

Interlinkages in Asia-Pacific Non-Deliverable Forward (NDF) Markets (A Comparison between Pre and Post Currency Futures Era)

Saravanan A^{1*} and Velmurugan PS²

¹Department of Commerce, School of Management, Pondicherry University, Puducherry, India

²Fulbright Postdoctoral Fellow (USA), Department of Commerce, School of Management, Pondicherry University, Puducherry, India

Abstract

This paper examines the inter-linkages in Asia Pacific, currency market before and after the introduction of currency futures in India using simple correlation and Granger causality tests. It is found that inter-linkages among Asia-Pacific markets have increased after the emergence of currency future, and Asia-Pacific NDF markets are closely linked with one another. Further, Indonesian market does not seem to have any influence on the other Asia-Pacific markets except India and similarly is not much affected by any market other than the China, India and Philippines. Vietnam market seems to be isolated from the region. Indonesia market appears to dominate other markets in the region and its effect on them is even greater than that of China. All eight Asia-Pacific markets affect one another and their effects are transmitted within three days in most of the cases.

Keywords: Non-deliverable forward; Asia-Pacific market; Exchange rate; Granger causality test

Introduction

These are inspiring times for the foreign exchange markets of emerging economies as they become growing flexible and market oriented and enhance their presence in the global financial system. According to the Bank of International Settlement (BIS) Triennial Central Bank Survey of Foreign exchange and Derivatives Market Activity, December 2007, the turnover of emerging market currencies grew much faster than aggregate turnover in the foreign exchange market. However, many emerging economies enforce restrictions on the trading of their currencies by foreign entities in the onshore forward markets. These restrictions have generally been designed to limit short-term capital flows not related to trade and direct investment and to discourage foreign market participants from holding short or long positions of a size that might exert pressure on the spot exchange rate. Most countries only permit hedging for transactions relating to trade and foreign direct investment. Also, non-residents are not allowed to borrow or fund themselves in the onshore market, except for obviously trade-related uses. Finally, some countries also control the counterparties with which foreign market participants can contact in the onshore currency market [1]. In short, these controls imply foreign exchange convertibility restrictions.

With such restrictions enforced by domestic financial regulators, the onshore forward market for non-domestic players, private companies and investors investing in these economies is non-existent leading to the felt need of these entities for alternative avenues to hedge their exposure to such currencies. This has led to the creation of non-deliverable forwards (NDF) as popular derivative tool catering to the offshore investors' demand for hedging [2].

The global financial system is witnessing an active, huge and growing NDF markets in most emerging economies' currencies, mainly Chinese Yuan, Indonesian Rupiah, Malaysian Ringgit, Korean Won, Philippine Peso, and Indian Rupee. The growing market for NDFs in emerging-market currencies is an example of financial innovation to meet the needs of market participants. These markets provide private companies and investors a method of hedging their exchange rate exposures in situations where local governments impose constraints on nonresident access to on-shore money markets [2].

Non-deliverable forward

An NDF is like a regular forward foreign exchange contract, except

at maturity the NDF does not require physical delivery of currencies, and is typically settled in an international financial center in U.S. dollars. A forward foreign exchange contract is an compulsion to purchase or sell a specific currency on a future date (settlement date) for a fixed price set on the date of the contract (trade date). For an NDF contract at maturity, settlement is made in U.S. dollars the other currency, usually an emerging market currency with capital controls is "non-deliverable".

The Non-deliverable forward markets help trade in foreign exchange forwards, mainly outside the borders of the currency's home judiciary ("offshore"). This allows investors to circumvent restrictions on trading in the home market ("onshore") and limits on delivery of the home currency offshore. The non-deliverable forward (NDF) is an outright forward contract in which, upon maturity, counterparties settle the difference between the NDF exchange rate and the current spot rate on an agreed notional amount via a cash payment. It is similar to other cash-settled forward contracts in markets such as commodities [3].

NDFs are foreign exchange derivative products traded over the counter (OTC). Different from deliverable exchange rate forwards, they trade outside the direct jurisdiction of the authorities of the corresponding currencies. NDFs usually exist because trading in some emerging market currencies is subject to limits and capital controls. NDFs can thus be used to hedge or construct an exposure to emerging market currencies. In addition, NDFs are a comfortable and effective tool used by international investors to gain exposure to a particular emerging market without the required to invest in onshore market [3].

Major centers of NDFs are operating in New York, Singapore, Tokyo, Hong Kong, London, Seoul and Taipei. London is the most important market for NDFs on Eastern European and Asian currencies.

***Corresponding author:** Saravanan A, Research Scholar, Department of Commerce, School of Management, Pondicherry University, Puducherry, India, Tel: 0413-2655179; E-mail: saravanan14mcom@gmail.com

Received November 12, 2014; Accepted February 25, 2015; Published March 04, 2015

Citation: Saravanan A, Velmurugan PS (2015) Interlinkages in Asia-Pacific Non-Deliverable Forward (NDF) Markets (A Comparison between Pre and Post Currency Futures Era). J Stock Forex Trad 4: 143. doi:10.4172/2168-9458.1000143

Copyright: © 2015 Saravanan A, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Though the majority of the trading volume is on foreign currency to US dollar pairs [3]. The NDF market participants include direct and portfolio investors wishing to hedge currency risk and speculators [4]. Banks and firms with onshore and offshore operations arbitrage, and thereby reduce, differences in forward rates. In recent years the growing importance of non-resident investors in local currency bond markets has increased the salience of NDF markets, particularly in times of strain [5].

Currency derivatives in India

Until 1973, the Indian rupee followed a fixed exchange rate regime wherein the rupee was pegged to the pound sterling. With the breakdown of the Bretton Woods system in the early 1970s, India changed to a system of managed exchange rates. During this period, the nominal exchange rate was the operating variable to achieve the intermediate target of a medium-term equilibrium path of the real effective exchange rate. In early 1990s, India was faced with a serious balance of payment crisis due to the huge rise in oil prices, the suspension of payments from the Gulf region and some other external developments. Amongst the many methods taken to overcome the crisis, was a devaluation of the rupee in July 1991 to retain the competitiveness of Indian exports. This initiated the move towards greater exchange rate flexibility. A liberalized exchange rate management system was put in place in March 1992 along with other measures to liberalize trade, industry and foreign investment [6].

The gradual liberalization of Indian economy has resulted in significant inflow of foreign capital into India. At the same time dismantling of trade obstacles has also facilitated the integration of domestic economy with world economy. With the globalization of trade and relatively free movement of financial assets, risk management through derivatives products has become a necessity in India also, like in other developed and developing countries. As Indian businesses turn into more global in their approach, evolution of a broad based, active and liquid foreign exchange derivatives markets was required to provide them with a spectrum of hedging products for effectively managing their foreign exchange exposures.

With successful implementation of derivative products in Indian stock market, RBI and SEBI jointly constituted a standing technical committee to analyze the currency market around the world and lay down the guidelines to introduce Exchange Traded Currency Futures in the Indian market. The committee submitted its report on May 29, 2008. Further RBI and SEBI issued circulars in this regard on August 06, 2008. Initially they started trade with USD only. In 2010 they enhanced to EURO, YEN and POUND. Currently, Indian Currency market trades with all the major currencies like USD, EUR, JPY and GBP.

The paper is organized in five sections (including introduction). Section 2 deals with a review of literature, Section 3 deals with data and methodological framework. Empirical analysis of data and summary and conclusion are in Sections 4 and 5 respectively.

Review of Literature

Anuradha Guru [2] tested the linkages between spot, domestic forward and NDF markets for INR/USD using Granger causality tests, co-integration tests and ARCH-GARCH models, over the period January, 2007 to April, 2009. They found that NDF markets are now exerting increased influence on the domestic currency markets through spillover effects and better information content.

Bekiros [7] examined the spillovers of the US subprime crisis

to Asian and European economies and in particular to what extent currency and stock markets have been affected by the crisis. Linear and nonlinear dependencies are detected after pairwise and system-wise causality analysis. A new stepwise multivariate filtering approach is implemented after controlling for conditional heteroskedasticity in the raw data and in VAR/VECM residuals using multivariate GARCH models. Significant nonlinear causal linkages persisted even after the application of GARCH-BEKK, CCC-GARCH and DCC-GARCH modeling. Their result indicated that volatility effects might partly induce nonlinear causality.

Dikas [8] investigated the linear and non-linear causal linkage in exchanges, equity and derivative markets. Specifically, in case of exchange market, among six currencies denoted relative to United State Dollar (USD), namely EUR, GBP, JPY, CHF, AUD, CAD. For the two periods before and after the structural break of the Asian financial crisis, they applied nonparametric test for Granger non-causality as well as the conventional linear Granger test on the return time series after controlling for co-integration and traditional pair-wise analysis. Their result indicated that spot and future returns may exhibit asymmetries and statistically significant higher order moments. Also, the result implied that if nonlinear effects are accounted for, neither market leads or lags the other consistently.

Kanas [9] investigated nonlinear relationship between macroeconomic fundamental and exchange rates for two country-pairs, namely the Netherlands- Germany and France-Germany. They employed two nonparametric nonlinear testing methodologies, namely a nonparametric nonlinear co-integration approach and a nonlinear Granger causality approach. Their result suggested that there is nonlinear cointegration among money, output and exchange rates for Netherlands- Germany, which can be interpreted as evidence of a long-run nonlinear relationship. For France-Germany, they unable to find evidence of nonlinear co-integration, but they found nonlinear Granger causality from French money to the FFr/DM exchange rate. They concluded that there is evidence of a dynamic nonlinear relationship and are consistent with the German dominance hypothesis.

Kumar [10] examined the return, volatility and correlation spillover in Indian exchange (USD, EUR, GBP and JPY) rates. They found that significant bidirectional return spillover between GBP and Japanese yen and unidirectional return spillover from Euro and Japanese yen to USD and from GBP to Japanese yen. They also document that conditional volatility spillover from USD to other exchange rates and from other exchange rates (except Japanese yen) to USD. They concluded that volatility shock in Indian exchange rate relative to USD tends to impact the volatility of other exchange rates and vice versa.

Roberta Colavecchio [11] used multivariate GARCH techniques to study volatility spillovers between the Chinese non-deliverable forward market and seven of its Asia-Pacific counterparts over the period January 1998 to March 2005. To account for the time-variability of conditional correlation, a dynamic correlation structure is included in the volatility model specification. The empirical results demonstrate that the Renminbi non-deliverable forward has been a driver of various Asian currency markets but that such co-movements exhibit a substantial degree of heterogeneity. As to the determinants of the magnitude of these co-movements, they tested the relevance of potential factors and find that it is the degree of real and financial integration, in particular, that exerts the largest influence on volatility transmission.

Robert McCauley [5] analyzed the direction of influence for nine currencies in 2005-13 as well as separately for the 2008-09 crisis and

May-August 2013. Granger causality tests point to two-way causation for most currencies for the full sample. The exception is the Malaysian Ringgit, where the NDF influences the deliverable forward market. There is no case where the deliverable rate leads the NDF. Analysis of the two subsample periods shows that the NDF's influence seems to increase during market stress. During the global financial crisis, the NDF tended to lead the onshore market. A rise in the influence of the NDF was even more noticeable in May–August 2013 (eight out of nine cases). In India, the impression that the offshore NDF drove the domestic market in summer 2013 has reportedly prompted consideration of opening up the domestic market to foreign investors.

Srivastava [12] examined the integration and correlation of major Asian markets and the US stock market over a period when much of the Asian market movements are perceived to be induced by FIIs. They found that integration vary considerably through time and were highest during last few years. The analysis suggested that the periods of globalization have both benefits and drawbacks for international investors.

Xingyun [13] examined inter-linkages among South-East Asian, Tokyo and New York stock market returns before and after the Asian currency crisis using simple correlations, Granger causality tests and VAR models. They found that inter-linkages among South-East Asian markets have increased after the emergence of crisis. The New York market affects the South East Asian markets but is not affected by them. Tokyo market seems to be isolated from the region. Singapore stock market appears to dominate other markets in the region and its effect on them is even greater than that of New York. All five South East Asian markets affect one another and their effects are transmitted within two days in most of the cases. And they concluded that inter-linkages among the SEA markets have increased after the crisis and markets respond more promptly and actively to the changes in neighboring markets.

Research gap

All the given studies have examined the relationship between exchange rates and equity markets. Later, there are some studies that examined the linkage between deliverable forward (DF) non-deliverable forward (NDF) in other country as well. As far as the Indian market is concerned, Anuradha Guru [2] have investigated in their article, 'the linkages between spot, domestic forward and NDF markets for INR/USD using Granger causality tests, co-integration tests. Though this study reported the linkage between domestic forward market and NDF market of USD/INR, the researchers pointed out that the 'study did not focused the recent up-gradation of currency future (CF) introduction in India and its impact on Indian NDF market with other Asia-Pacific NDF market'. Hence, the present study intends to fill this gap, by taking into consideration currency future introduction in India.

Research questions

In the course of our study we try to answer the following questions for both before-and after currency future introduction periods: are the Asia-Pacific NDF markets interlinked? How the Indian market is related to Asia-Pacific markets? Which market appears to be the most influential in the region? How much of the movements in one market can be explained by innovations in other markets? How rapidly are the NDF prices movements in one market transmitted to other markets?

Objectives of the Study

In line with above questions, the following objectives set for this study: to examine the interlinkage and information flows Among

the Asia-Pacific offshore forward, namely NDF markets. The major objective of the paper is to see whether there are any changes in the relationship among the Asia-Pacific NDF markets after the introduction of currency futures in India.

Rationale of the study

The rationale behind the study is to check the information flows between Indian NDF market and its counterparts i.e. other Asia-Pacific NDF markets. If lagged changes in one market cause variations in other Asia-Pacific and past fluctuations in NDF return cause variations in the other market returns, then bi-directional causality is implied between the two series. This behaviour indicates NDF market inefficiency. If market is inefficient with respect to information, then it has important implications both at micro and macro levels. At the micro level, this implies that the individual investor can earn considerably higher normal rate of returns from the NDF market. At the macro level, it elevates severe suspicions on the capability of the market to perform. In contrast, if changes in one market neither influence nor are influenced by NDF return fluctuations, then the two series are independent of each other and the market is information efficient.

Data and Methodology

Data source

In order to analyze of co-movements in Indian and Asia-Pacific forward exchange rates, we use daily observations of forward exchange rates for eight Asian countries. These eight countries are (1) India, (2) China, (3) Indonesia, (4) Korea, (5) Malaysia, (6) Philippines (7) Taiwan, and (8) Vietnam. Our dataset includes onshore (Spot) and off-shore (NDF) forward exchange rates with maturities of 1 month. As the NDF markets only began full scale trading in 1996–97, our sample commences in 2003 and spans the period 1 January 2003 to 31 December 2013, which is divided into two sub-periods. Sub-period I has been named before introduction of currency future in India and covers period from 01/01/2003 to 29/08/2008. The sub-period II has been named as the after introduction of currency future in India and covers period from 30/08/2008 to 31/12/2013.

These NDF market prices are transformed into continuously compounded daily rates of return, defined as:

$$R_{it} = (P_{it}/P_{it-1}) \times 100$$

Methodology

In order to answer the above research questions, analysis of correlations (and correlograms) and Granger causality tests are conducted to examine the co-movements among the pair-wise NDF prices and returns. Apart from that, we also estimate vector-autoregressive (VAR) models for both before-and after currency future introduction periods. The Eight NDF markets included in this study are China (CNY), Indonesia (IDR), India (INR), Malaysia (MYR), Philippines (PHP), Taiwan (TWN) and Vietnam (VND). These markets represent almost the entire Asia-Pacific region.

Correlations and cross-correlograms: Simple correlations of daily returns expose the link between the rates of change in the NDF rates. We also study the cross correlograms (up to 36 lags) between all pairs of the eight markets. Then we compute the correlation matrices for both Sub-period I and Sub-period II and then test their equality using the Box-M statistic. It can be defined as

$$M = \left[1 - \left(\frac{2k^2 + 3k - 1}{6(k+1)} \right) \left(\frac{1}{n_1 - 1} + \frac{1}{n_2 - 1} + \frac{1}{n_1 n_2 + 2} \right) \right] \times \left[(n_1 - 1) \ln |R_1^{-1} \hat{R}| + (n_2 - 1) \ln |R_2^{-1} \hat{R}| \right]$$

where

k = number of variable in correlation matrix

n_i = number of observations used to compute the i th correlation matrix

R_i = the i th correlation matrix

$$\check{R} = \frac{(n_1 - 1)R_1 + (n_2 - 1)R_2}{n_1 n_2 + -2}$$

M follows a χ^2 distribution with $k(k+1)/2$ degrees of freedom.

Granger causality test: Correlation does not necessarily involve causation in any economic sense. It is not unusual to find that high correlations may simply be the result of spurious relationship and thus not of much use. To address the question that whether some variable causes others, Granger proposed a test to see how much of the current x can be explained by past values of x and then to see whether adding lagged values of y can improve the explanation. In a bivariate VAR describing x and y , y does not Granger-cause x if the coefficient matrices Φ_j are lower triangular for all j

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \phi_{11}^{(1)} & 0 \\ \phi_{21}^{(1)} & \phi_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} \phi_{11}^{(2)} & 0 \\ \phi_{21}^{(2)} & \phi_{22}^{(2)} \end{bmatrix} \begin{bmatrix} x_{t-2} \\ y_{t-2} \end{bmatrix} + \dots + \begin{bmatrix} \phi_{11}^{(p)} & 0 \\ \phi_{21}^{(p)} & \phi_{22}^{(p)} \end{bmatrix} \begin{bmatrix} x_{t-p} \\ y_{t-p} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix}$$

where j is the number of lag and $j=1,2,p$.

To implement this test, we assume a particular autoregressive lag length p and estimate

$$x_t = c_1 + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \dots + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_p y_{t-p} + u_t$$

by OLS. We then conduct an F test of the null hypothesis

$$H_0 : \beta_1 = \beta_2 = \dots = \beta_p = 0$$

The VAR model: The popular time series method of VAR is due to the seminal work of Sims. It is used to study the dynamic interrelations between n different variables. Many studies of stock markets have used VAR models to study inter-linkages [14]. The VAR model for n markets can be expressed as:

$$R_t = C + \sum_{s=1}^m A_s R_{t-s} + e_t \tag{1}$$

where R_t is a $n \times 1$ column vector of daily rates of return of the n NDF markets, C and A_s are, respectively, $n \times 1$ and $n \times n$ matrices of coefficients, m is the lag length, and e_t is a $n \times 1$ column vector of error terms. The ij th component of A_s measures the direct effect that a change in the return to the j th market will have on the return of the i th market in s period.

Since the coefficients in equation (1) contain complicated cross-equation feedbacks and are difficult to describe intuitively, it is better to analyze the model's reaction to typical random shocks. By successive substitutions of the right-hand side of equation (1), we can obtain a moving average representation as follows:

$$R_t = C' + \sum_{s=0}^x B_s + e_{t-s} \tag{2}$$

Where each B_s is an $n \times n$ matrix. The $B_{ij,s}$ are called the impulse response functions, which show the response of the i th market in s -period after a unit random shock in the j th market, other things remaining constant. The decomposition of variance ($\sum B_{ij,s}^2 / \alpha_{i,s}^2$) can

reveal how much variance of market i is determined by the innovations of market j in the s period.

Result and Discussion

Preliminary findings

We start by plotting the NDF rates for the eight markets (Figure 1). During the entire sample period the India and Vietnam market shows an upward trend and China market shows a downward trend. Taiwan market has long periods of upward and downward movement with a slight downward trend. Indonesia and Korean NDF rates exhibit movements similar to one another. Malaysia market shows downward movements until the onset of currency future and after that we see some recovery followed by deep plunge. Onset of currency future all these markets shows a sudden peak. This similarity of movement among these markets is the first indication of possible linkages among Asia-Pacific markets.

Next we look at the graphs of NDF returns (Figure 2). All markets show an increase in volatility after the onset of Currency future. This supports the view that the currency future introduction has increased uncertainty in markets resulting in higher level of risk. Although the graphs clearly reflect the stationery of returns, we formally tested for unit roots and rejected the null hypothesis of unit roots in all eight series of returns.

Correlation matrices

To study the correlation matrices for returns among different pairs of these markets we construct correlation matrices for returns. We find prices to be correlated among all markets (Table 1) and average value of the correlation coefficient (r) is 0.18 in Sub-period I and 0.14 in the Sub-period II. All r are significant at 1% level except the Vietnam against all other markets in both Sub-periods I and II and Taiwan market is also not significant with other Asia-Pacific market except India. We notice from a comparison of Table 1 that among all the 28 correlations, there are only 6 that have increased in the Sub-period II and 4 out of these 6 involve India currency Market. The most remarkable result is that the correlation between India and Malaysia increased from 0.31 in Sub-period I to 0.60 in Sub-period II. These finding suggests that the linkages of Indian market with the other markets in the region have been affected by Introduction of currency future. This conclusion is further supported by the results of our VAR model below.

Granger causality test results

To study the bilateral linkages further we use Granger Causality Tests (GCTs). We run GCTs using lag lengths. We try 2 day lags. The results are reported in Table 2.

For both sub-period I and II we observe that the Chinese market affects all other markets and is not much affected by any of them. Indonesia market does not have any influence on the other Asia-Pacific markets except India (3.62246) and is not much affected by any market other than the China (16.7491 and 110.33), India (5.0528 and 5.5685) and Philippines (8.0886 and 78.3512).

The pair-wise linkages between different Asia-Pacific markets are very interesting. India affects other five markets except China (1.9682) and Vietnam (1.9104) in the Sub-period I, and is affected by China (12.9094) and Philippines (13.8774). In the Sub-period II, however, it is affected by all of them. This implies an increase in inter-linkages among Asia-Pacific markets after the introduction of currency future in India. Korea market affect does not have any influence on the Asia-Pacific markets except India (3.64691). The Malaysia market provides a

From 01/01/2003 to 31/12/2013

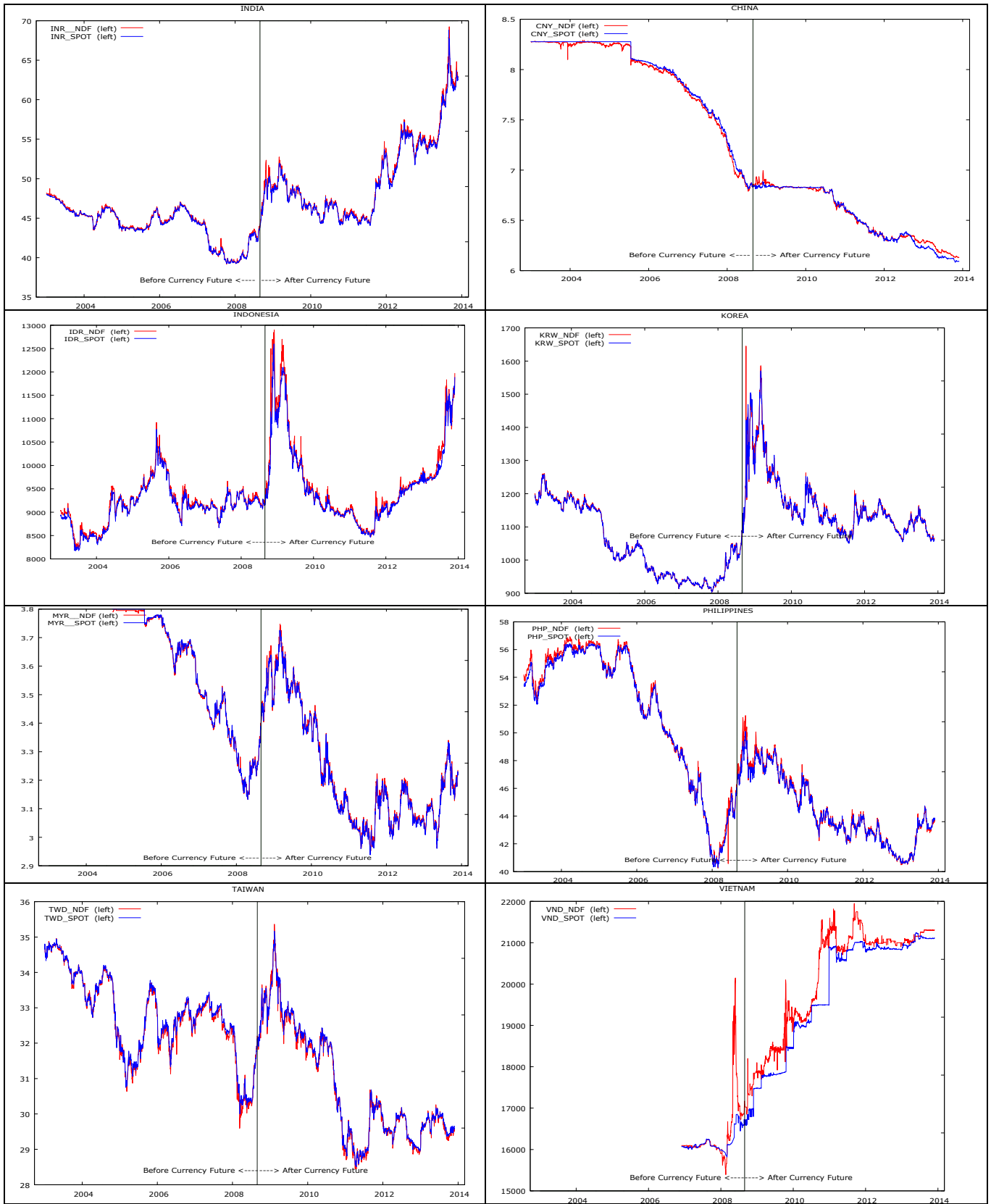


Figure 1: NDF and Spot Prices in Eight Markets.

Sub-Period I								
	INR	CNY	IDR	KRW	MYR	PHP	TWD	VND
INR	1							
CNY	0.1337*	1						
IDR	0.4097*	0.0881*	1					
KRW	0.3271*	0.0576*	0.3984*	1				
MYR	0.3103*	0.0832*	0.5907*	0.4304*	1			
PHP	0.3222*	0.1649*	0.4380*	0.1625*	0.3388*	1		
TWN	0.1788*	0.0176	0.0147	0.1263*	0.0427	0.0265	1	
VND	0.0222	0.0341	0.0334	0.0232	0.0183	0.0328	0.0633	1
Sub-Period II								
	INR	CNY	IDR	KRW	MYR	PHP	TWD	VND
INR	1							
CNY	0.0642*	1						
IDR	0.4880*#	-0.0852*	1					
KRW	0.4787*#	-0.0645*	0.4292*#	1				
MYR	0.5979*#	-0.0515*	0.5272*	0.5191*#	1			
PHP	0.3376*#	0.1151*	0.0674*	0.0018	0.0210	1		
TWN	0.1244*	0.0086	0.0139	-0.0280	0.0209	-0.007	1	
VND	0.0166	0.0016	-0.0054	0.0032	0.0099	0.0209	0.0303	1
Full Period								
	INR	CNY	IDR	KRW	MYR	PHP	TWD	VND
INR	1							
CNY	0.0615*	1						
IDR	0.4790*	-0.0514*	1					
KRW	0.4618*	-0.0558*	0.4261*	1				
MYR	0.5579*	0.0687*	0.5318*	0.5042*	1			
PHP	0.1369*	0.1288*	0.1208*	0.0211	0.0836*	1		
TWN	0.1327*	0.0337	0.0137	-0.0109	0.0245	0.0072	1	
VND	0.0169	0.0129	0.0025	0.0217	0.0116	0.0245	0.0389	1

[Each entry in the table represents the contemporaneous correlation coefficient of the returns between a pair of countries from the period 2003-2013.]

Source: computed by Authors' (2014)

* and ** significant at 1 and 5 respectively

This correlation coefficient is higher than its Sub-period I its counterpart

Table 1: Correlation Matrix^a.

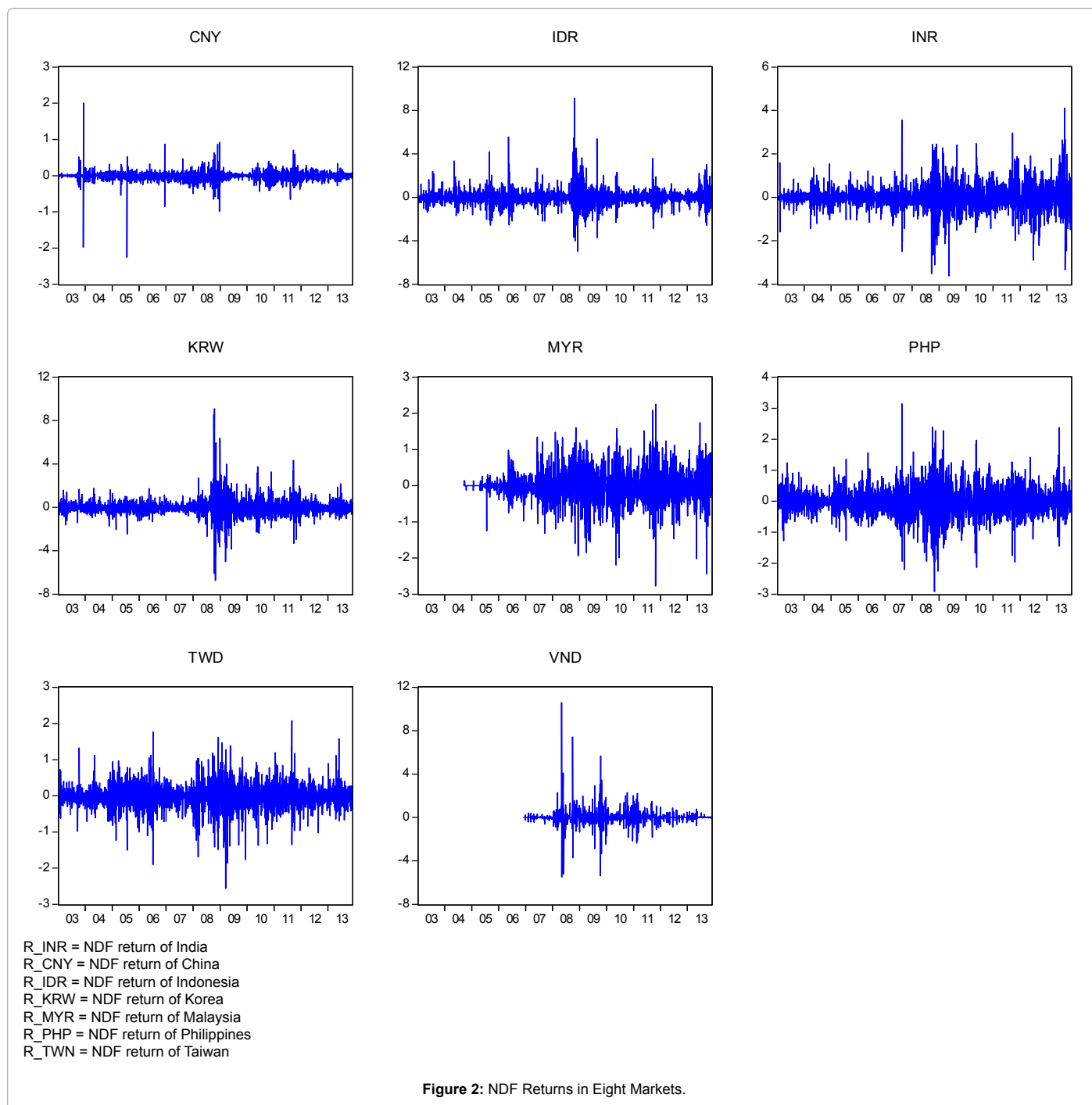
Null Hypothesis	Sub-Period I	Sub-Period II	Full Period	Null Hypothesis	Sub-Period I	Sub-Period II	Full Period
	F-Statistic	F-Statistic	F-Statistic		F-Statistic	F-Statistic	F-Statistic
CNY→IDR	16.7491*	110.33*	107.095*	IDR→CNY	0.57275	1.30028	1.8613
CNY→INR	12.9094*	131.304*	116.586*	INR→CNY	1.9682	0.05404	0.36928
CNY→KRW	22.6318*	106.038*	108.456*	KRW→CNY	0.31966	0.75363	0.02585
CNY→MYR	44.4501*	231.931*	241.97*	MYR→CNY	1.42702	3.27292**	4.1758**
CNY→PHP	19.2383*	0.10098	8.17481*	PHP→CNY	0.63638	26.74*	14.1842*
CNY→TWN	18.4651*	3.36363**	5.82897*	TWN→CNY	1.8484	0.08405	1.10407
CNY→VND	1.14024	0.5281	0.72356	VND→CNY	5.77205*	0.66126	3.42229**
IDR→INR	1.03528	3.62246**	0.65481	INR→IDR	5.0528*	5.56858*	11.6485*
IDR→KRW	0.43074	2.23075	2.58264	KRW→IDR	3.12812	0.68255	1.84753
IDR→MYR	1.25441	0.8002	1.55108	MYR→IDR	1.77426	2.06516	0.46528
IDR→PHP	0.55554	2.42918	4.47753	PHP→IDR	8.08868*	78.3512*	82.9923*
IDR→TWN	2.03315	0.42086	0.89963	TWN→IDR	1.08654	0.43005	0.34718
IDR→VND	2.6601	0.31436	0.69681	VND→IDR	0.01157	0.45511	0.33262
INR→KRW	3.52892**	5.99182*	10.7313*	KRW→INR	2.51778	3.64691**	2.7759
INR→MYR	20.4747*	4.84155*	11.961*	MYR→INR	0.46125	3.39658**	1.74669
INR→PHP	11.9994*	0.09785	3.25867**	PHP→INR	13.8774*	45.7863*	64.4439*
INR→TWN	4.36281*	0.50435	0.4031	TWN→INR	1.14129	4.44015*	1.35063
INR→VND	1.91041	0.39866	0.85236	VND→INR	0.10642	0.1585	0.15379
KRW→MYR	6.3689*	1.77591	4.2079**	MYR→KRW	2.06382	3.01709**	2.46951
KRW→PHP	0.02554	0.30258	0.32143	PHP→KRW	15.8938*	90.49*	125.86*
KRW→TWN	0.96647	0.53279	1.63862	TWN→KRW	0.33005	7.10916**	5.16595*
KRW→VND	3.70655	0.13731	0.42924	VND→KRW	5.42259*	0.34662	1.2915
MYR→PHP	0.28917	0.01618	0.10521	PHP→MYR	31.7596*	40.5113*	58.6116*
MYR→TWN	0.04783	2.15749	2.30975	TWN→MYR	12.5366*	1.7248	2.38301
MYR→VND	1.05761	0.58851	1.05608	VND→MYR	3.97706**	0.4632	0.62042
PHP→TWN	0.10766	0.24209	0.29053	TWN→PHP	1.21565	0.00091	0.5973
PHP→VND	1.08774	0.20364	0.14129	VND→PHP	1.90959	0.05382	0.46578
TWN→VND	0.03845	0.68167	0.62192	VND→TWN	2.03128	3.13314*	0.62192

[In vector autoregressive representation of two variables (one country with another country), changes in one variable can be related to the lagged changes of the other variable and its own past changes. The Granger causality test involves testing for the joint significance of the coefficients of the lagged changes of the other variables, which can be determined by the F-statistic. Based on Akaike's criterion, the optimal structure for the model contains two lags.]

Source: computed by Authors' (2014)

* and ** significant at 1 and 5 respectively

Table 2: Pair-wise granger causality test results.



good example of increase in linkages after the introduction of currency future. We notice that in the Sub-period-I it does not affect any of the market and is affected by all other Asia-Pacific market except Indonesia (1.25441). In the Sub-period II, it affects China (3.27292), India (3.39658) and Korea (3.01709) market.

When we look at all the eight Asia-Pacific markets together (Figure 3) we notice that the linkages have increased after introduction of currency futures in India (Sub-Period II). We also find that Indian markets have an increased influence on the other Asia-Pacific market.

Results of the VAR model

Before we estimate the VAR as defined in equation (1), it is very significant to determine the appropriate number of lags. As we are using daily returns and markets open five days a week, we estimate different VAR models with 30, 25, 20, 15, 10 and 5 to 1 lags. We compare Akaike information criterion (AIC) and Schwarz information criterion (SIC) values of different models and both statistics suggest 2 lags. Our results of pair-wise cross-correlograms also suggest that the maximum number of lags that exhibit correlations is 2. Shims, C.S. (1989) found that price changes in one market are transmitted to the other markets

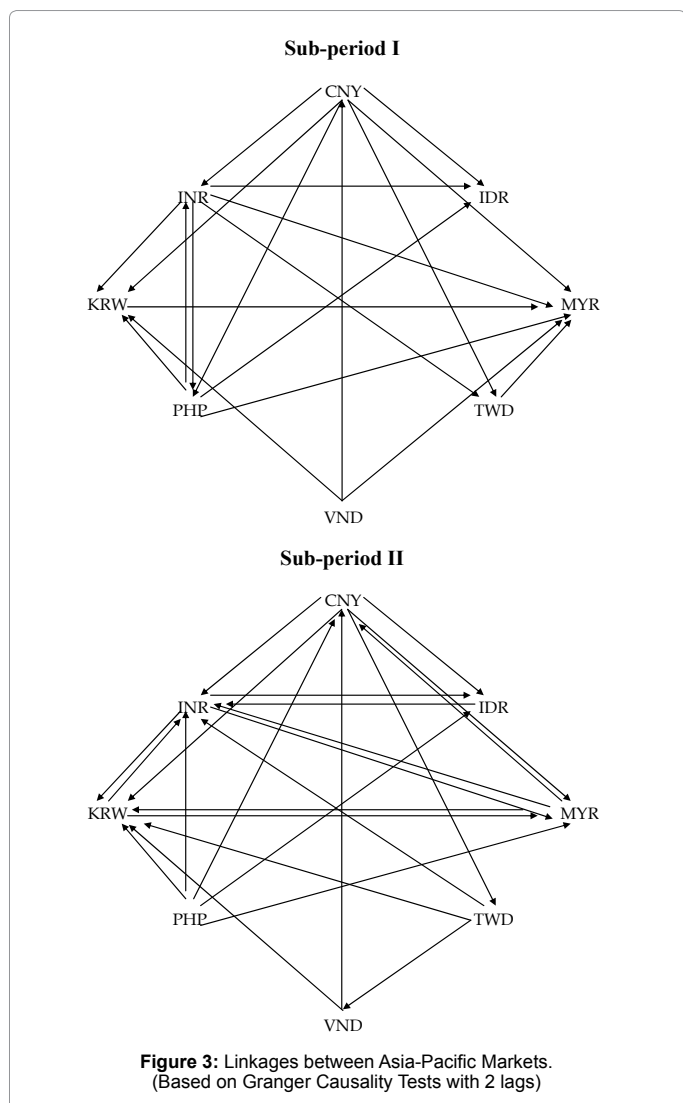


Figure 3: Linkages between Asia-Pacific Markets. (Based on Granger Causality Tests with 2 lags)

within a maximum of 48 hours. Xingyun also found that that effect of a shock in one market on others will extend beyond two days. On the basis of all the above reasons we choose two lags for our VAR model.

Impulse responses

First we examine the impulse responses of returns in various markets to a shock in their own and other market innovations. As before, our focus is on comparing the responses in two sub-periods. The graphic results are presented in Figures 4 and 5 for innovation in India market. Taking a 10-day forecasting perspective we see how the effects of a shock in India are reflected in the returns of other markets. In all cases the convergence is almost complete in less than 10 days although the most significant transmission takes place during the first three days. To simplify the analysis we concentrate on the first five days. The details are provided in Tables 3 and 4. We briefly comment on each Asia-Pacific market below.

In sub-period I the biggest shocks to Vietnam market (0.8677) come from its own innovations, followed by the shocks from Malaysia (0.1385) on the next day. Whereas in sub-period II the biggest shocks to Korea (0.9341) come from its own innovations, followed by the shocks from Philippines (0.4248) and China (0.3060) on the next day.

Most of the transmission is complete in three days. In the sub-period I the strongest response comes on the first day to its own innovations, and on the second day to China innovations, which is due to non-synchronism. In the sub-period II the responses on the second day to shocks from other regional market are much larger than the sub-period I (Figure 6).

The India market, before introduction of currency future (sub-period I), is affected by Indonesia (0.1917) on the first day and by Philippines (0.1156) on the second day. The other markets do not seem to have much effect on it. After introduction of the currency future (sub-period II), we notice that the shock in Indonesia (0.2186) has a slightly increased effect on India market. The effects of other markets, however, have increased after the introduction of currency future.

In the sub-period I, the Korea market is affected by Indonesia (0.1752) on the first day and by Philippines (0.1198) on the second. After the introduction of currency future (sub-period II) we notice that India (0.2071) affect Korea first day followed by Philippines (0.4248) and China (0.3060) on the second day.

All except Vietnam affect Taiwan market in the both periods. We

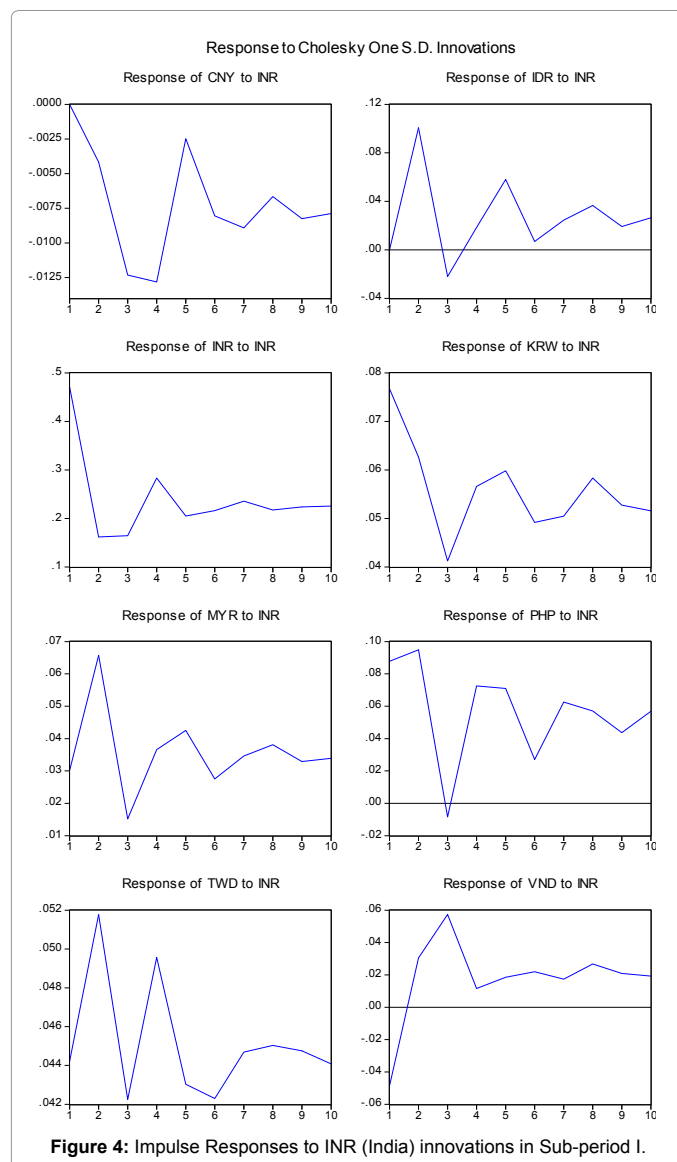


Figure 4: Impulse Responses to INR (India) innovations in Sub-period I.

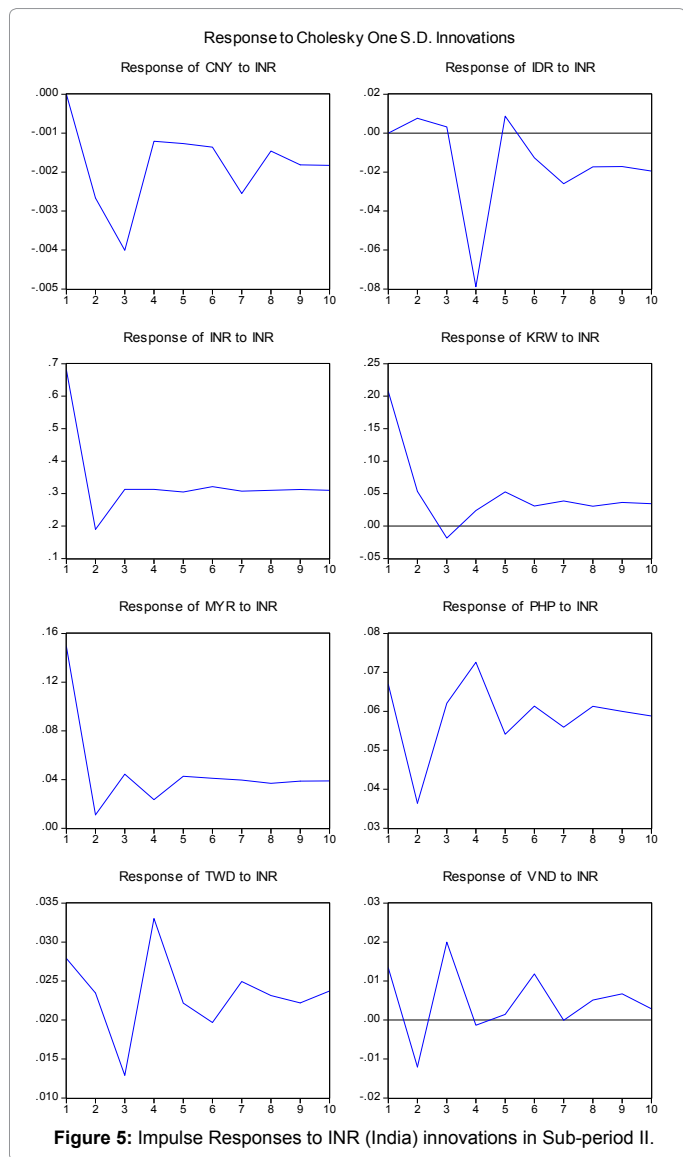


Figure 5: Impulse Responses to INR (India) innovations in Sub-period II.

observe the shock of other Asia-Pacific market decreased in sub-period II, but Indonesia (0.0016 and 0.0254) has a stronger effect than before on first day. In case of Vietnam we can see much change after the introduction of currency future. We notice that China and Indonesia has more influence on Asia-Pacific market effect in both sub-periods. This provides support to the idea of China and Indonesia acting as a regional leader after the introduction of currency future. We shall explore this point further in the following section (Table 5).

Variance decomposition

The problem with the impulse responses is that they show the effect of different days separately. If we are interested in some kind of cumulative effect the variance decomposition is a better tool. Once again we shall focus on Asia-pacific markets and compare the variance decomposition in two sub-periods. Although most of the transmission is completed in three days, we allow five days for impulse responses to fully show their effect and then discuss the variance decomposition on the fifth day when transmission is sure to be complete. All the following discussion is based on Tables 6 and 7.

Starting with China, we see that most of the forecast error variance

Sub-period I									
China	i/th Day after shock	CNY	IDR	INR	KRW	MYR	PHP	TWD	VND
	1	0.1475	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.0373	-0.0021	-0.0042	0.0109	-0.0059	0.0052	0.0212	-0.0017
	3	0.0370	-0.0027	-0.0123	0.0118	0.0162	0.0064	0.0130	0.0235
	4	0.0571	0.0056	-0.0128	0.0130	0.0227	0.0067	0.0223	0.0357
	5	0.0588	-0.0046	-0.0025	0.0105	-0.0010	0.0090	0.0206	0.0142
Indonesia									
	1	0.0425	0.5219	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.1292	0.1418	0.1007	0.0080	0.0142	0.1089	-0.0201	-0.0223
	3	0.0216	0.2327	-0.0220	-0.0064	0.0041	0.0075	0.0253	0.0016
	4	0.0501	0.2934	0.0183	0.0086	-0.0100	0.0138	-0.0280	-0.0039
	5	0.0753	0.2225	0.0580	0.0009	0.0256	0.0725	0.0032	-0.0008
India									
	1	0.0501	0.1917	0.4707	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.0816	0.0460	0.1619	0.0125	0.0275	0.1156	0.0533	-0.0121
	3	-0.0232	0.1137	0.1644	0.0264	-0.0013	0.0205	0.0028	-0.0072
	4	0.0360	0.1008	0.2831	-0.0017	0.0213	0.0121	0.0028	0.0357
	5	0.0541	0.0784	0.2052	0.0205	0.0238	0.0876	0.0435	-0.0013
Korea									
	1	0.0481	0.1752	0.0767	0.4245	0.0000	0.0000	0.0000	0.0000
	2	0.0788	0.1008	0.0627	0.1449	-0.0349	0.1198	-0.0487	0.0253
	3	0.0638	0.0662	0.0412	0.2048	-0.0380	-0.0102	-0.0265	-0.0386
	4	0.0575	0.1086	0.0566	0.2389	-0.0347	0.0149	-0.0422	-0.0333
	5	0.0683	0.1052	0.0598	0.2014	-0.0217	0.0673	-0.0372	0.0007
Malaysia									
	1	0.0526	0.2064	0.0302	0.0499	0.2998	0.0000	0.0000	0.0000
	2	0.1708	0.0720	0.0657	0.0132	0.0475	0.0690	-0.0328	-0.0053
	3	0.0881	0.0655	0.0152	-0.0044	0.0914	-0.0098	0.0162	-0.0332
	4	0.0651	0.1201	0.0366	0.0286	0.1357	-0.0013	-0.0477	-0.0485
	5	0.1177	0.0977	0.0425	0.0127	0.1197	0.0437	-0.0144	0.0035
Philippines									
	1	0.0975	0.2614	0.0878	-0.0435	0.0333	0.5113	0.0000	0.0000
	2	0.1129	0.1078	0.0948	-0.0547	-0.0038	0.1377	-0.0081	-0.0576
	3	0.0417	0.0792	-0.0084	-0.0145	0.0085	0.2088	-0.0129	0.0123
	4	0.0654	0.1712	0.0725	-0.0365	0.0180	0.3022	-0.0152	-0.0087
	5	0.0905	0.1195	0.0709	-0.0389	0.0140	0.2048	0.0053	-0.0216
Taiwan									
	1	0.0672	-0.0016	0.0442	0.0404	-0.0380	0.0094	0.3414	0.0000
	2	0.0442	0.0139	0.0518	-0.0137	-0.0708	0.0004	0.1526	-0.0401
	3	0.0344	0.0156	0.0422	-0.0156	-0.0731	-0.0031	0.0926	-0.0559
	4	0.0876	-0.0049	0.0496	0.0015	-0.0536	-0.0060	0.1674	-0.0632
	5	0.0501	0.0121	0.0430	-0.0032	-0.0645	-0.0028	0.1630	-0.0462
Vietnam									
	1	0.1264	-0.0478	-0.0486	0.0095	-0.1106	0.0655	0.0000	0.8677
	2	0.1117	-0.1320	0.0305	-0.0140	-0.1385	0.0952	-0.0481	0.3878
	3	0.0933	-0.0389	0.0573	0.0010	-0.2336	-0.0139	-0.0460	0.1244
	4	0.1698	-0.0378	0.0115	-0.0500	-0.1432	0.0098	-0.1109	0.3855
	5	0.1211	-0.0913	0.0185	-0.0050	-0.1290	0.0734	-0.0709	0.3947

[^aThe *i*/*j*th entry in this table represents the normalized impulse response of the *j*th (column) market on the *i*th day (row) to the unit shock in the other Asia-Pacific market. These entries are the estimates of coefficients of the VAR system divided by their standard errors.]

Source: computed by Authors' (2014)

Table 3: Impulse Responses^a.

is explained by movement in its own returns and by the movement in the returns of Malaysia (0.8118) and Korea (0.3244) market. Important thing to notice is that both markets (Malaysia (0.1157) and Korea (0.011)) explains fewer of the movement in China market after the Introduction of currency future (Sub-period II).

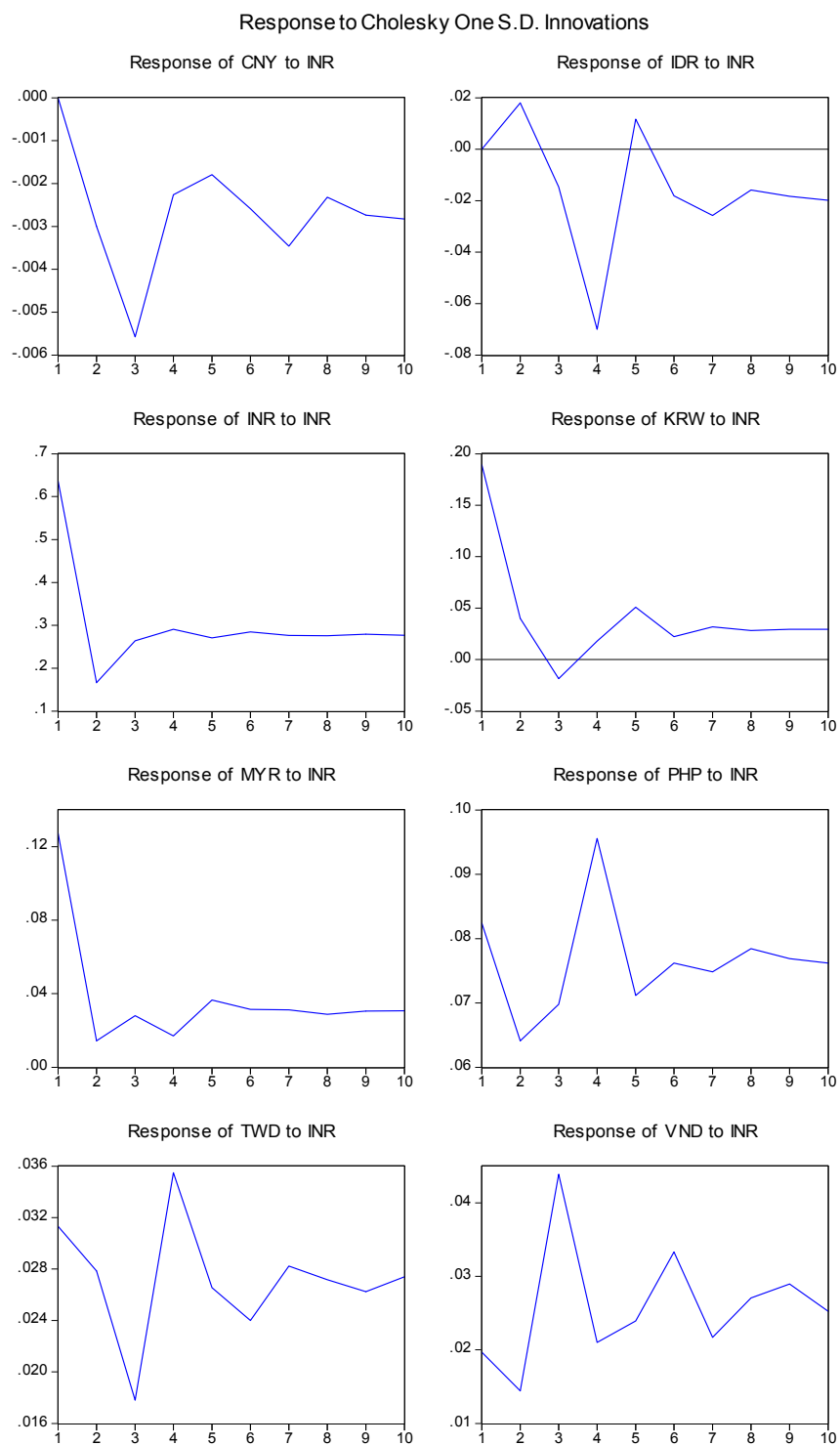
When we look at the Malaysia market we find that Indonesia explains a major portion of its variance in sub-period I (23%) but in

Sub-period II									
China	Period	CNY	IDR	INR	KRW	MYR	PHP	TWD	VND
	1	0.1441	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.0516	-0.0159	-0.0027	-0.0036	-0.0116	0.0088	0.0014	-0.0064
	3	0.0582	-0.0054	-0.0040	-0.0030	-0.0158	0.0211	-0.0026	-0.0048
	4	0.0788	-0.0023	-0.0012	-0.0020	0.0036	0.0000	0.0017	0.0019
	5	0.0699	-0.0103	-0.0013	0.0011	-0.0103	0.0042	-0.0003	-0.0062
Indonesia									
	1	-0.0892	0.8815	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.2964	0.2930	0.0076	-0.0710	-0.0979	0.3037	0.0325	-0.0029
	3	0.0568	0.3040	0.0032	-0.1152	-0.0174	0.2024	0.0267	-0.0257
	4	0.0413	0.4375	-0.0788	-0.1178	-0.0609	0.2976	0.0319	-0.0107
	5	0.1208	0.4038	0.0087	-0.0682	-0.0311	0.1811	0.0212	0.0048
India									
	1	-0.0192	0.2186	0.6804	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.2789	-0.0020	0.1896	-0.0454	-0.0350	0.1607	0.0307	-0.0061
	3	0.0223	-0.0170	0.3133	-0.1280	-0.0444	0.1945	0.0176	0.0028
	4	0.0630	0.0667	0.3130	-0.0884	-0.0275	0.2103	0.0259	-0.0179
	5	0.1350	0.0384	0.3046	-0.0554	-0.0051	0.1126	0.0238	0.0119
Korea									
	1	-0.1102	0.1584	0.2071	0.9341	0.0000	0.0000	0.0000	0.0000
	2	0.3060	0.0140	0.0535	0.1892	-0.0481	0.4248	0.0724	0.0030
	3	-0.0446	-0.1210	-0.0185	0.1748	-0.0278	0.3242	0.0051	-0.0318
	4	0.0563	0.0003	0.0238	0.3673	-0.0389	0.4290	0.0666	-0.0044
	5	0.0972	0.0242	0.0526	0.3095	0.0071	0.2598	0.0401	0.0054
Malaysia									
	1	-0.0496	0.1591	0.1491	0.0703	0.4026	0.0000	0.0000	0.0000
	2	0.2358	0.0088	0.0109	-0.0347	0.0994	0.0832	0.0238	-0.0082
	3	0.0434	0.0224	0.0443	-0.0716	0.1681	0.1340	-0.0022	-0.0073
	4	0.0447	0.0303	0.0235	-0.0425	0.1903	0.1876	0.0300	-0.0138
	5	0.1136	0.0439	0.0427	-0.0324	0.1892	0.0671	0.0110	0.0020
Philippines									
	1	0.0619	0.0837	0.0669	0.0367	-0.0089	0.5513	0.0000	0.0000
	2	-0.0023	0.0474	0.0364	0.0485	0.0038	0.0864	-0.0182	0.0031
	3	0.0093	0.0350	0.0621	0.0752	0.0286	0.1719	-0.0165	-0.0014
	4	-0.0015	0.1005	0.0726	0.0938	-0.0020	0.1620	-0.0206	0.0055
	5	0.0326	0.0517	0.0541	0.0573	0.0056	0.1881	-0.0156	0.0021
Taiwan									
	1	0.0104	0.0254	0.0279	0.0161	0.0364	-0.0156	0.4249	0.0000
	2	0.0047	0.0148	0.0235	0.0460	0.0376	-0.0124	0.1290	-0.0086
	3	-0.0104	0.0365	0.0129	0.0264	0.0105	-0.0265	0.1987	0.0215
	4	0.0011	0.0230	0.0330	0.0362	0.0330	-0.0467	0.2363	-0.0101
	5	0.0052	0.0228	0.0222	0.0383	0.0293	-0.0155	0.1936	0.0022
Vietnam									
	1	-0.0166	-0.0109	0.0134	0.0057	-0.0036	0.0165	0.0319	0.6392
	2	0.0141	-0.0102	-0.0121	0.0076	-0.0115	-0.0006	0.0207	0.1352
	3	0.0003	-0.0110	0.0200	0.0221	0.0064	0.0119	0.0172	0.2410
	4	-0.0118	-0.0039	-0.0013	0.0012	-0.0084	0.0007	0.0187	0.3867
	5	0.0068	-0.0111	0.0014	0.0115	-0.0052	0.0039	0.0207	0.2250

[^aThe i,jth entry in this table represents the normalized impulse response of the jth (column) market on the ith day (row) to the unit shock in the other Asia-Pacific market. These entries are the estimates of coefficients of the VAR system divided by their standard errors.]

Source: computed by Authors' (2014)

Table 4: Impulse Responses^a.



Full period II									
China	Period	CNY	IDR	INR	KRW	MYR	PHP	TWD	VND
	1	0.1473	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.0525	-0.0139	-0.0030	-0.0031	-0.0160	0.0089	0.0024	-0.0095
	3	0.0585	-0.0081	-0.0056	-0.0042	-0.0151	0.0187	-0.0029	-0.0034
	4	0.0816	-0.0023	-0.0023	-0.0030	0.0019	0.0034	0.0025	0.0012
	5	0.0714	-0.0098	-0.0018	-0.0001	-0.0128	0.0051	0.0004	-0.0073
Indonesia									
	1	-0.0638	0.8264	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.2431	0.2703	0.0180	-0.0432	-0.0801	0.2586	0.0217	0.0197
	3	0.0334	0.2993	-0.0146	-0.0759	-0.0167	0.1685	0.0287	0.0059
	4	0.0230	0.4146	-0.0700	-0.0809	-0.0609	0.2449	0.0296	0.0249
	5	0.1045	0.3783	0.0116	-0.0456	-0.0263	0.1641	0.0211	0.0201
India									
	1	-0.0065	0.2239	0.6362	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.2232	0.0014	0.1661	-0.0287	-0.0312	0.1689	0.0349	0.0072
	3	0.0035	0.0034	0.2635	-0.0962	-0.0391	0.1856	0.0189	0.0209
	4	0.0482	0.0694	0.2905	-0.0690	-0.0328	0.1965	0.0337	0.0207
	5	0.1079	0.0461	0.2704	-0.0386	-0.0070	0.1244	0.0288	0.0137
Korea									
	1	-0.0843	0.2022	0.1893	0.8652	0.0000	0.0000	0.0000	0.0000
	2	0.2332	0.0416	0.0402	0.2098	-0.0387	0.3716	0.0498	0.0624
	3	-0.0385	-0.0539	-0.0185	0.2295	-0.0321	0.2657	0.0114	0.0207
	4	0.0237	0.0367	0.0180	0.3906	-0.0475	0.3500	0.0619	0.0530
	5	0.0747	0.0623	0.0508	0.3178	-0.0024	0.2396	0.0345	0.0435
Malaysia									
	1	-0.0377	0.1749	0.1273	0.0763	0.3916	0.0000	0.0000	0.0000
	2	0.2045	0.0223	0.0143	-0.0138	0.0941	0.0944	0.0237	0.0242
	3	0.0379	0.0374	0.0281	-0.0395	0.1562	0.1166	0.0094	0.0131
	4	0.0252	0.0432	0.0171	-0.0134	0.1836	0.1675	0.0280	0.0156
	5	0.1025	0.0593	0.0366	-0.0114	0.1752	0.0741	0.0183	0.0247
Philippines									
	1	0.0764	0.1087	0.0824	0.0221	0.0182	0.5464	0.0000	0.0000
	2	0.0332	0.0627	0.0641	0.0351	0.0084	0.0803	-0.0145	-0.0292
	3	0.0248	0.0462	0.0698	0.0602	0.0399	0.1511	-0.0208	-0.0138
	4	0.0219	0.1172	0.0956	0.0706	0.0183	0.1641	-0.0250	-0.0242
	5	0.0587	0.0668	0.0712	0.0431	0.0189	0.1731	-0.0163	-0.0187
Taiwan									
	1	0.0151	0.0182	0.0313	0.0135	0.0252	-0.0120	0.4153	0.0000
	2	0.0054	0.0141	0.0278	0.0363	0.0237	-0.0101	0.1425	-0.0133
	3	-0.0098	0.0318	0.0178	0.0164	0.0041	-0.0222	0.1867	0.0087
	4	0.0075	0.0181	0.0355	0.0289	0.0271	-0.0423	0.2376	-0.0101
	5	0.0059	0.0206	0.0265	0.0301	0.0182	-0.0158	0.1944	-0.0064
Vietnam									
	1	-0.0067	0.0072	0.0197	0.0369	0.0155	-0.0067	0.0397	0.7311
	2	0.0187	-0.0043	0.0144	0.0398	-0.0044	-0.0204	0.0303	0.2408
	3	0.0001	0.0159	0.0439	0.0580	-0.0022	-0.0344	0.0202	0.2399
	4	-0.0130	0.0169	0.0210	0.0419	0.0163	-0.0549	0.0135	0.4499
	5	0.0148	0.0017	0.0239	0.0434	-0.0007	-0.0256	0.0276	0.3153

[*The i, j th entry in this table represents the normalized impulse response of the j th (column) market on the i th day (row) to the unit shock in the other Asia-Pacific market. These entries are the estimates of coefficients of the VAR system divided by their standard errors.]
 Source: computed by Authors' (2014)

Table 5: Impulse Responses*

sub-period II it falls to mere 11%.

Its own shock followed by the shocks in Indonesia (11.0866%) and China (3.9843%) caused the variance in India market. It is important to note that the influence of China (13.9044%) increased after the Introduction of currency future (sub-period II). Another important aspect to note is that China explained 4 % and 14% of the variance in India market in the two periods respectively, compared to 11% and

13% respectively explained by the Indonesia market. The implication is that China acts as a leader for India market in both the period and its effect has grown stronger in the later period.

When we look at the Indonesia market we find that China, India and Philippines explain each at 5% of its variance in Sub-period I. Whereas in Sub-period II, China and Philippines markets explains 12% and 10% respectively, but Indian market explain less than 1% only. This

Variance Decomposition	Period (in days)	Sub-period I								
		S.E.	CNY	IDR	INR	KRW	MYR	PHP	TWD	VND
China	1	0.1331	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.1348	97.4742	0.0098	0.0618	0.3244	0.8118	0.0631	0.2206	1.0344
	5	0.1405	91.1084	1.2024	0.1312	1.3306	1.1187	0.2107	1.3902	3.5079
	10	0.1418	89.7272	1.3605	0.2125	1.3183	1.2878	0.4104	1.6958	3.9876
Indonesia	1	0.4427	0.9712	99.0288	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.4798	5.3235	85.7477	4.0707	0.0817	0.0886	4.5885	0.0173	0.0820
	5	0.4912	5.5868	81.9077	5.0749	0.2071	0.2435	5.7899	0.7287	0.4615
	10	0.4928	5.5900	81.4309	5.0637	0.3076	0.2797	5.9122	0.8381	0.5777
India	1	0.4410	1.7592	11.7186	86.5222	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.4679	3.3967	11.0866	76.8875	0.1803	0.8182	7.2963	0.2334	0.1010
	5	0.4857	4.2728	10.6247	73.2716	0.9755	0.8492	7.1355	1.6958	1.1748
	10	0.4881	4.3277	10.6403	72.6931	1.1431	0.8952	7.2267	1.8145	1.2595
Korea	1	0.4110	0.7690	12.6998	3.0665	83.4647	0.0000	0.0000	0.0000	0.0000
	2	0.4457	1.7097	11.1832	3.9843	71.2490	0.3473	10.1377	0.5124	0.8764
	5	0.4556	1.9643	11.1045	5.1073	68.7624	0.8471	9.8408	0.9789	1.3947
	10	0.4565	2.0040	11.0812	5.1400	68.5875	0.8634	9.8600	0.9841	1.4798
Malaysia	1	0.3233	1.1419	29.4571	0.9664	2.3517	66.0829	0.0000	0.0000	0.0000
	2	0.3650	13.6834	23.1604	2.6084	1.9706	53.3389	5.0908	0.0351	0.1124
	5	0.3760	13.2116	22.5821	3.0495	2.5173	50.3729	5.3019	2.2385	0.7264
	10	0.3793	13.3722	22.3536	3.2341	2.5814	49.6430	5.3843	2.5979	0.8335
Philippines	1	0.5153	3.0350	17.7615	3.9373	0.0683	1.2180	73.9800	0.0000	0.0000
	2	0.5331	5.0515	16.6002	6.7708	0.3514	1.1390	69.6913	0.0393	0.3566
	5	0.5474	5.9178	16.3689	7.4303	1.1026	1.3768	66.6715	0.3967	0.7352
	10	0.5485	5.9709	16.3604	7.4358	1.1238	1.4004	66.4843	0.4077	0.8167
Taiwan	1	0.3096	1.8406	0.0231	0.2586	2.7069	0.0006	0.0139	95.1562	0.0000
	2	0.3135	1.8017	0.4510	0.2527	2.8586	0.1286	0.0147	94.2367	0.2560
	5	0.3281	3.0248	1.3900	0.7682	4.0307	0.5235	0.0347	88.5659	1.6623
	10	0.3294	3.1166	1.4527	0.7837	4.0762	0.5336	0.0420	87.9568	2.0383
Vietnam	1	0.7826	0.3314	0.0002	0.1275	0.3914	0.4109	0.7406	0.2077	97.7902
	2	0.7997	0.3679	0.3757	0.7993	0.6202	0.4509	1.8310	0.1994	95.3557
	5	0.8537	1.5264	1.4691	2.1398	1.0711	1.6281	3.1361	0.4450	88.5844
	10	0.8579	1.6955	1.5588	2.1888	1.1272	1.7264	3.2924	0.5279	87.8831

Each entry in the table denotes the percentage of forecast error variance of the left-hand side market explained by the market at the top.]

Table 6: Variance Decomposition with CNY IDR INR KRW MYR PHP TWD VND Ordering^a.

result shows that after the introduction of currency future in India, the impact of India market on Indonesia market has gradually declined.

Indonesia (16.6002%) appears to be the leader for Philippines market in both Sub-I and Sub-II periods. However, its influence is weak (Indonesia 2.0504%) in sub-period II. India (6.7708% and 1.2081%) affects Philippines fewer than after the currency future introduction (Sub-period II) and its effect is almost as much as that of China (1.6641%). Indonesia also has a strong effect on Korea as it explains 11% and 7% of its variance in the two periods respectively. Korea market explained by China and India 2% and 5% respectively in sub-period I. During sub-period II, China explained 13% while India explained 5% of Korea market. Philippines explained 10% of variance in Korea in the second period.

Before we draw any general conclusion from our analysis of variance decomposition it is worthwhile to mention our variance decomposition results using CNY IDR INR KRW MYR PHP TWD VND ordering. We notice that our conclusion about Indonesia's regional leadership is sensitive to the ordering in the Sub-period-I period. However, in the Sub-period-II period China emerges as a clear leader regardless of ordering (Table 8).

We conclude that Indonesia is a regional leader during sub-period I and its effect on the regional markets is even greater than that of China. This leadership has become weaker in sub-period II. Malaysia has been slightly alienated from the region in sub-period II. Most of the markets have become more sensitive to changes in India in the sub-

Variance Decomposition	Period (in days)	Sub-period II								
		S.E.	CNY	IDR	INR	KRW	MYR	PHP	TWD	VND
China	1	0.1211	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.1223	98.1136	0.9888	0.0016	0.0115	0.1157	0.7377	0.0063	0.0248
	5	0.1264	93.0659	1.1951	0.2123	0.3356	0.4985	3.9016	0.4098	0.3811
	10	0.1266	92.7550	1.2277	0.2273	0.3744	0.5122	4.0403	0.4631	0.4001
Indonesia	1	0.7810	0.7218	99.2782	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.8748	12.5168	79.2163	0.2554	0.0002	0.9961	6.9407	0.0714	0.0032
	5	0.9032	12.4795	74.5851	0.6919	0.1988	1.5740	10.1371	0.2468	0.0869
	10	0.9047	12.4854	74.3521	0.7070	0.3275	1.5763	10.1449	0.2982	0.1087
India	1	0.6241	0.0000	13.3599	86.6401	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.6855	13.9044	11.2045	71.9983	0.0317	0.1034	2.7548	0.0017	0.0012
	5	0.7169	14.1024	10.6636	66.5444	0.3515	0.3757	7.8165	0.0980	0.0480
	10	0.7186	14.0906	10.6273	66.2464	0.4475	0.3778	8.0093	0.1149	0.0862
Korea	1	0.8644	0.1995	8.5549	7.2871	83.9585	0.0000	0.0000	0.0000	0.0000
	2	0.9804	12.2916	6.8577	5.8130	66.5466	0.0000	8.4664	0.0036	0.0210
	5	1.0319	13.3048	6.8762	5.3797	61.7023	0.2418	10.8152	1.6334	0.0466
	10	1.0359	13.2911	6.9268	5.3947	61.6162	0.2976	10.7753	1.6368	0.0614
Malaysia	1	0.4136	0.4161	15.0342	12.4021	3.9491	68.1985	0.0000	0.0000	0.0000
	2	0.4773	22.6076	11.5614	9.3692	3.0014	52.0779	1.3350	0.0025	0.0451
	5	0.5045	20.4220	10.7684	8.5990	3.2207	46.6880	9.9058	0.3177	0.0784
	10	0.5062	20.4079	10.7207	8.5609	3.3347	46.3851	10.0971	0.3455	0.1481
Philippines	1	0.5116	1.2744	1.2697	0.9157	0.1807	0.0809	96.2787	0.0000	0.0000
	2	0.5127	1.3025	1.2649	0.9154	0.1840	0.0810	96.2300	0.0150	0.0072
	5	0.5182	1.4344	1.6152	1.0348	0.9149	0.3024	94.5966	0.0256	0.0762
	10	0.5186	1.4671	1.6146	1.0453	0.9603	0.3186	94.4525	0.0487	0.0928
Taiwan	1	0.3662	0.0099	0.2105	0.1118	0.0071	0.2566	0.0049	99.3992	0.0000
	2	0.3676	0.0874	0.2344	0.1215	0.3502	0.2710	0.0068	98.8737	0.0550
	5	0.3742	0.6879	0.5430	0.3347	0.5033	1.0448	0.4822	95.7354	0.6685
	10	0.3745	0.7281	0.5625	0.3458	0.5164	1.0725	0.5051	95.5875	0.6822
Vietnam	1	0.5195	0.0005	0.0433	0.0412	0.0001	0.0031	0.0437	0.1880	99.6801
	2	0.5404	0.1802	0.0444	0.1019	0.0040	0.0168	0.0867	0.1786	99.3874
	5	0.5498	0.2224	0.1731	0.1976	0.1826	0.3731	0.2976	0.4770	98.0767
	10	0.5511	0.2316	0.1805	0.2169	0.1930	0.3991	0.4537	0.4816	97.8436

Each entry in the table denotes the percentage of forecast error variance of the left-hand side market explained by the market at the top.]

Table 7: Variance Decomposition with CNY IDR INR KRW MYR PHP TWD VND Ordering^a.

period II. The possible reason could be the fact that Indian currency future market started enveloping the region very quickly.

Summary and Conclusion

In this paper, the inter-linkages among daily returns of Asia-Pacific NDF markets are examined for pre and post introduction of currency future periods separately, by using simple correlations, Granger causality tests and VAR models. It is found that Asia-Pacific markets are closely linked with one another. The Indonesia market does not have any influence on the other Asia-Pacific markets except India and is not much affected by any market other than the China, India and Philippines.

Correlation Matrices suggests that the linkages of Indian market with the other markets in the region have been affected by introduction of currency futures. Based on Granger causality test we found that the linkages have increased after introduction of currency futures in India.

Impulse response suggests that the shock of other Asia-Pacific market decreased after introduction of currency futures in India. In case of Vietnam much change is observed after the introduction of currency future. We also notice that China and Indonesia has more influence on Asia-Pacific market effect in both sub-periods. The findings support to the idea of China and Indonesia acting as a regional leader after the introduction of currency future.

From the Variance Decomposition result we conclude that

Variance Decomposition	Period (in days)	Full period								
		S.E.	CNY	IDR	INR	KRW	MYR	PHP	TWD	VND
China	1	0.1253	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.1262	98.5652	0.4979	0.0018	0.0475	0.2905	0.4468	0.0060	0.1444
	5	0.1294	94.5337	0.7480	0.0596	0.2737	0.5122	2.4897	0.3981	0.9851
	10	0.1296	94.3732	0.7677	0.0634	0.2931	0.5155	2.5268	0.4517	1.0085
Indonesia	1	0.7298	0.2347	99.7653	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.8008	10.2234	82.8917	0.4096	0.0001	0.8529	5.5701	0.0337	0.0185
	5	0.8165	10.2065	79.9105	0.6687	0.1234	1.2931	7.5879	0.1179	0.0919
	10	0.8173	10.2317	79.7520	0.6700	0.1937	1.2928	7.5810	0.1621	0.1167
India	1	0.5979	0.0682	15.0731	84.8587	0.0000	0.0000	0.0000	0.0000	0.0000
	2	0.6443	10.4969	13.1779	73.2664	0.0454	0.0475	2.9408	0.0007	0.0245
	5	0.6636	10.8947	12.5994	69.4379	0.2066	0.1821	6.4605	0.1828	0.0360
	10	0.6647	10.9299	12.5709	69.2168	0.2457	0.1860	6.6078	0.2006	0.0424
Korea	1	0.8082	0.1067	9.9950	7.0056	82.8927	0.0000	0.0000	0.0000	0.0000
	2	0.8927	8.9472	8.3490	5.8752	68.7694	0.0001	7.8857	0.0603	0.1129
	5	0.9222	9.6043	8.2244	5.5313	65.5556	0.1264	9.6522	1.1709	0.1349
	10	0.9244	9.6000	8.2398	5.5336	65.4694	0.1496	9.6554	1.2031	0.1491
Malaysia	1	0.4020	0.0586	17.7664	10.1308	4.1741	67.8700	0.0000	0.0000	0.0000
	2	0.4579	20.0287	13.8482	7.8058	3.2301	53.3388	1.7438	0.0023	0.0024
	5	0.4735	18.7994	13.3238	7.4601	3.3333	49.9630	6.8831	0.0828	0.1545
	10	0.4746	18.7578	13.3035	7.4341	3.3855	49.7416	7.0334	0.1267	0.2176
Philippines	1	0.5151	1.6641	2.0532	1.0729	0.3010	0.0193	94.8896	0.0000	0.0000
	2	0.5166	1.7052	2.0504	1.2081	0.3186	0.0281	94.6721	0.0054	0.0121
	5	0.5215	1.9934	2.3939	1.2733	1.0020	0.2082	92.9829	0.0259	0.1204
	10	0.5219	2.0130	2.3937	1.2756	1.0208	0.2160	92.9119	0.0433	0.1257
Taiwan	1	0.3557	0.1422	0.0948	0.0939	0.0207	0.1281	0.0003	99.5199	0.0000
	2	0.3567	0.1807	0.1155	0.0966	0.1930	0.1294	0.0118	98.9923	0.2807
	5	0.3612	0.5118	0.3482	0.2181	0.2826	0.7187	0.2945	96.9205	0.7057
	10	0.3613	0.5167	0.3537	0.2186	0.2919	0.7334	0.2958	96.8802	0.7097
Vietnam	1	0.6148	0.0065	0.0209	0.0160	0.0258	0.0036	0.0594	0.1437	99.7241
	2	0.6185	0.0641	0.0747	0.0160	0.0275	0.0822	0.0734	0.1604	99.5017
	5	0.6308	0.1253	0.2152	0.1807	0.2360	0.1818	0.1208	0.4370	98.5031
	10	0.6310	0.1316	0.2172	0.1823	0.2396	0.1924	0.1449	0.4451	98.4468

Each entry in the table denotes the percentage of forecast error variance of the left-hand side market explained by the market at the top.]

Table 8: Variance Decomposition with CNY IDR INR KRW MYR PHP TWD VND Ordering^a.

Indonesia is a regional leader during the sub-period I and its effect on the regional markets is even greater than that of China. This leadership has become weaker in sub-period II. Malaysia has been slightly alienated from the region in sub-period II. Most of the markets have become more sensitive to changes in India in the sub-period II. The possible reason could be the fact that Indian currency future market started enveloping the region very quickly.

Another important conclusion of our study is that inter-linkages among the Asia-Pacific markets have increased after the introduction of currency future and markets react more promptly and actively to the changes in neighboring markets.

References

- Guy D, Jacob G, Michael P (2006) Forward currency markets in Asia: lessons from the Australian experience. *BIS Quarterly Review*: 53-64.
- Guru A (2009) Non-deliverable forwards market for Indian rupee: an empirical study. *Social science research network* 8: 1-18.
- Economics LS (2012) BRIC currencies trading in London. *London School of Economics and Political Science*: 1-26.
- Guonan Ma, Corrinne H, Robert NM (2004) The markets for non-deliverable forwards in Asian currencies. *BIS Quarterly Review*: 81-94.
- Robert NM, Chang S, Guonan Ma (2014) Non-deliverable forwards: 2013 and beyond. *BIS Quarterly Review*: 75-88.
- Pami D, Partha S (2006) Capital Flow Volatility and Exchange Rates -- The Case of India. *Centre for Development Economics, Working paper series-144*: 1-40.
- Bekiros S (2014) Nonlinear causality testing with stepwise multivariate filtering: Evidence from stock and currency markets. *The North American Journal of Economics and Finance* 29: 1-13.
- Stelios DB, Diks CGH (2008) Nonparametric Nonlinear causality testing with

-
- stepwise multivariate filtering. Center for Nonlinear Dynamic in Economics and Finance (CeNDEF), Department of Quantitative Economics, University of Amsterdam: 1-46. Sims AC (1980) Macroeconomics and Reality. *Econometrica* 48: 1-48.
9. Kanas YM (1999) Testing for a nonlinear relationship among fundamentals and exchange rates in the ERM. Working Paper Series, Centre for Asian Pacific Studies: 1-30.
 10. Kumar D (2014) Correlations, Return and Volatility Spillovers in Indian Exchange Rates. *Global Business Review* 15: 77-91.
 11. Roberta C, Michael F (2008) Volatility transmissions between renminbi and Asia-Pacific on-shore and off-shore U.S. dollar futures. *China Economic Review* 19: 635-648.
 12. Srivastava A (2007) Cointegration of Asian Markets with US Markets: International Diversification Perspectives. *Global Business Review* 8: 251-265.
 13. Xingyun AR (2001) Interlinkages among South East Asian Stock Markets: A Comparison between Pre- and Post-1997-Crisis Periods. *Journal of International Money and Finance and the University of Rome Tor Vergata*: 1-33.
 14. Cheol SE, Sangdal S (1989) International Transmission of Stock Market Movements. *The Journal of Financial and Quantitative Analysis* 24: 241-256.