Research Journal of Recent Sciences _____ ISSN 2277-2502
Vol. **3(6),** 50-58, June **(2014)** *Res.J.Recent Sci.*

Correlation among Indian Financial Markets: Does Unit Root Matter?

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Available online at: www.isca.in, www.isca.me
Received 26th March 2014, revised 17th May 2014, accepted 28th May 2014

Abstract

In this research, the relationship among the four major financial markets of India including the currency, commodity, bond and stock markets is investigated during the period 2000-2012.Time series data are used at both original and first difference levels to calculate the correlation coefficient between variables under study. Validity of correlation coefficient will be evaluated through comparison of coefficient of determination and Durbin-Watson statistic. In order to identify the stationarity of data, the Augmented Dickey-Fuller test is used. Finally, the correlation coefficient between the variables is analyzed and compared before, after and during the year 2008 as the financial crisis year. The main findings of this study are: i. in the investigation of the relationship between variables based on the original level of data, the spurious regression has been observed. Therefore in order to obtain the real correlation coefficients, the first difference level of data is used. ii. On the whole, the considerable correlation coefficient does not exist between the variables. Though, the absolute of average for the correlation coefficients was relatively higher for the year 2008 compared to the period before and after that.

Keyword: Financial market, financial crisis, spurious regression, stock, bond, commodity, and currency correlation.

Introduction

Many researchers in the financial field have devoted their studies on the investigation of relationship among financial markets over the past decade. These studies encompass both different markets within the geographical boundaries of a country and different markets across countries.

Gayed states that behavior of any market is a function of trends and behaviors of other markets as well as other economic sectors[1]. This implies the markets are not only influenced by their special fundamentals, but also by movements from other markets. This reciprocal influence will lead to an interrelationship of different markets over the time and its consequence would be high degree of correlation among them. Murphy believes in a kind of causality relationship among currency, commodity, bond, and stock markets respectively[2]. Gayed had reached at similar results as Murphy did[1]. They argue that changes in commodity market cause a change in the trend of interest rate and consequently, bond price will be influenced by changing of interest rate and this in turn will impact the stock market. Their opinion has not been corroborated by other researchers .On the whole, there is no consensus among the researcher's findings regarding the relationship among different financial markets mentioned above. Different studies have come to different results.

Currency and Commodity Markets: There are lots of researches already done regarding the interrelationship between currency and commodity markets. Most of these studies have concentrated on two groups of countries that employ the regime of float rate. First group consists of countries in which commodities, as important export items, play a significant role in the economy of such countries such as Australia, Canada, New Zealand, and so on. Currency of these countries is referred to as the "commodity currency". Second group includes countries which are known either as the prominent producer and exporter of special commodity like metals, energy and agriculture products, or they make a combinational power in their market through forming a group of exporting countries. The commodities of these countries are called "currency commodity". In general, the result of most of these studies indicates that the exchange rate and commodity prices are interrelated in these countries and their currency because of pricing power can affect the world commodity prices.

Chen and Rogoff have investigated the behavior of real exchange rate in three countries comprising Australia, Canada, and New Zealand where primary commodities constitute a major part of their exports. They have specially found out that the exporting commodities price has a strong and stable effect on their floating exchange rates in the countries of Australia and New Zealand. Regarding Canada, evidence indicates the existence of not a very strong and even weak co-movement between the commodity prices and the real exchange rate in the short term. But the same study finds evidence for co-integrated relationship in the long term[3].

Clements and Fry have concentrated their study on both groups of countries which have "currency commodity" and "commodity currency". The findings of this research reveal that there are fewer evidences about the effect of commodity prices on the currency than vice versa[4].

Chen, Rogoff and Rossi have used the seasonal data to study the relationship between the commodity market and exchange rate in the exporting countries. The results of their study show that the exchange rate of the commodity currency of the exporting countries has a very strong and interesting power in predicting the world commodity prices. They have also reached at certain evidence regarding the effect and capability of commodity in predicting exchange rate but their predication did not have enough strength[5].

Kohlscheen has used the model of VAR in order to calculate the passage of the exchange rate to the consumer price index in some of emerging economies which use floating exchange rate system. Such calculations show that despite the fact that the countries being investigated in this research have witnessed a considerable fluctuation in the real and nominal exchange rate, the passage of the exchange rate to the consumer price index has not been very strong and it has actually been observed to be at a moderate level[6].

Chen, Tse and Williams have studied the relationship between the exchange market and the commodity futures market in the four countries of Australia, New Zealand, Canada and South Africa. They have found out that there exists a relationship between the exchange and commodity markets in the countries under study though this relationship has not been causal[7].

Currency and bond markets: The extant literatures on the relationship between currency and bond have certain qualities: first, they have studied the bonds at both national and international levels. The international or sovereign bond is a kind of bond which is issued in a monetary unit which is not that of the borrowing country. But national bond will be issued in the same monetary units as those of the borrowing country. Secondly, these researches have considered different monetary policies as well as different regimes of the exchange rate such as fixed system, floating system and the managed floating system. A few such studies are presented below.

Gagnon examines the behavior of government bond return after immense and sudden reductions of the exchange rate (currency crisis) which happened in the big industrial countries during the period between 1975 and 2004. The findings of this research indicate that the reduction of the value of currency in the industrial countries has not lead to the higher return on the bonds which is contrary to the expectorations. It means that the reduction of the currency value is in the same line with reduction of bond return (increase in the bond price). Gagnon sees the stable and anti-inflation monetary policies of the industrial countries to be interfering in this issue[8].

Jahjah, Wei and Yue have analyzed the relationship among different policies to determine the exchange rate and pricing of international bonds in 42 developing countries. They have come to the conclusion that policies for determining the exchange rate would be affecting international bond returns in considerable way. It means that countries which have the flexible regime in determining the exchange rate are inclined towards the payment of difference of the higher bond return[9].

Clarida has studied the changes in the exchange rate and the bond return (which is based on the inflation rate) according to daily data in the countries of England, Japan, and The European Union for the period 2001 to 2011. The researcher found that 30 to 60 percent of fluctuation of daily changes of the exchange rate is to be explained through simultaneous changes of bon fair value. He believes that this percentage is not a very high and therefore it does not show a very strong relationship[10].

Alexius and Sellin have investigated the relationship between the exchange rate and long term bonds. They have specifically studied the changes in the exchange rate of German Mark against the American Dollar on one hand and the difference in the returns of two groups of long term bonds issued based on Mark and Dollar on the other as the variables for their research. The results gained from the statistical test of this research indicate that beta co- efficient obtained is more that 60 percent and therefore, the assumption of equality of the return from the investment in two groups of long term bonds (Mark and Dollar) cannot be rejected. This implies lack of any kind of relationship between exchange rate and the long term bonds[11].

Currency and stock markets: Researches on the relationship between the currency and stock have highlighted two approaches: traditional and portfolio. In the traditional approach, it is assumed that the exchange rate would orientate the stock price and the reverse to that would happen in the portfolio approach in the sense that the stock market would be directing the exchange rate. Some of the researches done in this regard are presented below.

Aggarwal has indicated that a change in the exchange rate can change the share prices of international companies directly and the domestic ones indirectly[12].

Abdalla and Murinde have found out that changes in the exchange rate would direct the stock return through a research done on data collected from counties of India, Pakistan, South Korea and Philippines[13].

Granger, Huang and Yang have studied the causality relationship between stock price and exchange rate. They have specifically chosen the developing Asian countries for the purpose of studying the effect of the East Asian currency crisis of 1997. This research has found different results in different countries. While exchange rate directs the stock price in South Korea it happens the other way around in the Philippines, meaning that the changes of stock price are the reason for changes in exchange rate (with negative correlation), likewise, no pattern was observed in the relationship between stock and currency in Japan and Indonesia[14].

Patro, Wald and Wu have investigated the reaction of the stock market against the reduction of value of national currency created by the central banks of different countries. Both researches have come to similar conclusions. They have observed considerable negative stock returns over the months before the announcement of reduction in the value of national currency[15].

Cho and Yoo studied stock market volatility in South Korea during the currency crisis of 1997 and credit crisis of 2008. This study includes the monthly data of South Korean financial markets from 1980 to 2009. Results of this research indicate that stock return volatility has increased greatly throughout the currency crisis period. Though the stock market prices collapsed and the exchange rate of Won-Dollar rose throughout the credit crisis, but such fluctuations were still less than during the period of currency crisis[16].

Commodity and bond markets: The key to the relationship between commodity and bond prices is inflation. On one hand, commodity price is the preceding index to the inflation and on the other, inflation is intensely influenced by the monetary policies. As a result of that, most of the researchers have begun to study the effect of inflation and monetary policies on the relationship between commodity and bond in order to analyze this relationship[17].

Nimark has attempted to answer the question as to whether it is possible that formulating and arranging of the monetary policies can be done through extractive signals of the bond market. The results of this study shows that in the bond return of less than one year maturity in America, there is certain information that can help the Federal Reserve of America to recognize the economic shocks and consequently, codify the appropriate monetary policies. This research proves the effect of the bond market on the commodity market through monetary policies implicitly[18].

Browne and Cronin have studied the relationship between the commodity price, currency and inflation in the American economy. They have found that both the short term and long term relationships exist among the commodity price, consumer price (inflation) and currency. The effect of the commodity prices on the consumer price would be through currency and in proportion to supply of money. The implicit conclusion drawn from this research is that supply of money would affect the interest rate in reaction to the inflation. It is clear that the price of bond would be affected by the changes in the interest rate[19].

Bredin, Hyde and Reilly have examined the effect of unpredicted monetary policies on the international bond return in Germany, America and England. They have studied how it is possible for the bond return in these three countries to be affected by the changes in the momentary policies. Their results show that the bond return reacts to internal monetary policies. Though, the effect of monetary policies on the bond return in these countries has been very different basically. Stringent monetary policies have caused increase and decrease in bond return in Germany and England respectively. In this research, there is no evidence of the effect of monetary policies of America on the bond return of Germany and England. Such a finding is contrary to the findings of most other studies[20].

Commodity and stock markets: Many studies have been conducted about the relationship between commodity and stock. Most of these studies show historical negative correlation between the changes in commodity price and stock on the whole.

Bannister and Forward have studied the historical data on commodity and stock of America for the period 1871 to 2002. They have observed a stable negative correlation between the changes in commodity price and stock during this long period of time[21].

Zapata et al. have updated the above mentioned research of Bannister and Forward (2002) and have included data related to the commodity and stock price of America in their study for the year 1871 to 2010. This research has found that the correlation coefficient was -0.71 between the index of S.P 500(stock) and PPI (commodity) [22].

Delatte and Lopez and Creti, Joets and Mignon have reached at similar results and found that the correlation between the commodity and stock would change in the course of time, but most of the time, the correlation exists and it would face more fluctuation at the time of financial crisis and economic disorders[23, 24].

Mensi, Beljid, Boubaker, and Managi have investigated correlation and the volatility spill-over between the commodity and stock markets in America during the period 2000 to 2011. This research shows that there exist considerable correlation and transfer of volatility between the commodity and stock markets[25].

Bond and stock markets: Researchers have focused on the important factors such as interest rate, inflation rate, business cycle and economic disorders in order to analyze the relationship between bond and stock. On the whole, there is no unanimous agreement among the researchers regarding the relationship between stock and bond. Most of the findings of researches show that in the long term particularly during the economics disorder, stock and bond have moved in the opposite directions. That is the reason why the bonds have been used traditionally by investors as the haven against the risks of stock market.

Boyd, Hu and Jagannathan have observed that the correlation between stock and bond is positive when economy is in a boom, and it tends to be negative during the recession time[26]. d'Addona and Kind By using data from G7 countries, have

found that the real interest rate increases the correlation between the stock and bond while inflation decreases the correlation[27].

Cannolly, Stivers and Sun have studied the correlation between stock and bond in the G7 countries. They have done it by using the implied volatility index of option and future stock as the uncertainty index of market. They have found that co-movement and correlation of these two assets is inclined towards negativity at the time of increase in uncertainty and it tends to positivity when uncertainty comes down[28].

Data Description: Data from four major financial markets of India including the currency, commodity, bond and stock markets are analyzed in this research for period 2000 to 2012. For selecting this time period, the researchers have considered two objectives. First one is that the time period is coincidental with the financial crisis of 2008. The severity of this crisis was different in different countries. The financial markets of India were affected too by the crisis to some extent and have experienced fluctuation as a result. Therefore, it is important that the behavior of economic and financial variables before, during and after the crisis be studied and compared. To do that, the period under studying is divided into three sub-periods: 2000-2007, 2008, 2009-2012 and the statistical tests for these periods are done separately. The second objective for choosing this time period is that such a period is the second decade after extensive economic reforms were lunched in India. To examine the consequences of such reforms and their effects on the financial market is important for the policy makers, academicians and investors.

The variables under studying in this research include the index of CNX500, TBI, MCX, and ERI which are used as the representatives of stock, bond, commodity and currency markets respectively. The CNX500 is the index of National Stock Exchange of India, TBI is the index of long term government bond with maturity of 8+ years, MCX is the index of multi commodity exchange and ERI is the exchange rate of Reserve Bank of India (price of Rupee against Dollar).

Due to unavailability of data related to the commodity market (MCX index) for the years 2000 to 2005, the whole price index (WPI) has been used instead of MCX index.

As the data related to WPI exists only on a weekly basis, other indices were converted from daily to weekly basis in order to make a uniform time base of data. Therefore, data are used on a weekly basis in this research. Table 1 shows the important statistics of such data.

Methodology

The concept of correlation is one of the frequently used concepts in the field of investigating the relationship among different variables. Following the usage of the concept of correlation by Markowitz for developing the portfolio theory, the concept found a more extensive application in the field of financial researches. Markowitz proved that variance of return of one portfolio is the weighted mean of correlation coefficients of the return from the assets which make the same portfolio. Therefore, to decrease variance (risk) of portfolio, such assets have to be searched for that have no correlation and they should even have negative correlation coefficient[29].

The Pearson correlation coefficient from among the correlation coefficients is more appropriate under certain circumstances. This coefficient is a scale to measure the degree of the linear relationship between two variables and its value lies between -1 and +1 means $(-1 \leq r \leq +1)$.

$$r = \frac{\sum_{i=1}^{n}(Xi - \bar{x})(Yi - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(Xi - X)^2} \quad \sqrt{\sum_{i=1}^{n}(Yi - Y)^2}}$$

The analysis of Pearson correlation coefficient should be accomplished with more caution in order to study the relationship between the variables which are based on time series data, because this correlation coefficient is in fact nothing but deviation from the mean of data and does not give any information regarding the trend of assets' price (Lhabitant)[30]. Time series data have the trend and the mean is not constant for such data, which in condition, the time series are non-stationary. Therefore, calculating Pearson correlation coefficient, based on the original level of time series data, may reflect an unreal correlation. The original level of time series data is usually integrated and if these data are used in the regression models, a high coefficient of determination (R^2) would be obtained, even though such time series data are not dependent of one another. In such cases, the existence of the high coefficient of determination along with low value of Durbin Watson statistic ($R^2 >$ D.W) is indicative of a spurious regression[31].

Considering the above mentioned explanation and in order to make sure that there does not exist any spurious regression, the regression model needs to be run and then R^2 coefficient and D.W statistic need to be compared. To remove the spurious regression, some changes need to be made on time series data. One of the important methods for this purpose is to use data differences (P_n-P_{n-1}). In data differences, the issue of unit root will be solved and data would change from non-stationary to the stationary status. Under such circumstances, the Pearson coefficient would show the real value of correlation among the variables.

The augmented Dickey-Fuller test is one of the common tests extensively employed for the recognition of the unit root or non-stationarity in the time series data. In this test, the null hypothesis is that data have unit root and if P-value is less than 5% at the 95% of confidence level, the null hypothesis would be rejected. Otherwise, it would be accepted. The Augmented Dickey and Fuller (ADF) unit root test is generally written as below:

$$\Delta yt = \alpha + \beta t + (\rho - 1) + \sum_{i=1}^{k-1} \theta i \, \Delta y \, t - i \; + \; \alpha t$$

Where Δy_t is differenced level of y, *yt* is a macroeconomic variable such as currency, commodity, bond, or stock price, and a_t is a white noise term. In the ADF test the null hypothesis is formulated based on the existence of unit root, i.e. the variables being non-stationary at levels. If the coefficient of the lagged independent variable; (ρ-1) is zero, then a unit root exists, i.e. *H*0: ρ = 1, and then *yt* has the unit root property if one fails to reject *H*0.

The present study has primarily computed the correlation matrix of the investigated variables at the original level of data. Afterwards; the regression model is run for the comparison between the (R^2) and D.W statistic. Following that, the data are converted from the original level to the difference and the test of unit root is done on both the original and difference levels of data and finally, the correlation matrix is calculated at the difference level of data.

Results and Discussion

Table1 presents the descriptive statistics of the variables under study and includes the central parameters, dispersion parameters, skewness and kurtosis. These statistics are based on the original level of data, weekly price indices and consist of 678 observations in 13 years from 2000 to 2012. As can be seen in table 1, the higher standard deviation is related to stock, commodity, bond and currency indices respectively. The Jarque-Bera statistic indicates that time series data in the original level (price) does not have a normal distribution.

Table 2. The correlation coefficient of the variables under studying i.e. currency, commodity, bond and stock are presented in Table 2. This table includes the results related to both the whole period i.e. 2000 to 2012 and three sub-periods i.e. 2000 to 2007, 2008, 2009 to 2012. The absolute of average for correlation coefficient in three sub periods are 0.582, 0.629, and 0.423 respectively and for the whole period, the coefficient is 0.486 as can be seen from the table. Therefore, the highest absolute of average for correlation coefficient is related to the year 2008 which is the year of financial crisis.

Table-1
Descriptive Statistics for Original Level of Data on Price Index, 2000-2012

Statistics	LER	LMCX	LTB	LSP
Mean	2.172887	1561.667	295.0195	2574.412
Median	2.175805	1938.315	296.0750	2427.575
Maximum	2.546473	4206.290	398.9600	5502.600
Minimum	1.754608	145.9000	153.7300	545.8500
Std. Dev.	0.150277	1380.663	62.07409	1461.194
Skewness	0.006759	0.239655	-0.643010	0.105420
Kurtosis	3.769702	1.516359	2.733286	1.490908
Jarque-Bera	16.74163	68.67377	48.73079	65.59117
Probability	0.000232	0.000000	0.000000	0.000000
Observations/ weekly	678	678	678	678

ER (Exchange Rate), MCX (Multi Commodity Exchange), TB (Treasury bond), SP (Stock Price CNX 500)

Table-2
Correlation Matrix for Original Level of Data on Price Indices

YEAR	LER - LMCX	LER - LTB	LER - LSP	LMCX-LTB	LMCX-LSP	LTB - LSP	Total (Absolute)	Average (Absolute)
2000-2007	0.5559	0.3257	0.8132	0.3974	0.8801	0.5219	3.4944	0.582
2008	0.5875	-0.4374	0.9274	-0.8566	0.5479	-0.4189	3.7760	0.629
2009-2012	-0.4053	-0.7418	0.2889	0.4188	0.5651	-0.1105	2.5308	0.423
2000-2012	-0.1486	-0.2284	0.1151	0.7512	0.9210	0.7526	2.9172	0.486

ER (Exchange Rate), MCX (Multi Commodity Exchange), TB (Treasury bond), SP (Stock Price CNX 500).

Table 3: In order to evaluate the correlation coefficient obtained which have been presented in table 2; Regression model is used based on the original level of data too. Durbin Watson statist and coefficient of determination obtained from the estimation of regression model is shown in table 3. The results reveal two important findings. The first one is that prob. P-value is significant in all cases. It means that all independent variables are effective over the dependent variables. These results support the high correlation coefficients which are shown in table 2. The second finding is that in all cases that coefficient of determination is higher than Durbin Watson statistic (R^2 > D.W). This is one of the important signs to that spurious regression and consequently false correlation exist. Therefore, one can say that the correlation coefficients presented in table 2 are not reliable and they don't show the real value of correlation.

Table 4: One of the ways through which the real regression can be calculated is by using stationary time series data. This study has tested the stationarity of data by using the Augmented Dickey –Fuller (ADF) test. The results of ADF test are shown in Table 4. As can be seen, the P-value is higher than 5% at the original level of data for all variables and in the first difference level is less than 5%. Considering the null hypothesis, it can be concluded that all the variables are non-stationary at the original level and are stationary at the first difference level of data. Therefore, the first difference level of data is an appropriate level to calculate the correlation coefficient. In order to obtain real correlation coefficient, the data have been converted from original level to first difference, and then calculated correlation coefficient, which the results of are given in next table.

Table-3
Estimation of Regression Equation for Original Level of Data, 2000-2012

Dependent Variable	Independent Variable	Coefficient	t-Statistic	Prob.	R-squared	Durbin-Watson statistic
Exchange Rate Index (LER)	Multi-Commodity Exchange (LMCX)	-1.62E-05	-3.9086	0.0001	0.022100	0.015311
Exchange Rate Index (LER)	Treasury Bond Index (LTB)	-0.000553	-6.1013	0.0000	0.052194	0.015901
Exchange Rate Index (LER)	DSP Stock Price Index (LSP)	1.18E-05	3.0146	0.0027	0.013265	0.014043
Multi-Commodity Exchange (LMCX)	Treasury Bond Index (LTB)	16.70839	29.5896	0.0000	0.564306	0.019985
Multi-Commodity Exchange (LMCX)	Stock Price Index (LSP)	0.870314	61.5031	0.0000	0.848384	0.042584
Treasury Bond Index (LTB)	Stock Price Index (LSP)	0.031974	29.7205	0.0000	0.566475	0.023298

ER (Exchange Rate), MCX (Multi Commodity Exchange), TB (Treasury bond), SP (Stock Price CNX 500)

Table-4
Augmented Dickey-Fuller Unit Root Test

Market - Variable	year	Critical value at %5 level	Level		First Difference	
			t- Statistics	Probability (p - Value)	t- Statistics	Probability (p - Value)
Currency Market-Exchange Rate (ER)	2000-2007	-2.868285	0.458343	0.9851	-16.77662	0.0000
	2008	2.919952	-0.606127	0.8599	-6.108821	0.0000
	2009-2012	-2.875262	-0.615926	0.8631	-22.88828	0.0000
	2000-2012	-2.865598	-1.146049	0.6990	-22.88828	0.0000
Commodity Market-Multi Commodity Exchange (MCX)	2000 - 2007	-2.868268	-0.123823	0.9446	-20.13689	0.0000
	2008	-2.919952	0.625658	0.9891	-6.350687	0.0000
	2009 - 2012	-2.875262	-1.619366	0.4709	-15.15154	0.0000
	2000 - 2012	-2.865592	-0.170405	0.9395	-25.59868	0.0000
Bond Market - Treasury Bill (TB)	2000 - 2007	-2.868285	-2.025611	0.2758	-28.08165	0.0000
	2008	-2.919952	1.410431	0.9988	-6.351492	0.0000
	2009 - 2012	-2.875330	-1.596545	0.4825	-25.88786	0.0000
	2000 - 2012	-2.865598	-1.507008	0.5297	-39.17759	0.0000
Stock Market - S&P CNX 500 (SP)	2000 - 2007	-2.868268	3.580816	1.0000	-9.161380	0.0000
	2008	-2.919952	-1.908437	0.3260	-3.485569	0.0126
	2009 - 2012	-2.875262	-2.389956	0.1458	-13.64909	0.0000
	2000 - 2012	-2.865605	-0.765308	0.8276	-15.25928	0.0000

Null Hypothesis: The Variable Has a Unit Root (Is Non-Stationary)

Table 5 presents correlation coefficients between the variables namely currency, commodity, bond and stock. These coefficients are calculated based on the first difference level of data. The absolute of average for the correlations coefficients for three sub-periods 2000-2007, 2008, 2009-2012 are 0.1302, 0.2222, and 0.1460 respectively and it is 0.1058 for the whole period 2000 to 2012. These results also show that the highest degree of correlation is related to the year 2008 i.e. the year of financial crisis. The point to be considered is that the absolute of average for the correlation coefficients between variables, based on the first difference of data, are much smaller than the average obtained from the original level of data (table 2). This value is 0.1058 against 0.4862 for whole period 2000 to 2012, which has a considerable difference from one another.

Table 6 like table 3 shows the results of running the regression between the variables under studying including coefficient of determination (R^2) and Durbin Watson (D.W) statistic. The only difference is that the results of regression mentioned in table 3 are based on the original level of data while the figures in table 6 is the result of regression of variables based on the first difference level. As it can be seen from this table, firstly, (R^2) is smaller than D.W statistic in all cases. Therefore, we can conclude that spurious regression does not exist. Such finding is implicitly a confirmation that correlation coefficients presented in table 5 are real and reliable. Secondly, the results of running the regression on the first difference level of data (table 6) show that the P-value is smaller than 5% only in three cases during the period 2000 to 2012. This means that the independent variables are effective over the dependent ones in these three cases. These cases are as such: currency-stock, commodity-bond, and commodity-stock. The correlation coefficients between each pair of variables are 0.518, -0.132, and 0.174 respectively.

Table-5
Correlation Matrix for First Difference Level of Data, 2000-2012

Year	DER-DMCX	DER-DTB	DER-DSP	DMCX-DTB	DMCX-DSP	DTB-DSP	Total (Absolute)	Average (Absolute)
2000-2007	0.0093	0.0232	0.4323	-0.0213	0.1738	0.1210	0.7813	0.130
2008	-0.1249	-0.2765	0.4644	-0.3083	0.0507	-0.1081	1.3332	0.222
2009-2012	0.1175	0.0413	0.5812	-0.1099	0.2264	0.0194	0.8761	0.146
2000-2012	0.0394	-0.0182	0.5182*	-0.1323*	0.1745*	0.0164	0.6347	0.106

ER (Exchange Rate), MCX (Multi Commodity Exchange), TB (Treasury bond), SP (Stock Price CNX 500), *, p-value is significant.

Table-6
Estimation of Regression Equation for First Difference level of data, 2000-2012

Dependent Variable	Independent Variable	Coefficient	t-Statistic	Prob.	R-squared	Durbin-Watson statistic
Exchange Rate Index (DER)	Multi-Commodity Exchange (DMCX)	1.39E-05	1.0266	0.3050	0.001559	1.746720
Exchange Rate Index (DER)	Treasury Bond Index (DTB)	-6.12E-05	-0.4735	0.6360	0.000332	1.748880
Exchange Rate Index (DER)	DSP Stock Price Index (DSP)	9.60E-05	15.7428	0.0000	0.268560	1.832633
Multi-Commodity Exchange (DMCX)	Treasury Bond Index (DTB)	-1.260593	-3.4678	0.0006	0.017505	1.970891
Multi-Commodity Exchange (DMCX)	Stock Price Index (DSP)	0.091702	4.6068	0.0000	0.030483	1.932126
Treasury Bond Index (DTB)	Stock Price Index (DSP)	0.000908	0.4279	0.6688	0.000271	2.777971

ER (Exchange Rate), MCX (Multi Commodity Exchange), TB (Treasury bond), SP (Stock Price CNX 500).

Conclusion

In this research, the relationship among the four major financial markets of India consist of currency, commodity, bond and stock markets was investigated. The time period include 2000-2012 as a whole period and three sub-periods comprising 2000-2007, 2008, 2009-2012. At first, the correlation coefficient between the variables under study was calculated by using the original level of data. The results showed high correlation coefficient between the variables. But the comparison of coefficient of determination and Durbin-Watson statistic offered strong evidence that spurious regression exists. Therefore, in order to identify the appropriate level of data, the Augmented Dickey-Fuller test employed. This test showed that the first difference level of data is an appropriate level to calculate the correlation coefficient. The reason for that is non-existence of the unit root problem. The correlation coefficients between the variables were calculated based on the first difference level of data shows the following results: i. The highest correlation coefficient was observed between currency and stock markets. This coefficient for the whole period of 2000-2012 is +0.52 which is moderate and constant throughout the sub-periods. Therefore it can be concluded that the financial crisis did not influence on the relationship between those variables. ii. The correlation coefficient between commodity and stock markets for the time period of 2000-2012 was about +0.17 which is relatively weak. The relationship of these two variables has become weaker throughout the financial crisis, so that the correlation coefficient between them has reduced to +0.05 in the year 2008. iii. The correlation between commodity and bond markets was negative in the sub periods as well as the whole period. The correlation coefficient between them was -0.13 for the whole period. This coefficient has increased to -0.31 throughout the 2008 year. The result shows that the financial crisis has increased dependency of these two variables. iv. Regarding currency-commodity, currency-bond and bond-stock markets, the correlation coefficients obtained were very low (less than 0.05). The important point about the relationship between these markets is that the correlation coefficient between them has been positive before and after financial crisis. But it has changed into negative as well as increased in the year 2008. v. The absolute of mean for the correlation coefficients between the variables under study is relatively higher in the year 2008 compared to the years before and after the mentioned year. These coefficients were 0.13, 0.22, and 0.14 for the time period of 2000-2007, 2008 and 2009-2012 respectively.

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