Stock market, foreign exchange market and financial crisis

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Abstract

The global financial market is often taken as an inherently fragile system that is prone to irrational exuberance, unfound pessimism and crises. Faced with such a system, researchers and analysts often seek to explore the roots of crises and the channels through which they reverberate from the center to periphery. While financial disasters are probable it would be nice if they are predictable. The investors, analysts and the policy-makers would sit comfortably if stress or crisis in one financial market could be predicted from those in other markets. This is particularly the area where the present study intervenes with a focus on the foreign exchange market. It considers three exchange rates defined between (i) two emerging nations (India and Singapore), (ii) an emerging and a developed nation (India and US) and (iii) two developed nations (US and UK). In terms of stress indexes defined for each of these markets, it found no causality between stock market and foreign exchange market stresses for the developed-developed market pair. For the emerging markets, particularly for India, such channels of stress transmission remain and foreign exchange market crisis and stock market crisis (whether generated domestically or emanating from the developed, foreign market) may appear as "twin". For Singapore however, such a channel exists where stress is generated only in the other emerging market. Thus, the emerging markets that experience huge inflow of foreign capital in their stock markets might take stock market crises and foreign exchange market crises as twin. The policy implications however might differ. In some cases, it would be enough to regulate the domestic stock market, but in some other instances crises may be contagious coming from stock markets abroad.

Key words: Global financial market, financial crisis, stress index, granger causality, conditional correlation

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"What we know about the global financial crisis is that we don't know very much"...
Paul Sammuelson

1. Introduction

Whilst each cloud comes with a silver-lining, every silver-lining has a cloud behind it. Each boom brings a bubble in its train; and every crisis starts with a bubble. Fed by the initial and often irrational euphoria, financial booms soon tend to develop into bubbles: a trouble-spot that usually goes on unnoticed or is left unattended in intense speculative interest. Even in the presence of irrational exuberance, sheer recklessness or fraudulent behaviour people seem to keep absolute faith on the four most dangerous words in finance – '*this time it's different'*. Even in perceptible absence of real economic value creation, intervention is claimed to be sub-optimal. At one point in time financial vulnerabilities surpass any tolerance level and bubble transforms itself from a state of mind to a driving force for economic change. The bubble bursts, panic spreads with an ultimate devastating impact on other sectors of the economy. Frequent crashes in the financial market have raised questions about the myth of the *efficient market.* Shiller has pointed out that "*while markets are not totally crazy, they contain quite substantial noise, so substantial that it dominates the movements in the aggregate markets"* (Shiller, 2003). The global financial market should be taken as a system prone to "irrational exuberance and unfound pessimism. It is, in other words, extremely fragile and prone to collapse" (Roubini and Mihm, 2010).

In such an inherently unstable global financial system, researchers and analysts are often interested in exploring the root of such crisis and the channels through which crisis reverberate from the center to periphery. While financial disasters are probable it would be nice if they are predictable. The investors, analysts and the policy-makers would be equally happy if stress or crisis in one financial market could be predicted from those in other markets. This is particularly the area where the present study intervenes with a focus on the foreign exchange market crisis. A crisis in the foreign exchange market is often thought to transpire from a wide and complex variety of economic factors. In this era of financial integration, these are often triggered, particularly in an intrinsically vulnerable foreign

exchange market, by crises in other financial markets nearby. The newer generation models of twin crises emphasize the role financial sector and capital flows in currency crises (Stoker, 1995; Mishkin, 1996; Velasco, 1987; Calvo, 1995; Reinhart and Vegh, 1996; and Kaminsky and Reinhart, 1999). The present study delves in the issue to explore whether crises in the foreign exchange market could be predicted from the crises in other financial markets, particularly the stock market.

2. Earlier literature in the field

Owing to the great amount of integration between financial markets, volatility in foreign exchange is often considered to directly affect the stock markets. Contagion or co-movement between the financial markets has long been a hot topic for discussion. There have been numerous studies addressing this causal or predictive relationship between stock and foreign exchange market and most of them found a direct correlation between these two markets (Granger et al, 2000; Mishra, 2004). Studies have shown that stock market responds to volatility in foreign exchange market or in other words, there is a significant amount of volatility spillover between stock and foreign exchange markets. A change in the exchange rate directly affects both firms who are involved in international trade through their foreign exchange exposure as well as firms who trade only domestically through their portfolio adjustments (Bahmanee-Oskooee and Sohrabian, 1992). This in turn, changes the share prices of the affected firms and hence affecting the stock market. Nath and Samanta (2003) in their study in context of Indian Rupee/US Dollar, used cointegration test and Granger causality to conclude that there is a causal relationship from stock market returns to foreign exchange returns and only a mild causality in the reverse direction. Ajayi et al (1998) took seven developed economies and eight emerging Asian markets and used Granger causality to test for dynamic linkages. While most the developed economies showed a causal relation from foreign exchange to stock market, the result for the Asian economies were largely mixed. Muhammad and Rasheed (2002) studied the relationship between stock and foreign exchange markets in context of Pakistan, India, Bangladesh and Sri Lanka using cointegration, Vector Error Correction model and Granger causality. They found no short term association between these countries' foreign exchange market and stock markets. However, Bangladesh and Sri Lanka exhibit a long term relationship between these two markets. Stavárek (2005) conducted his study in context of nine countries (Austria, France, Germany, Slovakia, Czech Republic, France, Hungary, UK and US) and found significant short term and long term causal relation from stock market to foreign exchange markets for all of them. Tabak (2006)

conducted an extensive study in context of Brazil and found strong linear Granger causality from the stock market to foreign exchange market and non linear Granger causality from the foreign exchange market to stock market. Pan, Fok and Liu (2007) found evidence of causal relationships between daily exchange rates and stock prices for Hong Kong, Japan, Malaysia and Thailand before the 1997 Asian financial crisis. A causal relation from the stock market to the foreign exchange market was also found for Hong Kong, Korea, and Singapore. No country exhibited causality from stock prices to exchange rates during the Asian crisis, while exchange rates were found to influence stock prices for all countries except Malaysia. Several other researchers have shown similar dynamic linkages from stock market to foreign exchange market. Kasman (2005) in context of Turkey, Horobet and Ilie (2007) for Romania, Yang and Doong (2004) for G7 countries, Shew (2008) for Singapore, especially after the Asian crisis, Wickremasinghe (2006) for Sri Lanka, Choi et al (2010) for New Zealand are some of the significant studies.

The present study explores whether the crisis in the foreign exchange market could be predicted from the movements in other financial markets, particularly the stock market. Specifically, it inquires whether and to what extent the possible stressed situations in foreign exchange market could be predicted from the stresses in the stock market. For that purpose it seeks to define a stress index for each market and conducts the analysis in terms of these stress indexes. In this way, the study is different from the earlier approaches in the field that emphasise simply on the interdependence between stock prices and foreign currency rates.

3. The Study

While dealing with the issue, the study takes up the following trajectory and tries to answer the following set of questions:

1. Have the movements in the foreign exchange rates and stock prices been similar over the period of time?

2. Mere similarity in movements does not indicate any association. Hence, to what extent these markets move in conjunction?

3. However, mere correlation between returns may not imply correlated stress across markets. Prediction of stress in one market from that in the other is even more difficult (even in correlated markets) simply because of the fact that all change in market prices do not inflict stress on it. Hence, specifically, how to define stress?

4. Finally, does the stress in one market cause that in others? And, if so, is the relationship independent of the levels of financial development across markets?

Over a period of fifteen years ranging from 2000 to 2014, the study selects three exchange rates defined between (i) two developed financial markets namely the US and the UK; (ii) one developed (the US) and one emerging (India) market; and (iii) two emerging markets, namely India and Singapore. Thus, the three exchange rates chosen are British Pound per unit of US Dollar, Indian Rupee per unit of US Dollar and the Singapore Dollar per unit of Indian Rupee. The study would henceforth describe these rates as GBP/USD, INR/USD and SGD/INR respectively. These currencies are primarily floating. However, central government might intervene in extreme situations to avoid excessive and undesirable appreciations or depreciations.

The choice of the US and the UK in the first category is reasonably justified. The highly developed financial systems in the UK and the US have made these two the largest individual markets in the global arena. The widely and hugely traded GBP/USD ranks third among the most traded currency pairs in the global foreign exchange market. The trade in GBP/USD currency pair comprises nine percent of the total daily trading volume. In the second category, Indian currency and its relationship with a major global currency remains our point of concern. Although Indian currency is yet to be a full-float, the INR/USD trade is having a mass participation. Since late 2011, currency pairs between USD and currencies from BRIC nations, particularly the INR/USD are experiencing rapid growth. By late 2012, daily volume of trade in USD/INR currency pair stood at USD 2.4 Billion. In between October 2011 and October 2012, the volume of trade increased by 392% (Source: BIS, AITE Group 'Global FX Market Update 2013: Increased Market Transparency, More Competition', June 2013). Singapore is one of the emerging markets in the Asian region. According to the Bank for International Settlements, the Singapore Dollar was ranked 12th among the most actively traded currencies in the foreign exchange market in April 2010. It accounted for nearly 1.4 percent of average daily foreign exchange market trading volume. Singapore dollar is actively traded against the Indian Rupee.

The study considers two stock markets for each of these exchange rates. For GBP/USD rates, it selects the Dow Jones Industrial Average and the FTSE 100; the two significant indexes from the US and the UK respectively. For INR/USD currency pair, it selects BSE SENSEX (India) and Dow Jones Industrial Average (US). For SGD/INR currency pair, it considers

BSE SENSEX from India and FTSE Straits Time Index from Singapore. The most referred and closely-watched Dow Jones Industrial Average, invented in 1896, is a price-weighted index of thirty most significant 'blue-chip' stocks traded on the New York Stock Exchange and the NASDAQ. The index includes stocks from sectors such as conglomerate, consumer finance, telecommunication, aerospace and defence, construction and mining equipment, oil and gas, software and computer networking, beverages, chemical industry, banking, financial services, pharmaceuticals, retail, entertainment and insurance. By November 2014, the float-adjusted market capitalization of the thirty-stock index stood at USD 4864.4 Billion. The one-year and ten-year annualized total return has been 13.42% and 8.27% respectively (www.djindexes.com). The FTSE 100, introduced in 1984, is a market-capitalization weighted index of 100 blue-chip stocks traded on the London Stock Exchange. This index is seen as a barometer of business prosperity in the UK Market. The index includes stocks from sectors such as Banking and Insurance, mining and engineering, healthcare, consultancy, oil and gas, defense, property, media and entertainment, IT and telecom, industrial products, fashion and consumer goods, food, power and energy, chemicals, transportation and retail. By November 2014, the net market capitalization stood at GBP 1,704,341 million. It has yielded an annualized return of 10.8% and 9.1% over the last three and five years respectively (www.ftse.com). The S&P BSE SENSEX, introduced in 1986, is a free-float market-weighted stock market index of thirty blue-chip companies listed on Bombay Stock Exchange. It considers companies from different sectors such as capital goods, consumer durables, finance, FMCG, healthcare, real estate, IT and telecommunication, metal, metal products and mining, oil and gas, power, transport equipment and others. By November 2014, the market capitalisation of BSE SENSEX touched Rs. 100 Lakh Crore. It is taken as one of the world's top twenty stock exchanges by market capitalization. FTSE Straits Times Index (STI), introduced in 1966 and revamped and re-launched in 2008, is the market capitalisation-weighted bench-mark index of the Singapore stock market. It is constituted of the top thirty companies listed on the Singapore Exchange. As of February 2014, the market capitalization of the index stood at 262,718 million Singapore Dollars. It includes companies from sectors such as banking and insurance, telecommunication, real estate and holding, airlines, beverage, consumer goods, engineering, marine, diversified industrials, transportation and tourism, oil, farming and fishing, and others. Over the last year, the index offered a return of 9.52 percent (www.Bloomberg.com).

3.1. Stress in the GBP/USD exchange rate and the two stock markets:

The study starts its inquiry by plotting the exchange rate series and the two stock index series against time. Figure 1 shows the movement in GBP/USD exchange rate series over the fifteen years period ranging from January 2000 to December 2014. A major drop in the series is visible in January 2008. The steep fall continued for a period of one year when the series hit the slump in January 2009. The series is otherwise characterized by fluctuations that rarely developed into crisis.

Figure 1: Movements in GBP/USD series (2000-2014)

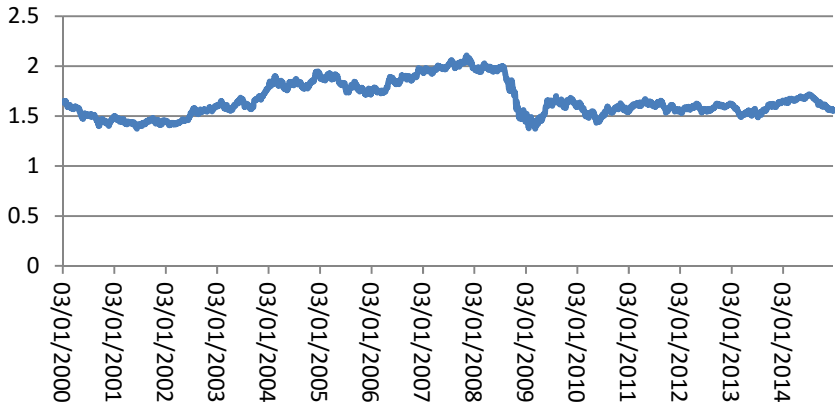
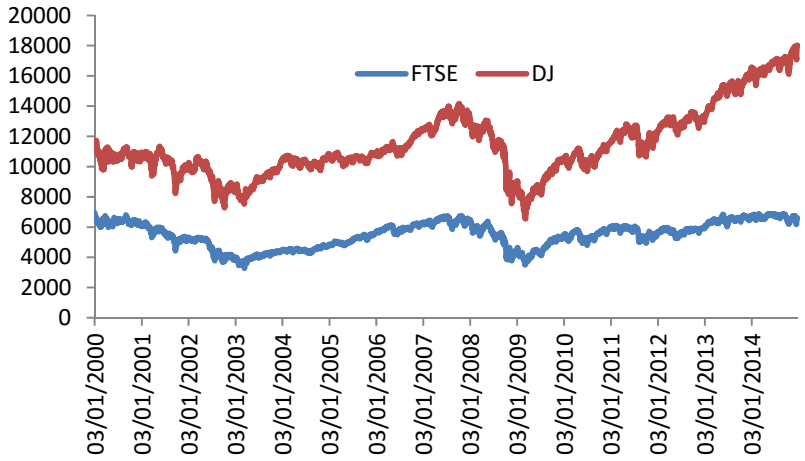


Figure 2 shows the movements in the US and the UK stock markets over the same time period.

Figure 2: Movements in FTSE 100 and DJIA series (2000-2014)



The movements in the two stock markets have been quite similar over the chosen time period. Both the markets turned bullish since 2003 and slipped in January 2008. Since January 2009,

both the markets are rising steadily. The upturn in the US market has been more significant than the UK market in recent years. The movements in the foreign exchange market have been similar to these but such a graphical introspection is hardly sufficient to predict stress in foreign exchange market from those in the stock markets.

To explore predictability of foreign exchange market stress from stock market crises, we start from the exploration into possible interconnection between foreign exchange market and the two corresponding stock markets. The daily change in each of the series are calculated using the formula $R_t = \ln(P_t/P_{t-1})$. This measures appreciation/depreciation for the foreign exchange rates and returns for the stock markets.

The possible interconnection between the two types of markets is explored using the conditional correlation coefficients. To estimate the conditional correlation coefficients, this study employs the widely used and flexible Diagonal Vector GARCH (VECH) version of the MVGARCH (multivariate generalized autoregressive conditional heteroscedasticity) model (Bollerslev et al., 1988). This model is frequently used in modelling financial time series on the presumption that the variance-covariance matrix of financial market returns vary over time. Following Bollerslev et al. (1988), the model could be described as:

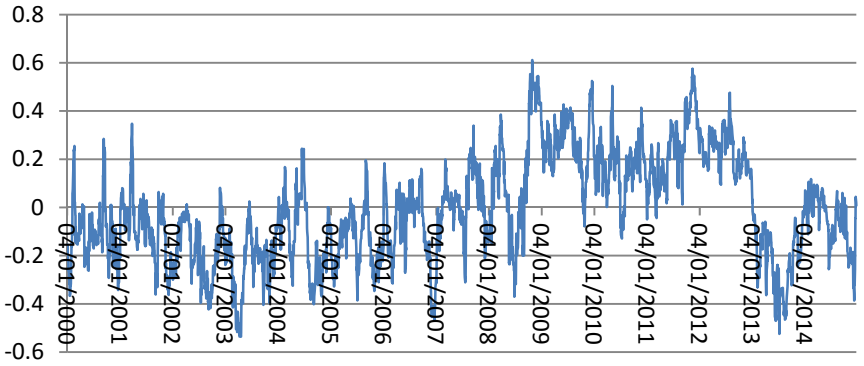
$$VECH(CV_t) = A + B.VECH(E_{t-1}.E'_{t-1}) + C.\ VECH(CV_{t-1}) \quad (1)$$

$$E_t|\psi_{t-1} \sim N(0, CV_t)$$

CV_t is n x n conditional variance-covariance matrix. E_t is 2 x 1 innovation vector, ψ_{t-1} is the information set at time *t*-1, A is N(N+1)/2 x 1 parameter vector and C and B are N(N+1)/2 x N(N+1)/2 parameter matrices. Since the number of parameters to be estimated might be a problematic issue, Bollerslev et al. (1988) as well as Goeij and Marquering (2004) suggested using the diagonal form of C and B.

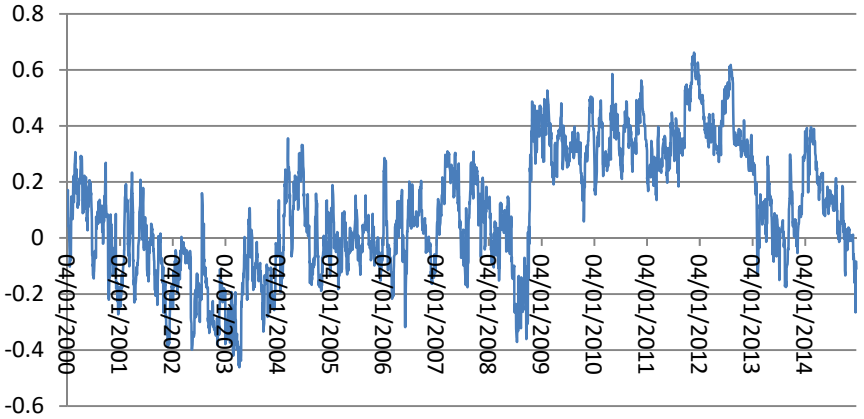
The estimated conditional correlation coefficients are shown in Figure 3 and Figure 4.

Figure 3: conditional correlation between FTSE and GBP/USD



The UK stock market and the GBP/USD market were mostly negatively correlated before the crisis of 2008. Over the period of crisis and during the aftermath of it, the two financial markets became positively correlated. The maximum value of correlation coefficient stood at 0.6. Since 2003 onwards, once again the markets have come to be negatively correlated. Figure 4 shows the conditional correlation between the US market and the GBP/USD rate.

Figure 4: conditional correlation between DJIA and GBP/USD



On the contrary, the US stock market and the foreign exchange market have mostly been positively correlated, except for a period from 2002 to 2004. During the period of crisis of 2008, the extent of correlation increased, but it was never more than 0.6. In recent years, the correlation coefficient values have fallen to some extent. They, however, have remained positive.

Thus, the two markets are related differently to the corresponding foreign exchange market. While the UK stock market is mostly negatively correlated, the US market is positively correlated with the foreign exchange market. The period of crisis, however, is characterized

by a positive correlation in both the cases. Moreover, the correlation values have never been excessively high. For the non-crisis period, it ranged mostly between -0.4 to 0.3 for both the stock market-foreign exchange market pairs.

This presence of correlation however says hardly anything about the predictability of the foreign exchange market crisis from the other financial markets. The study now explores into the possible causal relationship between the two types of markets using the method of Granger Causality Testing. Although the available literature does not concede the Granger Causality Testing as a true test for causality, it might give us some idea regarding the possible "lead-lag" relationship between the variables concerned.

The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if y helps in the prediction of x, or equivalently if the coefficients on the lagged x's are statistically significant. However, the fact that x Granger causes y does not imply that y is the effect or the result of x. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. Specifically, we run a bivariate model where:

$$\left.\begin{aligned} Y_t &= a_0 + a_1.Y_{t-1} + ... + a_l.Y_{t-l} + b_1.X_{t-1} + ... + b_l.X_{t-l} + e_t \\ X_t &= a_0 + a_1.X_{t-1} + ... + a_l.X_{t-l} + b_1.Y_{t-1} + ... + b_l.Y_{t-l} + u_t \end{aligned}\right\} \qquad (2)$$

And, we test the hypothesis: $H_0 : b_1 = b_2 = ... = b_l = 0$

The study tests for causality between financial markets for the three sub-phases: pre-2008 crisis, crisis period of 2008 and the aftermath of the crisis. The results are summarized in Table 1.

Table 1: Granger Causality Test – FTSE 100, DJIA and GBP/USD

Null Hypothesis	Probability of accepting H_0			
	2000-2014	2000-2008	2008-2009	2009-2014
FTSE does not Granger Cause GBP_USD	0.29	0.15	0.17	0.19
GBP_USD does not Granger Cause FTSE	0.85	0.32	0.31	0.29
DJ does not Granger Cause GBP_USD	0.00	0.00	0.00	0.00
GBP_USD does not Granger Cause DJ	0.18	0.56	0.48	0.42

DJ does not Granger Cause FTSE	0.00	0.00	0.00	0.00
FTSE does not Granger Cause DJ	0.00	0.48	0.01	0.52

In all the cases the US stock market leads the GBP/USD rate and the UK stock market. The UK market, however, leads neither the foreign exchange market nor the US stock market.

This, perhaps gives us a hint that crisis in the GBP/USD foreign exchange market perhaps might be predicted from the crises in the US stock market. To explore it in detail the study now introduces the stress index.

Stress Indexes for financial markets are available in current literature. This study follows the approach of Patel and Sarkar (1998) and of Vila (2000) with some modification to identify crises in the context of the constructed portfolios. This approach has been followed by Chakrabarti and Sen (2014). Patel and Sarkar (1998) introduced a method called "CMAX method" which is a hybrid volatility loss measure. In the method the stress index is constructed as follows:

$$CMAX = X_t / \max [X \in (X_{t-j} \mid j = 0,1,\ldots,T]$$

where X_t is the financial market index. The moving window is determined by T. Hence, CMAX compares the current value of a variable with its maximum value over the previous T periods. Vila (2000) used this method to identify periods of slide in the stock market. The trigger level is considered at either 1.5 or 2 standard deviations below the mean of the series.

In this study a stress index similar to CMAX is defined for four windows. Specifically it selects T to be equal to 15, 30, 45 and 60. Hence, it compares the current value of the financial variable with the maximum value over the previous 15 days, 30 days, 45 days and 60 days. Thus, stress is defined for four periods of different lengths. A particular market is in stress, if stress index is less than 2 standard deviations below the mean of the return for that market. In that case, the current return of the market falls significantly below the historical market return. The study now inquires whether and how the stress in the foreign exchange market is 'caused' by stresses in the associated stock markets. The Granger causality results are shown in Table 2.

Table 2: Granger Causality Test – Stress Indexes for FTSE 100, DJIA and GBP/USD

Null Hypothesis	Probability of accepting H_0			
	T=15	T = 30	T = 45	T = 60
Stress in FTSE does not Granger Cause stress in GBP_USD	0.41	0.56	0.34	0.36
Stress in GBP_USD does not Granger Cause Stress in FTSE	0.61	0.54	0.49	0.47
Stress in DJ does not Granger Cause Stress in GBP_USD	0.38	0.54	0.47	0.51
Stress in GBP_USD does not Granger Cause Stress in DJ	0.65	0.80	0.75	0.79
Stress in DJ does not Granger Cause Stress in FTSE	0.05	0.00	0.00	0.00
Stress in FTSE does not Granger Cause Stress in DJ	0.23	0.96	0.97	0.98

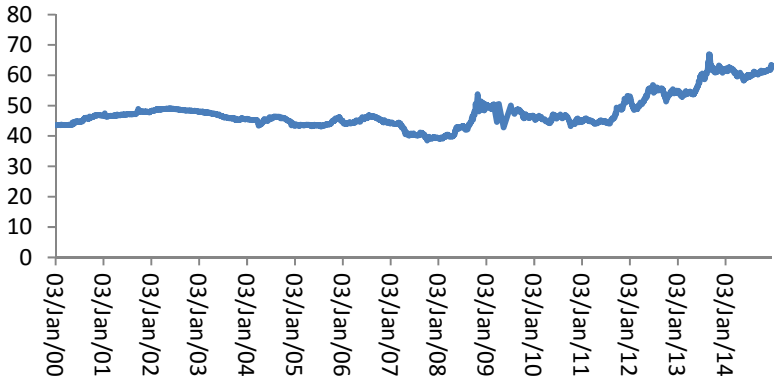
The stress in GBP/USD currency rate is not caused by stresses in any of the associated stock markets. The stress in the US stock market however causes stress in the UK stock market. But for the developed market currency pairs, stress in other financial markets cannot lead or lag stress in the foreign exchange market.

The study now explores the same relationship for the two other cases namely the case for a developed and an emerging market (that is the India-US market pair) and the case for two emerging markets (that is the India-Singapore market pair).

3.2. Stress in the INR/USD exchange rate and the two stock markets:

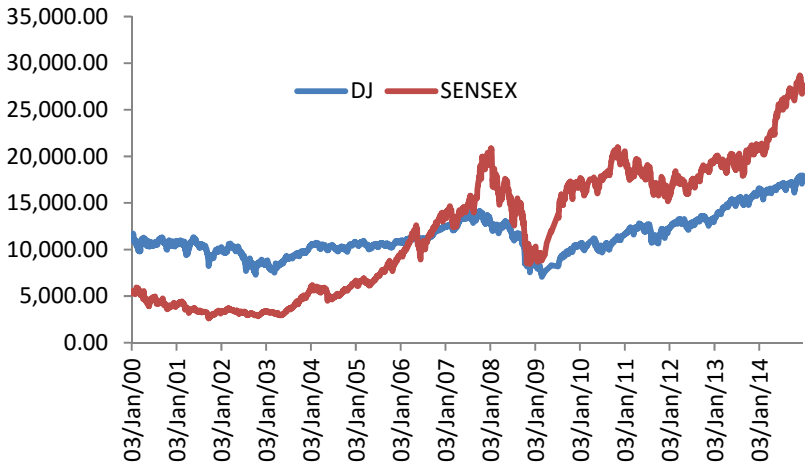
The study explores the relationship between the INR/USD exchange rate and the two stock indexes (namely, the BSE SENSEX and DJIA) following the same methodology that was followed in the earlier section. The movements in the INR/USD exchange rate and the SENSEX and DJIA are shown in figure 5 and figure 6.

Figure 5: Movements in INR/USD series (2000-2014)



The foreign exchange market faced a crisis in 2008. It is characterized by no other significant crisis over the fifteen year period. The stock market movements are shown in Figure 6.

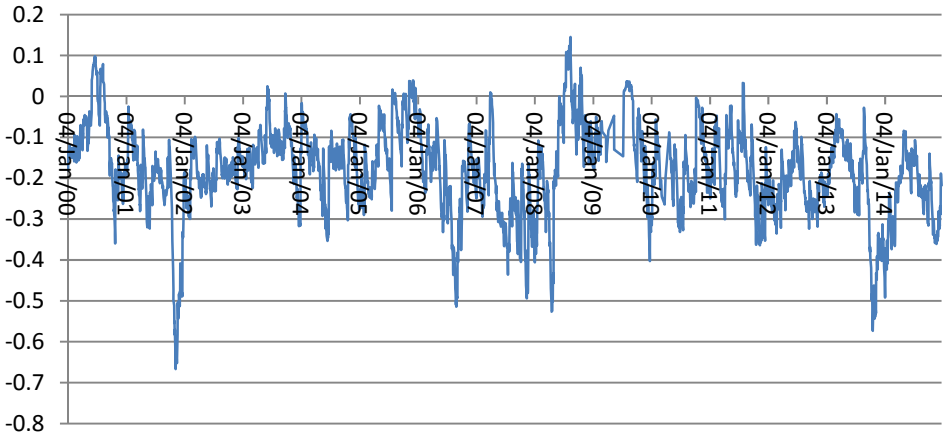
Figure 6: Movements in SENSEX and DJIA series (2000-2014)



Both the stock markets faced crisis during 2008. Before the crisis, the DJIA outperformed the SENSEX, while in the post-crisis period SENSEX has performed better than DJIA. The movements across the financial markets are once again similar but the association among them is yet to be explored.

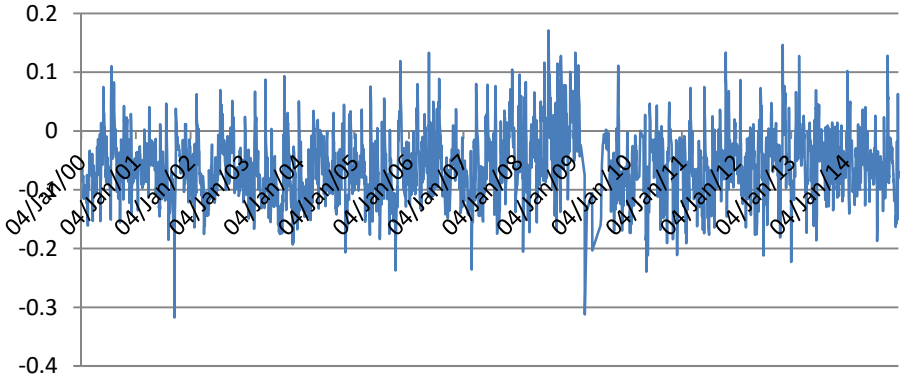
Figure 7 and Figure 8 depict the conditional correlation between the two financial market pairs, namely the INR/USD-SENSEX and the INR/USD-DJIA pairs.

Figure 7: conditional correlation between SENSEX and INR/USD



The conditional correlation between SENSEX and INR/USD has been negative except for two or three extreme cases. Moreover, the correlation values ranged between 0 to -0.3 in most cases. In only a few cases the coefficient fell to -0.5. Over the crisis period the correlation became positive only for a very small span. The value however was very low. Figure 8 shows the conditional correlation between DJIA and INR/USD over time.

Figure 8: conditional correlation between DJIA and INR/USD



The movement in the conditional correlation between DJIA and INR/USD has been quite different from the other cases considered earlier in the study. The conditional correlation fluctuated but remained within the band of 0.1 to -0.1. The crisis period witnessed no significant change in the nature of the movement in the conditional correlation.

The nature of movement in the conditional correlation however does not imply any causality between the occurrences of crises in the two types of markets. The possible causality between the two markets is then explored employing the Granger Causality test for the market pairs. The results are summarized in Table 3.

Table 3: Granger Causality Test – SENSEX, DJIA and INR/USD

Null Hypothesis	Probability of accepting H_0			
	2000-2014	2000-2008	2008-2009	2009-2014
SENSEX does not Granger Cause INR_USD	0.00	0.00	0.00	0.00
INR_USD does not Granger Cause SENSEX	0.00	0.02	0.39	0.00
DJ does not Granger Cause INR_USD	0.00	0.00	0.00	0.00
INR_USD does not Granger Cause DJ	0.53	0.86	0.51	0.84
DJ does not Granger Cause SENSEX	0.00	0.00	0.00	0.00
SENSEX does not Granger Cause DJ	0.61	0.18	0.53	0.16

The causality results obtained for the developed-emerging market pair is different from those obtained for those for the developed-developed market pair. While the developed-country stock market was leading the stock market of the emerging economy, the individual stock markets were leading the corresponding foreign exchange rate in all the three sub-phases. Except for the crisis period, the emerging-economy stock market has been related with the foreign exchange market with bi-way causality.

Table 4 shows the results obtained for Granger Causality Testing among the stress indexes for the financial markets.

Table 4: Granger Causality Test – Stress Indexes for SENSEX, DJIA and INR/USD

Null Hypothesis	Probability of accepting H_0			
	T=15	T = 30	T = 45	T = 60
Stress in SENSEX does not Granger Cause stress in INR_USD	0.00	0.00	0.00	0.00
Stress in INR_USD does not Granger Cause Stress in SENSEX	0.06	0.06	0.06	0.06
Stress in DJ does not Granger Cause Stress in INR_USD	0.00	0.00	0.00	0.00
Stress in INR_USD does not Granger Cause Stress in DJ	0.71	0.70	0.77	0.80
Stress in DJ does not Granger Cause Stress in SENSEX	0.00	0.00	0.00	0.00

Stress in SENSEX does not Granger Cause Stress in DJ	0.01	0.01	0.01	0.02

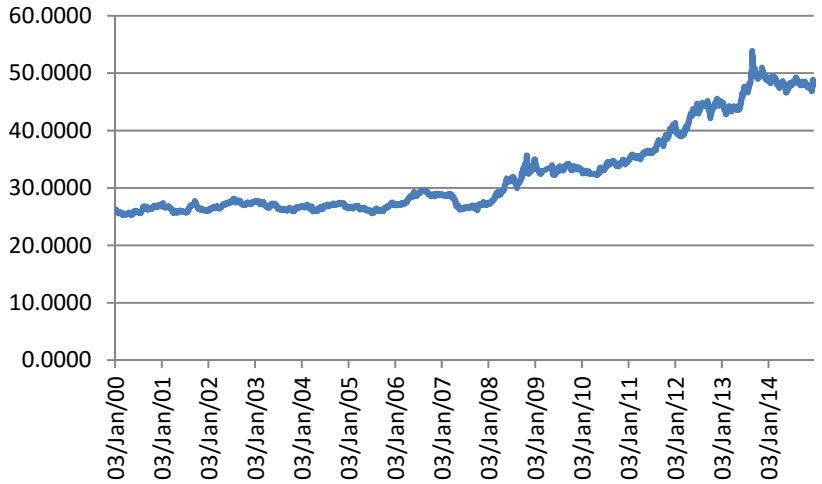
The results obtained for the developed-emerging market pair is once again different from those obtained for the developed-developed market pair. For all the chosen windows, the stresses in the US and the Indian market were causing stresses in the INR/USD exchange rate. The stock market stress indexes however are related by a both-way causality.

It now remains to explore the relationship for the emerging-emerging market pair and that is where the study moves next.

3.3. Stress in the INR/SGD exchange rate and the two stock markets:

Figure 9 and figure 10 depict the movements in the BSE SENSEX, STI and SGD/INR over time.

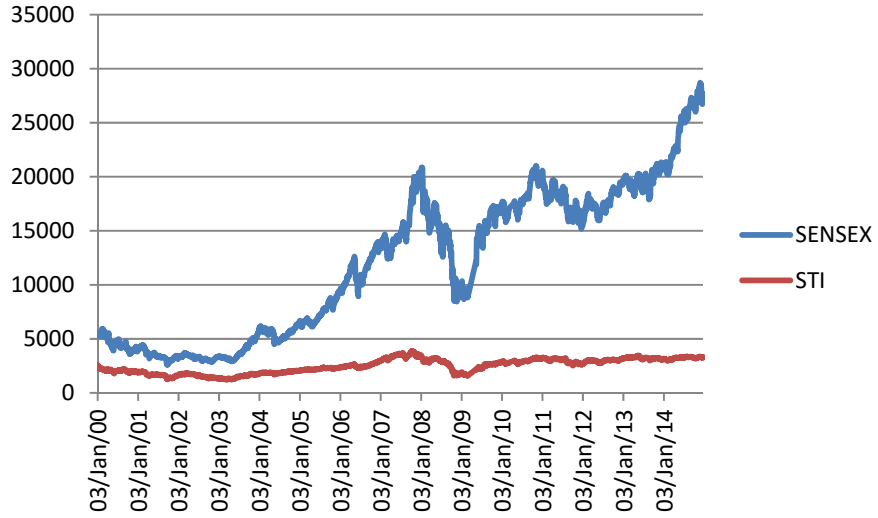
Figure 9: Movements in SGD/INR series (2000-2014)



The foreign exchange market witnessed a dip in 2008. However, the crisis was more acute in the context of developed-developed market pair. Since 2009, the SGD/INR rate has increased considerably. Like the two other currency pairs, SGD/INR has not experienced any other major crisis.

Figure 10 depicts the movements in the two emerging stock markets.

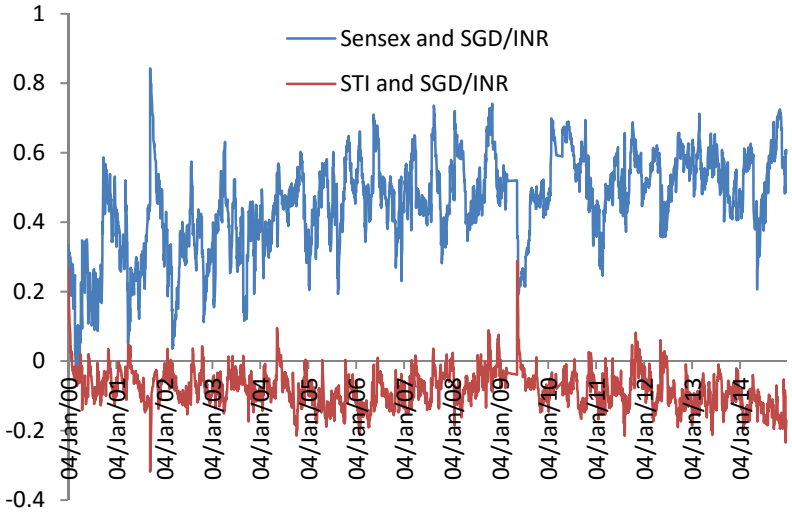
Figure 10: Movements in SENSEX and STI series (2000-2014)



Just like the Indian stock market, the Singapore market experienced a crisis in 2008. The market has recovered since then.

Figure 11 shows the conditional correlation between the two market pairs.

Figure 11: conditional correlation between market pairs



The conditional correlation between STI and SGD/INR has always been negative and remained within the band of 0 to -0.2. The conditional correlation between SENSEX and SGD/INR has always been positive and remained within the band of 0.1 to 0.7. The possible presence of causality is reported in Table 5.

Table 5: Granger Causality Test – SENSEX, STI and SGD/INR

Null Hypothesis	Probability of accepting H_0			
	2000-2014	2000-2008	2008-2009	2009-2014
SENSEX does not Granger Cause SGD/INR	0.00	0.00	0.00	0.00
SGD/INR does not Granger Cause SENSEX	0.94	0.92	0.85	0.83
STI does not Granger Cause SGD/INR	0.00	0.00	0.00	0.00
SGD/INR does not Granger Cause STI	0.19	0.18	0.16	0.14
STI does not Granger Cause SENSEX	0.02	0.00	0.00	0.00
SENSEX does not Granger Cause STI	0.00	0.00	0.00	0.00

The two stock markets are related by both-way causality, where as the individual stock markets lead the foreign exchange market. The tests for possible causality however reveal significantly different results. For all the stress windows chosen, stresses in the Indian stock market lead the stress in the SGD/INR. There is no other causal relationship present in the stress indexes (table 6).

Table 6: Granger Causality Test – Stress Indexes for SENSEX, STI and SGD/INR

Null Hypothesis	Probability of accepting H_0			
	T=15	T = 30	T = 45	T = 60
Stress in SENSEX does not Granger Cause stress in SGD/INR	0.01	0.01	0.01	0.01
Stress in SGD/INR does not Granger Cause Stress in SENSEX	0.83	0.86	0.82	0.82
Stress in STI does not Granger Cause Stress in SGD/INR	0.24	0.23	0.23	0.25
Stress in SGD/INR does not Granger Cause Stress in STI	0.31	0.28	0.31	0.33
Stress in STI does not Granger Cause Stress in SENSEX	0.27	0.23	0.28	0.29
Stress in SENSEX does not Granger Cause Stress in STI	0.16	0.16	0.17	0.16

4. Concluding remarks

The present study has been an exploration into the possibility of predicting stress in foreign exchange market from that in other financial markets, particularly the stock markets. The study however, differs from the approaches available in the existing literature in the sense that instead of delving into the mere association and causality among market returns it explores the presence of possible causality among stresses in different markets. In the process, it defines a stress index for each market. Over a period of fifteen years ranging from 2000 to 2014, the study finds stress in foreign exchange market to be 'caused' by those in stock markets. The relationship, however, is not always independent of the level of financial development of the markets. For the two developed markets, the stock markets and the corresponding foreign exchange market were positively correlated during the period of crisis. But in the non-crisis periods, the correlation was negative for the UK market and positive for the US market. The situation is similar for the two emerging market pairs. While the correlation between the Indian stock market and SGD/INR pair has always been positive, it has been negative for the STI and the SGD/INR pair. The observed results are completely different for the developed-emerging market pairs. The conditional correlation between SENSEX and INR/USD has been negative except for two or three extreme cases, while it fluctuated within a band of 0.1 to -0.1 for the US market. For the developed-developed market pair, however, stress in foreign exchange market is not at all caused by the corresponding developed country stock markets. For the US-India pair, stress in INR/USD rate is caused by stresses in both the stock markets. For the emerging-emerging market pair, stresses in Indian stock market causes the SGD/INR exchange rate but not the other way round. Thus, for the developed market, the stresses in the stock market are not causing (and are not even caused by) stresses in the foreign exchange market. However, for the emerging markets, particularly for India, the channel of stress transmission remains open between the two stock markets and the foreign exchange market. Hence, foreign exchange market crisis and stock market crisis (whether generated domestically or emanating from the developed, foreign market) may appear as "twin". The case for Singapore however, is slightly different from that of India. There remains a channel of stress transmission from the stock market to the foreign exchange market, where stress is generated only in the other emerging market. Thus, the emerging markets that experience huge inflow of foreign capital in their stock markets might take stock market crises and foreign exchange market crises as twins. The policy implications however might differ. In some cases, it would be enough to regulate the domestic stock market, but in some other instances crises may be contagious coming from stock markets abroad.

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