# *Lead – Lag Relationship in Indian Stock Market: Empirical Evidence*

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***ABSTRACT***

*This paper studies the lead lag relationship between the spot and future market in the context of introduction of Nifty futures at the National Stock Exchange (NSE) in June 2000. Co-integration and linear regression techniques are used to determine the existence of any such relation in the two markets during 1st April 2002 and 31st March 2005. The major findings from this endeavor are that the Nifty Futures market leads the nifty index cash market, a lead – lag relation can be traced for all the years under study individually, the relationship among the Nifty index futures and cash market has differed considerably during the mentioned time period. On the basis of this analysis we can say that the two markets are now becoming more efficient and we see a much faster flow of information between the two markets. Further the study tries to portray a picture for the individual stock in the S&P CNX Nifty. This paper indicates that the two markets are highly efficient and in some cases any shock in the market is simultaneously absorbed in both the markets, suggesting an absence of any lead – lag relationship in both the markets under consideration.*

## 1. INTRODUCTION

The temporal relation between stock Index and Index futures has been an area of interest to academicians, regulators and practitioners alike as it gives an idea about the efficiency of the market, its volatility and arbitrage opportunities, if any. Profitable arbitrage should not exist in perfectly efficient markets as prices should adjust instantaneously and fully to new information. Hence, new information disseminating into the market place should be immediately reflected in spot prices and the futures prices simultaneously. In other words, this suggests that there should be no lead – lag relationship between the cash and futures market.

However, futures markets perform an important function of price discovery to help improve efficiency of the market. From this argument, futures prices and their movements provide useful information about subsequent spot prices.

## 2. MOTIVATION

The capital market in India has observed many changes in the new millennium. From June 2000 onwards SEBI has introduced derivatives products such as Index futures, options, stock options and stock futures, in a phased manner in the securities market. These instruments have basically been used for risk management by many investors, including corporates, for the past five years. The futures markets perform some important tasks like that of risk hedging and price discovery. It is expected that price

discovery would take place first in the futures market and subsequently percolate to the underlying cash market (Pizzi et al, 1998). Due to some peculiarities in terms of capital required, cost of transactions etc, it would precede the underlying market in the information discounting process. This paper makes an attempt to measure whether price discovery *actually happens* first in the futures market or not; which in effect means that whether the futures market leads the spot market or not.

## 3. LITERATURE REVIEW

Kawaller et al. (*1987*) analyzed the intra day price-relationship existing between S&P 500 Index and the S&P 500 Index futures. The outcome showed that both S&P 500 spot and futures markets are related simultaneously minute-to-minute basis throughout the day of trading, and there is a presence of a lead lag relationship. From the paper it can be inferred that the lead from futures to cash is more pronounced relative to that existing between the cash to futures markets.

Similar to Kawaller, Stoll and Whaley (*1990*) also investigated the causal relationships between spot and futures markets by making use of intra day data for S&P 500 and the Major Market Index (MMI). Although a feedback was detected in their analysis, but the futures lead was much stronger than that of the cash Index lead.

Chan et al. (*1991*) in this paper, found strong bi-directional dependence between stock Index and stock Index futures while analyzing the inter dependence in price change. Chan (*1992*) also investigated the lead- lag relation (intra day) between the returns of S&P 500 futures and MMI futures. Outcome show that the futures lead the cash index and the results were consistent even for the for constituent stocks of the indices

Wahab and Lashgari (*1993*) made use of daily data and used co-integration analysis to examine the temporary cause-effect linkage between Index and stock Index futures prices for both the FTSE 100 Index and the S&P 500 from 1988 through 1992. They find that although there is a presence of feedback between futures and spot markets for both the FTSE 100 and the S&P 500 indices, they indicate that the spot to futures lead is more pronounced across days relative to the futures to spot lead.

Pizzi et al. (*1998*) determined the price discovery in the S&P 500 spot Index and its three and six month stock Index futures using minute by minute data. They use Co-integration analysis. The results projects that both the three and six months' futures markets lead the spot market by at least twenty minutes. Although there is bi-directional causality but still the futures market does tend to have a stronger lead effect.

Booth et al. (*1999*) examine the price discovery process among stock Index, Index options and Index futures in German market by using the DAX Index securities and intra day transactions data. Findings are that the spot Index and Index futures have much larger information shares than the Index options.

Frino et al. (*2000*) study the co-relation between the futures market and spot market around macroeconomic and other price- sensitive stock information releases. They found strengthening in the lead of stock index futures returns due to certain economic news releases. They also claim that stock specific information has led to weakening of the lead of the futures market around that news.

Roope et al. (*2002*) document a comparison of the information efficiencies between the Singapore exchange and the Taiwan futures exchange for the Taiwan Index futures which is listed in both the markets. The study provides strong evidence that price discovery primarily originates from the Singapore futures market and carried forward.

## 4. OBJECTIVE

This paper examines price discovery between the S&P CNX Nifty[1] and its corresponding futures between April 1, 2002 and March 31, 2005. The paper also looks at the presence of structural stability in the market during the period under study. It means that we study whether the lead – lag relationship has significantly changed during this time period.

## 5. METHODOLOGY

*5.1 Theoretical background*

The concept of co-integration analysis suggests that two variables may move together although they are non-stationary. The rationale is that there exists a long run equilibrium relationship between the two variables. In short run analysis, they may deviate from each other but market influenced forces, Bureaucratic intervention etc., will bring them back together. Engle and Granger (1987) extended this concept and showed in their work that co-integrated series have an error correction representation. In the presence of error correction representation, a portion of disequilibrium prevalent in one period is expected to get corrected in the subsequent period.

The method adopted in this paper deals with selection of relevant econometric techniques and data analysis. Prices of the assets in the cash market and the futures market are inter-related. The products traded are also similar in many aspects. The index futures value is derived from the intrinsic value of the cash market price added to it the associated interest rate. Any information, be it socio-economical, political, business related influences changes in the asset prices either in spot market or in the futures market. As the futures market has lesser trading costs and also commands higher liquidity than the underlying spot market, the information is first expected to be incorporated in the prices of futures and then to flow to cash market (Kawaller et al., 1987). However, this may not be the case in all circumstances for sometimes it can happen that the information is first reflected in the cash market and then influences the futures market. It is also possible that the information is reflected in both the markets simultaneously.

In this paper we study the lead – lag relation between the Nifty index's cash/ spot market and the Nifty index future market. We also see if this relationship has changed significantly over the time period under study. This essentially means that we try to understand the information flow between the two markets and its direction.

[1] S&P CNX Nifty (Nifty) is a diversified 50 stock market capitalisation weighted index which comprises of large and liquid securities. Nifty covers 25 sectors of the economy and a market capitalisation of about 56% of the total market capitalisation of the Indian stock markets (appox. It was arrived at after numerous calculations to ensure that a market index, besides being a true reflection of the stock market, could also be used for modern applications such as index funds and index derivatives.

There are some econometric techniques to measure the direction as well as the intensity of the information flow. Among others, Granger causality, Spectral Analysis[2] and co integration is appropriate techniques to find out speed of information flow and its intensity on prices are more appropriate techniques useful to find out speed of information flow and its intensity on prices. In order to choose an appropriate technique between these, the prices in their levels are tested for co-integration and found to be co-integrated[3].

The spot returns and the future returns series are found to be stationary using Augmented Dickey- Fuller Unit Root Test and co integrated at level.

*5.2 Econometric Techniques Used*

The equilibrium relationship which determines the price changes in one market and also influences price changes in the other (market), is given by the equation:

$$S_t - \alpha_0 - ß_1 F_t = e_t$$

Here,

Ft and St are returns of futures and spot prices at time t. $\alpha_0$ and $ß_1$ are parameters and $e_t$ is the error term (i.e. deviation from equilibrium).

Engle and Granger (1987) proposed that even if $F_t$ and $S_t$ are not stationary, although the deviations $e_t$ is stationary, then $S_t$ and $F_t$ are co-integrated and hence there exists a equilibrium between them. For Ft and St to be co-integrated, they must be integrated to their respective first order. In our analysis, we perform unit root test on each univariate price series with an objective to determine the order of the integration. The prices in the concerned data are co-integrated of order (1, 1), denoted as CI (1, 1) and $ß_1$ is the co-integrating coefficient. An error correction model exists for each of the series, which is not subject to spurious results. Ordinary least squares (OLS) analysis is inappropriate if the futures or spot prices are non- stationary as the standard errors are not consistent. Therefore, to study the lead – lag relationship, we do not use OLS on the level form, but on the first difference of the series. In our analysis the returns are stationary at level form and hence OLS is used following the equation which is expressed as:

$$\mathbf{R_{s,t} = a + \sum_{K=-n}^{n} b_k R_{f,t+k} + e_t}$$

Here, $R_{f,t}$ is the return (futures), $R_{s,\,t+k}$ is the return (cash market) , $a$ is intercept and $e_t$ is the error term.

[2] Much thanks to our reviewer for this suggestion regarding Spectral analysis.

[3] Let At and Bt be two non-stationary series. Generally, it is expected that a combination of At and Bt is also non-stationary. However, it is possible that a particular combination may be stationary. If such a combination exists, we would argue that At and Bt are co-integrated. Two co-integrated series will thus not drift far away overtime e.g. Futures and spot prices, income and consumption (Ramanathan, 2002). The regression assumes that mean values are stationary over any given time-period (of study). If the mean values of a parameter keep changing from one period to another then estimated coefficients will not be able to give unbiased estimates. Thus, it becomes necessary to test the stationary condition for both the dependent and the independent variables.

*5.3 Data Source and Time Period*

Index futures on S&P CNX Nifty and BSE Sensex started trading on National Stock Exchange (NSE) and on The Stock Exchange, Mumbai (BSE) respectively in June 2000.

Volumes traded on BSE are negligible (as for now) and they account for less than 1% of the total number of contracts traded on both the exchanges put together. Thus, for the purpose of the research study of price discovery process, only Index futures on S&P CNX Nifty are considered. For this study data on S&P CNX Nifty has been considered from 1st April 2002 to 31st March 2005. Data are obtained from NSE website for S&P CNX Nifty futures and from Prowess and NSE website for cash market.
The contract details for Nifty Index futures are given in Table 1.

Table 1: Nifty Index futures contracts

| | |
|---|---|
| Date of inception | June 12, 2000 |
| Underlying asset | S&P CNX Nifty Index |
| Trade cycle (in months) | 3 months |
| Expiry | Every month |
| Contract size (in nos.) | 200 |
| Tick size | Re.0.05 |

*5.4 Data Analysis*
The returns calculated as the subsequent log differences of closing price of the S&P CNX Nifty Index and its futures and for the individual component stocks are tested for stationarity. The results of the Augmented Dickey- Fuller Unit Root Test (ADF at 5% level of significance) are stated in table 2 and 3 respectively.
Table 2: ADF test for the future and spot returns for the S&P CNX Nifty Index.

| | Future | | Spot | |
|---|---|---|---|---|
| | ADF | critical@5% | ADF | critical@5% |
| S&P CNX Nifty Index | -11.5215 | -2.8658 | -11.494 | -2.8658 |

Table 3: ADF test for the future and spot returns for the constituent companies.

| | Future returns | | Spot returns | |
|---|---|---|---|---|
| Company Name | ADF | critical@5% | ADF | critical@5% |
| ACC | -12.13373 | -2.8658 | -12.2115 | -2.8658 |
| Bajaj Auto | -11.23569 | -2.8658 | -11.6308 | -2.8658 |
| BHEL | -12.40414 | -2.8658 | -12.5245 | -2.8658 |
| BPCL | -11.25451 | -2.8658 | -11.2118 | -2.8658 |
| Cipla | -11.99125 | -2.8658 | -11.7077 | -2.8658 |
| Dr Reddy | -12.69775 | -2.8658 | -12.8017 | -2.8658 |
| Grasim | -11.25981 | -2.8658 | -11.1819 | -2.8658 |

| | | | | |
|---|---|---|---|---|
| Gujarat Ambuja | -12.46017 | -2.8658 | -12.4824 | -2.8658 |
| Hindalco | -11.19258 | -2.8658 | -11.2049 | -2.8658 |
| HLL | -12.24498 | -2.8658 | -12.3498 | -2.8658 |
| HPCL | -11.34161 | -2.8658 | -11.3737 | -2.8658 |
| HDFC | -13.06155 | -2.8658 | -13.1907 | -2.8658 |
| ITC | -11.04887 | -2.8658 | -11.1116 | -2.8658 |
| Infosys | -12.32729 | -2.8658 | -12.341 | -2.8658 |
| MTNL | -14.10038 | -2.8658 | -12.734 | -2.8658 |
| M&M | -11.75665 | -2.8658 | -11.9384 | -2.8658 |
| Ranbaxy | -12.38974 | -2.8658 | -12.7663 | -2.8658 |
| Reliance | -11.84642 | -2.8658 | -12.1305 | -2.8658 |
| TISCO | -11.60695 | -2.8658 | -11.543 | -2.8658 |
| Tatapower | -11.85566 | -2.8658 | -11.8751 | -2.8658 |
| Tatatea | -11.75039 | -2.8658 | -11.6441 | -2.8658 |

Both table 2 and 3 suggest that the return series of futures and spot prices are stationary at level form. Thus, we can proceed to test for co integration. We make use of the Johanson co integration test for the S&P CNX Nifty Index[4]. The result is as shown in the (Table 4) below:-

**Table 4**

| S&P CNX Nifty Index | | | |
|---|---|---|---|
| Hypothesized | | 5 Percent | 1 Percent |
| No. of CE(s) | Eigen value | Critical Value | Critical Value |
| | | | |
| None ** | 0.289214 | 15.41 | 20.04 |
| At most 1 ** | 0.153946 | 3.76 | 6.65 |

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

(For the co integration test of the constituent stocks please refer. ***Appendix 1***)

## 6. RESULTS AND ANALYSIS

### 6.1 Lead – Lag relationship between S&P CNX Nifty Index and Index Futures.

The lead – lag relationship between the cash and futures markets of S&P CNX Nifty Index is examined by the regression

[4] This is as per the suggestion made by our reviewer. We thank him for his useful insight.

$$R_{s,t} = a + \sum_{K=-3}^{3} b_k R_{f,t+k} + e_t$$

Where, $R_{f,t}$ is the return on the futures, $R_{s,t+k}$ is the return on the price of the cash market , $a$ is the intercept and $e_t$ is the error term.
The results of this regression are presented in the table 5 below.
Table 5: Results of regression –S &P CNX Nifty Index from 1st Apr 02 -31st Mar 05.

| | | |
|---|---|---|
| A | .000 | .957 |
| $b_{-3}$ | -.016* | .025 |
| $b_{-2}$ | -.019* | .008 |
| $b_{-1}$ | .053* | .000 |
| $b_0$ | .916* | .000 |
| $b_{+1}$ | .034* | .000 |
| $b_{+2}$ | .002 | .802 |
| $b_{+3}$ | .001 | .913 |
| RSS | .006 | |
| Adjusted $R^2$ | .957 | |

* significant at 0.05 level
These results suggest that the lags are more significant, which means that the futures lead index's cash market. This result is consistent with the literature that suggests that futures lead the cash market. This model is estimated using the returns that are calculated as the subsequent log differences of closing price of the S&P CNX Nifty Index and its futures. We can conclude that futures' prices lead the spot prices in the S&P CNX Nifty Index at the same time we can infer that spots weakly lead the futures market.

### 6.2 Lead – Lag relationship during three years under study and their homogeneity.

The results (shown above) indicate that on a combined basis, the three years returns present a lead – lag relationship between the S&P CNX Nifty Index and its futures. In this section we will examine the same relationship for three different years and then test if the relationship has remained the same over these years.

In econometric terms it amounts to studying whether the coefficients obtained during regression are statistically different from each other during this time period. This result will give us an indication of the flow of information during these three years.
To examine this relationship once again we have used the equation:

$$R_{s,t} = a + \sum_{K=-3}^{3} b_k R_{f,t+k} + e_t$$

Where, $R_{f,t}$ is the return on the futures, $R_{s,t+k}$ is the return on the price of the cash market , $a$ is the intercept and $e_t$ is the error term.

The results for three years are summarised as follows:

Table 6: Results of regression for S&P CNX Nifty Index from 1st April 2002 to 31st March 2003.

| 1) | FOR Year ending March 31, 2003 | P- value |
|---|---|---|
| A | .000 | .970 |
| $b_{-3}$ | -.018 (-.894) | .372 |
| $b_{-2}$ | -.052* (-2.571) | .011 |
| $b_{-1}$ | .047* (2.360) | .019 |
| $b_0$ | 1.033* (51.656) | .000 |
| $b_{+1}$ | -.004 (-.179) | .858 |
| $b_{+2}$ | .039 (1.948) | .053 |
| $b_{+3}$ | -.015 (-.740) | .460 |
| RSS | .002 | |
| Adjusted $R^2$ | .917 | |

* significant at 0.05 level

Table 7: Results of regression for S&P CNX Nifty Index from 1st April 2003 to 31st March 2004.

| 2) | FOR Year ending March 31, 2004 | P values |
|---|---|---|
| A | .000 | .700 |
| $b_{-3}$ | -.039* | .001 |
| $b_{-2}$ | -.028* | .019 |
| $b_{-1}$ | .082* | .000 |
| $b_0$ | .954* | .000 |
| $b_{+1}$ | .001 | .916 |
| $b_{+2}$ | -.004 | .735 |
| $b_{+3}$ | .001 | .951 |
| RSS | .002 | |
| Adjusted $R^2$ | .966 | |

* significant at 0.05 level

Table 8: Results of regression for S&P CNX Nifty Index from 1st April 2004 to 31st March 2005.

| 3) | FOR Year ending March 31, 2005 | P values |
|---|---|---|
| A | .000 | |
| $b_{-3}$ | -.008 | .364 |
| $b_{-2}$ | -.016 | .083 |
| $b_{-1}$ | .043* | .000 |
| $b_0$ | .863* | .000 |
| $b_{+1}$ | .060* | .000 |
| $b_{+2}$ | -.014 | .124 |
| $b_{+3}$ | .011 | .208 |
| RSS | .002 | |
| Adjusted $R^2$ | .976 | |

* significant at 0.05 level

After looking at the three results we find that for all the three periods the lags are more significant, which means that the futures lead index's cash market. Now, to test whether the three time periods are homogeneous or not we take a look at the coefficients of the lag terms, we find that all of them are not significant during the said time frame. Some coefficients were significant in one time frame but insignificant in the other suggesting that there exists a structural shift in this time period.

We also observe that the number of significant lag variables has reduced indicating that the information flow between the two markets has become quicker and any news

(good/ bad) is passed from the futures market to the spot/ cash market much faster in financial year ending March 31, 2005 as against year ending March 31, 2004 and year ending March 31, 2003.

### 6.3 Lead – Lag relationship during three years under study for the constituent stocks of S&P CNX Nifty Index.

To analyse the lead – lag relationship between the futures and spot market of the constituent stocks of S&P CNX Nifty Index, we use the regression equation:

$$R_{s,t} = a + \sum_{K=-5}^{5} b_k R_{f,t+k} + e_t$$

Where, $R_{f,t}$ is the return on the futures, $R_{s,\ t+k}$ is the return on the price of the cash market , $a$ is the intercept and $e_t$ is the error term.

Analyzing this relationship for the nifty stocks we find that sufficient data is available for twenty-two stocks and their futures for the given time period. For the other stocks the futures data is not available for the year ending 31/03/2003 except for in the case of VSNL where the data is not available for the year ending 31/03/2005.

The analysis presents a mixed picture of lead- lag relationship in the Indian stock market (Ref *Appendix 2*). In some cases a lead – lag relationship can be traced for all the three time periods under study, while for others this relationship cannot be traced in some years. A summary of these results is as follows:

Table 8: Results of regression for constituent stocks of S&P CNX Nifty Index from 1st April 2002 to 31st March 2005.

| Company Name | FOR Year ending March 31, 2003 | FOR Year ending March 31, 2004 | FOR Year ending March 31, 2005 |
|---|---|---|---|
| ACC | No | Lead 1,(-)2<br>Lag (-)1 | Lead 1 |
| Bajaj Auto | Lead (-)4 | Lead (-)3<br>Lag (-)1 | Lag 1 |
| BHEL | Lag (-)4 | No | Lead 1<br>Lag 1 |
| BPCL | Lead (-)2 | No | No |
| Cipla | Lead (-)1 | Lag (-)3 | Lead (-)2,3 |
| Dr Reddy | Lead (-)5 | Lead (-)2 | Lead 1 |
| Grasim | Lag 4 | Lead (-)3,4 | No |
| Gujarat Ambuja | Lead (-)3,4<br>Lag 4 | Lead 1 | No |
| Hindalco | Lag 1 | Lead (-)3<br>Lag (-)1 | Lead (-)3<br>Lag 1 |
| HLL | No | Lead (-)3 | Lag 1 |
| HPCL | No | No | No |
| HDFC | No | Lag (-)3 | Lag 1 |
| ITC | No | No | Lead (-)1 |
| Infosys | Lead (-) 2 | Lead (-)1,<br>(-)2,3,(-)4 | No |
| MTNL | Lead (-)3,4,(-)5 | Lead 3,4<br>Lag 3 | Lead 2<br>Lag 1,2,4 |
| M&M | Lead (-)2,5<br>Lag 5 | Lead (-)2<br>Lag (-)5 | Lead 1,(-)2<br>Lag 2, (-)4 |
| Ranbaxy | No | Lead 1 | Lead 1,(-)3 |
| Reliance | No | Lead 1,(-)3 | No |
| Tisco | Lead (-)2 | Lead 3 | No |
| Tatapower | Lead 1,(-)3<br>Lag (-)3 | Lead 1<br>Lag 3 | Lead 1,(-)3 |
| Tatatea | Lead (-)2,3,<br>(-)4,5 | Lag 4 | Lead 1<br>Lag 2 |

As we see, over the years the lead – lag relationship does not remain same. In cases like ACC, BHEL, BPCL, Grasim, Gujarat Ambuja, HLL, HPCL, HDFC, ITC, Infosys, Ranbaxy, Reliance, TISCO in one or more years under study there existed no lead – lag relationship among the futures and spot market prices. This indicates that the Indian derivative market is highly efficient and there is quick price discovery in the market. Any shock in the market is being simultaneously absorbed in both the markets.

It is also observed that with passage of time (which means from Year ending March 31, 2003 to Year ending March 31, 2005) we find the number of leads and lags have

reduced significantly suggesting that the Indian stock market has become more efficient over this time frame and also that the price discovery process in the economy has become much faster now.

## 7. CONCLUSION

We have studied the lead lag relationship between the spot and future market in the context of introduction of Nifty futures at the National Stock Exchange (NSE) in June 2000. We use the techniques of Co-integration and linear regression to find the existence of any such relation in the two markets during 1st April 2002 and 31st March 2005. We find that the Nifty Futures market leads the nifty index cash market. At the same time a lead – lag relation has been traced for all the years under study individually. We can conclude that the relationship among the Nifty index futures and cash market has changed considerably during the period under study.

This means that information flows from one market to another market. The results are very useful to regulators as well as to market participants. Any regulatory initiative on futures market will have its desired impact on cash market. Therefore, regulators can take actions in the futures market such as reduction in contract size, changes to margins and others, which will have their impact on the cash market. Market participant such as investors can use these results to predict impact of shocks to the futures market on cash market.

In case of individual stocks though we see that a lead – lag relationship is not highly pronounced in all the cases but where it does exist, the futures market leads the spot market as in case of the index.

## 8. LIMITATION

One of the constraints of the data is that daily close values are used whereas the information might get transmitted much faster. This particular aspect can be stated more authoritatively only if high frequency data is used for this purpose. One of major conceptual limitation of regression analysis is that one can, at most, only ascertain the *relationships*, but can't be very sure about the underlying *causal* mechanism which influences the outcome. Working under the constraints, the paper is an attempt to determine the direction and the depth of the relationships.

# Appendix 1:

1.1 Results of Johanson cointegration test for the S&P CNX Nifty Index.

| S&P CNX Nifty Index | | | |
|---|---|---|---|
| Hypothesized | | 5 Percent | 1 Percent |
| No. of CE(s) | Eigen value | Critical Value | Critical Value |
| | | | |
| None ** | 0.289214 | 15.41 | 20.04 |
| At most 1 ** | 0.153946 | 3.76 | 6.65 |

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

1.2 Results of Johanson cointegration test for the component stocks.

| | Hypothesized No. of CE(s) | Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value |
|---|---|---|---|---|---|
| Company Name | | | | | |
| ACC | None ** | 0.251858 | 350.4764 | 15.41 | 20.04 |
| | At most 1 ** | 0.164433 | 134.0148 | 3.76 | 6.65 |
| Bajaj Auto | None ** | 0.25817 | 337.0425 | 15.41 | 20.04 |
| | At most 1 ** | 0.147262 | 117.2467 | 3.76 | 6.65 |
| BHEL | None ** | 0.288717 | 395.1047 | 15.41 | 20.04 |
| | At most 1 ** | 0.172168 | 140.9534 | 3.76 | 6.65 |
| BPCL | None ** | 0.241608 | 324.1971 | 15.41 | 20.04 |
| | At most 1 ** | 0.146172 | 117.8867 | 3.76 | 6.65 |
| Cipla | None ** | 0.409823 | 506.8415 | 15.41 | 20.04 |
| | At most 1 ** | 0.14108 | 113.4512 | 3.76 | 6.65 |
| Dr Reddy | None ** | 0.274354 | 385.9794 | 15.41 | 20.04 |
| | At most 1 ** | 0.178567 | 146.742 | 3.76 | 6.65 |
| Grasim | None ** | 0.26873 | 349.9377 | 15.41 | 20.04 |
| | At most 1 ** | 0.144538 | 116.4605 | 3.76 | 6.65 |
| Gujarat Ambuja | None ** | 0.235766 | 342.3076 | 15.41 | 20.04 |
| | At most 1 ** | 0.173021 | 141.7222 | 3.76 | 6.65 |
| Hindalco | None ** | 0.254642 | 334.5672 | 15.41 | 20.04 |
| | At most 1 ** | 0.143235 | 115.3249 | 3.76 | 6.65 |
| HLL | None ** | 0.177956 | 278.2209 | 15.41 | 20.04 |
| | At most 1 ** | 0.16263 | 132.2293 | 3.76 | 6.65 |
| HPCL | None ** | 0.234918 | 319.9632 | 15.41 | 20.04 |
| | At most 1 ** | 0.148821 | 120.205 | 3.76 | 6.65 |
| HDFC | None ** | 0.297758 | 419.0936 | 15.41 | 20.04 |
| | At most 1 ** | 0.185608 | 153.9854 | 3.76 | 6.65 |
| ITC | None ** | 0.23921 | 319.9967 | 15.41 | 20.04 |
| | At most 1 ** | 0.142097 | 114.9478 | 3.76 | 6.65 |
| Infosys | None ** | 0.259499 | 364.8911 | 15.41 | 20.04 |
| | At most 1 ** | 0.169804 | 139.5701 | 3.76 | 6.65 |
| MTNL | None ** | 0.33956 | 458.1729 | 15.41 | 20.04 |
| | At most 1 ** | 0.178028 | 147.0365 | 3.76 | 6.65 |
| M&M | None ** | 0.224088 | 315.4269 | 15.41 | 20.04 |
| | At most 1 ** | 0.154152 | 125.394 | 3.76 | 6.65 |
| Ranbaxy | None ** | 0.277069 | 374.6655 | 15.41 | 20.04 |
| | At most 1 ** | 0.160637 | 131.3339 | 3.76 | 6.65 |
| Reliance | None ** | 0.245827 | 333.5339 | 15.41 | 20.04 |
| | At most 1 ** | 0.150051 | 121.934 | 3.76 | 6.65 |
| Tisco | None ** | 0.184065 | 275.333 | 15.41 | 20.04 |
| | At most 1 ** | 0.150995 | 122.7679 | 3.76 | 6.65 |
| Tatapower | None ** | 0.247313 | 342.1848 | 15.41 | 20.04 |
| | At most 1 ** | 0.158139 | 129.1053 | 3.76 | 6.65 |
| Tatatea | None ** | 0.213781 | 306.0558 | 15.41 | 20.04 |
| | At most 1 ** | 0.15427 | 125.6661 | 3.76 | 6.65 |

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

# Appendix 2:

Results of regression for constituent stocks of S&P CNX Nifty Index from 1st April 2002 to 31st March 2005.

| **Co. Name** | ACC | P Value | Bajaj Auto | P Value | BHEL | P Value | BPCL | P Value |
|---|---|---|---|---|---|---|---|---|
| **Year ending 31/03/2003** | | | | | | | | |
| **Adj. $R^2$** | 0.968 | | 0.937 | | 0.962 | | 0.985 | |
| **DW** | 2.484 | | 2.399 | | 2.281 | | 1.970 | |
| **α** | 0.000018 | 0.928210 | -0.000010 | 0.973453 | 0.000109 | 0.627327 | 0.000100 | 0.675427 |
| **ß-1** | -0.006766 | 0.569175 | -0.034014 | 0.057077 | 0.002110 | 0.873907 | 0.000276 | 0.972888 |
| **ß-2** | -0.009149 | 0.440556 | -0.012232 | 0.491916 | 0.003806 | 0.774056 | **-0.018190** | **0.025996** |
| **ß-3** | -0.003038 | 0.798666 | 0.012273 | 0.490429 | -0.012700 | 0.340786 | 0.007925 | 0.329979 |
| **ß-4** | 0.000258 | 0.982764 | **-0.035896** | **0.045732** | 0.020132 | 0.134521 | 0.000427 | 0.958251 |
| **ß-5** | 0.006038 | 0.618783 | -0.023117 | 0.188466 | -0.019747 | 0.142068 | 0.000167 | 0.983666 |
| **ß0** | **0.999536** | 0.000000 | **1.050996** | **0.000000** | **1.020586** | **0.000000** | **1.002942** | **0.000000** |
| **ß+1** | -0.006120 | 0.604536 | 0.025910 | 0.145373 | -0.005574 | 0.675384 | -0.012187 | 0.133990 |
| **ß+2** | 0.015819 | 0.179560 | -0.025561 | 0.151110 | -0.006789 | 0.612470 | -0.000969 | 0.905082 |
| **ß+3** | 0.003811 | 0.746513 | 0.004138 | 0.815654 | 0.012372 | 0.359137 | -0.003841 | 0.635990 |
| **ß+4** | -0.008925 | 0.449871 | 0.028432 | 0.109723 | **-0.036114** | **0.007945** | **-0.005417** | **0.505677** |
| **ß+5** | 0.005318 | 0.652494 | -0.013329 | 0.450338 | 0.018037 | 0.178369 | **-0.000882** | **0.913808** |
| **RSS** | 0.002 | | 0.005 | | 0.003 | | 0.003 | |
| **Df** | 227 | | 231 | | 231 | | 231 | |
| **Year ending 31/03/2004** | | | | | | | | |
| **Adj. $R^2$** | 0.984 | | 0.926 | | 0.962 | | 0.953 | |
| **DW** | 2.467 | | 2.477 | | 2.740 | | 2.376 | |
| **α** | 0.000146 | 0.501237 | 0.000029 | 0.941559 | 0.000223 | 0.527168 | 0.000082 | 0.832804 |
| **ß-1** | **0.035681** | **0.000012** | 0.031437 | 0.103699 | 0.008187 | 0.535337 | 0.006070 | 0.670042 |
| **ß-2** | **-0.016810** | **0.036511** | -0.002879 | 0.881273 | -0.008441 | 0.522819 | -0.012252 | 0.391141 |
| **ß-3** | -0.013449 | 0.095489 | **-0.050** | **0.008860** | -0.019390 | 0.151261 | -0.022961 | 0.109460 |
| **ß-4** | -0.004612 | 0.565799 | 0.000 | 0.995690 | -0.007742 | 0.563029 | 0.008113 | 0.573367 |
| **ß-5** | -0.002172 | 0.789053 | 0.005112 | 0.789867 | -0.004281 | 0.748521 | 0.006965 | 0.631524 |
| **ß0** | **0.955063** | **0.000000** | **1.038394** | **0.000000** | **1.005428** | **0.000000** | **0.983545** | **0.000000** |
| **ß+1** | **-0.018634** | **0.020513** | **-0.043957** | **0.023537** | -0.009634 | 0.466097 | 0.005875 | 0.680476 |
| **ß+2** | 0.002247 | 0.778129 | -0.005007 | 0.795221 | 0.001402 | 0.915628 | -0.006620 | 0.639579 |
| **ß+3** | 0.008192 | 0.305036 | -0.001177 | 0.950833 | -0.002783 | 0.832179 | 0.023670 | 0.094769 |
| **ß+4** | -0.009781 | 0.222001 | 0.002589 | 0.891866 | 0.009348 | 0.473222 | 0.010368 | 0.467045 |
| **ß+5** | 0.001304 | 0.871671 | 0.007174 | 0.705236 | -0.016278 | 0.210868 | -0.004662 | 0.744466 |
| **RSS** | 0.002 | | 0.008 | | 0.005 | | 0.007 | |
| **Df** | 228 | | 231 | | 231 | | 231 | |
| **Year ending 31/03/2005** | | | | | | | | |
| **Adj. $R^2$** | 0.942 | | 0.865 | | 0.956 | | 0.853 | |
| **DW** | 2.789 | | 2.503 | | 2.763 | | 2.966 | |
| **α** | 0.000048 | 0.870190 | 0.000 | 0.904847 | 0.000127 | 0.736198 | -0.000020 | |
| **ß-1** | **0.044168** | **0.004708** | 0.043221 | 0.053888 | **0.040065** | **0.004094** | 0.007258 | |
| **ß-2** | -0.008399 | 0.584620 | 0.029412 | 0.186947 | -0.022260 | 0.108906 | 0.016410 | |
| **ß-3** | 0.003122 | 0.838452 | -0.013286 | 0.553828 | 0.026069 | 0.060500 | 0.031209 | |
| **ß-4** | | 0.015885 | 0.296387 | 0.006064 | 0.785677 | -0.007178 | 0.588855 | -0.037635 |
| **ß-5** | -0.017768 | 0.251883 | 0.006847 | 0.758046 | 0.022018 | 0.101167 | 0.013836 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ß0** | **0.899185** | **0.000000** | **0.865266** | **0.000000** | **0.904128** | **0.000000** | **0.903908** | |
| **ß+1** | 0.013626 | 0.379861 | **0.045711** | **0.040222** | **0.031078** | **0.025412** | -0.017775 | 0.975911 |
| **ß+2** | -0.008037 | 0.601850 | 0.017130 | 0.440396 | 0.012811 | 0.354844 | 0.006690 | 0.783016 |
| **ß+3** | -0.011483 | 0.455918 | 0.006142 | 0.784217 | -0.023561 | 0.089385 | 0.013517 | 0.534553 |
| **ß+4** | 0.004592 | 0.764030 | -0.010330 | 0.643601 | 0.004058 | 0.760539 | 0.027015 | 0.229012 |
| **ß+5** | 0.013612 | 0.382734 | 0.003367 | 0.878639 | -0.01764 | 0.189375 | 0.002933 | 0.143635 |
| **RSS** | 0.005 | | 0.008 | | 0.008 | | 0.025 | 0.595545 |
| **Df** | 231 | | 231 | | 231 | | 231 | **0.000000** |

| **Co. Name** | Cipla | P Value | Dr Reddy | P Value | Grasim | P Value | Gujarat Ambuja | P Value |
|---|---|---|---|---|---|---|---|---|
| **Year ending 31/03/2003** | | | | | | | | |
| **Adj. $R^2$** | 0.966 | | 0.981 | | 0.930 | | 0.915 | |
| **DW** | 2.489 | | 2.550 | | 2.380 | | 2.677 | |
| **α** | -0.000025 | 0.887199 | 0.000028 | 0.869636 | 0.000019 | 0.938140 | -0.000005 | 0.984719 |
| **ß-1** | -0.001495 | 0.902824 | -0.000223 | 0.980942 | -0.003587 | 0.841327 | -0.012390 | 0.510461 |
| **ß-2** | -0.006793 | 0.580383 | -0.015963 | 0.087383 | 0.009361 | 0.602314 | 0.013492 | 0.473633 |
| **ß-3** | 0.000110 | 0.992850 | -0.004090 | 0.660803 | -0.008293 | 0.647595 | **-0.041764** | **0.028153** |
| **ß-4** | -0.002123 | 0.862408 | 0.011416 | 0.220550 | 0.005981 | 0.740363 | **0.056717** | **0.002925** |
| **ß-5** | **-0.036547** | **0.003098** | -0.019970 | 0.032587 | 0.003674 | 0.840015 | 0.010571 | 0.568737 |
| **ß0** | **1.006690** | **0.000000** | **1.034468** | **0.000000** | **0.991686** | **0.000000** | **0.928942** | **0.000000** |
| **ß+1** | -0.004103 | 0.740855 | -0.001703 | 0.854957 | -0.002487 | 0.889834 | 0.000938 | 0.960331 |
| **ß+2** | 0.012169 | 0.329406 | -0.006088 | 0.513245 | 0.011481 | 0.524460 | 0.008481 | 0.652615 |
| **ß+3** | -0.016627 | 0.176637 | 0.005147 | 0.580585 | -0.022583 | 0.214703 | -0.000073 | 0.996942 |
| **ß+4** | -0.008429 | 0.493266 | -0.001091 | 0.906774 | **0.03653** | **0.044276** | **0.037601** | **0.047823** |
| **ß+5** | 0.004612 | 0.710738 | 0.005767 | 0.542789 | 0.009052 | 0.619582 | -0.030587 | 0.108064 |
| **RSS** | 0.002 | | 0.002 | | 0.003 | | 0.003 | |
| **Df** | 231 | | 227 | | 227 | | 227 | |
| **Year ending 31/03/2004** | | | | | | | | |
| **Adj. $R^2$** | 0.951 | | 0.976 | | 0.965 | | 0.961 | |
| **DW** | 2.784 | | 2.467 | | 2.549 | | 2.536 | |
| **α** | 0.000125 | 0.694804 | 0.000010 | 0.969270 | 0.000013 | 0.970752 | 0.000157 | 0.617063 |
| **ß-1** | 0.004766 | 0.742844 | 0.007615 | 0.459985 | 0.007609 | 0.547658 | **0.031499** | **0.013663** |
| **ß-2** | 0.002748 | 0.850043 | **-0.021178** | **0.040868** | 0.012151 | 0.339841 | -0.015026 | 0.239931 |
| **ß-3** | 0.000753 | 0.958822 | -0.010495 | 0.308651 | **-0.036681** | **0.004395** | -0.014483 | 0.259749 |
| **ß-4** | -0.007347 | 0.614792 | 0.009788 | 0.342623 | **0.025010** | **0.049676** | -0.001062 | 0.933834 |
| **ß-5** | -0.015073 | 0.306995 | -0.013797 | 0.180474 | 0.008471 | 0.496741 | 0.005133 | 0.687912 |
| **ß0** | **0.975185** | **0.000000** | **1.007061** | **0.000000** | **0.972433** | **0.000000** | **0.937111** | **0.000000** |
| **ß+1** | 0.002074 | 0.885384 | -0.006748 | 0.511625 | 0.001042 | 0.934430 | -0.012041 | 0.345008 |
| **ß+2** | 0.015897 | 0.270875 | -0.000496 | 0.961509 | 0.001621 | 0.897839 | -0.009124 | 0.473706 |
| **ß+3** | **-0.036299** | **0.011973** | -0.003652 | 0.727846 | 0.010459 | 0.407511 | 0.016684 | 0.191095 |
| **ß+4** | 0.026613 | 0.064857 | -0.001584 | 0.881167 | 0.003895 | 0.755565 | -0.012732 | 0.313632 |
| **ß+5** | -0.013338 | 0.353868 | 0.012551 | 0.234810 | -0.004389 | 0.721068 | 0.010716 | 0.395122 |
| **RSS** | 0.005 | | 0.004 | | 0.005 | | 0.005 | |
| **Df** | 231 | | 228 | | 227 | | 228 | |
| **Year ending 31/03/2005** | | | | | | | | |
| **Adj. $R^2$** | 0.940 | | 0.920 | | 0.944 | | 0.944 | |
| **DW** | 2.817 | | 2.462 | | 2.465 | | 2.821 | |
| **α** | 0.000251 | 0.883926 | -0.000057 | 0.874715 | 0.000032 | 0.916200 | -0.000050 | 0.878821 |
| **ß-1** | -0.029821 | 0.070661 | **0.042551** | **0.014186** | -0.005047 | 0.763860 | 0.020529 | 0.211097 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ß-2** | **-0.063558** | **0.000140** | 0.001092 | 0.949314 | -0.013017 | 0.433788 | -0.018232 | 0.267519 |
| **ß-3** | **0.128348** | **0.000000** | -0.032738 | 0.058852 | 0.017019 | 0.315833 | -0.016694 | 0.312399 |
| **ß-4** | -0.026632 | 0.104166 | -0.022799 | 0.187390 | -0.020364 | 0.221910 | 0.016617 | 0.308283 |
| **ß-5** | 0.000770 | 0.962400 | 0.020883 | 0.230046 | 0.006362 | 0.701049 | 0.002770 | 0.865602 |
| **ß0** | 0.019798 | 0.229297 | **0.888357** | **0.000000** | **0.984421** | **0.000000** | **0.986775** | **0.000000** |
| **ß+1** | **0.997677** | **0.000000** | 0.031818 | 0.064215 | 0.028071 | 0.095246 | -0.027437 | 0.094045 |
| **ß+2** | -0.013005 | 0.428679 | 0.002922 | 0.863800 | 0.007851 | 0.638021 | 0.030786 | 0.060787 |
| **ß+3** | 0.000078 | 0.996212 | -0.007073 | 0.683165 | -0.011777 | 0.483725 | 0.003219 | 0.844766 |
| **ß+4** | 0.010634 | 0.515275 | 0.002076 | 0.904388 | -0.002341 | 0.887927 | -0.007936 | 0.625594 |
| **ß+5** | -0.012415 | 0.447546 | 0.010215 | 0.556115 | 0.022104 | 0.185088 | -0.004107 | 0.801000 |
| **RSS** | 0.016 | | 0.007 | | 0.005 | | 0.006 | |
| **Df** | 231 | | 230 | | 230 | | 230 | |

| **Co. Name** | Hindalco | P Value | HLL | P Value | HPCL | P Value | HDFC | P Value |
|---|---|---|---|---|---|---|---|---|
| **Year ending 31/03/2003** | | | | | | | | |
| **Adj. $R^2$** | 0.638 | | 0.972 | | 0.989 | | 0.953 | |
| **DW** | 2.360 | | 2.407 | | 2.118 | | 2.749 | |
| **α** | 0.000027 | 0.957311 | -0.000017 | 0.925067 | 0.000037 | 0.877328 | 0.000036 | 0.958136 |
| **ß-1** | 0.006019 | 0.883366 | -0.008507 | 0.487894 | -0.002272 | 0.745585 | -0.002945 | 0.836974 |
| **ß-2** | -0.001582 | 0.969243 | -0.011879 | 0.334066 | -0.004474 | 0.522370 | -0.009177 | 0.521664 |
| **ß-3** | -0.056002 | 0.170490 | -0.017612 | 0.148517 | 0.004580 | 0.512562 | 0.018556 | 0.195443 |
| **ß-4** | 0.038751 | 0.327361 | -0.003135 | 0.795383 | -0.001614 | 0.817512 | -0.002839 | 0.842595 |
| **ß-5** | 0.008117 | 0.835596 | -0.011489 | 0.337792 | 0.007162 | 0.305723 | 0.008313 | 0.559999 |
| **ß0** | **0.779404** | **0.000000** | **1.039238** | **0.000000** | **0.995374** | **0.000000** | **0.985433** | **0.000000** |
| **ß+1** | **0.168523** | **0.000051** | -0.002235 | 0.852245 | -0.007398 | 0.290984 | 0.008134 | 0.569794 |
| **ß+2** | -0.006326 | 0.877601 | -0.003024 | 0.801489 | -0.006386 | 0.361228 | -0.007006 | 0.624462 |
| **ß+3** | 0.034175 | 0.406374 | 0.002384 | 0.843164 | -0.010399 | 0.137441 | 0.004486 | 0.753728 |
| **ß+4** | 0.003649 | 0.929063 | 0.000283 | 0.981121 | 0.005543 | 0.428107 | -0.003358 | 0.814189 |
| **ß+5** | 0.020946 | 0.608718 | -0.009168 | 0.434352 | -0.003433 | 0.623453 | -0.007589 | 0.594063 |
| **RSS** | 0.013 | | 0.002 | | 0.003 | | 0.024 | |
| **Df** | 227 | | 227 | | 227 | | 228 | |
| **Year ending 31/03/2004** | | | | | | | | |
| **Adj. $R^2$** | 0.951 | | 0.915 | | 0.963 | | 0.923 | |
| **DW** | 2.582 | | 2.059 | | 2.339 | | 2.406 | |
| **α** | 0.000065 | 0.853995 | 0.000020 | 0.956429 | 0.000101 | 0.753549 | -0.000024 | 0.957375 |
| **ß-1** | 0.015322 | 0.308512 | 0.025805 | 0.170671 | 0.014561 | 0.264918 | -0.027678 | 0.162509 |
| **ß-2** | 0.009498 | 0.527661 | 0.004699 | 0.802591 | -0.022821 | 0.083478 | 0.010687 | 0.585926 |
| **ß-3** | **-0.040196** | **0.008086** | **-0.038355** | **0.042127** | -0.003436 | 0.794177 | -0.005182 | 0.791411 |
| **ß-4** | -0.006028 | 0.688663 | -0.002197 | 0.907267 | 0.004551 | 0.729725 | -0.009861 | 0.610741 |
| **ß-5** | 0.017643 | 0.241843 | 0.013991 | 0.453511 | -0.004552 | 0.728614 | 0.000987 | 0.959446 |
| **ß0** | **1.002690** | **0.000000** | **0.933283** | **0.000000** | **0.996765** | **0.000000** | **1.026107** | **0.000000** |
| **ß+1** | **-0.041307** | **0.006434** | 0.004499 | 0.811424 | -0.016301 | 0.212074 | 0.007689 | 0.697305 |
| **ß+2** | 0.022443 | 0.136391 | -0.016825 | 0.369755 | 0.003422 | 0.794624 | 0.021224 | 0.278017 |
| **ß+3** | -0.008567 | 0.570367 | 0.016966 | 0.366144 | -0.006305 | 0.631901 | **-0.039290** | **0.045138** |
| **ß+4** | 0.014496 | 0.334565 | -0.026531 | 0.159675 | 0.000326 | 0.980228 | 0.023424 | 0.225961 |
| **ß+5** | -0.015553 | 0.299799 | 0.028724 | 0.128146 | -0.002143 | 0.869106 | -0.000910 | 0.962366 |
| **RSS** | 0.005 | | 0.008 | | 0.005 | | 0.009 | |
| **Df** | 228 | | 227 | | 228 | | 231 | |
| **Year ending 31/03/2005** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Adj. $R^2$** | 0.952 | | 0.952 | | 0.925 | | 0.924 | |
| **DW** | 2.588 | | 2.286 | | 2.488 | | 2.849 | |
| **α** | 0.000093 | 0.747766 | 0.000011 | 0.969290 | -0.000065 | 0.886081 | 0.000025 | 0.951745 |
| **ß-1** | | | -0.014226 | 0.314385 | 0.007500 | 0.668436 | -0.022840 | 0.225062 |
| **ß-2** | 0.007148 | 0.640169 | -0.005984 | 0.667346 | 0.005406 | 0.757758 | 0.008063 | 0.668591 |
| **ß-3** | -0.039808 | 0.010156 | -0.021257 | 0.129120 | 0.027889 | 0.111064 | -0.016234 | 0.380828 |
| **ß-4** | 0.012718 | 0.405697 | -0.001461 | 0.916633 | -0.027313 | 0.119744 | 0.015473 | 0.402193 |
| **ß-5** | 0.000067 | 0.996495 | 0.012380 | 0.376249 | 0.026167 | 0.138821 | -0.007788 | 0.671922 |
| **ß0** | 0.006442 | 0.672862 | **0.969223** | **0.000000** | **0.912792** | **0.000000** | **0.930292** | **0.000000** |
| **ß+1** | 0.979566 | 0.000000 | **0.059754** | **0.000032** | 0.017514 | 0.318379 | **0.098308** | **0.000000** |
| **ß+2** | 0.035374 | 0.023457 | -0.013087 | 0.354271 | 0.010990 | 0.532307 | -0.029581 | 0.112143 |
| **ß+3** | -0.005548 | 0.715959 | 0.015467 | 0.273269 | 0.010904 | 0.532006 | -0.007727 | 0.671524 |
| **ß+4** | -0.024332 | 0.108296 | 0.000838 | 0.952607 | -0.016423 | 0.348036 | 0.005009 | 0.781143 |
| **ß+5** | 0.020685 | 0.168857 | -0.007776 | 0.581600 | -0.005848 | 0.739406 | -0.016149 | 0.367477 |
| **RSS** | 0.005 | | 0.004 | | 0.011 | | 0.009 | |
| **Df** | 231 | | 230 | | 230 | | 230 | |

| **Co. Name** | ITC | P Value | Infosys | P Value | MTNL | P Value | M&M | P Value |
|---|---|---|---|---|---|---|---|---|
| **Year ending 31/03/2003** | | | | | | | | |
| **Adj. $R^2$** | 0.963 | | 0.982 | | 0.936 | | 0.969 | |
| **DW** | 2.651 | | 2.489 | | 2.620 | | 2.063 | |
| **α** | 0.000030 | 0.879911 | 0.000036 | 0.846168 | -0.000042 | 0.924571 | 0.000037 | 0.884674 |
| **ß-1** | -0.009962 | 0.456449 | -0.011305 | 0.234434 | -0.017120 | 0.312811 | 0.010777 | 0.377586 |
| **ß-2** | -0.009133 | 0.496636 | **-0.029709** | **0.001835** | 0.027232 | 0.109892 | **-0.025155** | **0.036062** |
| **ß-3** | 0.002043 | 0.879409 | -0.002477 | 0.792197 | **-0.046465** | **0.006691** | 0.004743 | 0.686961 |
| **ß-4** | 0.004930 | 0.713941 | -0.003197 | 0.733416 | **0.038282** | **0.024103** | -0.018328 | 0.124082 |
| **ß-5** | -0.017244 | 0.200485 | 0.001700 | 0.857129 | **-0.034561** | **0.039209** | **0.029097** | **0.013996** |
| **ß0** | **1.057302** | **0.000000** | **1.054614** | **0.000000** | **0.973864** | **0.000000** | **0.981704** | **0.000000** |
| **ß+1** | -0.001870 | 0.891806 | 0.016527 | 0.081384 | 0.042669 | 0.012355 | 0.005285 | 0.663557 |
| **ß+2** | 0.015011 | 0.279056 | 0.014088 | 0.139779 | 0.003999 | 0.813716 | -0.016671 | 0.170617 |
| **ß+3** | -0.011224 | 0.418054 | -0.017921 | 0.060974 | -0.014989 | 0.378335 | 0.003902 | 0.745497 |
| **ß+4** | 0.014423 | 0.300355 | -0.000960 | 0.919048 | 0.018563 | 0.275375 | -0.011961 | 0.323877 |
| **ß+5** | -0.017964 | 0.195637 | -0.003996 | 0.669590 | -0.022535 | 0.184839 | **0.020371** | **0.090183** |
| **RSS** | 0.002 | | 0.002 | | 0.010 | | 0.030 | |
| **Df** | 228 | | 228 | | 228 | | 228 | |
| **Year ending 31/03/2004** | | | | | | | | |
| **Adj. $R^2$** | 0.943 | | 0.988 | | 0.564 | | 0.964 | |
| **DW** | 2.505 | | 2.630 | | 2.222 | | 2.169 | |
| **α** | -0.000128 | 0.648494 | -0.000029 | 0.903566 | -0.000129 | 0.902956 | 0.000653 | 0.122985 |
| **ß-1** | 0.025348 | 0.124090 | **-0.025525** | **0.000708** | 0.066890 | 0.050274 | 0.015631 | 0.228797 |
| **ß-2** | 0.000282 | 0.986231 | **-0.022532** | **0.002433** | -0.048691 | 0.155370 | **-0.026086** | **0.044299** |
| **ß-3** | -0.012982 | 0.425921 | **0.020095** | **0.006768** | **0.094375** | **0.005226** | -0.006628 | 0.610260 |
| **ß-4** | 0.005085 | 0.758159 | **-0.018535** | **0.012659** | **0.066673** | **0.048868** | -0.009458 | 0.457353 |
| **ß-5** | 0.012815 | 0.438124 | 0.009546 | 0.192875 | 0.015518 | 0.645638 | 0.002819 | 0.824434 |
| **ß0** | **1.004813** | **0.000000** | **1.024773** | **0.000000** | **0.591515** | **0.000000** | **0.960161** | **0.000000** |
| **ß+1** | -0.012719 | 0.439193 | 0.007012 | 0.446005 | 0.036493 | 0.287406 | -0.020385 | 0.116927 |
| **ß+2** | 0.008582 | 0.602452 | 0.006082 | 0.527601 | 0.023134 | 0.497069 | 0.004067 | 0.751717 |
| **ß+3** | 0.015403 | 0.348789 | -0.006920 | 0.472266 | **0.095574** | **0.004594** | 0.003286 | 0.796211 |
| **ß+4** | 0.023686 | 0.154011 | -0.003656 | 0.705051 | 0.023152 | 0.485379 | 0.004433 | 0.721788 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ß+5** | -0.024340 | 0.143595 | 0.011544 | 0.235654 | 0.045991 | 0.164780 | **-0.036828** | **0.003242** |
| **RSS** | 0.004 | | 0.003 | | 0.061 | | 0.006 | |
| **Df** | 231 | | 230 | | 231 | | 231 | |
| **Year ending 31/03/2005** | | | | | | | | |
| **Adj. $R^2$** | 0.929 | | 0.998 | | 0.453 | | 0.946 | |
| **DW** | 2.681 | | 2.501 | | 1.883 | | 2.533 | |
| **α** | 0.000028 | 0.933895 | -0.000004 | 0.987969 | 0.000136 | 0.919336 | 0.000045 | 0.887362 |
| **ß-1** | **-0.051747** | **0.004941** | -0.000144 | 0.958312 | -0.005048 | 0.912019 | **0.080341** | **0.000000** |
| **ß-2** | 0.005983 | 0.739919 | -0.001229 | 0.654916 | **0.151656** | **0.001030** | **-0.030567** | **0.036508** |
| **ß-3** | 0.014257 | 0.432002 | 0.004024 | 0.144329 | -0.001592 | 0.972500 | -0.013155 | 0.365596 |
| **ß-4** | -0.008131 | 0.653740 | 0.000471 | 0.863953 | -0.049471 | 0.266857 | 0.026439 | 0.068081 |
| **ß-5** | -0.012207 | 0.500498 | -0.000959 | 0.727253 | 0.033810 | 0.452055 | -0.028386 | 0.053956 |
| **ß0** | **0.992240** | **0.000000** | **0.996249** | **0.000000** | **0.627847** | **0.000000** | **0.887218** | **0.000000** |
| **ß+1** | 0.029421 | 0.107658 | 0.001549 | 0.573613 | **0.092772** | **0.041911** | -0.012924 | 0.370930 |
| **ß+2** | 0.002422 | 0.892714 | 0.001817 | 0.509660 | **0.120755** | **0.008067** | **0.033945** | **0.019972** |
| **ß+3** | 0.020920 | 0.244838 | -0.000297 | 0.914015 | -0.002586 | 0.954778 | 0.021204 | 0.143336 |
| **ß+4** | -0.024160 | 0.178669 | -0.003801 | 0.168546 | **0.089662** | **0.042718** | **-0.030491** | **0.034678** |
| **ß+5** | 0.028599 | 0.109080 | 0.001185 | 0.667051 | 0.035115 | 0.429734 | 0.003731 | 0.797275 |
| **RSS** | 0.006 | | 0.003 | | 0.099 | | 0.005 | |
| **Df** | 230 | | 230.000000 | | 230 | | 229 | |

| **Co. Name** | Ranbaxy | P Value | Reliance | sig | Tisco | sig | Tatapower | sig |
|---|---|---|---|---|---|---|---|---|
| **Year ending 31/03/2003** | | | | | | | | |
| **Adj. $R^2$** | 0.994 | | 0.975 | | 0.969 | | 0.933 | |
| **DW** | 2.673 | | 2.209 | | 2.323 | | 2.177 | |
| **α** | -0.000001 | 0.997707 | 0.000026 | 0.888638 | 0.000053 | 0.819469 | 0.000020 | 0.939582 |
| **ß-1** | -0.003329 | 0.528974 | -0.000515 | 0.961247 | 0.003806 | 0.754687 | **0.043676** | **0.014133** |
| **ß-2** | 0.000318 | 0.952096 | -0.000755 | 0.943196 | **-0.030231** | **0.013575** | 0.009731 | 0.580403 |
| **ß-3** | -0.002311 | 0.662064 | -0.007667 | 0.466901 | 0.023262 | 0.056693 | **-0.046880** | **0.008217** |
| **ß-4** | -0.003837 | 0.470532 | -0.007755 | 0.462581 | 0.005953 | 0.625126 | -0.014959 | 0.394581 |
| **ß-5** | -0.008803 | 0.098858 | 0.000419 | 0.968371 | 0.023119 | 0.059133 | -0.001248 | 0.943140 |
| **ß0** | **1.020363** | **0.000000** | **1.005353** | **0.000000** | **1.002178** | **0.000000** | **0.968772** | **0.000000** |
| **ß+1** | -0.008137 | 0.124833 | -0.004283 | 0.683499 | -0.010969 | 0.363900 | 0.017435 | 0.321496 |
| **ß+2** | 0.002573 | 0.626971 | 0.008882 | 0.398580 | 0.005011 | 0.677070 | -0.002285 | 0.896040 |
| **ß+3** | 0.006839 | 0.196899 | -0.002283 | 0.827358 | -0.011995 | 0.319541 | **-0.035803** | **0.042899** |
| **ß+4** | -0.007666 | 0.148636 | -0.011820 | 0.258746 | **-0.024298** | **0.044463** | 0.001933 | 0.912431 |
| **ß+5** | -0.009357 | 0.078342 | -0.000437 | 0.966571 | -0.004830 | 0.689196 | -0.022888 | 0.191653 |
| **RSS** | 0.002 | | 0.002 | | 0.003 | | 0.004 | |
| **Df** | 228 | | 228 | | 228 | | 228 | |
| **Year ending 31/03/2004** | | | | | | | | |
| **Adj. $R^2$** | 0.953 | | 0.963 | | 0.950 | | 0.963 | |
| **DW** | 2.357 | | 2.503 | | 2.317 | | 2.267 | |
| **α** | 0.000063 | 0.794612 | 0.000173 | 0.491391 | 0.000026 | 0.950801 | -0.000054 | 0.882154 |
| **ß-1** | **0.045823** | **0.001243** | **0.040291** | **0.001315** | 0.013591 | 0.339009 | **0.040157** | **0.001559** |
| **ß-2** | -0.016209 | 0.249312 | -0.032138 | 0.009790 | -0.000782 | 0.956043 | -0.020073 | 0.111317 |
| **ß-3** | -0.016088 | 0.248711 | **-0.040063** | **0.001409** | **-0.030764** | **0.033641** | -0.011245 | 0.375316 |
| **ß-4** | 0.002942 | 0.832951 | 0.012591 | 0.310817 | 0.016519 | 0.250467 | 0.003275 | 0.795169 |
| **ß-5** | -0.002037 | 0.884226 | -0.005270 | 0.673835 | 0.008344 | 0.563084 | 0.008701 | 0.488720 |
| **ß0** | **0.948624** | **0.000000** | **0.965396** | **0.000000** | **0.949166** | **0.000000** | **0.940470** | **0.000000** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ß+1** | 0.006179 | 0.657122 | -0.016381 | 0.189382 | 0.010302 | 0.466647 | 0.011125 | 0.375773 |
| **ß+2** | 0.018726 | 0.179296 | -0.000093 | 0.994011 | 0.007880 | 0.577935 | 0.005857 | 0.641254 |
| **ß+3** | -0.020429 | 0.137803 | 0.020143 | 0.105230 | 0.005719 | 0.686458 | **0.032419** | **0.010018** |
| **ß+4** | -0.003949 | 0.774004 | -0.009055 | 0.469152 | 0.002230 | 0.875642 | 0.003008 | 0.808081 |
| **ß+5** | -0.020421 | 0.140369 | -0.011911 | 0.341066 | 0.010099 | 0.479035 | -0.004281 | 0.726595 |
| **RSS** | 0.003 | | 0.003 | | 0.008 | | 0.006 | |
| **Df** | 231 | | 231 | | 231 | | 231 | |
| **Year ending 31/03/2005** | | | | | | | | |
| **Adj. $R^2$** | 0.903 | | 0.986 | | 0.989 | | 0.974 | |
| **DW** | 2.505 | | 2.572 | | 2.384 | | 2.648 | |
| **α** | -0.000017 | 0.958342 | -0.000009 | 0.957979 | -0.000024 | 0.926561 | -0.000024 | 0.938675 |
| **ß-1** | **0.043578** | **0.029892** | 0.013874 | 0.081091 | 0.004752 | 0.474054 | **0.022309** | **0.035829** |
| **ß-2** | 0.028544 | 0.149177 | -0.015919 | 0.046094 | -0.007755 | 0.243425 | 0.014548 | 0.168511 |
| **ß-3** | **-0.051808** | **0.009230** | 0.003933 | 0.622884 | 0.001872 | 0.778160 | **-0.029606** | **0.005404** |
| **ß-4** | -0.008257 | 0.678650 | -0.004459 | 0.570235 | -0.001780 | 0.788993 | 0.027638 | 0.007694 |
| **ß-5** | 0.014352 | 0.466766 | 0.003052 | 0.699221 | -0.003530 | 0.597818 | -0.000661 | 0.949529 |
| **ß0** | **0.896241** | **0.000000** | **0.983860** | **0.000000** | **0.980145** | **0.000000** | **0.927069** | **0.000000** |
| **ß+1** | **0.060330** | **0.002631** | 0.009364 | 0.239113 | 0.001701 | 0.797624 | 0.006299 | 0.549511 |
| **ß+2** | 0.019506 | 0.321279 | 0.005814 | 0.465601 | 0.001595 | 0.809971 | -0.003212 | 0.758421 |
| **ß+3** | -0.017281 | 0.383613 | -0.009620 | 0.227696 | 0.004309 | 0.516183 | 0.001710 | 0.869545 |
| **ß+4** | -0.005233 | 0.790870 | -0.009304 | 0.234753 | 0.000309 | 0.962873 | 0.006437 | 0.526288 |
| **ß+5** | -0.031415 | 0.108531 | 0.007652 | 0.329945 | 0.005806 | 0.384873 | 0.000978 | 0.924475 |
| **RSS** | 0.006 | | 0.001 | | 0.004 | | 0.005 | |
| **Df** | 230 | | 230 | | 230 | | 230 | |

| **Co. Name** | Tatatea | P Value |
|---|---|---|
| **Year ending 31/03/2003** | | |
| **Adj. $R^2$** | 0.953 | |
| **DW** | 2.021 | |
| **α** | 0.000063 | 0.798128 |
| **ß-1** | 0.018129 | 0.238465 |
| **ß-2** | -0.048478 | 0.001815 |
| **ß-3** | 0.034612 | 0.022559 |
| **ß-4** | -0.042459 | 0.005149 |
| **ß-5** | 0.041006 | 0.006838 |
| **ß0** | 1.001690 | 0.000000 |
| **ß+1** | 0.000405 | 0.978912 |
| **ß+2** | 0.019783 | 0.195369 |
| **ß+3** | -0.001874 | 0.900487 |
| **ß+4** | -0.012259 | 0.408924 |
| **ß+5** | -0.005758 | 0.697602 |
| **RSS** | 0.003 | |
| **Df** | 228 | |
| **Year ending 31/03/2004** | | |
| **Adj. $R^2$** | 0.971 | |
| **DW** | 2.358 | |
| **α** | 0.000047 | 0.869936 |
| **ß-1** | 0.023405 | 0.051665 |
| **ß-2** | -0.009111 | 0.449046 |
| **ß-3** | -0.010355 | 0.393255 |
| **ß-4** | 0.016495 | 0.169963 |
| **ß-5** | -0.013016 | 0.268456 |
| **ß0** | **0.961981** | **0.000000** |
| **ß+1** | -0.001137 | 0.924503 |
| **ß+2** | 0.017734 | 0.139577 |
| **ß+3** | -0.020887 | 0.080824 |
| **ß+4** | **0.037147** | **0.001946** |
| **ß+5** | -0.020696 | 0.075146 |
| **RSS** | 0.004 | |
| **Df** | 231 | |
| **Year ending 31/03/2005** | | |
| **Adj. $R^2$** | 0.953 | |
| **DW** | 2.657 | |
| **α** | -0.000011 | 0.970290 |
| **ß-1** | **0.033782** | **0.013945** |
| **ß-2** | -0.010789 | 0.431267 |
| **ß-3** | 0.007825 | 0.567392 |
| **ß-4** | -0.001328 | 0.921915 |
| **ß-5** | 0.016352 | 0.227390 |
| **ß0** | **0.929614** | **0.000000** |
| **ß+1** | -0.008654 | 0.526210 |
| **ß+2** | **0.049305** | **0.000428** |
| **ß+3** | -0.010138 | 0.463316 |
| **ß+4** | 0.008575 | 0.531082 |
| **ß+5** | -0.002108 | 0.877548 |
| **RSS** | 0.004 | |
| **Df** | 230 | |

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