Currency Futures and its Impact on Volatility of Spot Prices

Anil Kothari *
Hemlata Chelawat **
Hitesh Chelawat ***

Derivatives have been hailed as the most desired instrument that allows market participants to manage risk in modern securities and currency markets. Derivatives are defined as future contracts whose value depends upon the underlying assets. The assets may be individual stocks, stock indices, commodities, interest rates, weather, etc. Currency derivatives can be described as contracts between currency sellers and buyers whose values are to be derived from the currencies they hold. Currency derivatives are basically risk management tools in forex and money markets, are used for hedging risks, and act as insurance against unforeseen and unpredictable currency and interest rate movements.

Currency derivatives were introduced in India with the launch of currency futures trading in US Dollar-Indian Rupee on August 29, 2008, on the NSE. Currency futures are standardized exchange traded contracts or a standardized agreement with an organized exchange to buy or sell currency at a fixed price at a certain date in future.

Generally, volatility is considered as synonymous with risk. High volatility is considered as high risk in the forex market. Increased volatility is undesirable for exporters/importers and others dealing in forex. The logic behind introduction of currency futures was to reduce the volatility and provide extra liquidity in the spot market.

*Faculty, Faculty of Management Studies, M.L. Sukhadia University, Udaipur

**Guest Faculty, Sun Institute of Management Studies, Udaipur

***Research Scholar, Department of Banking and Business Economics, University College of Commerce and Management Studies, Udaipur

This study examines the impact of introduction of currency futures on spot market volatility in India and studies whether volatility in the Indian currency spot market has undergone significant changes after currency futures trading was introduced.

Literature Review

Volatility is the variability of asset price changes over a particular period of time. Since the beginning of trading in financial futures and options, the effect of financial derivatives trading on spot market volatility has been of great interest to both academicians and practitioners.

The increased popularity for future contracts occurred during the time of increased volatility in underlying spot markets. These trends raise a question on the possible relationship between futures trading and the behaviour of cash markets: Can some of the spot volatility be attributed to the increasing futures trade or are the future traders only reacting to the unstable spot conditions?

A number of theoretical and empirical studies have been done on the impact of derivatives on volatility of spot prices. Figlewski (1980) provides three interesting arguments why futures trading can increase the spot market variability. First, he claims that futures price may be distorted by technical factors or manipulation. Obviously, under such circumstances futures market activity can increase cash price variability. Second, contrary to the popular argument that speculative futures trading destabilizes the spot market, he argues that there can be too many hedgers on the futures market and not enough speculators, which can distort the effective risk transfer. Thus the hedging pressure in futures can spill over into the cash market where the dealers and other market makers end up bearing risk transferred through cash and futures markets. Third, he points out that futures trading may increase price volatility if investors in futures do not have as good information as participants in the cash market. In such cases, their actions can push cash market prices away from their appropriate values and increase their variability.

According to Bessembinder and Seguin (1992) not only speculation but also the leverage associated with futures trading may be blamed for increasing the spot market volatility. Owing to lower margin requirements, traders in future are able to take larger positions than would be possible in the spot market. Thus, futures markets allow traders to generate larger order flows at lower cost, which can lead to spot market destabilization.

Antoniou and Holmes (1995) examined the impact of trading in index futures on the spot price volatility and concluded that futures trading improves the quality and speed of information flowing to spot markets. Their evidence suggests that there has been an increase in spot price daily volatility but that this is because of increased information in the market and not because of speculators having adverse destabilizing effect.

Chatrath, Ramchander, and Song (1996) investigated the relationship between level of dollar futures trading and volatility in the spot rates of the British Pound, Canadian Dollar, Japanese Yen, Swiss Franc, and Deutsche Mark against the US Dollar in the period 1980-1993. They provide strong evidence on the causality between futures trading volume and exchange rate volatility.

The impact of the introduction of index futures on the volatility of the stock market in India was examined by Darrat, Rahman, and Zhong (2002) using EGARCH approach and Granger Causality test. Their findings suggest that index future trading may not be blamed for the increasing volatility in the spot market.

Gupta (2002) examined the impact of index futures introduction on stock market volatility. He used daily price data (high, low, open, and close) for the BSE Sensex. The results indicate that stock market volatility has declined after the introduction of index futures.

A more recent study by Bae, Kwon, and Park (2004) focuses on the effect of index futures trading on spot price volatility in the Korean markets. Introducing futures and options trading resulted in both larger spot price volatility and greater market efficiency (allowing for quicker adjustment of market prices to information).

In all these studies, one of the issues investigated is whether futures trading increases price volatility of underlying markets and thus leads to destabilization. The studies provide mixed evidence and the question of the possible relationship between futures trading and the behaviour of cash markets remains inconclusively answered.

Though studies examine futures on index or commodities, very few studies exist for currency futures. Furthermore, there is little evidence whether there is causal relationship between level of trading activity in the currency futures market and exchange rate fluctuations. Also, there are few studies that analyse futures trading in the context of currency futures. In the Indian context, research on this issue considers only the stock market. In the context of the forex market, this topic has not been addressed at all as currency futures' trading in exchanges was introduced only very recently. Thus, this study is perhaps the first of its kind.

Objectives

This paper studies:

- the impact of currency derivative trading (in dollar rupee currency futures) on the volatility of the exchange rate
- the correlation between currency spot and future prices.

The study covers the recently introduced dollar-rupee currency futures on the National Stock Exchange (NSE). Not only is NSE the forerunner in introducing currency futures trading, it also accounts for the highest volume and value of contracts. The exchange rate data for a period of six months before the introduction of currency derivatives trading and six months after the introduction have been analysed.

Hypothesis

One view is that introduction of currency futures trading reduces volatility in spot market exchange rates by providing low cost contingent strategies and enables participants to minimize risk by using hedging techniques. An alternative view is that introduction of currency futures trading increases volatility in spot market exchange rates owing to high leverage and increased participation of speculators.

The hypotheses are as follows:

H_0: Introduction of currency futures trading on NSE has reduced the volatility of spot market exchange rates.

H_{Alt} : Introduction of currency futures trading has increased the volatility of spot market exchange rates.

Methodology

Secondary data have been used for the study. The spot price data which is the RBI reference rate for the day have been obtained from the RBI website (www.rbi.org.in). Daily observations of futures prices have been obtained from the NSE website (www.nseindia.com). (See Appendix)

Previous studies by Adrangi and Chatrath (1998) and Bhargava and Malhotra (2007) have suggested that GARCH should be the default approach while working with financial data in general and variance of spot and futures rates in particular. Unfortunately, while working with empirical data it is often hard to obtain results that fulfil all theoretical assumptions for the tests. In the attempt to estimate correct GARCH series, difficulties were faced in getting rid of autocorrelation in the mean and variance equations.

Also, GARCH is inapplicable to data series where there is a change in the kurtosis of the distribution (Varma, 1999). The Indian Rupee-Dollar price data when plotted on graph shows that there are periods of calm with sharp zigzags. This shows that there is a change in the kurtosis of the distribution.

Dimson and Marsh (1990) came up with a rather interesting finding that simple models and simple statistical measures to estimate volatility fare better against sophisticated models.

In our study, price can be regarded as continuous variable capable of assuming arbitrary fractional values. Also, the spot and future price data are normally distributed with 3σ covering 99 per cent of the values. Hence, we use standard deviation to measure variability.

Data Analysis

Analysis of Spot Exchange Rate Volatility

Table 1: Descriptive Statistics of Spot Prices

Price	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance	C.V.
spotprice1	118	39.8900	44.0700	4945.9400	41.9147	1.2743	1.624	3.04%
spotprice2	118	43.7900	50.5200	5691.4300	48.2325	1.5506	2.404	3.21%

Table 1 presents descriptive statistics and computations for two sets of data items: spotprice1: spot prices of Dollar vs. Rs. for the period March August 2008 (six months before the introduction of currency futures) and spotprice2: spot prices of Dollar vs. Rs. for the period September 2008 February 2009 (six months after the introduction of currency futures).

For the period prior to the introduction of currency futures (March-August 2008), the exchange rate of Dollar-Rupee moved between Rs.39.89/dollar (minimum) and Rs.44.07/dollar (maximum), showing a standard deviation of 1.2742 and coefficient of variation of 3.04 per cent.

For the post-futures introduction period (September 2008-February 2009), the Dollar-Rupee exchange rate fluctuated between Rs.43.79/dollar (minimum) and Rs.50.52/dollar (maximum), showing a standard deviation of 1.5506 and coefficient of variation of 3.21 per cent.

The standard deviation and coefficient of variation values have gone up for the post-introduction period compared to the period prior to the introduction of currency futures. This shows that volatility in spot prices has increased.

Figures 1 and 2 show spot price movements with the trend line and the deviations from the trend line for the period prior to the introduction of futures. Figure 3 and 4 show spot price movements with the trend line and the deviations from the trend line for the post-introduction period. These show an increased volatility post-introduction of currency futures.

Fig.1: Spot Price and Trend of Rupees/Dollar for March-August 2008

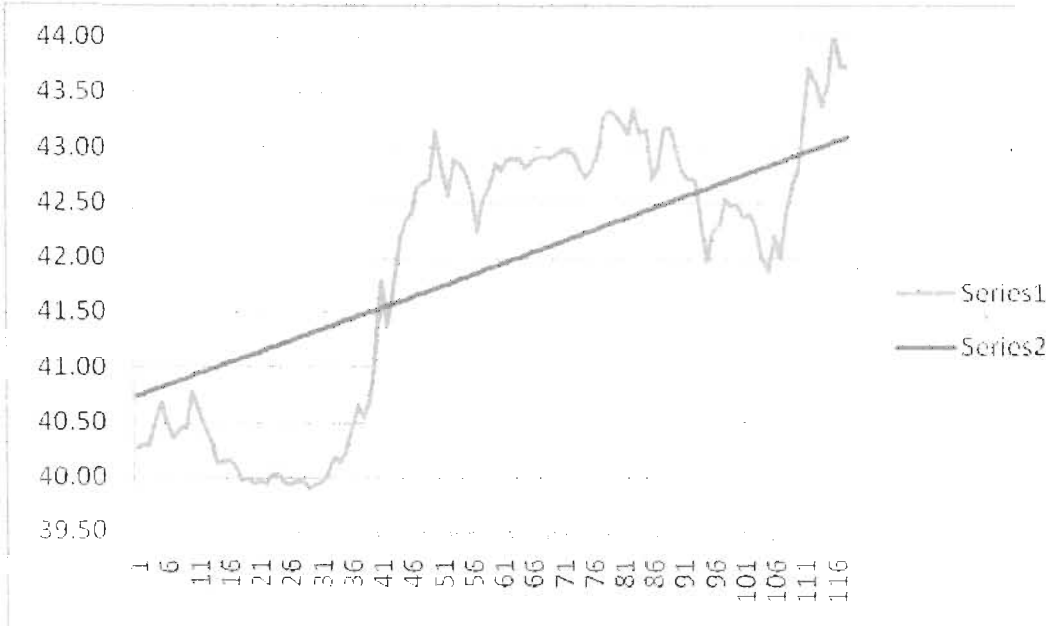


Fig. 2: Deviation of Spot Prices from Trend Line for Pre-Introduction Period

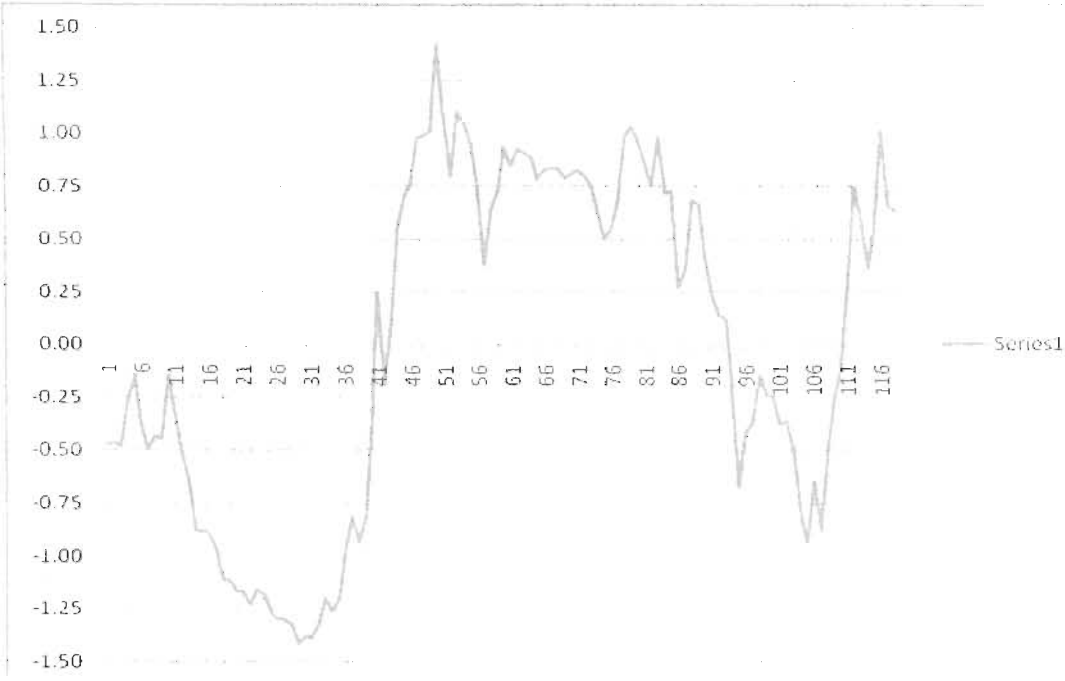


Fig.3: Spot Price Movement of Rupees/Dollar for September 2008-February 2009

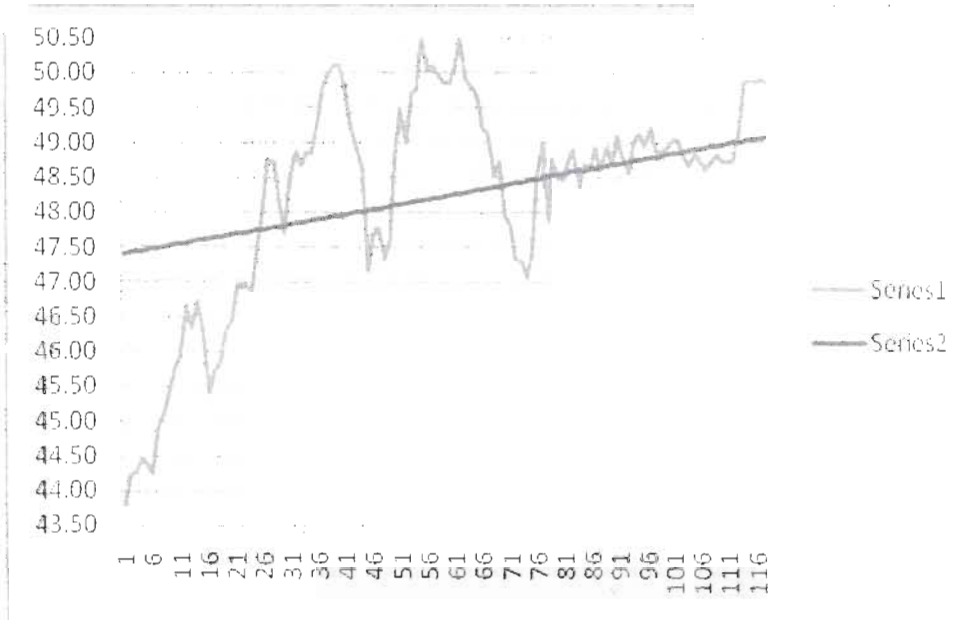
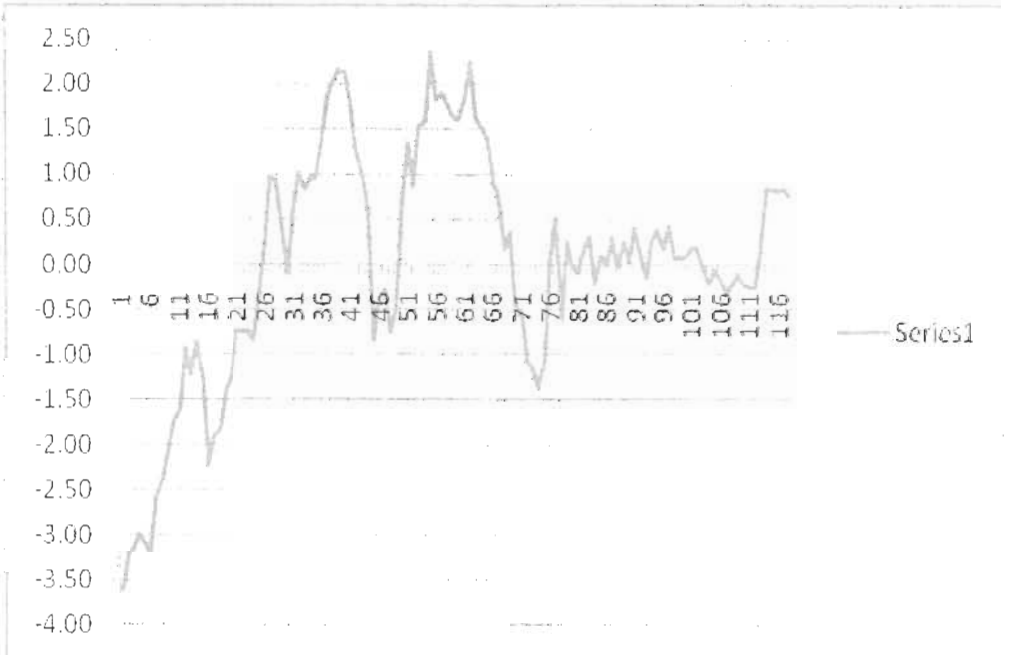


Fig. 4: Deviations of Spot Prices from Trend Line for Post-Introduction Period



Figures 5 and 6 show future prices with the trend line and deviations from the trend line for a period of six months using the prices of the most traded futures contract for the particular day, mostly being the current month future except for contract expiry days when next month futures are considered.

Fig.5: Futures Price Movement of Rupees/Dollar for September 2008-February 2009

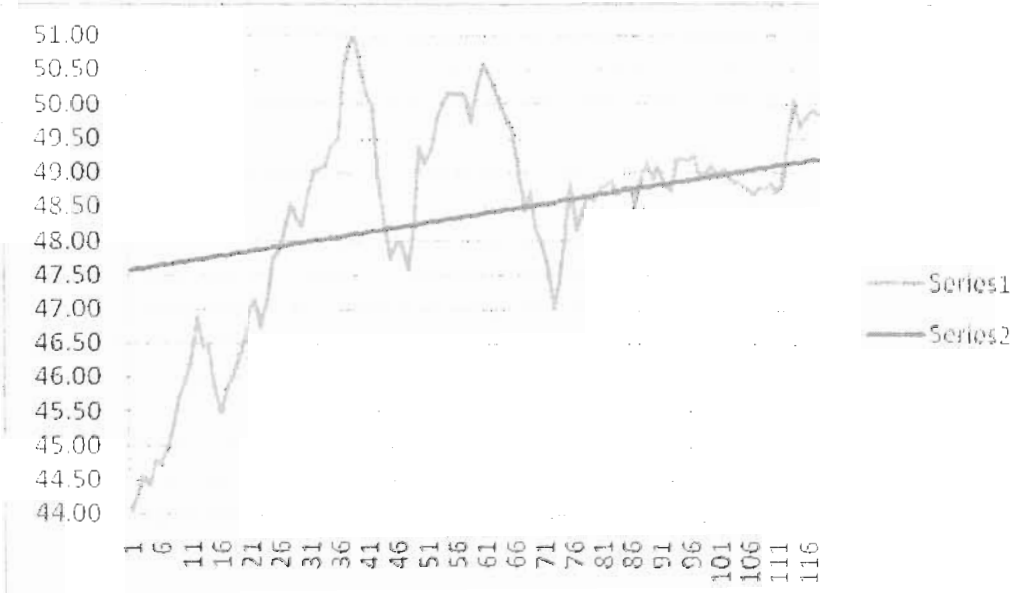


Fig. 6: Deviations of Futures Prices from Trend Line

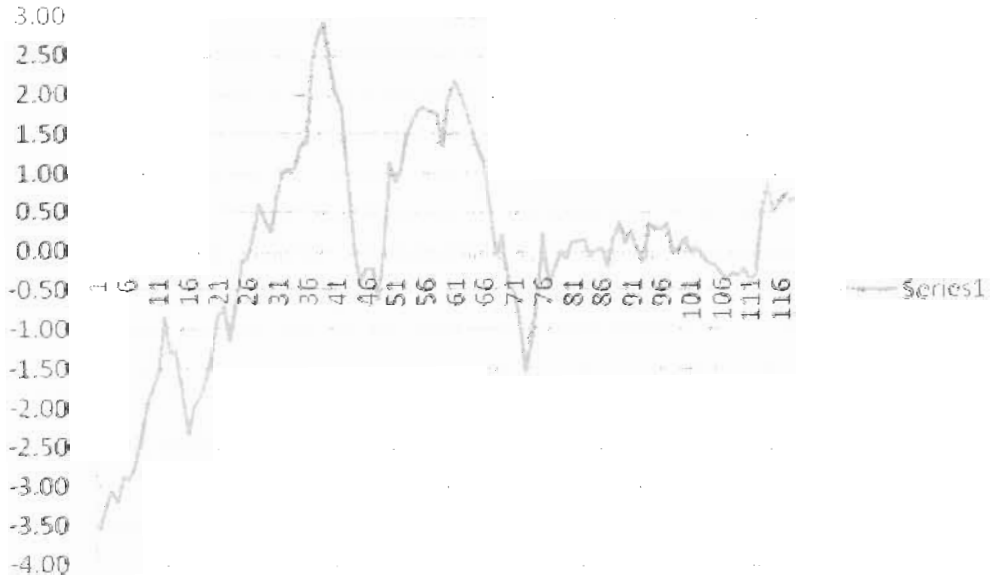
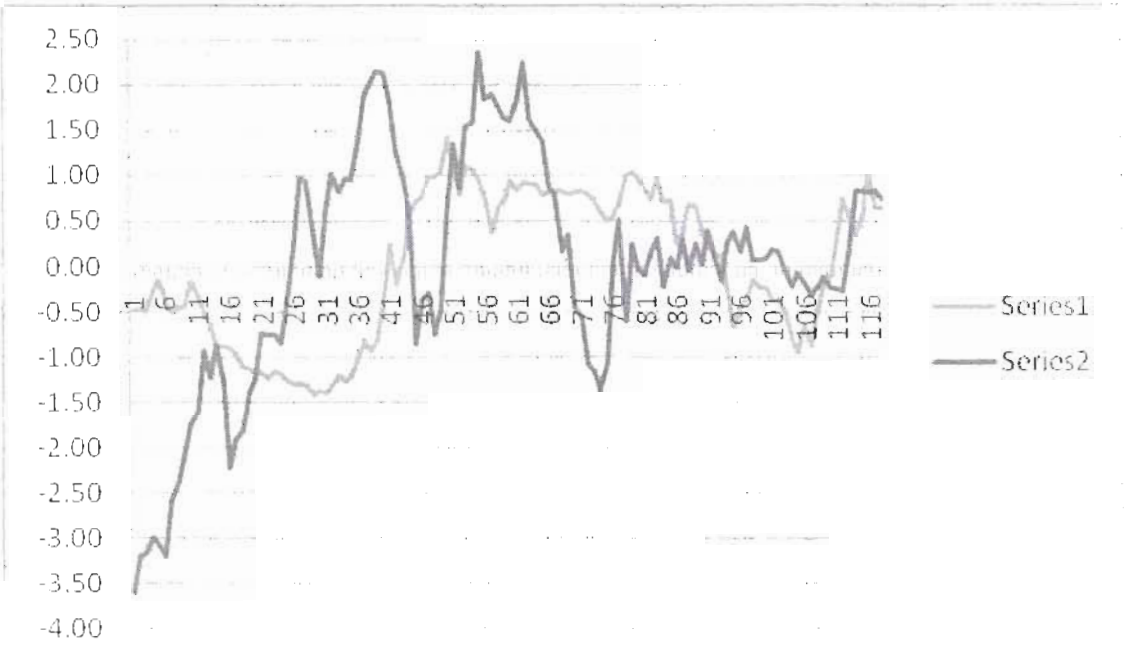


Figure 7 shows the deviations of spot prices from the trend for the period before and after the introduction of futures. It clearly shows a greater deviation or volatility of spot prices for the period after the introduction of futures compared to deviations for the pre-introduction period.

Fig. 7: Comparative Deviations of Spot Prices from Trend Line for Pre and Post Currency Futures Introduction Period



In Tables 2 and 3, we have analysed the volatility for the period prior to and post-introduction of currency futures on a monthly basis to determine if the trend of increased volatility is consistent for each month.

Table 2: Spot Prices for March-August 2008 on a Monthly Basis

Month	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance	C.V.
spricemar	18	39.9700	40.7700	726.4200	40.356667	0.2149145	0.046	0.53%
spriceapril	18	39.8900	40.4600	720.5000	40.027778	0.1407357	0.020	0.35%
spricemay	20	40.5500	43.1500	842.5100	42.125500	0.8260781	0.682	1.96%
spricejune	21	42.2400	42.9700	899.2200	42.820000	0.1727136	0.030	0.40%
spricejuly	23	41.9600	43.3700	985.2400	42.836522	0.4076831	0.166	0.95%
spriceaug	18	41.8900	44.0700	772.0500	42.891667	0.7290869	0.532	1.70%

Table 2 shows the spot prices separately for each of the six months prior to the introduction of currency futures. It shows that standard deviation is quite below 1 for all months and the coefficient of variation is between 0.35 per cent and 1.96 per cent period in the period prior to the introduction of futures.

Table 3: Spot and Future Prices for September 2008-February 2009 on a Monthly Basis

Month	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance	C.V.
spricesep	19	43.7900	46.7100	861.7000	45.352632	0.9209165	0.848	2.03%
fpricesep	19	44.0325	46.8700	863.9875	45.473026	0.8394929	0.705	1.85%
spriceoct	18	46.4300	50.0900	869.9100	48.328333	1.0997339	1.209	2.28%
fpriceoct	20	46.5550	50.1050	968.1625	48.408125	1.1174086	1.249	2.31%
spricenov	19	47.1800	50.5200	931.2400	49.012632	1.0465915	1.095	2.13%
fpricenov	20	47.6000	50.4425	985.2025	49.260125	0.9644502	0.930	1.96%
spricedec	20	47.0800	50.5200	974.3700	48.718500	1.0512763	1.105	2.16%
fpricedec	20	47.0175	50.5675	977.6575	48.882875	1.0705370	1.146	2.19%
spricejan	20	48.3700	49.1900	975.7200	48.786000	0.2277210	0.052	0.47%
fpricejan	20	48.5500	49.2425	977.9375	48.896875	0.2077636	0.043	0.42%
spricefeb	18	48.6000	49.8900	882.7800	49.043333	0.4663500	0.217	0.95%
fpricefeb	19	48.6550	50.0300	933.8025	49.147500	0.4773007	0.228	0.97%

Table 3 shows the spot and future price statistics separately for each of the six months after the introduction of currency futures. It shows that standard deviation is almost equal to or greater than 1 in all months except January and February; the coefficient of variation too is about 2 per cent in all months except January and February.

Comparisons of Tables 2 and 3 data show that spot and future prices oscillated in a wider range in each of the six months after the introduction of currency futures (excepting January and February) compared to the spot prices in each of six months prior to the introduction of currency futures.

Also, standard deviation and coefficient of variation which have been used as measures of exchange rate volatility were higher in the six months post-introduction (excepting January and February) compared to the standard deviation and coefficient of variation in the six months prior to the introduction of currency futures.

Movement of spot prices in a wider range and increased variability of spot prices (as witnessed by the coefficient of variation) indicates increased volatility of spot prices after the introduction of currency futures.

Table 4 shows the volatility of spot prices and futures prices from the trend line for the period before and after the introduction of futures. The table clearly indicates a much higher volatility for the period after the introduction of futures, thereby rejecting the suggested null hypothesis. Thus, the introduction of currency future seems to have increased the volatility of the exchange rate.

Table 4: Volatility of Spot and Future Prices in Comparison to the Trend Line for Pre and Post Currency Future Introduction Periods

Price	N	Std. Deviation	Variance	C.V.
spotprice1	118	0.8080	0.6528	1.9277%
spotprice2	118	1.2890	1.6616	2.6724%
futureprice	118	1.3289	1.7658	2.7468%

Next, the relationship between currency futures prices and spot exchange rates is investigated to determine if it exhibits significant correlation with each other such that spot volatility is associated with futures volatility.

Analysis of Correlation between Spot and Futures Prices

The correlation coefficient between spot and future prices for the entire period of six months is 0.9846 which is very high, showing high degree of positive correlation. Table 5 presents the correlations between the spot prices for each month post-futures and prices of available contracts for six months post-introduction of currency futures.

The correlation coefficients are highly positively correlated with each other (spot volatility is positively associated with futures volatility). This is true for all contracts except January contracts.

Table 5: Correlation Coefficient between Spot and Futures Prices

Month	fpricesep	Fpriceoct	Fpricenov	fpricedec	fpricejan	fpricefeb
spricesep	0.977	0.969	0.963	0.950	0.084	0.844
spriceoct	-	0.972	0.962	0.957	0.740	0.860
spricenov	-	-	0.951	0.948	- 0.811	0.954
spricedec	-	-	-	0.950	0.752	0.950
spricejan	-	-	-	-	0.740	0.741
spricefeb	-	-	-	-	-	0.956

It can be seen from the table that spot prices for a month are most highly (positively) correlated with the "nearby" futures contracts price and decreases for distant futures contracts prices. This implies that spot prices for September are most highly positively correlated with September futures contract prices (0.977) and shows a decreasing trend with future prices of October, November, etc.

This study has found that volatility in the Rupee spot price has increased after Dollar- Rupee currency futures were introduced. The study also has analysed the degree and direction of the relationship between spot and futures prices and found that they are highly correlated with each other. However, the prices in January are an aberration: the standard deviation for January spot prices is very low and prices for January futures contract show very low and even negative correlation with spot prices for the entire period in which the contract was traded. The reasons for this are incomprehensible.

Figures 8 and 9 show the spot and future prices and the deviations of spot and future prices from the trend line to show the extent of correlation between spot and future prices. The figures indicate a very high degree of correlation between the two prices.

Fig. 8: Spot and Future Prices for Post-Introduction Period

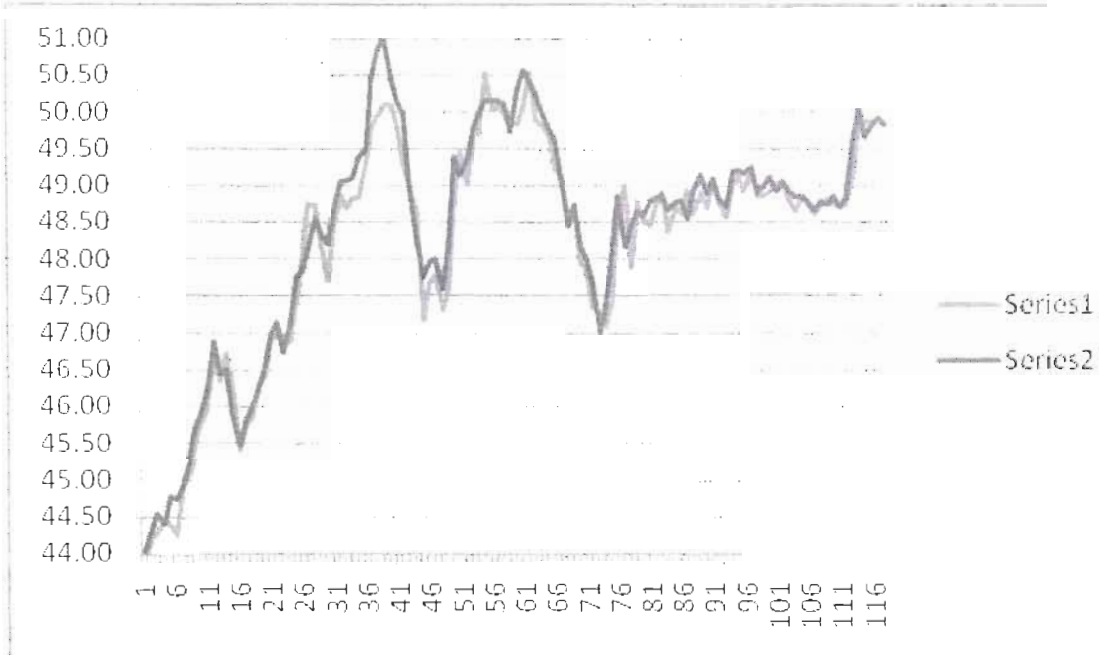
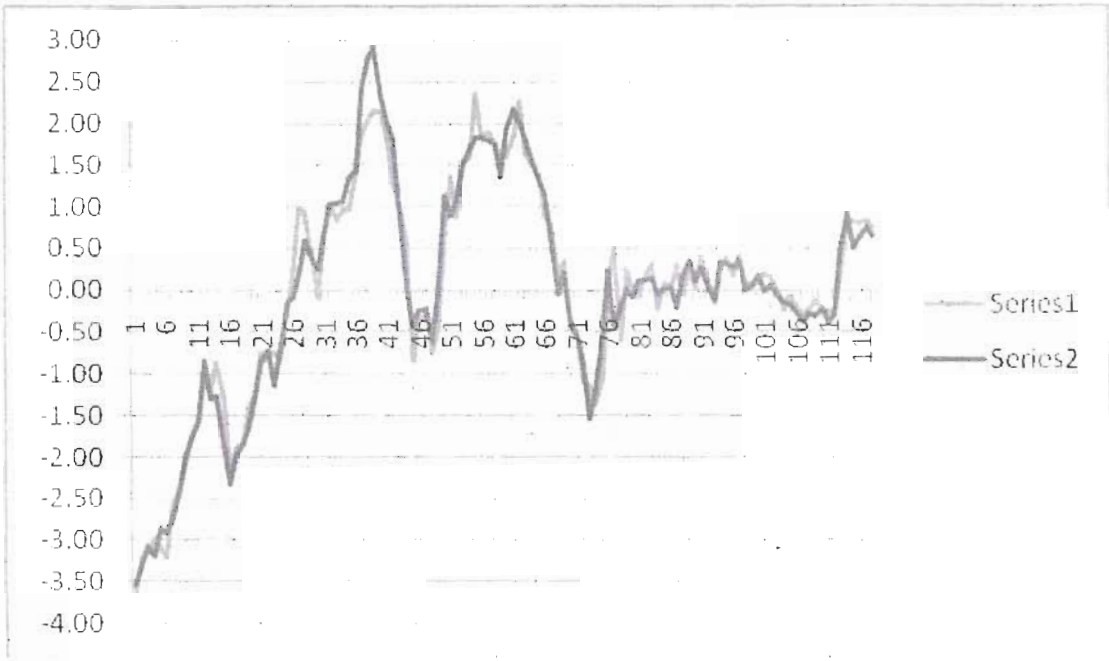


Fig. 9: Deviations of Spot and Future Prices from Trend Line



Conclusion

The objective of this paper was to examine the impact, if any, of the introduction of currency derivativea trading (in Dollar-Rupee currency futures) on the volatility of the spot exchange rate. The study was undertaken as an extension to the several previous studies on the relationship between futures trading and the underlying instrument volatility in general. This study investigated the Dollar - Rupee currency futures in particular, as there are few studies on currency futures. Moreover, there is no study of dollar - rupee futures as they have been only introduced recently in the Indian market.

High volatility is considered as high risk in the forex market. To reduce this risk factor in the Indian currency market, a number of steps were adopted by the market regulators. Introduction of currency futures trading was one of them as derivatives are meant to provide protection against currency fluctuations and help in currency risk management. But the currency futures' trading has not done its work. Though currency futures trading is increasing, volatility has not reduced. So, the null hypothesis that introduction of currency futures trading has reduced the volatility of spot market exchange rates is rejected. The alternative hypothesis that introduction of currency futures trading has increased the volatility of spot market exchange rates is accepted.

Reasons for excess volatility in the spot market are as follows:

- Introduction of futures trading attracts speculators who do not want to buy or sell currency but want to earn profit through price fluctuations by taking positions. Their actions create imbalance between buy and sell causing prices to rise or fall sharply, and increasing volatility.

- Owing to low margin requirements, traders in futures are able to take larger positions than would be possible in the spot market. Thus, the futures market allows traders to generate larger order flows at lower cost, which leads to spot market destabilization.

- An impending change in prices can be foreseen by speculators, but exaggerated in its importance, creating price movements greater than those which would have occurred in the absence of speculation.

Derivative trading is not the only factor affecting market volatility (risk). It is possible that there may be other factors in operation. But the impact of futures introduction is an important factor for increasing volatility in exchange rates. This is a cause for concern for policymakers because it raises important public policy issues about the stability of the market and the impact of volatility on the economy. It also raises questions on their premise that introduction of currency futures trading is an appropriate solution to mitigate risk in forex markets. Increased volatility is undesirable for exporters/importers and others dealing in forex, because it contributes to increased currency risk. What is needed is not increase in the use or volume or type of derivative products but a strong regulatory system for the well functioning of the market.

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Websites

www.nseindia.com

www.rbi.org.in

Appendix

Calculations and Data for Spot Price and Trend Line for Pre-Introduction Period

S.N.	Date	sprice1	Est. price	e	e^2
1	3-Mar-08	40.26	40.7357	-0.48	0.23
2	4-Mar-08	40.29	40.7559	-0.47	0.22
3	5-Mar-08	40.29	40.7761	-0.49	0.24
4	7-Mar-08	40.53	40.7962	-0.27	0.07
5	10-Mar-08	40.67	40.8164	-0.15	0.02
6	11-Mar-08	40.47	40.8365	-0.37	0.13
7	12-Mar-08	40.36	40.8567	-0.50	0.25
8	13-Mar-08	40.44	40.8768	-0.44	0.19
9	14-Mar-08	40.45	40.8970	-0.45	0.20
10	17-Mar-08	40.77	40.9171	-0.15	0.02
11	18-Mar-08	40.62	40.9373	-0.32	0.10
12	19-Mar-08	40.45	40.9574	-0.51	0.26
13	24-Mar-08	40.34	40.9776	-0.64	0.41
14	25-Mar-08	40.12	40.9977	-0.88	0.77
15	26-Mar-08	40.14	41.0179	-0.88	0.77
16	27-Mar-08	40.15	41.0381	-0.89	0.79
17	28-Mar-08	40.10	41.0582	-0.96	0.92
18	31-Mar-08	39.97	41.0784	-1.11	1.23
19	2-Apr-08	39.98	41.0985	-1.12	1.25
20	3-Apr-08	39.95	41.1187	-1.17	1.37
21	4-Apr-08	39.97	41.1388	-1.17	1.37
22	7-Apr-08	39.93	41.1590	-1.23	1.51
23	8-Apr-08	40.02	41.1791	-1.16	1.34
24	9-Apr-08	40.02	41.1993	-1.18	1.39
25	10-Apr-08	39.95	41.2194	-1.27	1.61
26	11-Apr-08	39.94	41.2396	-1.30	1.69
27	15-Apr-08	39.96	41.2597	-1.30	1.69
28	16-Apr-08	39.96	41.2799	-1.32	1.74
29	21-Apr-08	39.89	41.3001	-1.41	1.99

30	22-Apr-08	39.94	41.3202	-1.38	1.90
31	23-Apr-08	39.95	41.3404	-1.39	1.93
32	24-Apr-08	40.04	41.3605	-1.32	1.74
33	25-Apr-08	40.18	41.3807	-1.20	1.44
34	28-Apr-08	40.14	41.4008	-1.26	1.59
35	29-Apr-08	40.22	41.4210	-1.20	1.44
36	30-Apr-08	40.46	41.4411	-0.98	0.96
37	2-May-08	40.65	41.4613	-0.81	0.66
38	5-May-08	40.55	41.4814	-0.93	0.87
39	6-May-08	40.69	41.5016	-0.81	0.66
40	7-May-08	41.20	41.5217	-0.32	0.10
41	8-May-08	41.79	41.5419	0.25	0.06
42	9-May-08	41.38	41.5621	-0.18	0.03
43	12-May-08	41.68	41.5822	0.10	0.01
44	13-May-08	42.16	41.6024	0.56	0.31
45	14-May-08	42.33	41.6225	0.71	0.50
46	15-May-08	42.40	41.6427	0.76	0.57
47	16-May-08	42.64	41.6628	0.98	0.95
48	20-May-08	42.67	41.6830	0.99	0.97
49	21-May-08	42.72	41.7031	1.02	1.03
50	22-May-08	43.15	41.7233	1.43	2.04
51	23-May-08	42.84	41.7434	1.10	1.20
52	26-May-08	42.56	41.7636	0.80	0.63
53	27-May-08	42.89	41.7837	1.11	1.22
54	28-May-08	42.85	41.8039	1.05	1.09
55	29-May-08	42.77	41.8241	0.95	0.89
56	30-May-08	42.59	41.8442	0.75	0.56
57	2-Jun-08	42.24	41.8644	0.38	0.14
58	3-Jun-08	42.53	41.8845	0.65	0.42
59	4-Jun-08	42.63	41.9047	0.73	0.53
60	5-Jun-08	42.86	41.9248	0.94	0.87
61	6-Jun-08	42.79	41.9450	0.85	0.71

62	9-Jun-08	42.89	41.9651	0.92	0.86
63	10-Jun-08	42.89	41.9853	0.90	0.82
64	11-Jun-08	42.89	42.0054	0.88	0.78
65	12-Jun-08	42.81	42.0256	0.78	0.62
66	13-Jun-08	42.87	42.0457	0.82	0.68
67	16-Jun-08	42.90	42.0659	0.83	0.70
68	17-Jun-08	42.92	42.0861	0.83	0.70
69	18-Jun-08	42.90	42.1062	0.79	0.63
70	19-Jun-08	42.93	42.1264	0.80	0.65
71	20-Jun-08	42.97	42.1465	0.82	0.68
72	23-Jun-08	42.97	42.1667	0.80	0.65
73	24-Jun-08	42.94	42.1868	0.75	0.57
74	25-Jun-08	42.82	42.2070	0.61	0.38
75	26-Jun-08	42.73	42.2271	0.50	0.25
76	27-Jun-08	42.79	42.2473	0.54	0.29
77	30-Jun-08	42.95	42.2674	0.68	0.47
78	1-Jul-08	43.27	42.2876	0.98	0.97
79	2-Jul-08	43.34	42.3077	1.03	1.07
80	3-Jul-08	43.30	42.3279	0.97	0.94
81	4-Jul-08	43.21	42.3481	0.86	0.74
82	7-Jul-08	43.12	42.3682	0.75	0.57
83	8-Jul-08	43.37	42.3884	0.98	0.96
84	9-Jul-08	43.13	42.4085	0.72	0.52
85	10-Jul-08	43.16	42.4287	0.73	0.53
86	11-Jul-08	42.72	42.4488	0.27	0.07
87	14-Jul-08	42.82	42.4690	0.35	0.12
88	15-Jul-08	43.17	42.4891	0.68	0.46
89	16-Jul-08	43.17	42.5093	0.66	0.44
90	17-Jul-08	42.94	42.5294	0.41	0.17
91	18-Jul-08	42.78	42.5496	0.23	0.05
92	21-Jul-08	42.71	42.5697	0.14	0.02
93	22-Jul-08	42.71	42.5899	0.12	0.01

94	23-Jul-08	42.33	42.6101	-0.28	0.08
95	24-Jul-08	41.96	42.6302	-0.67	0.45
96	25-Jul-08	42.23	42.6504	-0.42	0.18
97	28-Jul-08	42.30	42.6705	-0.37	0.14
98	29-Jul-08	42.54	42.6907	-0.15	0.02
99	30-Jul-08	42.47	42.7108	-0.24	0.06
100	31-Jul-08	42.49	42.7310	-0.24	0.06
101	1-Aug-08	42.37	42.7511	-0.38	0.15
102	4-Aug-08	42.40	42.7713	-0.37	0.14
103	5-Aug-08	42.28	42.7914	-0.51	0.26
104	6-Aug-08	42.00	42.8116	-0.81	0.66
105	7-Aug-08	41.89	42.8317	-0.94	0.89
106	8-Aug-08	42.20	42.8519	-0.65	0.42
107	11-Aug-08	42.00	42.8721	-0.87	0.76
108	12-Aug-08	42.40	42.8922	-0.49	0.24
109	13-Aug-08	42.67	42.9124	-0.24	0.06
110	14-Aug-08	42.82	42.9325	-0.11	0.01
111	18-Aug-08	43.23	42.9527	0.28	0.08
112	20-Aug-08	43.72	42.9728	0.75	0.56
113	21-Aug-08	43.58	42.9930	0.59	0.34
114	22-Aug-08	43.38	43.0131	0.37	0.13
115	25-Aug-08	43.58	43.0333	0.55	0.30
116	26-Aug-08	44.07	43.0534	1.02	1.03
117	27-Aug-08	43.73	43.0736	0.66	0.43
118	28-Aug-08	43.73	43.0937	0.64	0.40
		4945.94		0.00	77.03

Calculations and Data for Spot Price, Future Price and Trend Lines for Post-Introduction Period

S.N.	Date	sprice2	Est. price	e	e^2	fprice	Est. price	e	e^2
1	29-Aug-08	43.79	47.3917	-3.60	12.97	44.03	47.5730	-3.54	12.54
2	1-Sep-08	44.21	47.4061	-3.20	10.21	44.28	47.5868	-3.31	10.94
3	2-Sep-08	44.26	47.4204	-3.16	9.99	44.53	47.6006	-3.07	9.43
4	4-Sep-08	44.45	47.4348	-2.98	8.91	44.43	47.6144	-3.19	10.16
5	5-Sep-08	44.37	47.4492	-3.08	9.48	44.77	47.6282	-2.86	8.16
6	8-Sep-08	44.26	47.4635	-3.20	10.26	44.74	47.6420	-2.90	8.44
7	9-Sep-08	44.89	47.4779	-2.59	6.70	44.91	47.6558	-2.75	7.55
8	10-Sep-08	45.12	47.4923	-2.37	5.63	45.30	47.6696	-2.37	5.62
9	11-Sep-08	45.44	47.5067	-2.07	4.27	45.71	47.6834	-1.97	3.89
10	12-Sep-08	45.77	47.5210	-1.75	3.07	45.91	47.6972	-1.78	3.19
11	15-Sep-08	45.94	47.5354	-1.60	2.55	46.18	47.7110	-1.53	2.35
12	16-Sep-08	46.63	47.5498	-0.92	0.85	46.87	47.7248	-0.85	0.73
13	17-Sep-08	46.34	47.5642	-1.22	1.50	46.44	47.7386	-1.30	1.69
14	18-Sep-08	46.71	47.5785	-0.87	0.75	46.50	47.7524	-1.26	1.58
15	19-Sep-08	46.32	47.5929	-1.27	1.62	45.89	47.7662	-1.88	3.52
16	22-Sep-08	45.40	47.6073	-2.21	4.87	45.47	47.7800	-2.32	5.36
17	23-Sep-08	45.72	47.6216	-1.90	3.62	45.82	47.7938	-1.98	3.92
18	24-Sep-08	45.83	47.6360	-1.81	3.26	45.98	47.8076	-1.83	3.36
19	25-Sep-08	46.25	47.6504	-1.40	1.96	46.21	47.8214	-1.61	2.60
20	26-Sep-08	46.43	47.6648	-1.23	1.52	46.56	47.8352	-1.28	1.64
21	29-Sep-08	46.94	47.6791	-0.74	0.55	46.99	47.8490	-0.86	0.74
22	30-Sep-08	46.94	47.6935	-0.75	0.57	47.14	47.8628	-0.73	0.53
23	1-Oct-08	46.96	47.7079	-0.75	0.56	46.74	47.8766	-1.14	1.30
24	3-Oct-08	46.88	47.7222	-0.84	0.71	47.16	47.8904	-0.73	0.53
25	6-Oct-08	47.46	47.7366	-0.28	0.08	47.75	47.9042	-0.16	0.03
26	7-Oct-08	48.01	47.7510	0.26	0.07	47.83	47.9180	-0.09	0.01
27	8-Oct-08	48.74	47.7654	0.97	0.95	48.12	47.9318	0.19	0.04
28	10-Oct-08	48.72	47.7797	0.94	0.88	48.54	47.9456	0.59	0.35
29	13-Oct-08	48.14	47.7941	0.35	0.12	48.33	47.9594	0.37	0.14

30	14-Oct-08	47.71	47.8085	-0.10	0.01	48.22	47.9732	0.24	0.06
31	15-Oct-08	48.43	47.8229	0.61	0.37	48.66	47.9870	0.67	0.45
32	16-Oct-08	48.86	47.8372	1.02	1.05	49.03	48.0008	1.03	1.06
33	17-Oct-08	48.68	47.8516	0.83	0.69	49.06	48.0145	1.04	1.08
34	20-Oct-08	48.83	47.8660	0.96	0.93	49.09	48.0283	1.06	1.13
35	21-Oct-08	48.83	47.8803	0.95	0.90	49.38	48.0421	1.34	1.79
36	22-Oct-08	49.29	47.8947	1.40	1.95	49.49	48.0559	1.44	2.06
37	23-Oct-08	49.79	47.9091	1.88	3.54	50.48	48.0697	2.41	5.80
38	24-Oct-08	49.95	47.9235	2.03	4.11	50.85	48.0835	2.77	7.65
39	27-Oct-08	50.09	47.9378	2.15	4.63	51.02	48.0973	2.92	8.53
40	28-Oct-08	50.09	47.9522	2.14	4.57	50.44	48.1111	2.33	5.44
41	29-Oct-08	49.77	47.9666	1.80	3.25	50.14	48.1249	2.01	4.05
42	31-Oct-08	49.25	47.9809	1.27	1.61	49.97	48.1387	1.83	3.34
43	3-Nov-08	48.96	47.9953	0.96	0.93	48.95	48.1525	0.79	0.63
44	4-Nov-08	48.62	48.0097	0.61	0.37	48.18	48.1663	0.02	0.00
45	5-Nov-08	47.18	48.0241	-0.84	0.71	47.75	48.1801	-0.43	0.18
46	6-Nov-08	47.67	48.0384	-0.37	0.14	47.95	48.1939	-0.24	0.06
47	7-Nov-08	47.76	48.0528	-0.29	0.09	47.99	48.2077	-0.22	0.05
48	10-Nov-08	47.32	48.0672	-0.75	0.56	47.60	48.2215	-0.62	0.39
49	11-Nov-08	47.59	48.0815	-0.49	0.24	48.20	48.2353	-0.04	0.00
50	12-Nov-08	48.79	48.0959	0.69	0.48	49.38	48.2491	1.13	1.27
51	14-Nov-08	49.46	48.1103	1.35	1.82	49.15	48.2629	0.88	0.78
52	17-Nov-08	48.99	48.1247	0.87	0.75	49.33	48.2767	1.05	1.11
53	18-Nov-08	49.68	48.1390	1.54	2.37	49.77	48.2905	1.48	2.19
54	19-Nov-08	49.74	48.1534	1.59	2.52	50.00	48.3043	1.69	2.86
55	20-Nov-08	50.52	48.1678	2.35	5.53	50.15	48.3181	1.83	3.36
56	21-Nov-08	50.03	48.1822	1.85	3.41	50.16	48.3319	1.83	3.33
57	24-Nov-08	50.09	48.1965	1.89	3.59	50.14	48.3457	1.80	3.23
58	25-Nov-08	49.97	48.2109	1.76	3.09	50.11	48.3595	1.75	3.05
59	26-Nov-08	49.85	48.2253	1.62	2.64	49.73	48.3733	1.36	1.84
60	28-Nov-08	49.84	48.2396	1.60	2.56	50.32	48.3871	1.93	3.72
61	1-Dec-08	50.09	48.2540	1.84	3.37	50.57	48.4009	2.17	4.69

62	2-Dec-08	50.52	48.2684	2.25	5.07	50.43	48.4147	2.02	4.06
63	3-Dec-08	49.90	48.2828	1.62	2.62	50.24	48.4285	1.81	3.28
64	4-Dec-08	49.79	48.2971	1.49	2.23	49.95	48.4423	1.51	2.28
65	5-Dec-08	49.69	48.3115	1.38	1.90	49.78	48.4561	1.32	1.75
66	8-Dec-08	49.22	48.3259	0.89	0.80	49.62	48.4698	1.15	1.32
67	10-Dec-08	49.12	48.3402	0.78	0.61	49.10	48.4836	0.61	0.38
68	11-Dec-08	48.52	48.3546	0.17	0.03	48.45	48.4974	-0.04	0.00
69	12-Dec-08	48.71	48.3690	0.34	0.12	48.73	48.5112	0.22	0.05
70	15-Dec-08	47.94	48.3834	-0.44	0.20	48.17	48.5250	-0.35	0.12
71	16-Dec-08	47.82	48.3977	-0.58	0.33	47.99	48.5388	-0.55	0.30
72	17-Dec-08	47.33	48.4121	-1.08	1.17	47.67	48.5526	-0.88	0.78
73	18-Dec-08	47.28	48.4265	-1.15	1.31	47.02	48.5664	-1.55	2.40
74	19-Dec-08	47.08	48.4409	-1.36	1.85	47.39	48.5802	-1.19	1.42
75	22-Dec-08	47.39	48.4552	-1.07	1.13	48.05	48.5940	-0.55	0.30
76	23-Dec-08	48.49	48.4696	0.02	0.00	48.83	48.6078	0.22	0.05
77	24-Dec-08	48.99	48.4840	0.51	0.26	48.17	48.6216	-0.45	0.20
78	26-Dec-08	47.89	48.4983	-0.61	0.37	48.45	48.6354	-0.19	0.04
79	29-Dec-08	48.76	48.5127	0.25	0.06	48.65	48.6492	0.00	0.00
80	30-Dec-08	48.50	48.5271	-0.03	0.00	48.58	48.6630	-0.09	0.01
81	31-Dec-08	48.45	48.5415	-0.09	0.01	48.79	48.6768	0.11	0.01
82	1-Jan-09	48.73	48.5558	0.17	0.03	48.81	48.6906	0.12	0.01
83	2-Jan-09	48.89	48.5702	0.32	0.10	48.85	48.7044	0.15	0.02
84	5-Jan-09	48.37	48.5846	-0.21	0.05	48.66	48.7182	-0.06	0.00
85	6-Jan-09	48.68	48.5989	0.08	0.01	48.76	48.7320	0.03	0.00
86	7-Jan-09	48.61	48.6133	0.00	0.00	48.78	48.7458	0.03	0.00
87	9-Jan-09	48.92	48.6277	0.29	0.09	48.55	48.7596	-0.21	0.04
88	12-Jan-09	48.60	48.6421	-0.04	0.00	48.93	48.7734	0.15	0.02
89	13-Jan-09	48.91	48.6564	0.25	0.06	49.14	48.7872	0.36	0.13
90	14-Jan-09	48.70	48.6708	0.03	0.00	48.90	48.8010	0.10	0.01
91	15-Jan-09	49.08	48.6852	0.39	0.16	49.08	48.8148	0.27	0.07
92	16-Jan-09	48.77	48.6996	0.07	0.00	48.83	48.8286	0.00	0.00
93	19-Jan-09	48.56	48.7139	-0.15	0.02	48.73	48.8424	-0.11	0.01

94	20-Jan-09	48.99	48.7283	0.26	0.07	49.19	48.8562	0.33	0.11
95	21-Jan-09	49.12	48.7427	0.38	0.14	49.19	48.8700	0.32	0.10
96	22-Jan-09	48.93	48.7570	0.17	0.03	49.16	48.8838	0.28	0.08
97	23-Jan-09	49.19	48.7714	0.42	0.18	49.24	48.8976	0.34	0.12
98	27-Jan-09	48.85	48.7858	0.06	0.00	48.91	48.9114	0.00	0.00
99	28-Jan-09	48.87	48.8002	0.07	0.00	48.99	48.9252	0.06	0.00
100	29-Jan-09	48.90	48.8145	0.09	0.01	49.11	48.9389	0.17	0.03
101	30-Jan-09	49.02	48.8289	0.19	0.04	48.93	48.9527	-0.02	0.00
102	2-Feb-09	49.01	48.8433	0.17	0.03	49.03	48.9665	0.06	0.00
103	3-Feb-09	48.80	48.8576	-0.06	0.00	48.92	48.9803	-0.06	0.00
104	4-Feb-09	48.65	48.8720	-0.22	0.05	48.85	48.9941	-0.15	0.02
105	5-Feb-09	48.82	48.8864	-0.07	0.00	48.84	49.0079	-0.17	0.03
106	6-Feb-09	48.73	48.9008	-0.17	0.03	48.76	49.0217	-0.26	0.07
107	9-Feb-09	48.60	48.9151	-0.32	0.10	48.66	49.0355	-0.38	0.14
108	10-Feb-09	48.70	48.9295	-0.23	0.05	48.77	49.0493	-0.28	0.08
109	11-Feb-09	48.82	48.9439	-0.12	0.02	48.75	49.0631	-0.31	0.10
110	12-Feb-09	48.72	48.9583	-0.24	0.06	48.85	49.0769	-0.23	0.05
111	13-Feb-09	48.72	48.9726	-0.25	0.06	48.71	49.0907	-0.39	0.15
112	16-Feb-09	48.72	48.9870	-0.27	0.07	48.82	49.1045	-0.28	0.08
113	17-Feb-09	49.16	49.0014	0.16	0.03	49.61	49.1183	0.49	0.24
114	18-Feb-09	49.85	49.0157	0.83	0.70	50.03	49.1321	0.90	0.81
115	19-Feb-09	49.85	49.0301	0.82	0.67	49.66	49.1459	0.51	0.26
116	20-Feb-09	49.85	49.0445	0.81	0.65	49.79	49.1597	0.63	0.39
117	24-Feb-09	49.89	49.0589	0.83	0.69	49.92	49.1735	0.74	0.55
118	25-Feb-09	49.82	49.0732	0.75	0.56	49.83	49.1873	0.64	0.41
		5691.43		0.00	196.07	5708.86		0.00	208.37