Analysis of Long-Term Relationship between Spot and Futures Prices Using Johansen's Test of Cointegration

Dr. Sathya Swaroop Debasish, Reader, Department of Business Administration, Utkal University, Vani Vihar, Bhubaneswar, Orissa

Abstract

The concern over how trading in futures contracts affects the spot market for underlying assets has been an interesting subject for investors, market makers, academicians, exchanges and regulators alike. The main objective of the study is to examine the long-term relationship between spot prices and futures prices. The study has used daily prices (closing, opening, high and low) in both spot market and futures market for the 40 sample individual stocks drawn from six leading sectors namely, Automobiles, Banking, Cement, Gas, Oil & Refineries, Information Technology and Pharmaceutical. The period of study is from 1st January 1997 to 31st May 2009. The long term relationship between spot prices and futures prices is statistically tested using Johansen's test of Cointegration employing likelihood Ratio (L.R.), under the hypothesis that there exists a single cointegration equation between spot and future prices. The study finds a single long-term relationship for each of the selected companies across the six sectors. Among the selected companies in each sector, those evidencing strongest relation in respective sector are Tata Motors, Punjab National Bank, Gujrat Ambuja Cements, Bongaigaon Refineries, I-Flex and GLAXO Pharma.

Introduction

The Indian capital market has witnessed a major transformation and structural change from the past one decade as a result of ongoing financial sector reforms initiated by the Government of India. One of the major objectives of these reforms was to bring the Indian capital market up to a certain international standard. Due to such reforming process, one of the significant step taken in the secondary market is the introduction of derivative products in two major Indian stock exchanges viz. National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) , with a view to provide tools for risk management to investors and to improve the informational efficiency of the cash market. Though the onset of derivative trading has significantly altered the movement of stock prices in Indian spot market, it is yet to be proved whether the derivative products have served the purpose as claimed by the Indian regulators. Equity derivatives in India were started as a part of capital market reforms to hedge price risk resulted from greater financial integration between nations in the 1990s.

These reforms were an integral part of financial sector reforms recommended by the *Narasimham Committee Report on Financial System* in September 1992. The reforms were aimed at enhancing, competition, transparency, and efficiency in the Indian financial market. the Indian capital market saw the launching of index futures on June 9, 2000 on BSE and on June 12, 2000 on the NSE. A year later options on index were also introduced for trading on these exchanges. Later, stock options on individual stocks were launched in July 2001. Stock futures entered the derivative segment on these exchanges from November 2001 onwards.

The advent of stock index futures has profoundly changed the nature of trading on stock exchanges. The concern over how trading in futures contracts affects the spot market for underlying assets has been an interesting subject for investors, market makers, academicians, exchanges and regulators alike. These markets offer investors flexibility in altering the composition of their portfolios and in timing their transactions. Futures markets also provide opportunities to hedge the risks involved with holding diversified equity portfolios. As a consequence, significant portion of cash market equity transactions are tied to futures and options market activity. However, it is yet to be known if the introduction of stock index futures has served the purpose claimed by the regulators.

Johansen's Test of Co-Integration

Economically speaking, two types of relationship may exist between two time series: i) long term, or equilibrium, and ii) short term relationship. In case of the long term relationship, a change in one variable permanently changes the equilibrium level of another variable. While, in the case of short term relationship, the impact of the change in one variable on another variable has short life and it is reversible. Statistically, the long term relationship is detected by the presence of co integration between the variable at their level form; while, short term relationship is analyzed at the differenced form. If two variables are co integrated, there exists a long term or equilibrium relationship between them. However, in the short run, there may be disequilibrium, which is corrected through the 'error correction mechanism'.

The test of Cointegration identifies the long run structural relationship among the variables under consideration. In other words, it tries to establish whether in the long run the variables under study would move in the same direction or not. The current study envisages to study whether the spot market and futures market under consideration move in the same direction in the long run or not.

Consider two time series x_t and y_t, these two time series can be said to be cointegrated if:

(a) both time series (x_t and y_t) are I(1) .i.e., become stationary after first differencing, and

(b) there is some linear combination of x_t and y_t which is I(0) i.e., stationary in level form

In general for two I(1) variables, any linear combination among them, would be of the form: $y_t=b_0+b_1x_t+u_t$, with b_0 and b_1 taking different values, to be I(1) as well. However, if x_t and y_t are linked together in a linear (long-term) relationship then one will find something unusual occurring, namely the second of the two conditions for the existence of cointegration will hold: there will be at least one linear combination of x_t and y_t that will be I(0), that is stationary. When this is the case, one can be certain that any correlation over time between x_t and y_t is not spurious. When conditions (a) and (b) above hold, it is said that the time series x_t and y_t are cointegrated. Thus, cointegration is the statistical equivalent of the existence of a long-run economic relationship between I(1) variables. The meaning is that of existence of long-run equilibrium relationship. This cointegration between S_t and F_{t-i} is a necessary condition for market efficiency (Lai and Lai, 1991).

Cointegration theory implies that for a vector of time series, the variables are said to be cointegrated if linear combinations are stationary without differencing, even if the individual elements of the vector need to be differenced at least once to become stationary (Johansen and Juselius, 1990).

Although the two series may be non stationary they may move closely together in the long run so that the difference between them is stationary. Two series S_t (spot price) and F_t (futures prices) are said to be integrated of the order one, denoted by I(1), if they become stationary after first difference. If there are two such series which are I(1) integrated and their linear combination is stationary, then these two series are said to be cointegrated. This relationship is the long run equilibrium relationship between S_t and F_t.

However, the most crucial requirement for applying the standard cointegration tests (including the most popular, the Johansen's cointegration test) is that the variables should be integrated of the same order. Before testing for cointegration, each individual price series should be examined for stationarity. Phillips-Perron (PP) unit root test and Augmented Dickey-Fuller (ADF) tests as discussed in section 3.4.3 are the common methods. If both the futures and cash price series are stationary at the same level, Johansen's cointegration tests can be conducted.

The finding that many macro time series may contain a unit root has spurred the development of the theory of non-stationary time series analysis. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary, or I(0), linear combination exists, the non-stationary (with a unit root), time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship between the variables. For example, consumption and income are likely to be cointegrated. If they were not, then in the long-run consumption might drift above or below income, so that

consumers were irrationally spending or piling up savings.

If there are k endogenous variables, each of which has one unit root, there can be from zero to k-1 linearly independent cointegrating relations. Let r denote the number of cointegrating relationship equations. Since we have two variables namely spot price series and futures prices series, we test two sets of the null hypothesis (H_0) and alternative hypothesis (H_1) as given below.

a) $H_0: r=0$; $H_1: r>0$

b) $H_0: r\leq 1$; $H_1: r>1$

Objectives of the Study

The main objective of the study is to examine the long-term relationship between spot prices and futures prices. For this purpose, the study has used Johansen's test of Cointegration.

Literature Review

Brooks, Rew and Ritson (2001) estimated the lead-lag relation between the FTSE 100 stock index futures and the FTSE 100 index. Based on the results obtained, they developed a trading strategy based on the predictive abilities of the futures market. The study was conducted using Co-integration and Error Correction model, ARMA model and vector auto-regressive model. The results indicated that futures led the spot market and this was attributable to faster flow of information into futures market mainly due to lower transaction costs. It was shown that the error cointegration model predicted the correct direction of the spot returns 68.75% of the time. Ghosh (1993) also observed a similar lead-lag relationship for the U.S. market with the use of an error correction model. Pati and Kumar (2007) in their study found a positive contemporaneous relationship between futures price volatility and volume. Their study concluded that time-to-maturity is not a strong determinant of futures price volatility, but the rate of information arrival proxied by volume and open interest are the important sources of volatility.

Data and Sources

The study has used daily prices (closing, opening, high and low) in both spot market and futures market for the 40 sample individual stocks drawn from six leading sectors namely, Automobiles, Banking, Cement, Gas, Oil & Refineries, Information Technology and Pharmaceutical. The results of the 40 selected companies are presented in the section Analysis and Findings. In terms of market capitalization, the leading stocks under each of the six selected sectors were shortlisted. On the basis of complete data availability of spot prices during the study period and a minimum 24 months of continuous daily futures data, we finalized the selected 40 companies. The spot prices and the one-month futures prices of the selected stocks are taken for the study. The futures time series analyzed here uses data on the near month contract as they are most heavily traded. The study used data on daily opening,

low, high and closing prices of the selected indices and individual stocks traded in the spot market. The futures data include the near-month prices of daily opening, low, high and closing. The study was entirely based on time series data from secondary sources and collected from official website of National Stock Exchange (www.nse-india.com). The period of study is from 1st January 1997 to 31st May 2009.

Research Methodology

The daily returns based on spot and futures prices were computed. The price series consisted of open price, low, high, and closing prices for both spot and futures market. The returns for the futures contract and the spot index are defined as $RF_t = \{Ln (F_t / F_{t-1})\}$ and $RS_t = \{Ln (S_t / S_{t-1}) \}$, respectively where F_t and S_t are the futures prices and spot prices on day t, respectively. The long term relationship between spot prices and futures prices is statistically tested using Johansen's test of Cointegration employing likelihood Ratio (L.R.), under the hypothesis that there exists a single cointegration equation between spot and future prices.

Two sets of null hypotheses are tested to find out the number of cointegrating relations between the spot and futures prices series. These are as given below:

a) First Null Hypothesis: r = 0 (There exists no cointegration relationship between the spot and futures prices)
b) Second Null Hypothesis: r≤ 1 (There exists less than or equal to one cointegration relationship between the spot and futures prices)

Acceptance of the first hypothesis indicates that there is no conintegration relationship between spot and futures prices. If only the first null hypothesis is rejected, it implies that there exists cointegration relation-ship.

The study assumes linear deterministic trend in the data and testing of hypothesis is done employing Likelihood Ratio (L.R.) test using Eviews software package. The null hypothesis testing is estimated for 1% and 5% level of significance. If the first hypothesis is rejected and the second hypothesis is not rejected, we conclude that there exists one single cointegrating relation between spot prices and futures prices.

Analysis and Findings

The detailed analysis of the long-term relation between spot prices and futures prices of the selected companies are presented below, across the six leading sectors of Indian economy.

Analysis of Test of Cointegration between Spot and Futures Prices for selected companies in Automobile sector

The results of the Johansen's test of cointegration between spot prices and futures prices for the selected Automobile companies are presented in Table-1. Highest eigen value for the first hypothesis is seen for Hero Honda with 66.378 and lowest for M & M with 35.642 (significant at 5% level). Further, the second hypothesis is rejected at 5% (not 1% level) for two

other companies namely, Maruti Udyog (39.641) and TVS Motors (38.852).

Table-1: Results of Johansen's Test of Cointegration for selected companies in Automobile sector

Sl.No.	Companies	Null Hypothesis	Alternative Hypothesis	Eigen Value (λ_{Trace})	Result
1	Bajaj Auto	r=0	r>0	46.237*	Null Hypothesis is REJECTED
		r= 1	r>1	3.623	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 7.51 + 0.81 F_t			
2	Hero Honda	r=0	r>0	66.378*	Null Hypothesis is REJECTED
		r= 1	r>1	6.289	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 11.73 + 0.94 F_t			
3	Maruti Udyog	r=0	r>0	39.641**	Null Hypothesis is REJECTED
		r= 1	r>1	3.782	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -8.14 + 0.94 F_t			
4	M & M	r=0	r>0	35.642**	Null Hypothesis is REJECTED
		r= 1	r>1	5.397	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 5.27 + 0.94 F_t			
5	Tata Motors	r=0	r>0	57.896*	Null Hypothesis is REJECTED
		r= 1	r>1	5.682	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 6.38 + 0.95 F_t			
6	TVS Motors	r=0	r>0	38.852**	Null Hypothesis is REJECTED
		r= 1	r>1	6.495	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -2.74 + 0.94 F_t			

Assumption: Linear deterministic trend in the data;

*Note: * denote significance at 1% and ** denote significance at 5% level; Testing of Hypothesis done using Likelihood (L.R.) Test; S- spot price, F- futures price, t- time. 'r' denotes the number of cointegration equations.*

Testing the two sets of null hypotheses, it is found that only the first null hypothesis is rejected with statistical significance (at 1% or 5%), while the second hypothesis could not be rejected at either 1% or 5% level of significance. This implies that only one cointegration equation exists between the spot prices (S_t) and futures prices (F_t) for all the six Automobile Companies. Tata Motors evidenced the strongest relation between futures and spot prices as seen by the highest value of 0.95 (slope) in the cointegration equation, and weak relation was witnessed for Bajaj Auto (0.85). The constant term is the highest for Hero Honda (11.73) and the lowest for Maruti Udyog (-8.14).

Analysis of Test of Cointegration between Spot and Futures Prices for selected companies in Banking Sector

Table 2 provides the results of the Johansen's test of cointegration between spot prices and futures prices for the selected nine banks. Examining the two sets of null hypotheses, it is found that maximum eigen value for the first hypothesis is seen for Bank of Baroda with 83.937and minimum is evidenced for ICICI Bank with eigen value of 31.658 (significant at 5% level). It is observed from the eigen values for these banks that only the first null hypothesis is rejected with statistical significance, while the second hypothesis is not rejected at either 1% or 5% level of significance. This implies that only one cointegration equation exists between the spot prices (S_t) and futures prices (F_t) for all the nine Banks. Further, the first hypothesis is rejected at 5% (not 1% level) for two other banks namely, HDFC Bank (36.529) and Union Bank of India (39.628). The second hypothesis cannot be rejected for any of the selected banks. PNB evidenced strongest relation between futures and spot prices as seen by the highest value of slope (0.93) in the single cointegration equation, followed by SBI (0.92). Weak relation between futures and spot prices was witnessed for Oriental Bank (0.78), followed by IDBI (0.84). The constant term was the highest for Bank of Baroda (15.64) followed by SBI (12.44) and the lowest for Canara Bank with value of -9.18. Two other banks showing negative values for the constant term in the cointegration equation are HDFC Bank (-10.54) and IDBI (-6.51).

Table-2: Results of Johansen's Test of Cointegration for selected companies in Banking sector

Sl.No.	Companies	Null Hypothesis	Alternative Hypothesis	Eigen Value (λ_{Trace})	Result
1	Bank of Baroda	r=0	r>0	83.937*	Null Hypothesis is REJECTED
		r= 1	r>1	5.682	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 15.64 + 0.85 F_t			
2	Canara bank	r=0	r>0	75.623*	Null Hypothesis is REJECTED
		r= 1	r>1	3.186	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -11.23 + 0.87 F_t			
3	HDFC Bank	r=0	r>0	36.529**	Null Hypothesis is REJECTED
		r=.1	r>1	5.683	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -10.54 + 0.89 F_t			
4	ICICI Bank	r=0	r>0	31.658**	Null Hypothesis is REJECTED
		r= 1	r>1	6.859	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 9.72 + 0.87 F_t			
5	IDBI	r=0	r>0	59.682*	Null Hypothesis is REJECTED
		r= 1	r>1	6.374	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -6.51 + 0.84 F_t			
6	Oriental Bank	r=0	r>0	55.689*	Null Hypothesis is REJECTED
		r= 1	r>1	4.318	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 11.41 + 0.78 F_t			
7	PNB	r=0	r>0	64.538*	Null Hypothesis is REJECTED
		r= 1	r>1	3.592	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 5.61 + 0.93 F_t			
8	SBI	r=0	r>0	55.683*	Null Hypothesis is REJECTED
		r= 1	r>1	6.589	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 12.44 + 0.92 F_t			
9	Union Bank of India	r=0	r>0	39.628**	Null Hypothesis is REJECTED
		r= 1	r>1	4.369	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 6.68 + 0.91 F_t			

Assumption: Linear deterministic trend in the data;
*Note: * denote significance at 1% and ** denote significance at 5% level; Testing of Hypothesis done using Likelihood (L.R.) Test; S- spot price, F- futures price, t- time. 'r' denotes the number of cointegration equations.*

Analysis of Test of Cointegration between Spot and Futures Prices for selected companies in Cement sector

The results of the Johansen's test of cointegration between spot prices and futures prices for the selected Cement companies are presented in table 3. Highest eigen value for the first hypothesis is seen for ACC with 49.247and minimum for Grasim Cements with 30.462 (significant at 5% level). Further, the first hypothesis is rejected at 5% (not 1% level) for two other companies namely, Gujrat Ambuja Cements and India Cements with eigen values of 32.591 and 35.846, respectively. Testing the two sets of null hypotheses, it is found that only the first null hypothesis is rejected with statistical significance either at 1% or 5%, while the second hypothesis could not be rejected at either 1% or 5% level of significance. This implies that only one cointegration equation exists between the spot prices (S_t) and futures prices (F_t) for all the four selected Cement companies. Gujrat Ambuja Cements evidenced strongest relation between futures and spot prices as seen by the highest value of 0.97 (slope) in the cointegration equation, and weak relation was witnessed for ACC (0.83). The constant term was the highest for Grasim Cements (12.79) and the lowest for India Cements with value of -4.26.

Table-3: Results of Johansen's Test of Cointegration for selected companies in Cement sector

S.No.	Companies	Null Hypothesis	Alternative Hypothesis	Eigen Value (λ_{Trace})	Result
1	ACC	r=0	r>0	49.247*	Null Hypothesis is REJECTED
		r= 1	r> 1	2.385	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 5.88 + 0.83 F_t			
2	Grasim Cements	r=0	r>0	30.462**	Null Hypothesis is REJECTED
		r= 1	r>1	3.684	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 12.79 + 0.86 F_t			
3	Gujrat Ambuja Cements	r=0	r>0	32.591**	Null Hypothesis is REJECTED
		r= 1	r>1	3.689	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 10.52 + 0.97 F_t			
4	India Cements	r=0	r>0	35.846**	Null Hypothesis is REJECTED
		r= 1	r>1	6.386	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -4.26 + 0.89 F_t			

Assumption: Linear deterministic trend in the data;
*Note: * denote significance at 1% and ** denote significance at 5% level; Testing of Hypothesis done using Likelihood (L.R.) Test; S- spot price, F- futures price, t- time. 'r' denotes the number of cointegration equations.*

Analysis of Test of Cointegration between Spot and Futures Prices for selected companies in Gas, Oil & Refineries sector

Table 4 provides the results of the Johansen's test of cointegration between spot prices and futures prices for the selected eight companies in the Gas, Oil & Refineries sector. Two sets of null hypotheses are tested to find out the number of cointegration relationship between the spot and futures prices series. Maximum eigen value for the first hypothesis is seen for Reliance Industries (67.594), followed by GAIL (65.329) and BPCL (56.325). Minimum eigen values for first hypothesis was witnessed for IOC (32.659) followed by IPCL (33.965) and HPCL (46.398), all the three being significant at 5% level. It is observed from the eigen values for the selected companies that only the first null hypothesis is rejected with statistical significance, while the second hypothesis is not rejected at either 1% or 5% level of significance.

This implies that only one cointegration equation exists between the spot prices (S_t) and futures prices (F_t) for all the eight Companies in the Gas, Oil & Refineries sector. Further, the second hypothesis could not be rejected for any of the selected companies. Bongaigaon Refineries evidenced strongest relation between futures and spot prices as seen by the highest value of slope (0.94) of the cointegration equation, followed by IPCL (0.91) and HPCL (0.87). Weakest relation between futures and spot prices was witnessed for BPCL (0.77), followed by IOC (0.80) and Reliance Industries (0.81). The constant term is the highest for ONGC (11.26) and the lowest for GAIL with value of -8.26. Two other companies showing negative values for the constant term in the cointegration equation are HPCL (-4.94) and BPCL (-5.24).

Table-4: Results of Johansen's Test of Cointegration for Selected Companies in Gas, Oil & Refineries Sector

S.No.	Companies	Null Hypothesis	Alternative Hypothesis	Eigen Value (λ_{Trace})	Result
1	BPCL	r=0	r>0	56.325*	Null Hypothesis is REJECTED
		r= 1	r>1	5.396	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -5.24 + 0.77 F_t			
2	Bongaigaon Refineries	r=0	r>0	52.329*	Null Hypothesis is REJECTED
		r= 1	r>1	3.658	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 10.51 + 0.94 F_t			
3	GAIL	r=0	r>0	65.329*	Null Hypothesis is REJECTED
		r= 1	r>1	4.683	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -8.26 + 0.81 F_t			
4	HPCL	r=0	r>0	46.398*	Null Hypothesis is REJECTED
		r= 1	r>1	2.396	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -4.94 + 0.87 F_t			
5	IOC	r=0	r>0	32.659**	Null Hypothesis is REJECTED
		r= 1	r>1	4.682	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 9.24 + 0.80 F_t			
6	IPCL	r=0	r>0	33.965**	Null Hypothesis is REJECTED
		r= 1	r>1	6.761	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 7.66 + 0.91 F_t			
7	ONGC	r=0	r>0	49.653*	Null Hypothesis is REJECTED
		r= 1	r>1	3.695	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 11.26 + 0.81 F_t			
8	Reliance Industries	r=0	r>0	67.594*	Null Hypothesis is REJECTED
		r= 1	r>1	4.569	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 6.75 + 0.81 F_t			

Assumption: Linear deterministic trend in the data;
*Note: * denote significance at 1% and ** denote significance at 5% level; Testing of Hypothesis done using Likelihood (L.R.) Test; S- spot price, F- futures price, t- time. 'r' denotes the number of cointegration equations.*

Analysis of Test of Cointegration between Spot and Futures Prices for selected companies in Information Technology (IT) sector

The results of the Johansen's test of cointegration between spot prices and futures prices for the selected IT companies are presented in table 5. Highest eigen value for the first hypothesis is seen for Polaris (71.526), followed by Satyam Computers (66.329).Minimum eigen value for first hypothesis is found in case of Infosys Tech (40.236) followed by WIPRO (57.961), all being found to be significant at 1% level. Testing the two sets of null hypotheses, it is found that only the first null hypothesis is rejected with statistical significance, while the second hypotheis could not be rejected at either 1% or 5% level of significance. This implies that only one cointegration equation exists between the spot prices (S_t) and futures prices (F_t) for all the seven IT companies.

Table-5: Results of Johansen's Test of Cointegration for selected companies in Information Technology (IT) sector

S.No.	Indices	Null Hypothesis	Alternative Hypothesis	Eigen Value (λ_{trace})	Result
1	I-Flex	r=0	r>0	59.527*	Null Hypothesis is REJECTED
		r= 1	r>1	6.329	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = - 7.54+ 0.97 F_t			
2	InfosysTech	r=0	r>0	40.236*	Null Hypothesis is REJECTED
		r= 1	r>1	6.264	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 8.56+ 0.79 F_t			
3	Patni Computers	r=0	r>0	64.329*	Null Hypothesis is REJECTED
		r= 1	r>1	2.395	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -12.42+ 0.91 F_t			
4	Polaris	r=0	r>0	71.526*	Null Hypothesis is REJECTED
		r= 1	r>1	4.759	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 6.41+ 0.76 F_t			
5	Satyam Computers	r=0	r>0	66.329*	Null Hypothesis is REJECTED
		r= 1	r>1	4.238	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 14.68+ 0.84 F_t			
6	TCS	r=0	r>0	60.385*	Null Hypothesis is REJECTED
		r= 1	r>1	3.310	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 10.49+ 0.89 F_t			
7	WIPRO	r=0	r>0	57.961*	Null Hypothesis is REJECTED
		r= 1	r>1	5.686	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -9.7 1+ 0.82 F_t			

Assumption: Linear deterministic trend in the data;

*Note: * denote significance at 1% and ** denote significance at 5% level; Testing of Hypothesis done using Likelihood (L.R.) Test; S- spot price, F- futures price, t- time. 'r' denotes the number of cointegration equations.*

I-Flex evidenced strongest relation between futures and spot prices as seen by the highest value of slope (0.97) of the cointegration equation, followed by Patni Computers (0.93) and TCS (0.89). Weakest relationship between spot prices and futures prices was witnessed for Polaris (0.76), followed by Infosys Tech (0.79) and WIPRO (0.82). The constant term was highest for Satyam Computers (14.68) and lowest for Patni Computers with negative value of -12.42. Two other companies showing negative values for the constant term in the cointegration equation are WIPRO (-9.71) and I-Flex (-7.54).

Analysis of Test of Cointegration between Spot and Futures Prices for selected companies in Pharmaceutical sector

Table-6 provides the results of the Johansen's test of cointegration between spot prices and futures prices for the selected six Pharmaceutical companies.

Table-6: Results of Johansen's Test of Cointegration for selected companies in Pharmaceutical sector

S.No.	Companies	Null Hypothesis	Alternative Hypothesis	Eigen Value (λ_{Trace})	Result
		r=0	r>0	43.156*	Null Hypothesis is REJECTED
1	CIPLA	r= 1	r>1	5.692	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -11.23+ 0.86 F_t			
		r=0	r>0	87.263*	Null Hypothesis is REJECTED
2	Dr. Reddy's	r= 1	r>1	5.896	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 9.46+ 0.82 F_t			
		r=0	r>0	35.620**	Null Hypothesis is REJECTED
3	DABUR	r= 1	r>1	5.629	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = -13.55+ 0.74 F_t			
		r=0	r>0	38.694*	Null Hypothesis is REJECTED
4	GLAXO Pharma	r= 1	r>1	3.647	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 5.79+ 0.89 F_t			
		r=0	r>0	76.528*	Null Hypothesis is REJECTED
5	Ranbaxy	r= 1	r>1	6.194	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 12.38 + 0.79 F_t			
		r=0	r>0	55.648*	Null Hypothesis is REJECTED
6	Wockhardt	r= 1	r>1	2.392	Null Hypothesis is ACCEPTED
		Cointegration Equation : S_t = 8.29+ 0.72 F_t			

Assumption: Linear deterministic trend in the data;
*Note: * denote significance at 1% and ** denote significance at 5% level; Testing of Hypothesis done using Likelihood (L.R.) Test; S- spot price, F- futures price, t- time. 'r' denotes the number of cointegration equations.*

Two sets of null hypotheses are tested to find out the number of cointegration relations between the spot and futures price series. Highest eigen value for the first hypothesis is seen for Dr. Reddy's (87.263), followed by Ranbaxy (76.528) and Wockhardt (55.648). Lowest eigen value for first hypothesis was witnessed for DABUR with value of 35.628 (significant at 5%

level) followed by GLAXO Pharma (38.694) and CIPLA (43.156), all the others being significant at 1% level. Further, it is observed from the eigen values for the selected companies that only the first null hypothesis is rejected with statistical significance, while the second hypothesis could not be rejected at either 1% or 5% level of significance. This indicates that only one cointegration equation exists between the spot prices (S_t) and futures prices (F_t) for all the six companies in the Pharmaceutical sector.

Further, the second hypothesis could not be rejected for any of the selected Pharmaceutical companies. GLAXO Pharma evidenced strongest relation between futures and spot prices as seen by the highest value of slope (0.89) in the cointegration equation, followed by CIPLA (0.86) and Dr. Reddy's (0.82).The cointegration equations shows that weakest relationship between futures and spot prices was witnessed for Wockhardt (0.72), followed by DABUR (0.74) and Ranbaxy (0.79). The constant term in the cointegration equations was found to be highest for Ranbaxy (12.38) followed by Dr. Reddy's (9.46), whereas lowest value for the constant term was seen for DABUR (-13.55) followed by CIPLA(-11.23).

Conclusion

For all the six Automobile companies, a single cointegration (long-term) relationship exists between the spot prices and futures prices. Further, Tata Motors is found to have strongest relation between futures and spot prices and Bajaj Auto has the weakest relation. The Johansen's test of cointegration between spot prices and futures prices for the selected nine banks reveals a for each bank. PNB evidenced strongest relation between futures and spot prices, and Oriental Bank is found to have the weakest relationship.

In the Cement sector, the single cointegration equation between the spot and futures prices for each of the four Cement companies indicate that both spot and futures prices are stationary in the first difference form. Gujrat Ambuja Cements evidences strongest relation between futures and spot prices, and ACC is found to have the weakest relationship. Each of the eight companies in the Gas, Oil & Refineries sector also evidence single cointegration relation between spot and futures prices, significant at 1% or 5% level. Bongaigaon Refineries is observed to evidence strongest relation between futures and spot prices, with weakest relation for BPCL. Among the seven selected IT companies, I-Flex showed strongest relation between futures and spot prices, with weakest relation for Polaris. Although each of the six selected Pharmaceutical companies showed single cointegration relation between spot and futures prices, GLAXO Pharma is found to have strongest relation and Wockhardt is found to have the weakest relationship between spot and futures prices.

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