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## Impact of Political Events on Financial Market Volatility Evidence from Pakistan using Data since 1999

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### Abstract:

This paper investigates the impact of political shocks (positive and negative) on financial markets. Using data from Pakistan for the period January 1999 to September 2006, we try to link 'a' political event to the financial market volatility. We use high frequency data for currency market for empirical estimation. We first use a Markov Switching process to identify low and high volatility regimes in Pakistan's currency market and then link these regimes to certain political events. Later, we extend the analysis to other two indicators of the financial markets, namely stock market and the money market. We use data on exchange rates, stock prices and interest rates and use Granger causality, Variance Decomposition and Impulse responses in a VAR model to determine if the three markets are interlinked. Finally, we trace the impact of political events moving from one market to another using these linkages and causal relationship. The results suggest that the markets have some weak linkages but do not support a long-run causal relationship. The results also confirm the changes in the market volatility as a result of some domestic and international events having impact on the domestic economy and the financial market.

***NOTE: Part of the empirical tests for this study are being performed and a revised version of the paper will be submitted soon.***

JEL Classification: **F30, F31, F32, F34, F41**

Key Words: Financial Market Linkages, Granger Causality, Variance Decomposition, Impulse Responses.

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## 1. Introduction

The recent wave of financial sector reforms and internationalization in the emerging markets has increased the interlinkages within various sectors of a country's financial market. For example, a strong linkage between stock prices and exchange rates is a popular view in the academic research. Similarly, changes in stock prices and exchange rates are expected to influence the movements in interest rates. A number of hypotheses suggest such a causal relationship. For instance, using a goods market approach, any changes in the value of currency would affect the competitiveness of multinational firms and hence influence stock prices (Dornbusch and Fischer, 1980). Similarly, the hypotheses of 'exchange rate pass-through' and interest rate pass-through' suggest that changes in exchange rates and/or interest rates could affect stock prices. The portfolio balance model suggests that fluctuations in stock prices influence exchange rate changes.

Empirical research on the validity of the above stated hypothesis received mixed results. In this paper, we only discuss some recent empirical work with a focus on emerging economies. Fukuda and Kano (1997) investigate how prices in East Asian economies correlate with those in Japan and the United States and found that overall price levels in East Asia are more correlated to the price level in the United States. Aggarwal and Kyaw (2005) study the equity market integration in the NAFTA region and found evidence supporting an integrated market. Khalid and Kawai (2003) found support for currency market linkages within East Asian region. Khalid and Rajaguru (2006) used a multivariate GARCH model and found evidence indicating that East Asian

markets are interlinked. However, they did not find the same result for currency markets between India and Pakistan. Khalid, Kawai and Rajaguru (2005) investigate a global cross-market linkages and found empirical support for it. Pan, Fok and Liu (2006) examine the dynamic linkages between exchange rates and stock prices for seven East Asian countries and found evidence of a causal relationship between the two markets in all countries except Malaysia.

Like many other emerging economies, Pakistan also implemented policies of financial sector reforms and liberalization as early as 1990s.<sup>2</sup> These reforms and some external factors had a positive impact on the economy and led to a slight appreciation of the currency as well as improvement in country's credit rating. Table 1 provides a summary of the basic economic indicators for Pakistan since 1970s with a focus the period since 2000.<sup>3</sup> As a result of these reforms and deregulations of many sectors of the economy, the movements of important financial market indicators such as exchange rate, stock prices and interest rates were determined by market forces. At the same time and due to minimum intervention by the State Bank of Pakistan in foreign exchange market and domestic money market, these variables are subject to external and internal shocks. If markets are interlinked then shock to one market is expected to have impact on other markets as well. This is, however, a testable hypothesis and is the focus of this paper.

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<sup>2</sup> For a detailed discussion on financial sector reforms and development in Pakistan, see Ariff and Khalid (2005). Hussain and Qayyum (2005) and Hussain (2006) also look at the stock market liberalization in Pakistan and the region.

<sup>3</sup> It can be seen from Table 1 that by 2003, for the first time in the last three decades, that the country has experienced a growth rate of 5.1 percent with single digit inflation (3.3 percent). This momentum seems to be continued till 2004 when economy registered a growth rate of 6.8 percent. Although, the overall economic growth rate continued to increase in 2005 (reached a level of 7.8 percent), some other indicator show a slowing down in the economy. For example, inflation jumped from 4.5 percent to 9.3 percent in 2005. Fiscal deficit (as a ratio to GDP) increased from (-) 2.1 percent to (-) 4.1 percent. Similarly, trade balance (as a ratio to GDP) increased from (-1) 1.3 per cent to (-1) 4.1 percent. These declining trends suggest that economy experienced some negative shocks during the period of 2004.

## **INSERT TABLE 1 AROUND HERE**

Looking at Pakistan's perspective, there is limited research available investigating the interlinkages and volatility spillover within Pakistan's financial market. Khalid and Rajaguru (2006), support a link between exchange rates, stock prices and interest rates. The empirical evidence in Qayyum (2006) suggests that volatility spillover takes place from stock market to the foreign exchange market but not the vice-versa. This paper, use high frequency data to investigate the interlinkages among the three sectors of the financial market in Pakistan. We investigate if the Currency, stock and money markets in Pakistan are linked together. We use three financial market indicators namely, the exchange rate, the stock price and the interest rate and investigate presence of linkages within these three markets. We use daily observations and Granger causality, variance decomposition and impulse responses, in a VAR to establish evidence of any market interlinkages. The paper is organized in the following manner. Section 2 followed by Introduction discusses the data and methodological details. The results of the empirical model are presented in Section 3. Finally, some conclusions are drawn in Section 4.

### **2. Data and Methodological Details**

We use daily observations on exchange rate (WMR; against US dollar), stock prices (MSCI index) and interest rate (30-day repo) for the period from 1 January 1999 to 13 September 2006. For empirical estimation, we split the sample into two: full sample and a sub-sample. The sub-sample covers the period from 25 September 2001 to 13 September 2006, thus focusing on the post- September 11 period. All data is obtained from DataStream database.

## 2.1 Unit Root Testing

The time series property of the data is examined by conducting Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and KPSS unit root tests (see Dickey and Fuller, 1979, Phillips and Perron (1988) and Kwiatkowski, Phillips, Schmidt and Shin (1992)) on the logarithm of exchange rate, stock price and interest rate. If the variables are non-stationary then these three tests are conducted on logged differenced series in order to determine the correct order of integration. Both ADF and PP tests set the null of non-stationary while the KPSS tests the stationary null hypothesis. These three results together determine the most robust estimates for the order of integration.

## 2.2 Cointegration Analysis

In order to capture the dynamic relationships between three variables, we tested for their co-integration relationship among logarithm of exchange rate, stock price and interest rate. If all three variables are  $I(1)$  and are co-integrated then the linear combination (co-integrating vectors) of one or more of these series may exhibit a long-run relationship. And the dynamic linkages (causality) between the variables could be determined through vector error correction model. On the other hand, it could be modelled as vector autoregression (VAR) if either (i) all of these series are stationary or (ii) these series are non-stationary but not co-integrated. In our study, we use the multivariate co-integration test based on the Johansen-Juselius (1990) procedure to test for the existence of long-run relationship between exchange rate, stock price and interest rate.

We begin the analysis by letting a vector of  $n$ -variables  $z_t$  possess the  $p$ -th order Gaussian vector autoregression (VAR) process

$$z_t = \mu + \sum_{i=1}^p \Pi_i z_{t-i} + \varepsilon_t, t = 1, 2, \dots, T \quad (3)$$

Where  $\mu$  is a vector of constants and  $\varepsilon_t$  is a normally and independently distributed  $n$ -dimensional vector of innovations with zero mean non-singular covariance matrix  $\Omega$ . And  $z_t$  is a vector of endogenous variable. It is convenient to rewrite the above process in the following error correction form:

$$\Delta z_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-i} - \Gamma_0 z_{t-1} + \varepsilon_t \quad (4)$$

Where  $\Gamma_0 = I - (\Pi_1 + \Pi_2 + \dots + \Pi_p)$  and  $\Gamma_i = -\sum_{j=i+1}^p \Pi_j$ ,  $i = 1, 2, \dots, p$ . The long run  $n \times n$  matrix  $\Pi$  is equal to  $\Gamma_0$  and it determines how many linear combinations of  $z_t$  are stationary. In particular, the rank of the matrix  $\Pi$ ,  $r$  gives the number of independent co-integrating vectors. The co-integrating rank  $r$  ( $0 < r < n$ ) and hence, the number of distinct co-integrating vectors can be formally tested with  $\lambda_{\text{trace}}$  and  $\lambda_{\text{max}}$  statistic. The  $\lambda_{\text{trace}}$  statistic test the null hypothesis that  $H_0: r = g$  vectors against the alternative that  $H_1: r \leq g$  and it is given by

$$\lambda_{\text{trace}}(g) = -T \sum_{i=g+1}^n \ln(1 - \lambda_i), \quad (5)$$

The  $\lambda_{\text{max}}$  statistic test the null hypothesis that  $H_0: r = g$  vectors against the alternative that  $H_1: r = g+1$  and it is given by

$$\lambda_{\text{max}}(g) = -T \log(1 - \lambda_{g+1}) \quad (6)$$

where  $\lambda_i$ 's are the Eigen values of  $\Pi$  such that  $\lambda_1 > \lambda_2 > \dots > \lambda_n$ . The optimal lag length  $p$  is determined by SC (Schwartz) criteria.

### 2.3 Error Correction Models and Vector Autoregressions

As discussed earlier, if all variables are co-integrated then they are modelled as vector error correction model to capture both long-run and short-run linkages between exchange rate, stock price and interest rates. On the other hand, if these three markets are not co-integrated then they will be modelled as vector error correction model. As we shall see later, all three markets are not co-integrated; we proceed with the discussion on vector autoregressions. The vector autoregression (VAR) is commonly used for analysing the dynamic impact of random disturbances on the system of variables. The VAR approach models every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system and can be specified as:

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + \varepsilon_t \quad (7)$$

Where  $y_t$  is a  $k$  vector of endogenous variables,  $A_1, \dots, A_p$  are matrices of coefficients to be estimated, and  $\varepsilon_t$  is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and uncorrelated with all of the lagged endogenous variables. It is very important to determine the lag length before estimating a VAR. Rather than using a lag length arbitrarily, we use three different criteria, namely, Akaike information criteria (AIC), Schwartz information criteria (SIC) and likelihood ratio (LR) to determine the appropriate lag length. Surprisingly, lag length of one is justified by both the AIC and SIC while LR is inclusive. We, therefore, choose a one lag for the VAR system used in this study. Since we have same lag length, the system may be estimated using OLS.

The parameter estimates obtained from estimated VAR model are then used to identify any causal relationship among different markets. This is accomplished by

testing Granger causality and running a VAR on the system of equations and testing for zero restrictions on the appropriate VAR coefficients.

Next, we compute the variance decomposition to evaluate the dynamic linkages between three markets. Variance decomposition decomposes the forecast error variances (at different time-horizons) of one variable into all variables in the system.

Later, we analyse the impulse responses by introducing a shock in each of the markets and analyse its impact in all other markets. An impulse response function traces the effect of one unit of shock of the innovations on current and future values of the endogenous variables. A shock to  $i$ -th variable directly affects the  $i$ -th variable, and is also transmitted to all of the endogenous variables through the dynamic structure of the VAR. Since innovations are usually correlated, one cannot isolate the effect of  $i$ -th variable on  $j$ -th variable without disturbing all other variables. These shocks can be orthogonalized by applying Cholesky decomposition. However, orthogonalizing the shocks through Cholesky decomposition add additional problem to this impulse response analysis as the response functions are very sensitive to the ordering of variables.

### **3. Empirical Results**

In this section, we perform econometric tests to determine if the three markets are interlinked over the sample period. We, first, perform a unit root test to determine the order of integration of the three series. The results reported in Table 2 indicate the all three series are stationary in first differences. These results are consistent using three different tests (ADF, PP, and KPSS) on both sample periods. Next step is to determine if the series have a long-run relationship. The co-integration test results are reported in

Table 3 and do not support a long-run relationship between the three variables for either of the sample periods. Since the series are not co-integrated, any possible market interlinkages can be tested using Granger causality method within VAR framework.

**INSERT TABLE 2 AROUND HERE**

**INSERT TABLE 3 AROUND HERE**

The results of Granger causality for the full-sample period are reported in Table 4a. These results suggest that changes in exchange rates do cause fluctuations in the stock prices in Pakistan during the sample period. However, the same changes do not have any influence on interest rates. There also an empirical evidence of a causal relationship between stock prices and the interest rates. Finally, the results suggest that changes in interest rates do not affect exchange rates or stock prices over the period under investigation. The results of Granger causality for the Sub-Sample period (see Table 4b) are consistent with the above findings. In summary, these results establish a link between the three markets where changes in currency market influence the stock market which then lead to some changes in the money market.

**INSERT TABLE 4a AROUND HERE**

**INSERT TABLE 4b AROUND HERE**

Next, we perform a variance decomposition analysis using the same two sample periods. The results of these tests are presented in Tables 5a (Full-Sample) and 5b (Sub-Sample). These results suggest that most of the variations in each market are due to its own lag(s). The impact of cross-market variations is very small. These results are consistent with the results obtained using the Granger causality tests.

**INSERT TABLE 5a AROUND HERE**

**INSERT TABLE 5b AROUND HERE**

Finally, we use impulse response analysis to verify the robustness of our findings. Here, we introduce a shock in each of the market and observe the intensity and duration of these shocks across markets. The results are reported in Figure 1a (Full-Sample) and 1b (Sub-Sample) which are, again, consistent with the earlier results. In general, the results of these three different empirical methodologies suggest that there is no long-run relationship between three financial market variables but one can find a short-term link from currency market to stock market and from stock market to money market.

**INSERT FIGURE 1a AROUND HERE**

**INSERT FIGURE 1b AROUND HERE**

#### **4. Concluding Remarks**

This study examines the dynamic linkages among the currency (foreign exchange), stock and money markets for Pakistan. We used high frequency data (daily observations for exchange rate, stock prices and interest rates) and three different empirical testing procedures to determine if the three markets are interlinked in Pakistan. Based on co-integration tests, the empirical results failed to find support for a long-run relationship among the three markets. The Granger causality tests, however, find empirical evidence suggesting a causal relation from currency market to stock market and from stock market to money market thus suggesting a link among the three markets. The results for the subsample are very much the same. The empirical findings based on variance decomposition and impulse response analysis are consistent with the above findings where most of the variations in each market variable can be explained by its own lag. It is interesting to note that our results are consistent with the theoretical hypothesis mentioned in section 1 of this paper. Given that the three markets are linked, any internal or external shock would affect all three markets in a direct or indirect way. This is an important finding and could have important policy implications. For example, policy makers, while making a decision on internal policy should be mindful of the implications of their decision. On the flip side of the coin, policy makers could take a priori measure in one of the markets (say interest rate) if an external shock is forthcoming and expected to hit a market (say foreign exchange). A possible future extension of this research could be to use some data from some actual shocks and analyze its impact in one of the markets and then see if the shock is transmitted to other two markets. This issue will be explored in a separate paper.

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**TABLE 1: BASIC ECONOMIC & SOCIAL INDICATORS OF DEVELOPMENT IN PAKISTAN**

Indicators	1961-70	1971-80	1981-90	1991-95	1996-2000	2000	2001	2002	2003	2004	2005
<b>NATIONAL ACCOUNTS:</b>											
GDP Growth (%)	3.35	4.81	6.19	4.85	3.07	4.26	2.72	4.41	5.0	6.4	7.8
Per Capita GDP (US\$)	138.86	180.18	327.06	404.85	438.82	426.64	380.54	439	542	610	709
Private Consumption/GDP	77.71	79.00	76.92	70.81	73.99	74.43	75.15	74.96	73.6	73.3	80.0
Government Consumption/GDP	12.51	13.79	17.06	18.16	15.51	15.01	13.65	15.25	8.9	8.4	7.8
<b>FINANCIAL INDICATOR (%):</b>											
Gross Domestic Savings/GDP	-	13.81	13.83	14.81	13.29	14.4	14.6	13.6	17.5	18.4	12.2
Fixed Capital Formation/GDP	15.37	15.38	16.96	18.07	15.41	14.37	14.29	12.33	16.9	17.3	17.8
Inflation (per year)	3.51	12.42	6.98	11.20	7.30	4.37	3.15	3.29	3.19	4.49	9.32
M2/GDP	36.14	41.76	41.25	43.39	46.63	46.92	48.30	51.74	47.0	49.4	48.9
Fiscal Balance/GDP	-5.17	-7.41	-6.74	-7.67	-6.91	-5.47	-4.71	-4.62	-4.1	-2.1	-4.1
Trade Balance/GDP	-	-8.06	-9.31	-5.15	-3.73	-2.4	-2.3	-0.5	-0.4	-1.3	-4.1
Current Account Balance/GDP	-	-5.35	-2.91	-4.49	-3.17	-0.14	3.41	4.5	4.9	1.9	-1.4
Total Trade/GDP	21.20	28.00	33.59	36.73	35.16	34.30	37.37	35.75	-	31.7	34.1
Debt/Exports	403.90	606.09	509.28	-	-	550.66	260.7	211.2*	189.1*	176.3*	-
Debt/GDP	33.91	61.96	64.15	-	-	90.00	45.7**	48.7**	44.8**	38.0**	-
Foreign Reserves/Imports	21.27	17.98	11.52	14.24	10.56	14.23	34.05	71.86	-	-	-

\* Numbers are for external debt to exports ratio. \*\* Numbers are for Debt to GNI ratio.

Source: IMF International Financial Statistics (CD-ROM), World Development Report (Various Issues) and Asian Development Outlook (various issues); Ariff and Khalid (2005).

**Table 2 Unit Root Tests:**

	Full Sample (12 October 1999 – 13 September 2006)			Sub-Sample (25 September 2001 – 13 September 2006)		
	ADF	PP	KPSS	ADF	PP	KPSS
<b>ER</b>	-2.26	-2.24	1.29***	-2.81	-2.86	0.91***
<b>SP</b>	-1.88	-1.91	0.79***	-3.01	-3.01	0.49***
<b>IR1</b>	-1.39	-1.98	1.41***	-2.68	-1.92	1.26***
<b><math>\Delta</math>ER</b>	-26.9***	-38.72***	0.34	-15.77***	-35.88***	0.32
<b><math>\Delta</math>SP</b>	-41.1***	-41.09***	0.12	-35.18***	-35.18***	0.12
<b><math>\Delta</math>IR1</b>	-44.7***	-51.9***	0.17	-37.98***	-45.04***	0.28

Note: \*\*\* denotes the rejection of null of non-stationary for ADF and PP tests and the rejection of null of stationary for KPSS test at 1% level of significance.

**Table 3 Co-integration Test**

**Co-integration between exchange rate, stock price and interest rate**

	Full Sample		Sub-Sample	
	Trace	Max	Trace	Max
<b>r = 0</b>	14.67	9.74	29.06	16.99
<b>r = 1</b>	4.93	4.50	12.07	11.35
<b>r = 2</b>	0.43	0.43	0.72	0.72

Note: \*, \*\* and \*\*\* denotes the rejection of null at 10%, 5% and 1% level of significance respectively.

**Table 4a: Granger Causality between exchange rate, stock price and interest rate (Full sample)**

Cause ( $\downarrow$ ) and Effect ( $\rightarrow$ )	$\Delta$ ER	$\Delta$ SP	$\Delta$ IR
$\Delta$ ER	-	2.54**	0.29
$\Delta$ SP	0.12	-	2.20*
$\Delta$ IR	1.01	1.38	-

Note: \*, \*\* and \*\*\* denotes the rejection of null of Granger non-causality at 10%, 5% and 1% level of significance respectively.

**Table 4b: Granger Causality between exchange rate, stock price and interest rate (Sub sample)**

Cause ( $\downarrow$ ) and Effect ( $\rightarrow$ )	$\Delta$ ER	$\Delta$ SP	$\Delta$ IR2
$\Delta$ ER	-	2.53**	0.74
$\Delta$ SP	0.12	-	2.44*
$\Delta$ IR2	0.09	1.55	-

Note: \*, \*\* and \*\*\* denotes the rejection of null of Granger non-causality at 10%, 5% and 1% level of significance respectively.

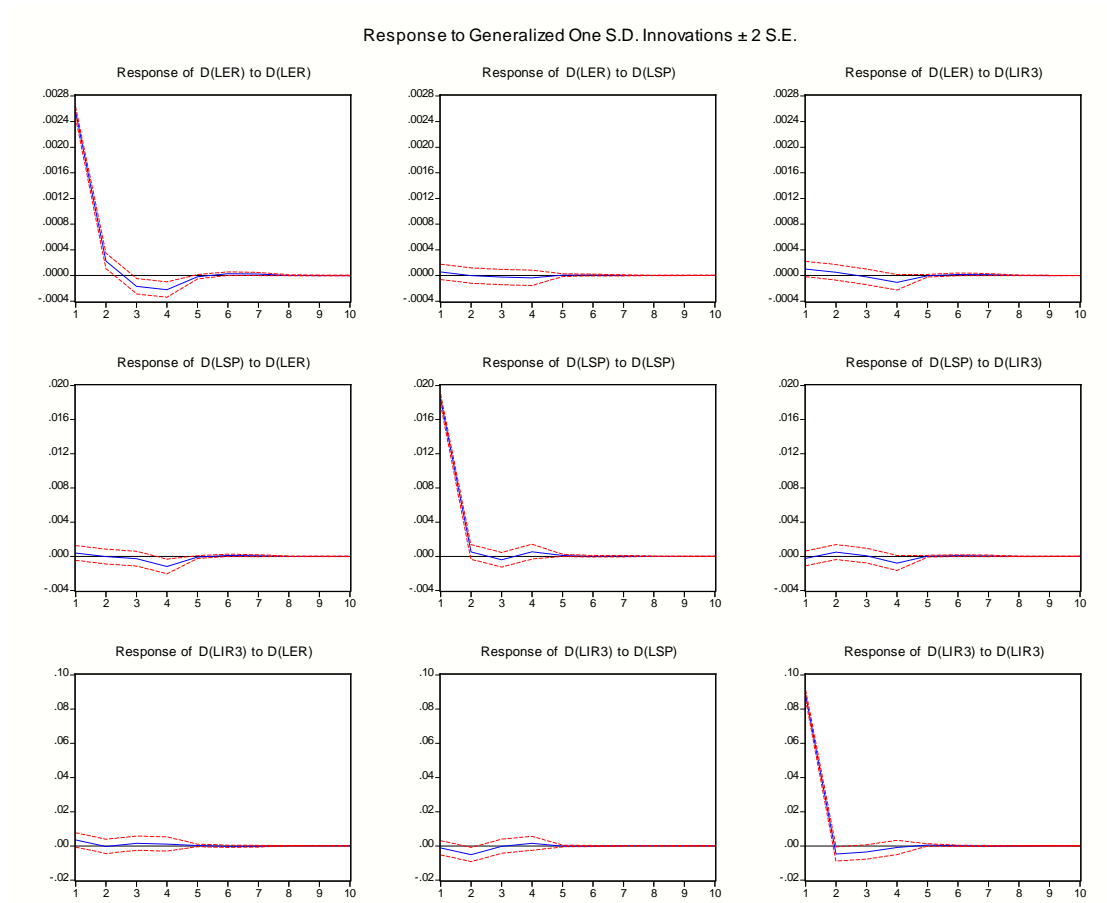
**Table 5a Variance Decomposition of Exchange rate, stock price and interest rate (Full sample)**

	Decomposition of $\Delta ER$			Decomposition of $\Delta SP$			Decomposition of $\Delta IR1$		
	$\Delta ER$	$\Delta SP$	$\Delta IR1$	$\Delta ER$	$\Delta SP$	$\Delta IR1$	$\Delta ER$	$\Delta SP$	$\Delta IR1$
1	100.00	0.000	0.000	0.04	99.96	0.00	0.16	0.02	99.83
2	99.98	0.001	0.022	0.04	99.88	0.07	0.16	0.35	99.50
3	99.96	0.009	0.027	0.07	99.86	0.07	0.18	0.35	99.47
4	99.80	0.027	0.177	0.49	99.28	0.23	0.20	0.38	99.43
5	99.80	0.028	0.177	0.49	99.27	0.23	0.20	0.38	99.43
6	99.79	0.028	0.180	0.50	99.27	0.24	0.20	0.38	99.42
7	99.79	0.028	0.182	0.50	99.27	0.24	0.20	0.38	99.42
8	99.79	0.028	0.182	0.50	99.27	0.24	0.20	0.38	99.42
9	99.79	0.028	0.182	0.50	99.27	0.24	0.20	0.38	99.42
10	99.79	0.028	0.182	0.50	99.27	0.24	0.20	0.38	99.42

**Table 5b Variance Decomposition of Exchange rate, stock price and interest rate (Sub sample)**

	Decomposition of $\Delta ER$			Decomposition of $\Delta SP$			Decomposition of $\Delta IR1$		
	$\Delta ER$	$\Delta SP$	$\Delta IR1$	$\Delta ER$	$\Delta SP$	$\Delta IR1$	$\Delta ER$	$\Delta SP$	$\Delta IR1$
1	100.00	0.000	0.000	0.08	99.92	0.00	0.14	0.02	99.84
2	99.97	0.000	0.026	0.08	99.84	0.08	0.14	0.36	99.49
3	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
4	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
5	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
6	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
7	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
8	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
9	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49
10	99.97	0.001	0.026	0.08	99.84	0.08	0.14	0.37	99.49

**Figure 1a: Generalized Impulse Response Function for exchange rate, stock price and interest rate (Full Sample)**



**Figure 1b: Generalized Impulse Response Function for exchange rate, stock price and interest rate (Sub Sample)**

