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Are Financial Markets Co-Integrated During Economic Crisis: An Empirical Study on the Indian Capital Market?

Atul Kumar*

Abstract

This paper examines whether the futures market and the spot market are co-integrated during the time of economic crisis. The study was done on the Nifty Spot index and Nifty Futures index for the period 1st August 2007 to 31st December 2008. The lead-lag relationship was analyzed by the ECM model. The result suggest that even at the time of economic crisis both the markets are co-integrated but no specific lead-lag relationship exists between the market. Granger causality test also gave similar evidences that there is no causal relationship between the Nifty spot index and Nifty futures index.

Keywords: Lead-Lag Relationship, Co-integration, ECM, Nifty Spot Index, Nifty Futures Index

Introduction

That the spot market and the futures market are co-integrated has been established by many researchers. It says that both the markets do have a long term association. This association may not exist at the time of structural breaks e.g. economic crisis, technological changes, institutional developments, changes in people behaviour etc. This paper has been undertaken to study whether co-integration exists during the time of economic crisis. The time frame for data analysis has been taken based on the information reported in the print media and index movement.

The prices of spot and futures market differ because of cost of carrying model. Stock index futures can be priced by using the COC Model:

Futures price = Spot price + Cost of carry – Benefits of ownership

$$F_t = Se_{rt} - D \quad (1)$$

For a financial derivative the cost of carryis the interest cost and a dividend yield is the benefit that can be derived by owning the asset. In equation (1), F_t equals the futures price for a contract that matures at time t, S is the spot index value at the present time, r is the risk-free interest rate compounded continuously for the period t and D is the value of dividends paid on the stocks.

If both the markets are efficient then the price of futures and spot should be related as per the equation. In the practical world there are inefficiencies in the market due to transaction cost, liquidity difference, non-synchronous trading effect, short selling restrictions, different taxation regime, and dividend uncertainty etc the prices of futures may not be according to the equation (1).

The research question addressed in this paper is that if information is received by both the markets at the same time, how it is incorporated in the prices and whether there exists a lead-lag relationship between both the markets. Studies based on the international and national market suggest that there exist a lead-lag relationship between both the markets.Chan (1992) studied intra-day data for major market cash index and major market index futures. He found that the lead-lag relationship holds between the futures and the cash market. Empirical results show strong evidence that futures lead the cash index and weak evidence that cash index leads the futures. Futures market is the main source of market wide information. Though futures market should lead the spot market because of the trading cost advantage of the futures market over the spot

* Associate Professor, Galgotias Business School, Greater Noida, Uttar Pradesh, India. Email: atulk@galgotiasbschool.in

market and the price discovery takes place in the futures market (Fleming, Ostdiek & Whaley, 1996).

Daigler (1990) found that intraday arbitrage profits exist due to the lead-lag between the futures and cash indices. A lag as short as five minutes eliminates apparent profits that seem to exist when simultaneous prices are employed.

Thenmozi (2002) have found that the futures market in India has more power in disseminating information and therefore has been found to play the leading role in the matter of price discovery. Karmakar (2009) found S&P CNX Nifty Futures lead the underlying CNX Nifty Index when the data were taken on the daily basis. The futures market was found to be more efficient and Nifty Futures are more important indicators for stock movements. Futures prices tend to discover new information more rapidly than spot prices.

Ching-chung *et al*. (2002) studied the Taiwan market taking the data on 5 minutes interval and found bi-directional Granger causality between index spot and index futures markets, but spot market plays a more important role in price discovery. The results of impulse response function and information share indicate that most of the price discovery happens in index spot market. Frino, Walter & West (2000) also gave the similar conclusion that some evidence of a strengthening in feedback from the equities market to the futures market and weakening in the lead of the futures market around major stock-specific information releases are found

Mukherjee and Mishra (2006) used intra-day minute-by-minute data and found that the spot market playsa comparatively stronger leading role indisseminating information available to the market though thereis a strong contemporaneous and bi-directional relationship between the spot and futures market in India.

Mallikarjunappa (2011) took intra-day minute-by-minute spot and futures price, and found no clear lead-lag relationship between spot and futures market. The relationship is moreover a contemporaneous and bi-directional between the spot and futures markets. Spot market spillover to futures market is more significant than spillover from futures to spot market. Market becomes volatile in response to a bad news but the same volatility is not seen in response to good news.

Methodology

The first step to proceed is to test both the series for the presence of unit root. The presence of unit root is tested by Augmented Dickey Fuller (ADF) test. The order of integration can be found out by the unit root test. If a series is non-stationary in the level form and becomes stationary after first differencing then it is said to be integrated of order one, denoted by I(1).

Test for Co-Integration

Engle & Granger (1987) method has been used to test the co-integration between spot and futures market. The complete methodology of testing co-integration and ECM is done in four steps. The first two steps find out whether the two series are co-integrated or not. The third and the fourth steps deal with analysing the short term disequilibrium with long term association.

The concept of co-integration says that if two series are non-stationary at the level form and their first difference become stationary means the series are integrated of order one, I (1). If we run a regression model at the level form then the relationship between the two variables regression might not be spurious. The second step tests the error term of the model whether it is stationary or not. If the error term is stationary then it is said that the two variables are co-integrated and the equation is referred as co-integrating regression.

Regression Model

Nifty Spot Index = a + b*Nifty Future Index + error term

$$S_t = a + b*F_t + e_t ; \quad (2)$$

where, S_t = ln(Nifty spot Index), F_t = ln(Nifty futures Index)

To test whether the above regression model is stationary, we test for the stationary properties of the error term. If the error term is white noise then we say that the model in equation (2) is a co-integrating regression model, despite S_t and F_t being non stationary.

$$e_t = S_t - a - b*F_t; \quad (3)$$

The third step analyses the Error Correction Mechanism (ECM) between the two variables. An important theorem known as the Granger representation theorem, states that if two variables Y and X are co-integrated, then the relationship between the two can be expressed as ECM (Gujarati, 2005). For running the ECM model both the series should be made stationary and then the short term disequilibrium is analysed and seen how it adjusts to its long term equilibrium. The following two models were taken for analysis:

$$\Delta S_t = a + e_{t-1} + \text{lagged}(\Delta St, \Delta F_t) + e_{st} \quad (4)$$

$$\Delta F_t = b + e_{t-1} + \text{lagged}(\Delta St, \Delta F_t) + e_{ft} \quad (5)$$

where ΔS_t is the first difference of ln (Nifty Spot Index), ΔF_t is the first difference of ln (Nifty Futures Index), e_{st} and e_{ft} are the white noise of the equations (4) and (5)

The fourth step deals with the diagnostic testing of the error term in the ECM model. If the model is found to be robust then we can predict about the short term adjustment of the dependent variable with its long term equilibrium.

Pair-wise Granger Causality test was used to establish the cause and effect relationship. To use the test both the series should be stationary. ΔS_t and ΔF_t series are stationary and were used for the causality test. Selection of lag length was done by using Akaike Information Criterion (AIC) in the restricted Vector Auto Regressive (VAR) model framework. The optimal lag length was found out to be 1 where the value of AIC was minimum.

Data

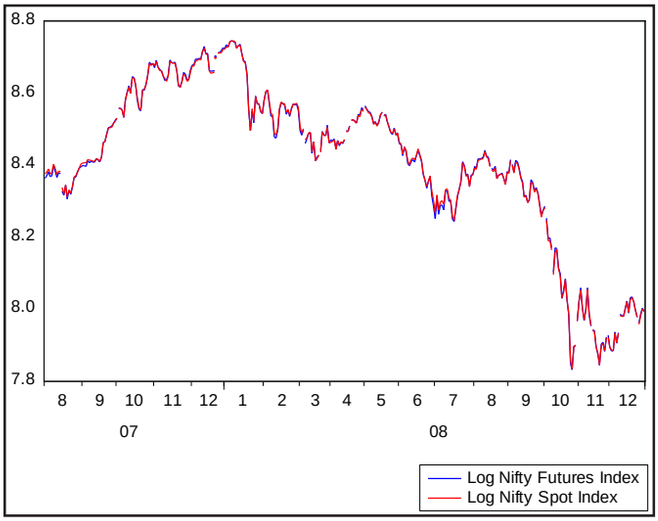
The data for the analysis have been taken from NSE website: www.nseindia.com. The data have been taken for the period 1st August 2007 to 31st December 2008. This period has been selected as this was the period of global financial crisis. The first indication of the global crisis was on August 9, 2007, when BNP Paribas terminated withdrawals from three hedge funds citing "a complete evaporation of liquidity" (Wikipedia). So the data have been taken from 1st August 2007. A preliminary analysis on the data was done by looking at the value of Nifty index. It was seen that Nifty started regaining from 20th November 2008. That is the reason the data have been taken up till 31st December 2008. So the period 1st August 2007 to 31st December 2008 captures the period of global financial crisis.

The data are taken for Nifty Spot Indexand Nifty futures Index. Two have been selected as they are highly liquid.For Nifty Index futures contracts there are three expiration cycles. The near month contracts are highly liquid, therefore only the near month contract price has been taken for analysis.

The daily closing prices of Nifty spot Index and Nifty futures Index have been taken. For each day a synchronous pair of both the values was made and there were 351 pairs for analysis. The Nifty spot Index and Nifty futures Index values were taken in log form to normalize the data series. The data has been analysed in E Views 7 software.

Research Findings and Discussions

Figure 1: Daily ln(Nifty Spot Index) and ln (Nifty Futures Index)



The natural log of Nifty Futures Index and Nifty Spot Index were plotted together in Fig. 1. The graph suggests that both the series are non-stationary and there is long term association between them. Augmented Dickey Fuller (ADF) was applied on the Nifty futures index and Nifty spot index series. From the Table 1, both the series were found to be non-stationary in the level form as the absolute value of test statistic was less than the critical values. Therefore, we accept the null hypothesis that there exist a unit root in the Nifty futures index and Nifty spot index series. Table 2 shows the test of unit root on the log of first difference, both the series are found to be stationary on their first difference as ADF test statistic absolute value is greater than the critical values. Therefore, we reject the null hypothesis that the series are non-stationary. After the

Table 1: Unit Root Test on ln(Nifty Spot Index) and ln (Nifty Futures Index)

Null Hypothesis: Nifty Spot Index has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on AIC, maxlag=16)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.259684	0.4545
Test critical values:	1% level		-3.984496	
	5% level		-3.422716	
	10% level		-3.134249	

*MacKinnon (1996) one-sided p-values.

Table 2: Unit Root Test on First Difference on ln(Nifty Futures Index) and ln (Nifty Spot Index)

Null Hypothesis: D(F) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on AIC, maxlag=16)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-18.17960	0.0000
Test critical values:	1% level		-3.984572	
	5% level		-3.422753	
	10% level		-3.134271	
*MacKinnon (1996) one-sided p-values.				
Null Hypothesis: D(S) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on AIC, maxlag=16)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-17.38011	0.0000
Test critical values:	1% level		-3.984572	
	5% level		-3.422753	
	10% level		-3.134271	

*MacKinnon (1996) one-sided p-values.

ADF test we can conclude that Nifty futures index and Nifty spot index are integrated of order one, denoted by I(1).

Now since S_t and F_t are co-integrated so we can apply Granger representation theorem. The short term and the long term relationship can be analysed by ECM. As per Table 5, the changes in Spot Market do not depend on the lagged spot and futures prices as they are not significant. The lagged term of futures is significant at 10 percent level. The coefficient of e_{t-1} is 0.58 and is significant at 10 percent, which signifies that adjustment is done in the spot for it to be in its long term equilibrium. At the same time changes in the Futures market does not depend on the lagged spot and futures value. The long term error term e_{t-1} is significant and is 0.81, which signifies that 0.81 of the discrepancy of the previous day is eliminated today for the Nifty futures Index to be into its long term equilibrium.

Diagnostic testing of the ECM model was done by applying the ADF test on the residual terms of the ECM models. From Table 6 it is evident that the ECM model is stationary as the absolute test statistic value is greater than the critical value. Therefore,we can reject the null hypothesis that the e_{st} is non-stationary. The same inferences can be drawn for the error term(e_{ft}) of Nifty futures Index. Therefore we can say our ECM model is robust.

Table 3: Co-integrating Regression Model; $S_t = a + b*F_t + e_t$;

Dependent Variable: St				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011746	0.008714	1.347867	0.1786
Ft	0.998633	0.001036	964.1726	0.0000
R-squared	0.999625	Mean dependent var		8.410750
Adjusted R-squared	0.999624	S.D. dependent var		0.223652
S.E. of regression	0.004339	Akaike info criterion		-8.036754
Sum squared resid	0.006570	Schwarz criterion		-8.014756
Log likelihood	1412.450	Hannan-Quinn criter.		-8.027999
F-statistic	929628.9	Durbin-Watson stat		0.659717
Prob(F-statistic)	0.000000			

Table 4: Testing of Residual of Co-Integrating Regression

Null Hypothesis: et has a unit root				
Exogenous: None				
Lag Length: 2 (Automatic - based on AIC, maxlag=16)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.676617	0.0000
Test critical values:	1% level		-2.571624	
	5% level		-1.941737	
	10% level		-1.616089	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(et)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
et(-1)	-0.200103	0.042788	-4.676617	0.0000
D(et(-1))	-0.414277	0.057396	-7.217917	0.0000
D(et(-2))	-0.178267	0.052398	-3.402185	0.0007
R-squared	0.283176	Mean dependent var		-3.07E-05
Adjusted R-squared	0.279021	S.D. dependent var		0.003526
S.E. of regression	0.002994	Akaike info criterion		-8.775642
Sum squared resid	0.003093	Schwarz criterion		-8.742433
Log likelihood	1529.962	Hannan-Quinn criter.		-8.762421
Durbin-Watson stat	2.019247			

Conclusion

The data have been taken for the period when there was a global financial crisis i.e. from 1st August 2007 to 31st December 2008. Engle &Granger (1987) co-integration test was applied on the data for the specified period. From the evidences found we can conclude that the Nifty spot Index and Nifty Futures Index do have a long term association. The change in the Nifty spot Index does

Table 5: Error Correction Model for Nifty Spot Index and Nifty futures Index

Dependent Variable: ΔS				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001062	0.001373	-0.773407	0.4398
Et-1	0.589136	0.353069	1.668613	0.0961
ΔS(-1)	-0.715808	0.469472	-1.524710	0.1282
ΔF(-1)	0.775554	0.446704	1.736169	0.0834
R-squared	0.018086	Mean dependent var		-0.001108
Adjusted R-squared	0.009548	S.D. dependent var		0.025728
S.E. of regression	0.025605	Akaike info criterion		-4.480668
Sum squared resid	0.226186	Schwarz criterion		-4.436483
Log likelihood	785.8765	Hannan-Quinn criter.		-4.463079
F-statistic	2.118252	Durbin-Watson stat		1.999921
Prob(F-statistic)	0.097634			

Error Correction Model for Nifty Futures Index

Dependent Variable: ΔF				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001033	0.001462	-0.706716	0.4802
Et-1	0.810426	0.376043	2.155143	0.0318
ΔS(-1)	-0.470496	0.500019	-0.940956	0.3474
ΔF(-1)	0.509877	0.475770	1.071686	0.2846
R-squared	0.014472	Mean dependent var		-0.001076
Adjusted R-squared	0.005902	S.D. dependent var		0.027352
S.E. of regression	0.027271	Akaike info criterion		-4.354590
Sum squared resid	0.256579	Schwarz criterion		-4.310406
Log likelihood	763.8760	Hannan-Quinn criter.		-4.337002
F-statistic	1.688702	Durbin-Watson stat		1.998061
Prob(F-statistic)	0.169141			

Table 6: Diagnostic Test of ECM Model for Nifty Spot Index and Nifty Futures Index

Null Hypothesis: est has a unit root				
Lag Length: 2 (Fixed)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-10.82824	0.0000
Test critical values:	1% level		-2.571663	
	5% level		-1.941742	
	10% level		-1.616086	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(est)				
Method: Least Squares				

Null Hypothesis: est has a unit root				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
est (-1)	-1.005902	0.092896	-10.82824	0.0000
D(est(-1))	0.006828	0.076462	0.089300	0.9289
D(est (-2))	0.028103	0.054053	0.519909	0.6035
R-squared	0.500447	Mean dependent var		-1.25E-05
Adjusted R-squared	0.497534	S.D. dependent var		0.036175
S.E. of regression	0.025642	Akaike info criterion		-4.480517
Sum squared resid	0.225531	Schwarz criterion		-4.447166
Log likelihood	778.1294	Hannan-Quinn criter.		-4.467236
Durbin-Watson stat	2.001156			
Null Hypothesis: eft has a unit root				
Exogenous: None				
Lag Length: 2 (Fixed)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-10.79667	0.0000
Test critical values:	1% level		-2.571663	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(eft)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
eft(-1)	-1.004478	0.093036	-10.79667	0.0000
D(eft(-1))	0.005792	0.076441	0.075774	0.9396
D(eft(-2))	0.021440	0.054064	0.396566	0.6919
R-squared	0.499851	Mean dependent var		-2.48E-06
Adjusted R-squared	0.496934	S.D. dependent var		0.038518
S.E. of regression	0.027319	Akaike info criterion		-4.353803
Sum squared resid	0.255999	Schwarz criterion		-4.320453
Log likelihood	756.2080	Hannan-Quinn criter.		-4.340523
Durbin-Watson stat	1.999649			

Table 7: Pairwise Granger Causality Test

Pairwise Granger Causality Tests			
Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Prob.
ΔS does not Granger Cause ΔF	349	0.11134	0.7388
ΔF does not Granger Cause ΔS		1.59539	0.2074

not depend on the lagged terms of Nifty spot Index and Nifty futures index. The vice-versa is also true that the changes in the Nifty futures Index do not depend on the changes in the lagged terms of Nifty spot Index and Nifty futures Index. The similar conclusion can be drawn from the Granger causality test. In the ECM models, the error term of co-integrating regression equation is significant at 10 percent. The coefficient of the error term is also

high which states that a great proportion of discrepancy of the previous period is adjusted in the current period. The research finding is similar to Mallikarjunappa (2011) evidences that there is no significant lead-lag relationship between the two markets.

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