
Non Deliverable Foreign Exchange Forward Market: An Overview

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Recognising the growing activity in the non deliverable forward (NDF) market in the recent years, the paper attempts to present a detailed analysis of the NDF market with special focus on Indian rupee. An attempt is made to study the interlinkages among the spot, forward and NDF markets for Indian rupee. Using daily exchange rate data from Reuters database for the period November 2004 to February 2007, and applying Granger causality test and augmented GARCH formulation, the study finds that the NDF market is generally influenced by spot and forward markets and the volatility spillover effect exists from spot and forward markets to NDF market. Evidences are also observed for volatility spillover in the reverse direction, *i.e.*, from NDF to spot market, though the extent is marginal. Furthermore, using the covered interest parity formulation, the study has found that the spread between the onshore and offshore implied yield is positive, thus, providing evidence towards appreciation pressures operating on rupee in the domestic market. Hence, the study has suggested for close monitoring of NDF market.

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Keywords : Non deliverable forward, volatility, implied yield

Introduction

The Indian foreign exchange market has seen a massive transformation over the past decade. From a closed and heavily controlled setting of the 1970s and 1980s, it has moved to a more open and market-oriented regime during the 1990s. Turnover has increased in both the spot and forward segments of the market. A

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recent feature has been the growing trading of the Indian rupee in the non-deliverable forward (NDF) foreign exchange market.

The NDF markets have generally evolved for currencies with foreign exchange convertibility restrictions, particularly in the emerging Asian economies, *viz.*, Taiwan, Korea, Indonesia, India, China, Philippines, *etc.*, With controls imposed by local financial regulators and consequently the non-existence of a natural forward market for non-domestic players, private companies and investors investing in these economies look for alternative avenues to hedge their exposure to such currencies. In this context, non deliverable forwards have become popular derivative instruments catering to the offshore investors' demand for hedging. NDFs are types of derivatives for trading in non-convertible or restricted currencies without delivery of the underlying currency.

Trading in the NDF market generally takes place in offshore centres. In this market, no exchange takes place of the two currencies' principal sums; the only cash flow is the movement of the difference between the NDF rate and the prevailing spot market rate and this amount is settled on the settlement date in a convertible currency, generally in US dollars, in an offshore financial centre. The other currency, usually an emerging market currency with capital controls, is non-deliverable. In this particular respect, of course, NDFs are similar to commodities futures market where commodities, like wheat or corn, are traded in organized futures markets and positions are later settled in dollars, wheat or corn being non-deliverable. The NDF prices are generally determined by the perceived probability of changes in foreign exchange regime, speculative positioning, conditions in local onshore interest rate markets, the relationship between the offshore and onshore currency forward markets and central bank policies.

Being offshore, the market has remained outside the regulatory purview of the local monetary authorities. Yet, considering the linkages that prevail between the onshore spot and forward markets and the offshore NDF market, activity in these markets has always been of interest to the regulators. However, studies on NDF markets are rather limited and in India, this aspect has remained unexplored.

Against this backdrop, the paper attempts to explore the various facets of the NDF market in the Asian region, with particular focus on the transactions in Indian rupee in the NDF markets. Section I traces the evolution of NDF markets in the Asian region. A review of the extent of activity in the Asian NDFs, at present, is attempted in Section II. Section III then, provides a detailed overview of the current NDF market structure for Indian rupee. It undertakes an assessment of the available market infrastructure in terms of market players, market regulation, settlement period, trading platform and the offshore centers for INR-USD NDFs. An assessment of the market activity in terms of market turnover, volatility and bid-offer spreads are also part of this section. Section IV tries to explore the linkages in terms of information flows between the offshore rupee NDF and the onshore markets. Empirical exercises have also been attempted to examine (1) the causality that exists between the two markets, (2) the volatility spillover that takes place between the two markets and (3) the extent of market segmentation between onshore and offshore interest rates implied by the NDFs. Section V dwells upon the policy implications of the analysis. Section VI then lists out the concluding observations along with the outlook for the future.

Section I

Evolution of NDF markets

Capital flow to emerging market economies (EMEs), particularly Asia, rose significantly during the 1980s and 1990s. During this period, however, while in some EMEs domestic forward markets were not developed, others were characterized by restrictions on non-residents' access to domestic forward market. The objective was clear. Local monetary authorities feared that easy access to onshore local currency loans and deposits, and the ability to easily transfer local currencies to non-residents, encourages speculative financial movements, greater exchange rate volatility, and ultimately some loss of monetary control (Higgins and Humpage, 2005). Consequently, some international banks, starting from the early 1990s, began offering non-deliverable forward contracts to investors to hedge their exposures in EME currencies.

Initially, most NDF trading was in Latin American currencies. Trading volume in NDFs began to increase in 1994 after voice brokers entered the market as intermediaries facilitating interbank trading, which allowed dealers to more easily offset positions with one another that they had accumulated from their market making activities for clients. At that time, Mexican *peso* NDFs had the largest trading volume, reflecting market participant expectations for a devaluation of Mexican *peso* from its then-fixed level against the dollar. As investment flows into emerging economies grew, the NDF market increased and expanded beyond Latin American currencies to Asian and Eastern European currencies. The International Swaps and Derivatives Association (ISDA) added settlement provisions for NDF transactions to its 1997 draft FX and currency option definitions. Interest in NDF trading further increased leading up to the Asian crisis of 1997. Many emerging market countries tightened their restrictions following the financial crises of 1997 and 1998, giving a further impetus to an already developing offshore NDF market.

Today, a large and increasingly active market in NDFs exists for many Latin American, East Asian, and Eastern European currencies, with centers in Hong Kong, Singapore, South Korea, Taiwan, Japan, London (for Eastern European currencies and Asian currencies), and New York (for Latin American currencies). Experience suggests that NDF markets are likely to be most developed for countries with significant cross-border capital movements (both portfolio and/or foreign direct investment) but with some convertibility restrictions operating (Lipscomb, 2005). Conversely, NDF markets in currencies of countries that have allowed increased capital convertibility, to the point where currency hedging is fully available onshore have dissipated and/or disappeared (*e.g.* Australia).

Even today many emerging market economies, including China, Indonesia, South Korea, the Philippines, and Taiwan, restrict foreign access to their currency and onshore money markets, making it very difficult—if not impossible—for foreign firms or international investors to hedge in local forward exchange markets, even when such markets exist. As a part of foreign exchange control, access to onshore forward markets by non-residents is not allowed in China

and Taiwan, whereas the access is allowed, subject to underlying transactions requirement in countries like Indonesia, Korea and Philippines including India (Ma *et al.* 2004).

The Indonesian rupiah NDF is a very recent one that had its birth in early 2001. Before January 2001, *deliverable* rupiah forwards were actively traded offshore, mostly in Singapore, and non-residents enjoyed easy access to rupiah funding. To reduce speculative pressure on the rupiah, rupiah loans and transfers by banks to non-residents and related derivative transactions were prohibited or restricted by Bank Indonesia in January 2001. This effectively limited the offshore deliverability of the rupiah and dried up trading in offshore *deliverable* rupiah forwards. To meet the offshore hedging or speculative demand, an offshore market in rupiah NDFs gradually developed over the following months.

It is interesting to observe that the Malaysian ringgit and Thai baht are not traded actively in the NDF markets despite these countries having capital controls, because of certain policies pursued by them. In the case of Malaysia, an offshore NDF market for Malaysian ringgit could not develop after Malaysia moved to a fixed exchange rate system in September 1998. Besides, in the case of Malaysia, the absence of a reference exchange rate for the settlement of NDF contracts among market players is also another factor contributing towards lack of development of NDF market. Moreover, exchange controls in Malaysia prohibit domestic banks to undertake forward foreign exchange transactions with offshore counterparties. Thus, restricting availability of offshore institutions to hedge their exposure derived from the NDF contracts hinders the development of the market¹. Similarly in Thailand, the Bank of Thailand (BoT) actively discourages foreign banks from quoting in the NDF market. There is an implied threat that if the foreign banks quoted in the NDF market, their domestic branches would have to face the consequences. By adopting this stance, the BoT makes it difficult for banks to quote in the NDF market. However, it is felt that a more actively traded Thai baht NDF market could emerge in the future in response to the Bank of Thailand measures in the recent past to limit non-resident holdings of Thai baht bank accounts.

Annex 1 gives in detail the current restrictions that operate in the forward exchange market and on the access of onshore forward market by non-residents for select Asian countries.

Section II

Activity in Asian NDFs

Comparable and quality data on NDF turnover is generally limited. The Emerging Markets Traders Association (EMTA) Survey held in early 2003 is the latest available official source. As per the EMTA survey, Asia's NDF turnover accounts for the majority of global NDF turnover. In particular, NDFs in the Korean won, the New Taiwan dollar, the Chinese renminbi, the Indian rupee, the Indonesian rupiah and the Philippine peso amount to more than 60 per cent of the emerging market NDF turnover globally. The major remaining NDF markets are those in Latin American currencies (mainly the Brazilian real and Chilean peso) and the Russian rouble, according to the survey. The Korean won NDF market has been the deepest in Asia as well as globally, with average daily trading volume in excess of US \$ 500 million and representing nearly half of the emerging market NDF turnover (Table 1). The reason generally stated is that Korea allows domestic banks to operate in the NDF market and that is one of the reasons why the South Korean won is the most liquid NDF currency.² Turnover in the New Taiwan dollar NDF market has been the second most active in Asia. The earlier shallow NDF markets in Asia, viz., Chinese renminbi, Indian rupee, Indonesian rupiah and Philippine peso have deepened significantly over the past few years. Also, for most of the currencies, there is limited liquidity in contracts with a maturity over one year.

NDFs form an important part of overall forward trading in regional currencies. For the six emerging Asian currencies, discussed above, the reported NDF turnover represents some 10-20 per cent of the combined trading volume of the onshore outright forwards, foreign exchange swaps and NDFs. In the case of China, domestic trading of outright forwards being a recent phenomenon and with the lack of an onshore swap market, renminbi NDFs amount to about 90 per cent

Table 1: Average daily NDF turnover in Asia

(in millions of US dollars)

Sources of estimates	HSBC	Deutsche Bank	EMTA	Lehman Brothers	Forwards and forex swaps
	(mid-2003)	(2003-04)	(1st quarter 2003)	(June 2001)	(April 2001)
1	2	3	4	5	6
Chinese renminbi	1,000	50	150	50	55
Indian rupee	100	20-50	38	35	1,628
Indonesian rupiah	100	50	65	50	301
Korean won	500	700-1,000	1,350	500	4,025
Philippine peso	50	20-30	38	35	301
New Taiwan dollar	500	300-500	250	250	922
Asian six total	2,250	1,140-1,680	1,890	920	7,232
As a percentage of April 2001 forwards, Forex swaps and NDFs	25.1	13-19	20.7	11.3	

Source: Ma *et al.* 2004, BIS Quarterly Review.

of the estimated combined turnover of onshore deliverable forwards and offshore NDFs.

The investor base for the Asian NDF markets has broadened significantly over the past few years. The investor base mainly comprises multinational corporations, portfolio investors, hedge funds and proprietary foreign exchange accounts of commercial and investment banks. Both hedging demand and speculative demand are present in Asian NDF markets. In the case of the won and the New Taiwan dollar, portfolio investors and hedge funds seem to be the most important players. In contrast, in the case of renminbi, multinationals associated with large FDI into China and more recently hedge funds associated with greater speculation, play a greater role (Ma *et al.* 2004).

An interface with the financial institutions in conjunction with the Committee on the Global Financial System work group project on foreign direct investment in emerging market financial sectors reveal that as much as 60 to 80 percent of NDF volume is generated by speculative interest, reflecting growing participation from international hedge funds. Major financial institutions are generally

involved in NDF markets through their market-making activities. These market-making activities are a service to their customers for which the firm is compensated by a bid/ask spread as well as effective management of the firm's NDF book. Currently, major international banks primarily offset NDF positions incurred through market-making activities with other major banks through the broker market, but also deal directly with other banks and onshore market players and exchanges (Lipscomb, 2005).

Section III

Features of Indian Rupee NDF market

Trading platform and offshore centre

NDFs are primarily over-the-counter, rather than exchange-traded products, thus making it difficult to gauge the volume of contracts traded, who trades the contracts, and where they are traded. At the international level, New York tends to dominate trading in Latin American NDFs, Singapore (and to a lesser extent Hong Kong) dominate trading in non- Japan Asian NDFs, while London spans these markets. The INR NDF is largely concentrated in Singapore and Hong Kong, with small volumes being traded in the Middle East (Dubai and Bahrain) as well.

NDF Market Regulation

At present, there are no controls on the offshore participation in INR NDF markets. The onshore financial institutions in India, however, are not allowed to transact in the NDF markets. Domestic banking entities are allowed specific open position and gap limits for their foreign exchange exposures and through these limits domestic entities could play in the NDF markets to take advantage of any arbitrage or even speculate. This itself restricts the extent to which domestic banks could participate in NDF markets. The objective has been that allowing domestic banks to participate in the NDF markets would require an enhanced level of intervention from the Reserve Bank of India (RBI) to protect Indian rupee from any speculative attack.

Market Players

NDF market players generally operate with an objective of hedging, speculating and arbitraging. While the INR NDF market has been around for over the last 10 years or so, the characteristics of this market seem to have evolved over this period in tandem with the onshore exchange controls and regulations. In the late 1990s the NDF market was provided liquidity by foreign residents who had a genuine exposure to the Indian rupee but were unable to hedge their exposure in the domestic market due to existing controls. However, with the gradual relaxation of the exchange controls, reasonable hedging facilities are available to offshore non-residents who have exposures to the rupee, especially when compared with the hedging facilities provided by some other competitor Asian countries such as China. Hence, the INR NDF market presently derives its liquidity largely from (i) Non-residents wishing to speculate on the Indian rupee without any exposure to the country, and from (ii) arbitrageurs who try to exploit the differentials in the prices in the two markets without any outlay of capital on their part by two offsetting transactions. (For the Indian rupee it is believed that arbitrage is profitable when there is difference of around 10 paise in the forwards prices. Such opportunities are not very common, but tend to occur whenever speculative actions increase).

The behaviour of NDF market players depends critically on their objective for participation. Foreign investors who participate in the NDF market to hedge their exposures generally take long positions *e.g.* multinational companies. Speculators, on the other hand, operate mostly in the short end of the market *e.g.* hedge funds, also corporates entities with an international presence who undertake speculative or arbitrage trades, jewel exporters and manufacturers that constitute another group who are active arbitraging between domestic and NDF markets.

As reported by market participants, some of the foreign banks which trade in the rupee NDFs include Deutsche Bank, UBS AG, Standard Chartered Bank, Citibank, JP Morgan Chase, ABN Amro, Barclays, ANZ Investment bank and BNP.

Settlement period

The settlement period refers to the gap between the day the NDF contract is fixed and the actual delivery date. The fixing date is the day on which the comparison between the NDF rate and the prevailing spot rate is made. The settlement date is the day whereby the difference is paid or received. Depending on the currencies dealt, there are variations whereby for some currencies, the settlement period is one day whereas for others it is two business days. Generally, the spot rate used in the NDF market is based on a reference page on Reuters or Telerate with a fallback of calling four leading dealers in the relevant market for a quote. For the Indian rupee NDF, the RBI reference rate is generally used as the fixing rate.

Market Turnover

Information on the traded volumes in the NDF market is rather difficult. Various estimates are available though they are published with a lag. As per an estimate by HSBC for mid-2003, the daily volumes for INR NDF was about US \$ 100 million. The latest available information on NDF turnover indicates a substantial pick up in NDF turnover in Indian rupee in line with the pick up in domestic onshore spot and forward market turnover. The NDF market turnover, however, remains small when compared with onshore market turnover. The daily average turnover in the spot market is about 4.4 times and forward/swap market is about 4.1 times the turnover in the NDF market (Table 2). The turnover is high for 1-month and 1-year maturity. As compared with some other Asian currencies traded in the NDF market such as the Korean won, Chinese yuan and Taiwanese dollar, the turnover in the NDF market is very small for Indian rupee.

Bid Offer Spreads

Markets are generally, perceived as efficient when market prices reflect all available information, so that it is not possible for any trader to earn excess profits in a systematic manner. The efficiency/liquidity of the foreign exchange market is often gauged in terms of bid/offer spreads. The bid-ask spread refers to the transaction costs

Table 2: Daily average turnover on Indian spot, forward and NDF market during 2007

(US \$ million)

Spot	16,381
Forward/Swap	15,378
NDF	3,736
<i>Of which</i> 1 Month	993
2 Month	735
3 Month	990
6 Month	913
1 Year	1,018

Note : Turnover for NDF is the average daily volume of NDF bidding for the period January 5 to April 20, 2007. Turnover of spot, forward and swap is for January-April, 2007.

Source : Reuters and Reserve Bank of India.

and operating costs involved with the transaction of the currency. With the increase in the volume of transaction of the currency, these costs/bid-ask spreads may reduce.

In India, the spread is almost flat and very low in the spot segment of the foreign exchange market. The spread in the NDF segment remains higher than that of the spot and forward market reflecting lower liquidity in the NDF market (Table 3)³. As compared with other Asian currencies, the spreads for Indian rupee NDFs remain lower than that of Indonesian Rupiah and Philippine peso, but higher than that of Chinese renminbi and Korean won reflecting the higher liquidity available in the latter two currencies (Table 4).

Table 3: Bid-ask spread (Re-USD) in Foreign Exchange market

(in per cent)

	Spot	Forward	1M NDF	3M NDF	6M NDF
1	2	3	4	5	6
Average	0.03	0.09	0.11	0.21	0.29
Min	0.01	0.02	0.05	0.11	0.15
Max	0.17	0.38	0.28	0.29	0.34

Source: Reuters, Authors' calculation.

Table 4: Bid-Ask Spreads in NDF market for select Asian currencies

(in per cent)

	1M NDF	3M NDF	6M NDF
1	2	3	4
Chinese Yuan			
Average	0.06	0.06	0.09
Min	0.01	0.01	0.01
Max	0.76	0.13	0.61
Korean Won			
Average	0.09	0.10	0.14
Min	0.01	0.02	0.02
Max	0.34	0.24	0.29
Indonesian Rupiah			
Average	0.51	0.73	1.09
Min	0.22	0.22	0.28
Max	1.92	2.73	3.13
Philippine Peso			
Average	0.22	0.23	0.39
Min	0.09	0.09	0.14
Max	0.51	0.51	0.75

Source: Reuters, Authors' calculation.

Market Volatility

Looking at the volatility in the INR NDF market, it is observed that NDF volatilities have been consistently higher than their spot counterparts (Table 5). This is essentially attributed to official intervention in the spot and forward markets by the Reserve Bank. This is a feature observed for most other Asian currencies, particularly

Table 5: Volatility of Indian rupee

(in per cent)

Market	Volatility
1	2
Spot	0.24
Forward	0.27
1M NDF	0.35
3M NDF	0.50
6M NDF	0.47

Note : Volatility is calculated from the standard deviation of the percentage return of rupee-dollar exchange rates.

Source : Reuters, Authors' calculation.

China, Philippines and Taiwan where intervention is an important component of monetary policy (Ma *et al.* 2004).

Section IV

The Linkage between Onshore (spot and forward) and Offshore (NDF) market for Indian Rupee

Causality between NDF and onshore Spot and Forward market

With an objective to examine the causal link between the spot, forward and NDF market for Indian rupee, Granger causality test was carried out. The results are reported in Table 6⁴. As expected, two way causation was exhibited between percentage change in spot and forward rupee-dollar rates as the null hypothesis is rejected at very low levels of significance. Further strong unidirectional causality was observed from percentage change in spot to NDF rates and forwards to NDF rates reflecting the fact that the price in the NDF market is determined primarily on the basis of the RBI reference rate. The causality from NDF to spot and forward markets, however, remained insignificant⁵. Such a result seems obvious in the Indian context given the fact that the domestic market players participation in offshore NDF market for Indian rupee is limited. A similar result

Table 6: Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Probability
1	2	3
RFW does not Granger Cause RSP	4.27*	0.00
RSP does not Granger Cause RFW	4.10*	0.00
RNDF1 does not Granger Cause RSP	2.02**	0.06
RSP does not Granger Cause RNDF1	21.97*	0.00
RNDF1 does not Granger Cause RFW	0.80	0.57
RFW does not Granger Cause RNDF1	17.84*	0.00

* and ** stand for rejection of the null hypothesis at 5 percent and 10 per cent level of significance respectively.

Note: RSP = Percentage return on rupee-dollar spot rates;

RFW = Percentage return on 1 month forward rupee-dollar rates and

RNDF1 = Percentage return on 1 month rupee-dollar NDF rates.

Selected lag length = 6

X represent a set of exogenous variables (including the AR and MA terms), which determine μ_t ,

ε_t is a conditional residual term follows a normal distribution of mean 0 and variance h_t , with the given information set \mathcal{I}_{t-1} , and

h_t is the conditional variance of rupee-dollar exchange rate changes of market i at time t .

Taking the lagged residuals from the above model, the augmented GARCH(1,1) can be of the form:

$$h_t = \omega + \alpha_1 r_{i,t-1}^2 + \delta + \xi_t \quad (3)$$

$$h_t = \alpha + \alpha \xi_{i,t-1} + \beta h_{i,t-1} + \gamma \varepsilon_{i,t-1}^2 \quad (4)$$

with $\alpha, \beta, \gamma > 0$ and

where $r_{i,t}$ is the rupee-dollar percentage return in market i at time t ,

$r_{j,t-1}$ represents the rupee-dollar percentage return in market j at one period lag, which shows the mean spillover effect from market i to market j ,

X represent the set of exogenous variables (including the AR and MA terms), which determine μ_t ,

h_t is the conditional variance on rupee-dollar exchange rate changes of market i at time t ,

$\xi_{i,t-1}$ is the one period lagged squared residuals from the mean equation (3) and

$\varepsilon_{i,t-1}^2$ is one period lag squared residuals from the GARCH(1,1) model jointly determined from equation (1) and (2), which exhibits the volatility spillover effect from market j to market i .

Results of the empirical analysis are reported in Table 7⁶. As observed earlier, mean spillover effect represented by coefficient b_i from both spot and forward to NDF market is significant with the counterparty lagged return coefficient being high. The mean spillover effect in the reverse direction *i.e.* from NDF to spot and forward is observed to be insignificant. This reflects the fact that information flows

Table 7: Volatility spillover effect

Variable	Coefficients				
		α			
i = Spot	0.06	0.01	0.17	0.61	0.05
j = NDF1	(1.56)	(2.32) *	(2.51) *	(6.61) *	(2.00) *
i = Forward	0.02	0.01	0.24	0.57	0.07
j = NDF1	(0.37)	(2.15) *	(3.05) *	(4.74) *	(1.67) **
i = NDF1	0.43	0.01	0.17	0.53	0.36
j = Spot	(5.09) *	(2.43) *	(2.28) *	(7.01) *	(2.80) *
i = NDF1	0.36	0.01	0.16	0.71	0.10
j = Forward	(4.78) *	(1.61)	(2.59) *	(6.90) *	(1.20)

* and ** stand for rejection of the null hypothesis at 5 percent and 10 per cent level of significance respectively. Figures in brackets are t-statistics.

from spot and forward markets to determine the returns in NDF market, thus, supporting the efficient market hypothesis for NDF market.

The coefficient γ reflects the volatility spillover impact between the markets. As can be observed this coefficient is significant from spot to NDF which is expected, considering that NDF market draws information from spot market. It is also important to mention here that this effect from spot to NDF is quite strong. The volatility spillover effect doesn't exist from forward to NDF.

It is also observed that this coefficient is also significant from NDF to spot and forward markets. This indicates that there is volatility spillover from NDF to spot market and NDF to forward market although the spillover effect is not large given the low value of the coefficients in both the cases.

Onshore/Offshore Interest Rate Spreads

Another way to look at market efficiency is to analyse the extent of market segmentation between onshore interest rates and offshore interest rates implied by the NDFs. Under the covered interest parity condition, the forward exchange rate of the home currency, in the absence of capital controls, is linked by arbitrage to its spot rate and

the interest rate differential between the home currency and the US dollar as set out in equation 5 :

$$F = S(1+r)/(1+r^{\$}) \quad (5)$$

where F is the forward rate, S the spot rate, r the interest rate on the home currency and $r^{\$}$, the US dollar interest rate. When there are no cross-border restrictions, borrowing and lending ensure that the above holds.

However, when capital controls bind, non-residents may not have full access to onshore credit or placements, giving rise to NDFs (equation 6).

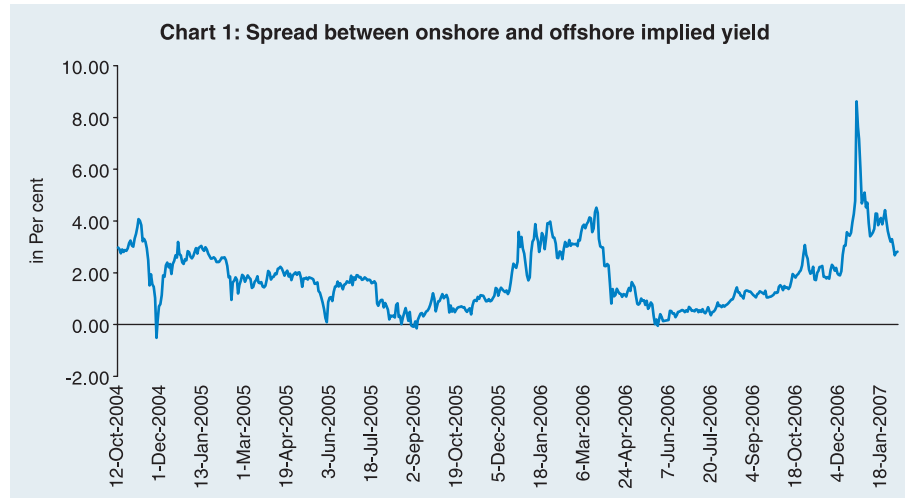
$$NDF = S(1+i)/(1+r^{\$}) \quad (6)$$

where i is the NDF-implied yield on the home currency offshore.

To the extent that the arbitrage between the onshore money market and offshore NDF market is effectively constrained by capital controls, the NDF-implied offshore interest rate, i , can differ considerably from the interest rate prevailing in the onshore money market, r . A large and persistent onshore/offshore spread ($r - i$) indicates the presence of effective cross-border restrictions.

Further, the sign of the onshore/offshore yield spread can signal underlying market pressure on the currency. An onshore interest rate above its offshore NDF-implied counterpart would indicate underlying appreciation pressure on the home currency but effective capital controls limiting capital inflows into the home currency. An onshore rate below its offshore counterpart would indicate depreciation pressure but effective stemming of capital outflows. A zero spread may suggest the absence of effective capital controls, or the absence of market pressure on the home currency, or both.

Based on the above analogy, the NDF implied yield on the Indian currency offshore was computed using data for the period November 2004 to February 2007. In the absence of a meaningful/comparable onshore money market rate, an equivalent approach generally used



is to estimate the implied onshore yield on the home currency using the onshore deliverable forward premia and then to compare it with the NDF implied offshore yields. Accordingly, the implied forward yield and spread have been computed for the Indian rupee (Chart 1). The non-zero spread between the implied yield in the forward and NDF market seems to be indicative of presence of capital controls in India that weaken and prevent cross border arbitrage to some extent. During this period, the offshore implied yield has also mostly remained lower than onshore rates reflecting the general appreciation pressure on the rupee onshore during this period. On certain occasions, the spread has touched zero implying no underlying pressures on the domestic INR.

It is interesting to compare the above findings with the results of Ma *et al.* 2004. For the period January 1999 to December 2001, they had observed the spread to be mostly negative implying continuing depreciation pressures operating in the Indian economy. In fact this was true for most Asian currencies in the post East Asian crisis period. The absolute spread was also very high ranging from (-) 400 to (-)1000 basis points during that period. For the period 2004-2007, the spreads seem to have narrowed considerably ranging between 0-400 basis points⁷. This feature could be attributed to the growing liquidity in the INR NDF markets and the diminishing capital controls in India during the past 6-7 years⁸.

An interesting observation from the recent trend with regard to the implied NDF yields depicts the fact that despite substantial capital controls, Chinese yuan is observed to have a very low implied yield in the NDF market *vis-à-vis* other Asian currencies including Indian rupee. For example, the one year NDF implied yield for Chinese yuan is presently placed at around 0.2 per cent as against 7-8 per cent for the Indian rupee NDF implied yield. This is essentially attributed to relatively controlled currency of China along with low domestic yuan interest rates.

Section V

Policy Perspective

Policy Implications of NDF market

From a broader perspective, markets for non-deliverable currency forwards (NDFs) are of interest to policy makers because they are a product generally used to hedge exposure or speculate on a currency movement where local market authorities limit such activity. NDF prices are also a useful tool for market monitoring in that these prices reflect market expectations, and supply and demand factors that cannot be fully manifested in onshore prices in a country with capital controls. The difference between onshore currency forward prices, where they are available, and NDFs can increase in periods of heightened investor caution or concern over potential change in the exchange rate regime or a perceived increase in onshore country risk (Lipscomb, 2005).

In the Indian context, as can be observed from the previous sections, the NDF market draws its information mostly from the onshore spot and forward markets and the reverse causality is poor. The NDF market turnover volumes are also not large enough to affect the domestic onshore INR market. Yet it may be important from the policy angle to take cognizance of the developments in the NDF markets. There are evidences of volatility spillover from NDF market to onshore spot market, though not large. Hence, if not in regular market conditions, in volatile market conditions the NDF market transactions can have an impact on the domestic spot markets. It

would be pertinent to monitor the NDF prices so as to tap the additional information with the NDF market players especially pertaining to dollar movements in offshore markets. Besides, prices in the NDF market can be a useful informational tool for authorities and investors to gauge market expectations of potential pressures on the exchange rate in future. Gradually, however, once India moves on to fuller capital account convertibility, the NDF transactions are going to perish. Till that time, close monitoring of the NDF market activity could be crucial. The relatively low turnover and marginal volatility spillover impact, however, discounts for the need of regulatory control on these markets.

Recent Policy Initiatives

Efforts have been made towards improving the hedging facilities that are available to offshore non-residents who have exposures to the rupee, particularly the foreign direct investors. As far as the foreign institutional investors (FIIs) are concerned, they were not allowed to rebook contracts once cancelled till recently. The Committee on Fuller Capital Account Convertibility (FCAC) recommended that to minimise the influence of NDF markets abroad, the FIIs may be provided with the facility of canceling and rebooking forward contracts and other derivatives booked to hedge rupee exposures. The Mid-Term Review of Annual Policy Statement 2006-07, announced by the Reserve Bank of India in October 2006 proposed to implement this recommendation. Accordingly, AD category – I banks have been permitted to allow FIIs to cancel and rebook forward contracts up to a limit of 2 per cent of the market value of their entire investment in India as at the beginning of the financial year. The outstanding contracts must also be duly supported by underlying exposure at all times.

Besides, recently initiatives have been undertaken to expand the range of hedging tools available to the domestic market participants to hedge economic exposures *viz.*, importers' customs duty component, price risk on aluminium, copper, lead, nickel and zinc in international commodity exchanges, actual users of aviation turbine

fuel (ATF) to hedge their economic exposures in the international commodity exchanges, free cancellation and rebooking of forward contract up to 75 per cent, 100 per cent for corporates with overseas direct investments and small and medium enterprises (SMEs).

Section VI

Concluding Observations and Future Outlook

With the growing interest of the global players in the Indian economy and the consequent increase in capital inflows into India over last few years, there has been an increase in liquidity in the INR NDF market. This market essentially draws information from the onshore spot and forward markets. The bid-offer spread and volatility in this market has, however, generally remained higher than that of onshore counterparts. While the offshore NDF rates do not directly influence the spot and forward rates in the domestic market, volatility in NDF markets is empirically tested to influence the onshore markets.

Looking forward, India is expected to remain an attractive destination for foreign investors in near future. Consequently, transactions in NDF market may rise to hedge against rupee exposure. The activity in the NDF market will also be governed by the following factors: (a) further move towards capital account convertibility, the roadmap for which has been provided by the FCAC (b) further development of financial markets particularly in terms of better fulfillment of interest rate parity conditions (c) introduction of more and more derivative products for both onshore and offshore investors so as to provide them more avenues for hedging in the domestic market, particularly to offshore investors and lastly, (d) complete phasing out of the underlying exposure criteria for booking a forward contract.

With India continuing its initiatives towards further opening up of the capital account, the NDF market activity is expected to decline and finally disappear. However, so long as there is differential treatment between residents and non-residents with regard to their operation in derivatives market, offshore INR NDF market will continue to thrive. Till that point, the NDF markets could be regarded

as essential for sustenance of offshore investor's interest in the domestic economy. Activity in the NDF market needs to be closely monitored to keep track of the pressures operating on the Indian currency as well as to prevent speculative attack on Indian currency during volatile conditions.

Notes:

¹ In case of Malaysia, it is also stated that "offshore banks possibly refrained from engaging in creative transactions such as NDF to circumvent the controls so as not to risk their local franchise." In countries where major market players have strong incentives to build and maintain good relationships with regulators, the effectiveness of regulations is more likely to be ensured (Ishii, 2001).

² Korean authorities briefly sought to limit the effect of NDF demand on local markets by restricting local banks' participation in the NDF market. The presumed intent was to lessen the need for central bank intervention as the effect of foreign demand for long won positions would be limited onshore. The regulations were reportedly seen as adversely affecting local banks and were subsequently largely rescinded.

³ The percentage spread is calculated as: $(\text{Ask}-\text{Bid}) / [(\text{Ask}+\text{Bid})/2] * 100$.

⁴ The detailed discussion about the estimation is reported in Annexure II.

⁵ NDF Granger causes spot at 10 per cent level of significance.

⁶ The constant term in conditional variance equation, ARCH and GARCH coefficients are significant and have expected signs except in the last case where the constant term is insignificant.

The detailed discussion on estimation and empirical results is reported in Annexure II.

⁷ There was one occasional spike in the spread to 800 basis point on December 26, 2006 associated more with liquidity pressures in the domestic market on that day.

⁸ Any interpretations of onshore/offshore interest spreads need qualifications. Ideally, the comparison should be between a liquid onshore bank interest rate and a similarly liquid offshore implied rate. But the fact that the domestic money market is most liquid at short maturities, while NDF markets tend to be more liquid at medium to long maturities, makes it hard to find good liquidity at matching maturities.

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ANNEX I**Extant Restrictions on Forward Exchange Market**

People's Republic of China	
Forward exchange market	Forward exchange operations by the Industrial and Commercial Bank of China, Agricultural Bank of China, Bank of China, China Construction Bank, Bank of Communications, CITIC Industrial Bank, and China Merchants Bank are allowed with respect to current transactions, banks' own foreign exchange loans, and repayment of foreign exchange loan obtained abroad and registered with the SAFE, with a maximum maturity of 365 days.
Controls on Derivatives and other Instruments	
Purchase locally by nonresidents	These transactions are not allowed.
Sale or issue locally by nonresident	These transactions are not allowed.
India	
Forward exchange market	<p>ADs are allowed to deal forward in any permitted currency. The RBI may enter into swap transactions with ADs, under which it buys or sells spot U.S. dollars and sells or forward dollars for maturities available in the market.</p> <p>A resident may enter into forward contracts with ADs to hedge against exchange risks. Forward contracts of importers and exporters booked and outstanding must not exceed at any point of time 100% of the eligible limit, provided that any amount in excess of 20% of the eligible limit shall be only on a deliverable basis. The eligible limit is defined as the last three years' average of import or export turnover, or the previous years' turnover, whichever is higher. A resident with an underlying contract may enter into a forward contract with an AD in India to hedge exposure to exchange risk to the full extent of such a contract.</p> <p>ADs may provide forward exchange cover to foreign institutional investors (FII) up to the full extent of their investment in debt instruments and equities. FIIs may hedge the entire market value of their investments in debt instruments and equities. FIIs may hedge the entire market value of their investments in equities. ADs may also provide forward cover not exceeding six months to foreign direct investors to hedge their currency risk arising from proposed direct investments in India after ensuring that the foreign entity involved has completed all formalities and obtained the necessary approvals (where applicable) for the investment in India.</p>

	<p>Nonresident Indians (NRIs) may enter into forward contracts with ADs to hedge the amount of dividends due them or the balances held in their foreign currency nonresident (FCNR) accounts or nonresident external (NRE) accounts. They are also eligible to have forward cover with respect to their investments in portfolio investment schemes.</p> <p>ADs may offer plain vanilla European forward options to customers who have genuine foreign currency exposures. All conditions applicable for booking, rolling over, and canceling forward contracts are applicable to options contracts. Only one hedge transaction can be booked against a particular exposure or part thereof for a given time period. Options contracts also cannot be used to hedge contingent or derived exposures, with the exception of exposures arising from the submission of tender bids in foreign exchange.</p> <p>Residents with overseas direct investments in equities and loans may hedge against exchange risks arising from such investments.</p>
Controls on Derivatives and other Instruments	
Purchase locally by non resident	<p>ADs may offer forward or option contracts to nonresidents outside India to hedge their direct investments that were made in India after January 1, 1993, subject to verification of exposure in India. FII may hedge the market value of their entire investment in equity or debt. NRI may hedge the dividends due to them, balances held in FCNR and NRE accounts, and portfolio investments.</p> <p>FII and NRIs may trade in all exchange-trade derivative contracts that have been approved by the SEBI, subject to prescribed limits. FIIs and NRIs may also invest in these contracts using rupee funds held in India on a nonrepatriable basis, subject to the limit prescribed by the SEBI.</p>
Sale or issue locally by non resident	These transactions are not allowed.
Republic of Korea	
Forward exchange market	<p>There are no controls on the trading of over the counter-related derivatives if the transactions are made through domestic foreign exchange banks. However, transactions in credit derivatives with the domestic foreign exchange banks and those directly related to specific capital transactions require BOK notification. Security companies may carry out freely transactions in derivatives-such as forwards, foreign exchange swaps, foreign currency swap options, and interest rate swap options - with nonresident juridical persons. Other transactions in derivatives require BOK approval.</p>

Controls on Derivatives and other Instruments	
Purchase locally by non resident	Yes
Sale or issue by non resident	There are controls on all derivative transactions by nonresidents involving the use of won-denominated financing.
Indonesia	
Forward exchange market	If there is no underlying local investment activity, forward foreign currency contracts offered by domestic banks to nonresidents are limited to \$ 3 million or its equivalent a customer. These restrictions do not apply to investment-related transactions, such as equity participation, purchase of securities, and provision of credit.
Controls on Derivatives and other Instruments	
Purchase locally by nonresident	Nonresidents are not allowed to buy real estate. However, they are permitted to engage in inward direct investments in local real estate.
Sale locally by non residents	Yes.
Philippines	
Forward exchange market	<p>All forward contracts to sell (<i>i.e.</i> excluding purchases) foreign exchange to nonresidents with no full delivery of principal, including cancellations and rollovers/renewals, require prior BSP clearance. All long-term (exceeding one year) foreign exchange forward contracts and nondeliverable forward (NDF) contracts (whether with residents or nonresidents) may only be undertaken by banks with expanded derivatives licenses.</p> <p>The BSP authorizes the rollover, without prior approval, of short-term deliverable forward contracts with nonresidents at every maturity during the course of the underlying long-term Philippine government securities, provided that (1) the underlying transactions for each short -term deliverable foreign exchange forward contracts are BSP-registered foreign investments in government securities, (2) the actual delivery or settlement of the foreign contract coincides with the date of the repatriation of the BSP-registered investments, (3) the value of the forward contract does not exceed the foreign currency equivalent of the maturity value or net proceeds of the BSP -registered investments computed on the basis of the agreed forward exchange rate (4) the repatriation and remittance out of the country of the BSP-</p>

	<p>registered investments comply with the documentary requirements under existing BSP rules, and (5) the bank concerned submits to the BSP a weekly report on forward contracts with nonresidents.</p> <p>The maturity of all forward contracts <i>-i.e.</i> outright forward and forward swap contracts to cover long-term foreign currency requirements- may not exceed six months.</p> <p>The maturity of foreign exchange forward (whether deliverable or nondeliverable) and swaps (sale of foreign exchange at the first leg and purchase of foreign exchange at the second leg) must not be longer than (1) the maturity of the underlying foreign exchange obligation or (2) the approximate due date or settlement of the foreign exchange exposure. However, for foreign currency loans, the maturity of deliverable foreign exchange forwards must be coterminous with the maturity of the underlying obligation. The maturity of the above mentioned swap contracts may not be less than 30 calendar days and not longer than (1) the maturity of the underlying foreign exchange obligation or (2) the approximate due date or settlement of the foreign exchange exposure.</p>
Controls on Derivatives and other Instruments	
Purchase locally by nonresident	Derivative involving forward purchase of foreign exchange by nonresidents are not allowed, except for BSP - registered foreign investments under certain conditions.
Sale or issue locally by nonresidents	Swap contracts involving the sale of foreign exchange by nonresidents to bank as a first leg require BSP approval. NDF foreign exchange sales by nonresidents require prior BSP clearance.
Malaysia	
Forward exchange market	Forward exchange contracts may be effected for both commercial and financial transactions. For financial transactions, prior approval is required. For commercial transactions, forward cover for import may be provided for up to 12 months from the intended date of import, while for export purposes, forward cover may be provided for up to 6 months from the export date. Effective contracts to buy or sell foreign currency against ringgit or another foreign currency to hedge (1) payment or receipts for current account transactions, based on firm commitments or on an anticipatory basis (for forward contracts entered into on an anticipatory basis), the total outstanding value of forward contracts should not exceed the total amount paid or received; (2) payment for permitted investment abroad including lending to nonresidents in foreign currency, other than from conversion from ringgit for placement in a foreign currency account

	<p>(FCA); (3) foreign currency exposure of permitted investments abroad; and (4) prepayments or repayments of permitted foreign currency credit facilities that are payable within the next 24 months. Second, nonresidents may enter into forward contracts to buy or sell foreign currency against ringgit to hedge (1) committed payments or receipts for current account transactions that are permitted to be settled in ringgit with residents, and (2) committed inflow and outflows for investment in, or divestments of, ringgit assets other than funds in external accounts, including fixed deposits negotiable instruments of deposits in ringgit, and over-the-counter derivatives or structured products that are tantamount to lending or borrowing of ringgit between residents and nonresidents</p> <p>Nonresident intermediaries may enter into swap arrangements not exceeding three working days with licensed onshore banks to cover payment for ringgit securities purchased by the nonresident intermediaries' nonresident clients with the following conditions: (1) swap arrangement shall be based on a firm commitment and not be on an anticipatory basis; and (2) the maturity date of the arrangement shall be the committed payment date with no rollover option.</p> <p>Multilateral development banks (MDBs) and foreign multinational corporations (MNCs) that are allowed to issue ringgit-denominated bonds may enter into forward contracts foreign currency for ringgit to meet coupon or principal payment of the bonds. In addition, they may also purchase forward foreign currency for repatriation of proceeds of the issuance abroad.</p> <p>Forward contracts against ringgit entered into by ADs and approved merchant banks are subject to net open position limits. Effective April 1, 2004, residents are allowed to sell forward nonexport foreign currency received for ringgit or another foreign currency to an AD or an approved merchant bank for any purpose up to the tenure of the underlying transaction, provided that the transaction is supported by a firm underlying commitment to receive the currency (previously, such receivables could be sold forward up to 12 months only). Also effective that date, residents with permitted foreign currency borrowing are allowed to enter into interest rate swaps with an onshore licensed bank, an approved merchant bank, or a licensed offshore bank in Labuan, provided that the transaction was supported by a firm underlying commitment to receive the currency.</p> <p>Forward exchange contracts against the ringgit or another foreign currency with nonresidents require the prior approval of the Controller of Foreign Exchange (COFE), with</p>
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	<p>following exceptions: (1) ADs may enter into short-term currency swap arrangement with nonresident custodian banks and stockbroking companies for payments of share purchase on the Malaysia Security Exchange Berhad (MSEB) that have maturities of up to three working days and that are based on firm commitments; and (2) ADs may enter in to outright ringgit forward sale contracts with nonresidents that have maturities of up to three working days and that are based on firm underlying commitments to purchase share on the MSEB.</p> <p>Forward Exchange contracts against foreign currency entered into by ADs and approved banks with nonresidents are subject to net open position limits.</p>
Controls on Derivatives and other Instruments	
Purchase locally by nonresident	No controls apply on the trading of futures and options by nonresidents on the Malaysian Derivatives Exchange.
Sale or issue locally by nonresidents	The issuance of derivatives by nonresidents requires approval from the COFE. The purchase of foreign currency-denominated derivatives not traded on a future exchange in Malaysia by residents to nonresident requires prior approval.
Thailand	
Forward exchange market	Financial institutions may engage in spot foreign exchange market transactions with nonresidents in local currency. Approval is required for nonresidents to sell foreign currencies for baht for same-day delivery (value same day) and for next -day delivery (value tomorrow) Forward transactions must be related to the underlying trade and financial transactions.
Controls on Derivatives and other Instruments	
Purchase locally by nonresident	In case where there are no underlying trade and investment activities in Thailand, both credit facilities, including swap and forward exchange contracts obtained by a nonresident from all domestic financial institutions combined, are subject to maximum outstanding limit of 50 million. The nonresident's head office, branches representative offices, and affiliated companies are counted as one entity.
Sale or issue locally by nonresidents	The issuance of warrants or equity-related instruments and bonds by nonresidents in the local market is subject to approval by the SEC. The approval criteria are based on the soundness of the underlying stock. There is no penalty for nonresidents for participating in financial market.

Source : Annual Report on Exchange Arrangements and Exchange Restrictions, International Monetary Fund, 2006.

ANNEX II**Data and some empirical results***Data*

The data used in the study are daily series and collected from the Reuters database. The study spans from December 10, 2004 to February 9, 2007. However, the period chosen is different for the tables and empirical analysis as per the data availability and comparability since the longer timeseries data are not available for all the currencies. Also the NDF turnover data are available for very short period.

The exchange rates (spot, forward and NDF) used in this paper are the closing prices for bid and ask. The bid-ask spreads reported in the study are the average percentage spreads, *i.e.* the difference between ask and bid prices, and divided by the average of the two multiplied with 100 for expressing in percentage terms.

Empirical results

All the variables used for empirical work have been tested for unitroots. However the exchange rates are non-stationary at their levels, they are stationary when taken in percentage return terms in all the cases.

For Granger-causality tests, the variables used are spot, forward and NDF returns and they are stationary. The lag length is selected on the basis of final prediction error (FPE) and log-likelihood criteria and it is 6.

For estimating the augmented GARCH model, *i.e.* equation (3) & (4), the lagged residuals are derived from the GARCH (1,1) model, *i.e.* jointly estimating equation (1) & (2). The GARCH (1,1) is estimated to model spot, forward and NDF volatility where a variety of mean equations, *i.e.* ARMA models are chosen on the basis of AIC and SC criteria[#]. All the pre- and post-diagnostic tests like test

[#] Descriptive statistics were calculated for all the return series and were found to be fat tailed leptokurtic and non-normal. Further, before estimating GARCH(1,1) models, the unconditional mean equations were also estimated to check the presence of ARCH effect and the non linear autorrelation was found to be significant up to lag length 8 providing evidence for presence of ARCH effect.

of ARCH effect (LB-Q test, ARCH-LM test), coefficient stationary test (Wald test) were conducted and all the results were found to be robust. Further, all the coefficients in variance and mean equations were also statistically significant without violating any non-negativity restrictions. The results are reported in Table A1.

Table A1: Estimates of GARCH(1,1) model

Variable	Model	Coefficients		t-Statistics	DW	LB-Q(8)	LM(8)	Wald
1	2	3	4	5	6	7	8	9
Spot	ARMA(2,2)- GARCH(1,1)	C	-0.01	-1.83(0.07)**	1.91	2.39 (0.88)	2.43(0.96)	4.22(0.04) *
		AR (2)	-0.64	-3.45(0.00)*				
		MA (2)	0.68	3.77(0.00)*				
		C	0.01	2.52(0.01)*				
		ARCH	0.22	3.55(0.00)*				
		GARCH	0.65	7.53(0.00)*				
Forward	ARMA(2,2)- GARCH(1,1)	C	-0.01	-1.31(0.19)	2.03	2.39(0.88)	2.30(0.97)	3.56(0.09) **
		AR(2)	-0.86	-9.77(0.00)*				
		MA(2)	0.90	12.53(0.00)*				
		C	0.01	2.22(0.03)**				
		ARCH	0.27	3.67(0.00)*				
		GARCH	0.64	6.45(0.00)*				
NDF	AR(1)- GARCH(1,1)	C	-0.01	-0.89(0.37)	2.10	5.88(0.55)	5.94(0.65)	2.80(0.09) **
		AR(1)	-0.12	-2.26(0.02)*				
		C	0.01	1.94(0.05)*				
		ARCH	0.17	2.91(0.00)*				
		GARCH	0.74	8.17(0.00)*				

*, ** indicate the significance level at 5% and 10% level respectively. Figures in brackets are P-values.