have greater effect than do secret policies. The results indicate that the effects are achieved mainly through the coordination channel and the signalling channel. Moreover, the effect is greater when policies involve a financial cost (risk), suggesting that simple announcements can be considered as only an imperfect substitute for actual interventions.

4.1.2. Event Studies in Emerging Markets

Leon and Williams (2012) contribute to the literature on the effects of intervention by analysing a unique daily data set for the Dominican Republic, covering 1997-2005, thereby providing a case study for small developing and emerging markets. A matched-sample test shows that sterilized intervention by the central bank can produce its effects in the short term in terms of the direction and reversal of exchange rate movements. The authors also use alternative event window definitions and alternative criteria to check the robustness of their results on the intervention effects. Their paper finds that the Dominican Republic authorities were following a policy of 'leaning-against-the-wind', aimed at either smoothing the exchange rate or reversing the trend direction, and that they were successful in keeping the exchange rate within a 'target' corridor. Furthermore, the results reveal two objectives of intervention in the Dominican foreign exchange market, namely ensuring and maintaining export competitiveness. The findings suggest that the authorities intervened in part due to the 'fear of floating', in particular fear of strong appreciation that could conflict with their objective of ensuring competitiveness. In addition, the results imply that interventions can be used effectively in emerging market economies and developing countries to contribute towards maintaining export competitiveness, while containing imported inflation. These

findings constitute an interesting case study, which suggests that intervention can be an appropriate policy tool in some small open and emerging market economies.

There is great controversy as to which exchange rate model should be used or which channel should be considered when measuring the effects of exchange rate policy. Since most of the literature relies on structural models to address the identification problem, the validity of the results largely depends on how accurate the assumptions are in describing the full extent of the economy. Using an event study approach, Echavarria et al. (2013) compare the effects of different types of central bank intervention for the Colombian case during the period 2000-2012, without imposing restrictive parametric assumptions and without the need to adopt a structural model. Following Fatum and Hutchison (2003), they define four criteria to evaluate the effects of intervention: direction, reversal, smoothing, and matching. Echavarria et al. (2013) find that all types of intervention (international reserve accumulation options, volatility options and discretionary) have been successful according to the smoothing criterion, with volatility options having the strongest effect. Results are robust when using different window sizes and counterfactuals. Two counterfactual exercises are conducted. First, they consider the evolution of the Brazilian exchange rate in periods corresponding to pre- and post-Colombian volatility interventions. Second, they consider periods in which volatility options should have been conducted if the intervention rule was in place, but were not, because the board of the central bank decided to suspend interventions in that period.

4.2.An Event Study Methodology for This Paper

In this section, we begin by defining the length of the intervention event, or the 'event window'. This comprises the pre-event days (also known as the estimation window), the

event day or days, and the post-event days (MacKinlay, 1997). Thereafter, some measure of a successful event is established.

The reason for choosing the event study approach to analyse intervention is that communication tends to happen in clusters. In certain periods several interventions may occur within a few days, while on other days there are no interventions (MacKinlay, 1997). The most likely explanation for this lies in the fact that monetary authorities often continue to use sequent interventions until they achieve a certain objective or else realize the efforts are in vain.

In finance, many events, such as earnings announcements or issuance of new debt, may take place on a single day. However, it is problematic to define each single day on which exchange rate communication occurs as a separate event. The pre- and post-event windows allow us to compare exchange rate movements around the defined event. Since the central bank often intervenes on consecutive days, a one-day event definition would lead to other one-day events happening within the pre- and post-event windows around one-day events. Therefore, exchange rate movements around one-day events might be caused by other one-day events occurring during the pre- and post-event windows. This would make the event study useless. For example, in the period 18-24 May 2007, exchange rate communications between the PBOC governor and the US Treasury Secretary occurred on six consecutive days, all around the theme of appreciation of the Chinese yuan. These six days should naturally be viewed as a single event.

Another important issue is to define the length of the event window. On the one hand, the longer the event window is, the more interventions will be clustered. If the event period is set too long, then it may put together interventions that should belong to different intervention episodes. On the other hand, if the event period is set too short, then it may

separate into different events interventions that should belong to one intervention episode. Furthermore, too-short event periods may lead to a number of overlapping event windows.

Therefore, we define an event as a period of days with exchange rate communication tending in one direction, pushing for either appreciation or depreciation, and perhaps including a number of days without intervention. In addition, to select the appropriate length of event windows, we need to decide how many consecutive days of no intervention should be included.

Following Hutchison (2002), Fatum and Hutchison (2003), and Fratzscher (2012), we set the lengths of the pre- and post-event windows to be two, five, ten and fifteen days. This variety of event window length also means that the results can be employed in the robustness checks for different model specifications.

Following Fatum and Hutchison (2006), Fratzscher (2008), and Echavarria et al. (2013), we look at the dimensions of the effects of an intervention. Specifically, these dimensions involve intervention outcomes in relation to exchange rate changes (Δs) before ('pre'), after ('post') and during the event ('eve'); the average exchange rate change $\overline{(\Delta s)}$; and the event type or objective of the intervention event (I). We standardize exchange rate return by an estimated standard deviation for RMB exchange rate, as one solution to the heteroscedasticity is to standardize return (Ederington et al., 2015). Based on Jaffe (1974), Mandelker (1974) and Patell (1976), we calculate standardized returns as follows:

$$\Delta s_t = er_t/\sigma_t, \tag{4}$$

where er_t is RMB exchange rate return ($\log RMB_t - \log RMB_{t-1}$), and σ_t is an estimate of the standard deviation of the er_t.

To capture different directions of exchange rate movements, we set $I<0$ to indicate an attempt to strengthen the domestic currency and $I>0$ an attempt to weaken it. The 'event' type is used when investigating whether the direction of change to the RMB exchange rate is related to the interventions during the event; that is, whether or not an oral intervention leads to strengthening of the Chinese yuan:

$$(\Delta s^{eve} > 0, I > 0) \; or \; (\Delta s^{eve} < 0, I < 0) \tag{5}$$

Frankel (1994) argues that a suitable criterion to determine whether exchange rate movement is in the direction desired by the central bank is simply whether the direction of the movement is the same as the direction entailed in the central bank's intervention operation. For example, intervention carried out by selling the foreign currency should lead to a drop in its price. If the actual price of the foreign currency on the foreign exchange market declines, then one can say that the exchange rate movement is in the direction desired by the central bank. Therefore, in this paper, the 'direction' dimension is defined as positive if the exchange rate movement over the post-event window is in the desired direction, and negative otherwise:

$$(\Delta s^{post} > 0, I > 0) \; or \; (\Delta s^{post} < 0, I < 0) \tag{6}$$

The next dimension of the intervention effects, 'reversal', refers to whether the intervention succeeds in appreciating (depreciating) the currency after the event if the exchange rate had been depreciating (appreciating) before the event:

$$(\Delta s^{post} > 0, I > 0 \;\; if \; \Delta s^{pre} < 0) \; or \; (\Delta s^{post} < 0, I < 0 \;\; if \; \Delta s^{pre} > 0) \tag{7}$$

Although the fourth dimension, 'smoothing', also considers the pre-event period, it is less demanding. This concept investigates whether intervention has reduced or smoothed the strength of the pre-event exchange rate movements:

$(\Delta s^{post} > \Delta s^{pre}, I > 0 \ \ if\ \Delta s^{pre} < 0)$

$or\ (\Delta s^{post} < \Delta s^{pre}, I < 0 \ \ \ if\ \Delta s^{pre} > 0)$ (8)

Overall, testing of the reversal dimension is the most demanding of the four tests. This is because the direction test does not consider the pre-event period, and the smoothing test does not require the exchange rate to appreciate after intervention by the central bank.

It is natural to begin by considering the application of parametric tests to check the effect of oral intervention. However, parametric tests are valid only if the variable's distribution is normal. It is known that distribution of the daily changes of the exchange rate departs from the normal distribution. Results of formal statistical analysis of the intervention variable are presented in Table 4. From the table, we can see that the exchange rate change variable fails to pass the JB normality test. In addition, the skewness is greater than 0 and the kurtosis is far away from 3. This evidence all points to the eventuality that the distribution of daily changes of exchange rate is not normal. In this case, parametric tests are not appropriate. However, we still use parametric tests, together with nonparametric tests. We can then compare the results of the two types of test.

Table 4

Descriptive statistics for exchange rate changes

	Obs.	Mean	Std.Dev.	Skewness	Kurtosis	Jarque-Bera
Oral intervention	2087	-0.001	0.007	-0.131	7.813	2020.421 **[0.000]*** **

Notes: ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

We then choose the nonparametric test for our model, which does not require the distribution to be normal. Table 5 gives the details of parametric and nonparametric tests. We

use two statistical tests, the sign test and the rank test, in our nonparametric estimation. The reason for using the sign test is that, unlike the Wilcoxon test, it does not assume a symmetric distribution. In addition, Mood's Median test focuses on testing whether the medians of two or more groups differ, while the Mann-Whitney test and Friedman test need two samples. The nonparametric sign test is used to test whether or not two groups are equally sized. Also called the binominal test, the sign test is based on the plus and minus sign of the observation. The null hypothesis is that two populations are equal or are equal in their central tendency. In our model, we employ the nonparametric sign test to investigate whether there is no difference between the exchange rate movements before and following the intervention events in terms of the event and direction. Following the generalized sign test (Brown and Warner, 1980, 1985), our null hypothesis is that the number of positive values ('success') (n_+) is the same as the number of negative values ('non-success') ($n\_$). If the hypothesis is correct, the probability of successful events is the same as that of non-successful events. A sign test based on a binomial distribution checks whether the probability of a 'successful event' (p) is greater than 0.5 ($n_+ \sim binomial(n, p = 0.5)$), where n is the total number of events.

Table 5

Description of Nonparametric and Parametric Tests

Nonparametric tests	Alternative parametric tests
Sign test	1-sample Z-test, 1-sample t-test
Wilcoxon test	1-sample Z-test, 1-sample t-test
Mann-Whitney test	2-sample t-test
Rank test	One-way ANOVA
Mood's Median test	One-way ANOVA
Friedman test	Two-way ANOVA

Notes: ANOVA stands for analysis of variance, which can be employed to analyse the differences among group means.

The sign test is a relatively weak test, since it tests the pair value below or above the median only, but does not measure the pair difference. There is another nonparametric test, known as the rank test. Based on the Wilcoxon rank test and developed by Corrado (1989) and Corrado and Zivney (1992), the rank text, like the sign test, does not require distribution symmetry (Dutta, 2014). The null hypothesis of this test is that the rank of exchange rate changes is equal to the mean of total observations ('success'). Under the null hypothesis, the rank of exchange rate changes is uniform distribution (Corrado, 1989). We use the rank test to check the effects of intervention in terms of exchange rate reversal and smoothing. The rank test statistic is given by:

$$R = \frac{K_t - \overline{K}}{S(K)} \tag{9}$$

where K_i is the rank of exchange rate changes; $\overline{K}$ is the average rank ($\overline{K} = \frac{T+1}{2}$, T is the number of observations); $S(K)$ is the standard deviation, and is calculated as:

$$S(K) = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(K_t - \overline{K})^2} \tag{10}$$

This statistic is distributed asymptotically as unit normal.

5. Results of the Event Study

5.1.Results from Parametric Tests

In this section, we evaluate whether China's interventions are successful based on the criteria given above. Table 6 displays the numbers of China's exchange rate communication events. Table 7 reports the results for the success of exchange rate communication in the whole sample period. In each table the columns from left to right show the different event window lengths: 2, 5, 10 and 15 days. The rows display the total number of communications, the

number of successful communications (as a percentage), and the probability value for the four criteria. To study the first two criteria, event and direction, we use sign test based on a binomial distribution; the hypothesis is that the number of successful events is the same as the number of non-successful events. The remaining criteria are tested by the rank test; here, the hypothesis is that the rank of exchange rate changes is equal to the mean of total observations.

Table 6

Number of exchange rate communication events

	2^a	5^b	10^c	15^d
Total Comm. Num.	270	187	120	85
$IO_t = 1$	100	76	57	44
$IO_t = -1$	170	111	63	41

Notes: a. pre- and post-event window length is 2 days;

b. pre- and post-event window length is 5 days;

c. pre- and post-event window length is 10 days;

d. pre- and post-event window length is 15 days.

As can be seen from Table 6, for the 2-day pre- and post-event windows the number of appreciating communications ($IO_t = -1$) is larger than that of depreciating communications ($IO_t = 1$), accounting for 63% of the total. However, the difference between the numbers of appreciating and depreciating communications decreases from the 2-day event window to the 15-day event window, where the numbers of the two types become almost equal. In order to avoid overlapping communication days, the longer the event window length is, the more communication days are included. For example, in the 15-day event window, we put 12 communication days into one event, which runs from 12/04/2007 to 21/06/2007. According to the trend of difference between the numbers of appreciating and depreciating events, we find that appreciating communication is more compact. In other

words, the authorities, especially the US President and Treasury Secretary, try to appreciate the RMB exchange rate with greater pressure.

Table 7

Results of one-sample t tests for event and direction and ANOVA tests for reversal and smoothing

Event Window Length			2	5	10	15
Total Num.	$IO_t = 1$		100	76	57	44
	$IO_t = -1$		170	111	63	41
Event	$IO_t = 1$	Success %(Num.)	46%(46)	50%(38)	81%(26)	34%(15)
		ρ-Value	0.387	0.117	0.389	0.326
	$IO_t = -1$	Success %(Num.)	52%(88)	52%(58)	60%(38)	71%(29)
		ρ-Value	0.234	0.318	0.320	0.147
Direction	$IO_t = 1$	Success %(Num.)	45%(45)	37%(28)	28%(16)	34%(15)
		ρ-Value	0.833	0.423	**0.000*** **	**0.006*** **
	$IO_t = -1$	Success %(Num.)	49%(83)	55%(61)	75%(47)	78%(32)
		ρ-Value	0.323	**0.001*** **	**0.000*** **	**0.000*** **
Reversal	$IO_t = 1$	Success %(Num.)	29%(29)	37%(16)	25%(14)	20%(9)
		ρ-Value	0.988	0.249	**0.000*** **	0.436
	$IO_t = -1$	Success %(Num.)	19%(32)	16%(18)	16%(10)	15%(6)
		ρ-Value	0.902	**0.000*** **	**0.000*** **	**0.000*** **
Smoothing	$IO_t = 1$	Success %(Num.)	45%(45)	45%(34)	56%(32)	43%(19)
		ρ-Value	0.987	**0.009*** **	**0.000*** **	**0.006*** **
	$IO_t = -1$	Success %(Num.)	30%(51)	27%(30)	17%(11)	20%(8)
		ρ-Value	0.323	**0.001*** **	**0.000*** **	**0.000*** **

Notes: $IO_t = 1$ stands for oral intervention for appreciation, and $IO_t = -1$ is oral intervention for depreciation. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

From Table 7, we find that interventions have no effects according to the event criterion, because there are no significant ρ-values for this criterion. Another finding is that the intervention is more effective in the long term than in the short term. The significances in 10-day and 15-day event window lengths are greater than that in 2- and 5-day event window lengths. Late, we will also use nonparametric tests to collaborate our finding.

5.2.Results from Nonparametric Tests

Table 8

Results of sign tests for event and direction and rank tests for reversal and smoothing

Event Window Length			2	5	10	15
Total Num.	$IO_t = 1$		100	76	57	44
	$IO_t = -1$		170	111	63	41
Event	$IO_t = 1$	Success %(Num.)	46%(46)	50%(38)	81%(26)	34%(15)
		ρ-Value	0.484	0.188	0.596	**0.050****
	$IO_t = -1$	Success %(Num.)	52%(88)	52%(58)	60%(38)	71%(29)
		ρ-Value	0.701	0.704	0.131	**0.012****
Direction	$IO_t = 1$	Success %(Num.)	45%(45)	37%(28)	28%(16)	34%(15)
		ρ-Value	0.368	**0.029****	**0.001*****	**0.050****
	$IO_t = -1$	Success %(Num.)	49%(83)	55%(61)	75%(47)	78%(32)
		ρ-Value	0.818	0.343	**0.000*****	**0.001*****
Reversal	$IO_t = 1$	Success %(Num.)	29%(29)	37%(16)	25%(14)	20%(9)
		ρ-Value	**0.001*****	**0.001*****	**0.000*****	**0.002*****
	$IO_t = -1$	Success %(Num.)	19%(32)	16%(18)	16%(10)	15%(6)
		ρ-Value	**0.007*****	**0.000*****	**0.000*****	**0.000*****
Smoothing	$IO_t = 1$	Success %(Num.)	45%(45)	45%(34)	56%(32)	43%(19)
		ρ-Value	0.160	**0.005*****	**0.001*****	**0.012****
	$IO_t = -1$	Success %(Num.)	30%(51)	27%(30)	17%(11)	20%(8)
		ρ-Value	0.424	0.211	**0.000*****	**0.000*****

Notes: $IO_t = 1$ stands for oral intervention for appreciation, and $IO_t = -1$ is oral intervention for depreciation. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 8 shows the results from the sign tests based on the event and direction of exchange rate movements, and results from the rank test based on the reversal and smoothing criteria for successfulness of an event. From these results, we can find that: 1) the exchange rate communication events have no effect according to the event criterion; 2) all event window lengths are significant in terms of the reversal effect; 3) the longer the event window length is, the more significant the oral intervention effects. Compared with the results from parametric tests, we find that nonparametric tests have more significant ρ-values.

For the event dimension, both appreciating and depreciating communications have no effects. The only significant communication effects are at the 15-day event window length. This means that China's exchange rate communication cannot impact the exchange rate movement during the event. This finding is the same as that from the parametric tests. Another notable phenomenon is that, in terms of the direction and smoothing dimensions, oral intervention events are significant at the 5% and 1% levels only at the 10- and 15-day event window lengths. This means that the communication intervention has a property of leaning-against-the-wind, and the strength of pre-event exchange rate movements tends to diminish two weeks after the oral intervention. Reversal is the only dimension for which the communication events are significant at all event window lengths. In other words, if the exchange rate was depreciating before the event, oral intervention can be effective in appreciating the RMB after the event; alternatively, if the currency was appreciating before the event, the intervention can be effective in depreciating the RMB.

Based on the difference between the results at different event window lengths, we can see that the effects of oral intervention via exchange rate communication are more obvious in the longer term than in the short term. Communications have more significance in the 10- and 15-day event window lengths, and especially in the latter. This suggests that, in the Chinese context, oral intervention via exchange rate communication would have greater effect on the RMB exchange rate after two weeks. This finding further confirms the robustness of the parametric test results.

Table 9

Robust tests

Event Window Length			2	5	10	15
Total Num.	$IO_t = 1$		100	76	57	44
	$IO_t = -1$		170	111	63	41
Event	$IO_t = 1$	Wilcoxon signed rank test	0.622	0.758	0.471	**0.000*** **
	$IO_t = -1$	Wilcoxon signed rank test	0.173	0.230	0.191	**0.032** **
Direction	$IO_t = 1$	Wilcoxon signed rank test	0.160	**0.005*** **	**0.001*** **	**0.012** **
	$IO_t = -1$	Wilcoxon signed rank test	0.422	**0.004*** **	**0.000*** **	**0.000*** **
Reversal	$IO_t = 1$	Cochran's Q test	**0.029** **	**0.016** **	**0.000*** **	**0.006*** **
		Skillings-Mack test	**0.005*** **	**0.001*** **	**0.000*** **	**0.003*** **
		Kruskal-Wallis test	**0.000*** **	**0.001*** **	**0.000*** **	**0.000*** **
	$IO_t = -1$	Cochran's Q test	**0.016** **	**0.001*** **	**0.000*** **	**0.000*** **
		Skillings-Mack test	**0.050** **	**0.000*** **	**0.000*** **	**0.000*** **
		Kruskal-Wallis test	**0.012** **	**0.000*** **	**0.000*** **	**0.000*** **
Smoothing	$IO_t = 1$	Cochran's Q test	**0.088***	**0.025** **	**0.001*** **	0.131
		Skillings-Mack test	0.317	**0.028** **	**0.001*** **	**0.035** **
		Kruskal-Wallis test	0.150	0.150	**0.018** **	**0.050** **
	$IO_t = -1$	Cochran's Q test	0.180	**0.001*** **	**0.003*** **	**0.004*** **
		Skillings-Mack test	0.635	0.178	**0.000*** **	**0.000*** **
		Kruskal-Wallis test	0.992	**0.014** **	**0.021** **	**0.030** **

Notes: $IO_t = 1$ stands for oral intervention for appreciation, and $IO_t = -1$ is oral intervention for depreciation. Figures displayed in the table are ρ values for the relevant tests. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 9 reports the results of robustness testing, using non-parametric statistical hypothesis tests including the Wilcoxon signed rank test for the event and direction criteria, the Cochran's Q test, the Skillings-Mack test, and the Kruskal-Wallis test for the reversal and smoothing criteria. The outcome of the Wilcoxon signed rank test exhibits a similar patter as that of the sign test. The test results generally accept the null and reject the alternative suggesting that intervention through communication is not efficacious in the event criterion. Only at the longer event window length (15 days) the null is rejected, indicating communication intervention would only be effective after some longer delay. In the direction criterion, oral intervention is again effective only after longer lags. These results are consistent with the sign test outcome, and hence indicate robustness of the results from the sign test.

For the robustness of the rank test that checks the effects of intervention in terms of reversal and smoothing criteria, results of the Cochran's Q test, Skillings-Mack test, Kruskal-Wallis are generally significant. The significance of the smoothing dimension confirms that China takes a leaning-against-the-wind strategy of intervention. Consistent with the rank test, reversal criterion proves significant at all event window lengths. This outcome suggests that if the RMB exchange rate was depreciating before the event, oral intervention can effectively change it to appreciating after the event; and vice versa. Again, these results confirm that the results of the rank test are maintained in additional nonparametric tests.

5.3.Specific Results for Domestic and External Communications

Oral intervention in the RMB exchange rate has two sources: domestic and external. The US authorities have for a long time tried to pressurise China to appreciate the RMB exchange rate. Here, we examine to what extent exchange rate communications initiated by the US may influence the RMB exchange rate. In particular, the US Treasury is required by Congress to submit a half-yearly examination report on China's currency issues. If China were found to be manipulating the RMB exchange rate, US law requires that the US government must impose punitive tariffs on imports from China. In order to avoid this punitive action, the Chinese government seems responsive to the oral intervention via such reports and would, in most cases, appreciate the exchange rate secretly.

Table 10

Parametric and nonparametric tests for domestic and external communications

Type			Domestic		External	
Event Window Length			2	15	2	15
Total Num.	$IO_t = 1$		100	44	0	0
	$IO_t = -1$		78	48	119	41
Event	$IO_t = 1$	Success %(Num.)	46%(46)	34%(15)		
		Parametric test	0.706	0.868		
		Nonparametric test	0.484	**0.050****		
	$IO_t = -1$	Success %(Num.)	46%(36)	56%(27)	55%(65)	71%(29)
		Parametric test	0.669	0.914	**0.012****	**0.010*****
		Nonparametric test	0.571	0.470	0.359	**0.012*****
Direction	$IO_t = 1$	Success %(Num.)	45%(45)	34%(15)		
		Parametric test	**0.031****	**0.013****		
		Nonparametric test	0.368	**0.050****		
	$IO_t = -1$	Success %(Num.)	51%(40)	77%(37)	47%(56)	73%(30)
		Parametric test	**0.091***	**0.000*****	0.160	**0.001*****
		Nonparametric test	0.910	**0.000*****	0.582	**0.005*****
Reversal	$IO_t = 1$	Success %(Num.)	29%(29)	20%(9)		
		Parametric test	**0.000*****	**0.000*****		
		Nonparametric test	**0.005*****	**0.001*****		
	$IO_t = -1$	Success %(Num.)	21%(16)	15%(7)	18%(21)	10%(4)
		Parametric test	**0.004*****	**0.000*****	**0.005*****	**0.000*****
		Nonparametric test	**0.017****	**0.000*****	**0.017****	**0.000*****
Smoothing	$IO_t = 1$	Success %(Num.)	45%(45)	43%(19)		
		Parametric test	**0.031****	**0.013****		
		Nonparametric test	0.317	**0.035****		
	$IO_t = -1$	Success %(Num.)	33%(26)	15%(7)	29%(34)	15%(6)
		Parametric test	**0.091***	**0.000*****	0.160	**0.001*****
		Nonparametric test	0.821	**0.000*****	0.774	**0.003*****

Notes: $IO_t = 1$ stands for oral intervention for appreciation, and $IO_t = -1$ is oral intervention for depreciation. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Relevant tests are performed to check the robustness of the nonparametric analysis. The robustness testing includes the Wilcoxon signed rank test, Cochran's Q test, Skillings-Mack test and Kruskal-Wallis test. The outcome is consistent with the sign and rank tests confirming that appreciation calls from the US can impact the RMB exchange rate movements, as the Chinese government is responsive to pressure from the US. Robustness testing results are available upon request.

Table 10 displays the results of parametric and nonparametric tests for domestic and external communications. For both tests, there are more significant results for all dimensions of intervention effects in the 15-day event window length. This proves the robustness of the finding that exchange rate communication has more effect on exchange rate movements after two weeks. Reversal is the only dimension of the intervention effects for which the communication events are significant at all event window lengths. Based on the results in Table 10, the appreciation exchange rate communication from the US can influence the RMB exchange rate movements, as the table shows that communication events are significant. The Chinese government is responsive to oral pressure from the US, and would initiate the RMB appreciation after some delay, perhaps about two weeks.

5.4.Volatility Analysis

Government intervention usually has two main objectives: to change the level of the exchange rate in a certain direction and to calm excessive volatility (Sarno and Taylor, 2001; Utsunomiya, 2013). Previous sections in this paper are mainly concerned with the first objective, i.e. changing the level of the exchange rate. Next, we examine the effects of oral intervention on the volatility of China's currency. For this purpose, it is pertinent to use open, close, high and low daily exchange rates from 2005 to 2013. The data are obtained from Bloomberg and the event window lengths are set to be 2 days and 15 days. We investigate the volatility in 207 pre-event and post-event periods for the 2-day event window length, and in 28 periods for the 15-day event window length. In other words, we calculate the range-based variance of the USD/RMB exchange rate during the 48 hours (2-day windows) or 360 hours (15-day windows) before and after each event, respectively. The formula (Garman and Klass, 1980) to calculate the range-based variance of the USD/RMB exchange rate is shown below:

$$\sigma_{rb}^2 = 0.5[\ln(\frac{H_t}{L_t})]^2 - [2\ln(2) - 1][\ln(\frac{C_t}{O_t})]^2. \quad (11)$$

where σ_{rb}^2 is the range-based variance of the exchange rate; H_t is the highest price of the t^{th} trading day; L_t is the lowest price of the t^{th} trading day; C_t is the closing price of the t^{th} trading day; O_t is the opening price of the t^{th} trading day.

For the event window length at 15 days, 14 events have lower post-event volatility, while for the 2-day event window length, 121 events have lower post-event volatility. We use the Kruskal-Wallis test to study whether the oral intervention can reduce volatility. The null hypothesis of the Kruskal-Wallis test is that the mean ranks of the two groups are the same. In our study, the null hypothesis is that pre-event volatility is the same as post-event volatility. The ranks are always whole numbers from 1 to N. We check the variation ranks among the groups:

$$SST = SSG\ for\ the\ ranks \quad (12)$$

where SST is the total variation and SSG is the variation among the groups. The test statistic is given by:

$$H = \frac{12}{N(N+1)}\sum\frac{RA^2}{n_i} - 3(N+1), \quad (13)$$

where N is the total number of observations, n_i is the number of observations in group i, and RA is the rank of observation. Table 11 shows the results of difference of volatilities between the pre- and post-event periods at 2- and 15-day event window lengths. Based on the results in Table 11, we do not find evidence of a link between oral intervention and volatility reduction, as no variables are significant in the test outcome.

Table 11

USD/RMB exchange rate volatility during pre- and post-event windows

Event Window Length		2	15
Total Num.		207	28
Event	Success %(Num.)	58%(121)	50%(14)
	ρ-Value	0.978	0.935

While we find no link between oral intervention events and exchange rate volatility, it should be noted that this result might be influenced by certain factors. The exchange rate communication data used in this paper are available only at daily frequency: we cannot know the exact time within the day when the communication happened, nor the length of communication time. In other words, the pre-event volatility window may end before the first day of the communication event; the communication event may take place over successive days; or, the post-event volatility window may start after the event has ended.

Then, we test whether successive oral interventions can reduce volatility. Table 12 shows the result for reducing volatility when two or more successive oral interventions happen. Based on Table 12, we find evidence that successive oral interventions could reduce volatility. Therefore, the central bank tries to calm excessive volatility by successive oral interventions.

Table 12

Effects of successive interventions on volatility

	Two or more successive oral interventions
Total Num.	48
Success %(Num.)	58%(28)
ρ-Value	**0.020****

Notes: ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

6. Conclusions

This research evaluates China's exchange rate communication and its efficacy on the level and volatility of the RMB exchange rate. Daily data are employed to investigate the oral intervention effects during the sample period from 22 July 2005, when the most recent reform was launched to sever the rigid link between the RMB and the USD and allow the RMB to move within a certain band, to 22 July 2013, when the most recent data are available to this research. An event study approach is employed in this paper. In the empirical examination, we postulate that the effects of an intervention event can have four dimensions, namely event, direction, reversal, and smoothing.

Given the property of the distribution of our datasets, this research uses parametric and nonparametric tests for the four dimensions of the oral intervention effects. The two samples for tests are constructed at the pre- and post-event window lengths of two, five, ten and fifteen days. In general, the results show that oral intervention can have effects on the level of the Chinese exchange rate. While the outcome shows no significant effects in the event dimension, all event window lengths are significant in terms of the reversal effect. Finally, the effect may vary with the event window length. Compared with the 2- and 5-day event window lengths, communications have more significant effects at the 10-day, and particularly the 15-day event window lengths, suggesting that in the Chinese context the most significant intervention effects would occur about two weeks after the exchange rate communication. We also find that nonparametric tests have more significant effects than parametric tests.

Effects of the international aspects of China's exchange rate communication provide further insights on China's exchange rate intervention. Evidence of China's response to calls from the US authorities for changes of China's exchange rate policy, especially for exchange

rate appreciation confirms that the Chinese government is generally responsive to US pressure for RMB appreciation. But the response is moderately reluctant as it would quietly appreciate the exchange rate after a delay of around two weeks.

This paper also sheds light on another objective of China's intervention: calming excess volatility. We use a range-based variance model to calculate the variance. The Kruskal-Wallis test is used to study whether or not exchange rate communication can reduce volatility. We find that, regardless of the event window length, there is no evidence of a link between isolated oral intervention and volatility reduction. However, the results show that successive oral intervention can reduce volatility.

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