# CAPITAL MARKET REFORM
# AND ASSET PRICING:
# THE CASE OF INDIA

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# ABSTRACT

The reforms of the Indian capital market provide a unique opportunity to test if reforms affect asset pricing. The reform that is the focus of this study is the establishment of the National Stock Exchange (NSE) in late 1994. The NSE, among other reforms, introduced nationwide screen-based trading with a dish-to-satellite data transmission system that provides instant trading access to brokers anywhere in India. The establishment of the National Stock Exchange (NSE) provides a unique natural experiment in that the NSE resulted in a dramatic reduction in market frictions and a tremendous improvement in market efficiency.

The model that is employed here to test the asset pricing behavior is the Fama-French (1993) three-factor model. We fit the Fama-French model, which is the Capital Asset Pricing Model (CAPM) supplemented by two additional factors, namely the size and the value factor, in the pre-NSE period and the post-NSE period. We test if there is any change in the explanatory power of the Fama-French (1993) model and the sensitivities of the asset returns to the three factors, namely market return, size and value across the two periods.

## Choice of the Fama-French Three Factor Model

Researchers have long reported that the CAPM has anomalies – anomalies imply the phenomenon that the market factor or the beta is inadequate to explain the variation in stock returns and factors other than the market factor explain a portion of the unexplained return variation. Some of the noteworthy anomalies include the earnings-price effect (Basu 1977, 1983), size effect (Banz 1981, Reinganum 1981 a), book-equity to market

equity ratio effect (Stattman 1980, Rosenberg, Reid, and Lanstein 1985), debt/equity ratio effect (Bhandari 1988), cash flow to price ratio (Chan, et al. 1991), etc.

The Fama-French three-factor model (Fama and French, 1992, 1993) corrects for almost all the reported anomalies in the CAPM and has found empirical support across the globe and in India. This is the reason this model was employed in this study.

## The Fama French Three-Factor Model

The Fama-French three factor model:

$$\mathbf{R_i - R_f = \alpha_i + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML)}$$

Where $R_i$ is the rate of return expected by the equity shareholders of the firm i, $R_f$ is the risk-free rate of return, $\beta_i$, $s_i$ , $h_i$ are the regression coefficients for the firm i, $R_m$ is the rate of return on the market portfolio, SMB is the size factor risk premium (Expected return of a portfolio of small stocks minus the expected return on portfolio of large stocks), HML is the distress factor risk premium (value premium) where distress is measured by book equity divided by market equity (Expected return of a portfolio of high book-to-market stocks minus the expected return of a portfolio of low book-to-market stocks).

## The National Stock Exchange

The NSE was established in 1994 as a competitor to the Bombay Stock Exchange (BSE). The exchange introduced nationwide screen-based trading with a dish-to-satellite data transmission system that provides instant trading access to brokers anywhere in India. The system now has instantaneous access through 2888 VSATs from nearly 365 cities spread across the country. NSE forced BSE and other exchanges to adapt by upgrading to computerized systems and by reforming trading rules and procedures, which included increased surveillance over the capital adequacy of brokers. BSE shifted from an "open outcry" trading system to a screen-based system, making major investments in equipment, and revised its own procedures to provide transparency for investors.

## Exchange Automation and Market Efficiency

Pirrong (1996) has shown that automated exchanges can be deeper and more liquid than open outcry exchanges. Shah and Thomas (1996) have studied the impact of automation (introduction of BSE Online Trading - BOLT) on the Mumbai Stock Exchange (BSE). They examine two measures of liquidity - aggregate trading volume and trading frequency at the security level - and show that both have improved strongly. Naidu and Rozeff (1994) measure the impact of automation in the Singapore Stock Exchange, which took place in 1989, upon a sample on 28 securities, and note an increase of volatility and liquidity as well as an improvement in efficiency.

## Market Efficiency and Asset Pricing

Fama (1991) in his review of the literature on efficient capital markets elaborates on the joint hypothesis problem. Market efficiency per se is not testable and it must be tested jointly with some model of equilibrium, an asset-pricing model. If we have to determine if information is correctly reflected in prices it can be done so only in the context of a model that defines the meaning of "correctly." If anomalies are observed in the behavior of returns one cannot tell if they are due to mis-specified asset-pricing models or due to market inefficiency.

The joint hypothesis problem implies that given a correct equilibrium asset-pricing model, improvement in market efficiency would improve the performance of the model. Since there is evidence that automated exchanges could improve market efficiency it can be inferred that exchange automation would impact asset pricing.

The argument that improvement in market efficiency could impact asset pricing can also be drawn from the school of thought which states that the CAPM anomalies owe their existence to market inefficiency. Since stock exchange automation improves market efficiency it implies that exchange automation could impact the sensitivities to the size and value factors. This in turn would affect the performance of both the Fama-French three-factor model and the CAPM in the post-NSE era.

## Testing for the Change in Asset Pricing Behavior

The Fama-French model described earlier has three factors, market, size and value. Testing for the change in the asset pricing behavior across two periods basically implies testing for the changes in the intercept $\alpha_I$ and the sensitivities (coefficients) to the three factors across the two periods. The specific sets of null and alternate hypotheses that were tested are detailed later in this chapter.

## Data and Methodology

### The Dummy Variable Approach to Test for the Change in the Coefficients across the Two Periods

The dummy variable technique was followed to test for the changes in the intercept $\alpha_i$, $\beta_I$, $s_i$ and $h_i$. The following equation with dummy variables was fitted for each of the test portfolios.

$$R_i - R_f = \alpha_i + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_\alpha D + d_{\beta i} D (R_m - R_f) + d_{si} D(SMB) + d_{hi} D(HML) \quad (1)$$

**D = 0 for the period before the break point.**

**D = 1 for the period after the break point.**

If the coefficients $d_\alpha$, $d_{\beta I}$, $d_{si}$ and $d_{hi}$ are significantly different from zero, it means that the intercept $\alpha_I$ and the coefficients $\beta_I$, $s_i$ and $h_i$ have changed significantly across the two periods.

Various considerations were made for the choice of date for the break point and finally July 01, 1999 was found to be the ideal choice for the break point.

## Data

The share price data considered for the study was weekly share price data and was extracted from Prowess, the CMIE database. The data from 07/07/1990 to 30/06/1996 is from the Mumbai Stock Exchange (BSE) and the index returns for this period are the BSE Sensex returns. Data from 06/07/1996 to 30/06/2006 is from the National Stock Exchange (NSE) and the index returns for this period are the S & P CNX Nifty returns.

The entire universe of stocks has been considered but the criterion for inclusion of stocks in the study was that they have weekly returns data for all the weeks in the year.

From January 1993 to June 2006 the yield of the 91-day Government of India T-bill was taken as the proxy for the risk free rate. The 91-day T-bill auctions are held weekly and the weekly yields were considered for the study. For the period July 7, 1990 to April 18, 1992, the yield of the 182-day Government of India T-bill was considered as the proxy of the risk free rate. For the period April 25, 1992 to December 26, 1992 the yields of the 364-day T-bill were taken as the proxy for the risk free rate.

## Construction of the Test Portfolios

Six test portfolios were constructed on the basis of the methodology followed in Davis, Fama and French (2000). The Fama-French model states that:

$$\mathbf{R_i - R_f = \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML)}$$

Where $R_i$ is the return on stock i, $R_f$ is the risk free interest rate, $\beta_i$ is the sensitivity of the return on the ith stock to the return on the market portfolio and $R_m$ is the return on the market portfolio. SMB is the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, constructed to be neutral with respect to BE/ME (book equity to market equity). HML is the difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks, constructed to be neutral with respect to size.

The portfolios were formed on July 1 of every year based on the market capitalization and BE/ME data as at the end of March for the year. Based on the market capitalization and BE/ME data as at the end of March for the year the stocks were allocated into two size and three BE/ME groups. Big stocks (B) are above the median market equity of BSE/NSE firms and small stocks (S) are below. Similarly, low BE/ME stocks (L) are below the 30th percentile of BE/ME for BSE/NSE firms, medium BE/ME stocks (M) are in the middle 40 percent, and high BE/ME stocks (H) are in the top 30 percent. Six portfolios, S/L, S/M, S/H, B/L, B/M, and B/H, were formed as the intersections of the size and BE/ME groups. For example, S/L refers to the portfolio of stocks that are below the BSE median in size and in the bottom 30 percent of BE/ME.

The portfolios are formed both on a market capitalization (market capitalization as at the end of March of the year) and equally weighted basis.

## Estimation of the Size Premium, SMB

Davis, Fama and French (2000) define SMB as the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, constructed to be neutral to BE/ME. In line with this definition Davis, Fama and French (2000) use the below formula to estimate SMB and the same formula has been used in the present study too.

SMB is the difference between the equal-weight averages of the returns on the three small stock portfolios and the three big stock portfolios,

SMB = (S/L + S/M + S/H)/3 - (B/L + B/M + B/H)/3

## Estimation of the Value Premium, HML

Similarly Davis, Fama and French (2000) define HML as the difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks, constructed to be neutral with respect to size. In line with this definition Davis, Fama and French (2000) use the below formula to estimate HML and the same formula has been used in the present study too.

HML = (S/H + B/H)/2 - (S/L + B/L)/2

## Research Questions

To test for change in asset pricing behavior across the pre and post break point periods four sets of null and alternate hypotheses were tested, each set concerning the intercept.

To test for the structural breaks across the two periods the following hypotheses were tested.

Let the subscript i1 for the various items refer to the characteristics of the ith portfolio for the pre-NSE period. Let the subscript i2 for the various items refer to the characteristics of the ith portfolio for the post-NSE period.

Set 1:

Null Hypothesis: There is no difference in the intercept term α in the pre-NSE and post-NSE periods.

$H_0: \alpha_{i1} = \alpha_{i2}$

Alternate Hypothesis: There is a difference in the intercept term α in the pre-NSE and post-NSE periods.

$H_1: \alpha_{i1} \neq \alpha_{i2}$

Set 2:

Null Hypothesis: There is no difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-NSE and post-NSE periods.

$H_0: \beta_{i1} = \beta_{i2}$

$H_1: \beta_{i1} \neq \beta_{i2}$

Here $\beta_{i1}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the pre-NSE period and $\beta_{i2}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the post-NSE period.

Set 3:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-NSE and post-NSE periods.

$H_0$: $s_{i1} = s_{i2}$

$H_1$: $s_{i1} \neq s_{i2}$

Set 4:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-NSE and post-NSE periods.

$H_0$: $h_{i1} = h_{i2}$

$H_1$: $h_{i1} \neq h_{i2}$

## Summary of Results

### Summary of the Results for the Market Capitalization Weighted Test Portfolios with July 01, 1999 as the Break Point

1. Hypotheses Set 1: We cannot reject the null hypothesis for all the test portfolios.

   The intercept is insignificant for all the portfolios except one. There is no significant change in the intercept in the post break point period for all the portfolios.

Thus we can conclude that we cannot reject the null hypothesis that there is no difference in the intercept term α in the pre-break point and post-break point periods.

2. Hypotheses Set 2: We cannot reject the null hypothesis in favor of the alternative hypothesis for five of the six test portfolios.

   The coefficient for the market factor is significant (and positive) for all the portfolios. For all the portfolios except one there has been no significant change in the coefficient for the market factor. Thus for all the test portfolios except one we cannot reject the null hypothesis.

3. Hypotheses Set 3: We cannot reject the null hypothesis for four of the six test portfolios.

   For all the portfolios except one the coefficient for the size factor, SMB, is significant (and positive). For all the portfolios except one, there is no significant change in the sensitivities to SMB in the post break point period. Thus for all the portfolios except one we cannot reject the null hypothesis that there is no difference in the sensitivities of the portfolio returns to the size factor, SMB, in the pre-break point and post-break point periods.

4. Hypotheses Set 4: We reject the null hypothesis in favor of the alternate hypothesis for five of the six test portfolios.

   In the pre-break point period, the coefficient for the value factor, HML, is significant for all the portfolios except one. And among the portfolios for which the coefficient is significant, it (the coefficient) is positive for all the portfolios except one.

In the post break point period there has been a significant (and negative) change in the coefficient for the value factor for all the portfolios except one. The coefficient of the value factor is negative for two of the six test portfolios in the post break point period.

Thus for five of the six test portfolios we reject the null hypothesis in favor of the alternate hypothesis that there is a difference in the sensitivities of the portfolio returns to the value factor, HML, in the pre-break point and post break point periods.

## Results and Interpretation

There has been a significant change in the asset pricing behavior in the post NSE period as all the test portfolios have at least one statistically significant dummy variable coefficient.

In the post-break point period the Fama-French three factor model appears to be a perfect descriptor of returns as:

- For almost all the test portfolios all the factors in the model have statistically significant coefficients.

- The intercept has been insignificant for all the test portfolios except one.

For all test portfolios except one the sensitivity (coefficient) to the market factor has remained constant. For all the portfolios except one the sensitivity to the size factor has remained constant. The sensitivity to the value factor has decreased for all the portfolios except one. This could be interpreted as the movement of the market towards CAPM in light of the fact that in the post NSE era the market has moved closer to satisfying some of the conditions of the CAPM.

The interpretation that the market has moved closer to the CAPM could also be made if one considers the school of thought that the anomalies owe their existence to market inefficiency. As the market became more efficient (in terms of reduced market frictions) in the post NSE era this could have contributed to an increased role for beta and a reduced role for one of the 'anomaly' factors in the description of stock returns.

The interpretation that the market has moved closer to CAPM does not necessarily imply that the CAPM would turn out to be best descriptor of stock returns in India in the future. As the market becomes more efficient the 'true' asset-pricing model performs better. Whether the true asset pricing model is the CAPM or the Fama-French three factor model would be revealed to us in the distant future as it takes fairly long periods to establish patterns in asset pricing behavior.

# INTRODUCTION

## Indian Economic Environment

For four decades after independence, India followed a development strategy based on extensive government direction of the economy. This included broad public ownership of commercial enterprises, a requirement for government approval for new investment by large private companies, substantial protection against imports, restrictions on exports, strict limitations on foreign investment, and a government policy framework that posed strong obstacles to the development of capital markets. Most finance for investment projects was done through banks, heavily administered by the government. India's private sector was probably the most controlled in the non-socialist world. The decades of government control had marginalized India from the world economy. Its share of world trade was less than 0.5 percent, down from 2 percent in 1950. Government restrictions on inflows of foreign investment and capital goods deprived the country of new foreign technology. An overextended public sector did an inefficient job of allocating nearly half the country's gross investment, while government capital market regulations and controls directed much of the private sector's investment. The result was severe structural and financial imbalances, which along with low productivity growth (rather than inadequate savings) translated into weak economic growth performance. From 1950 to the 1980s GDP growth rates stayed ahead of population growth, but only barely so, and improvement in average living standards was extremely slow.

Although the rate of Indian economic growth had picked up during the 1980s, this had not prevented a growing belief that India's self reliant approach to development was not working. Other countries in Asia were achieving rates of economic growth and improvements in the standards of living of ordinary people that were dramatically faster than India's. In June 1991, in the midst of severe fiscal and external imbalances, which had generated double-digit inflation and put the country on the verge of defaulting on its external debt obligations, a new government undertook the major task of stabilizing and liberalizing the economy. Since 1991, reform of the investment, exchange rate, and trade regimes has ended four decades of state planning and set in motion a quiet economic revolution.

After the initial economic shock of reform in fiscal year 1991 (GDP growth of only 1 percent), annual growth accelerated to 5 percent in fiscal years 1992–94, 6 percent in FY 1995, and 7 percent in FYs 1996 and 1997. Growth, now driven by exports and private investment, is accompanied by an increase in domestic savings and a sharp decline in inflation. Exports have risen significantly, and private capital inflows have increased.

## Capital Markets Institutions and Their Evolution

### The Investment Regime

Before 1991, investment in the most important areas of the economy was a public sector monopoly, private investment was carefully directed, and foreign investment discouraged.

Even in areas that were not a public sector monopoly, severe licensing restrictions regulated the amount of investment a private firm could undertake. Capital markets were constrained by five particular government policies:

- The government owned and controlled almost all of the banking system and prevented foreign and domestic institutions from entering it.

- The insurance and pension fund industry was government owned and had to invest most of its assets in low-yielding government securities.

- The government set nearly all interest rates, and financial institutions were directed on how they should allocate some of their investments.

- Banks had to meet high reserve requirements, and the funds were used to finance the government's fiscal deficit—in effect preempting private investment.

- Private capital markets were small and needed government approval (including government determination of price and terms) on new capital issues.

Since 1991, there has been a substantial and steady liberalization of the economy to increase the role for market forces. Most interest rates have been deregulated. Foreign investment has been permitted to enter both debt and equity markets. The private sector has been allowed to set up mutual funds. Government control of the prices of initial public offerings (IPOs) has ended. Finally, better regulation, enforced disclosure, and investor protection have greatly improved the integrity of the private capital market.

Although the changes in the last decade have been substantial, a large number of problems remain. The banking system is still predominantly government owned and inefficient. Government crowding out of private investment continues, including through (declining) reserve requirements. Investment in some sectors is still controlled by government. Numerous regulations and administrative burdens affecting capital are far from transparent and differ from state to state. On balance, however, there are few areas where private investors—domestic or foreign—cannot invest, and India's foreign investment regime now compares favorably with several East Asian countries.

## Capital Market Institutions and Characteristics

The number of stock exchanges in India was 22 as on March 31, 2007 and the total turnover on all these in 2006-07 was Rs. Rs.29,014,715 million (excluding turnover in the Wholesale Debt Market (WDM) and Derivatives segments of all the exchanges). Of this the share of National Stock Exchange (NSE) was around 67.01 percent. The share of Mumbai Stock Exchange (BSE) was far behind at around 32.94 percent.

The total number of companies available for trading at the NSE as on March 31, 2007 was 1084 (includes listed/permitted to trade companies but excludes suspended companies). The total number of companies listed on the BSE as on March 31, 2007 was 7561.

The total turnover (including turnover in the Wholesale Debt Market (WDM) and Derivatives segments of all the exchanges) on all the stock exchanges was Rs.105,390,419 million as at the end of 2006-07. It is noteworthy that of this total turnover, the turnover on the derivatives segments of the exchanges was Rs.74,152,780 million, far exceeding the equity segment which amounted to only Rs.29,014,715 million. This scenario is in spite of the fact that activity in the derivatives segment started only in the year 2000-01.

At the end of the financial year 2006-07 the 22 stock exchanges had a total of 9,384 registered brokers and 27,540 registered sub brokers trading on them. It can be seen that as on March 31, 2007 BSE and NSE put together have 95.16 percent of the total number of registered sub-brokers on all the stock exchanges in the country.

Prior to the NSE, the equity market in India had three elements: the Bombay Stock Exchange (BSE), 20 smaller regional stock exchanges, and the Over-the-Counter Exchange of India (OTCEI). Of these, the BSE dominated. It typically accounted for 75% of the total trading volume of the country. It also dominated in terms of public visibility and its role in price discovery. For the most part, India's equity market was synonymous with the BSE. The BSE and all major financial institutions were located in Bombay. In an environment where telecommunications infrastructure was primitive, this implied that the institutional order flow almost exclusively went to the BSE. The BSE was founded in 1875, and the major institutional investors have existed since the 1960s, so there were close relationships between institutional invstors and BSE member firms.

## Problems in BSE and other Stock Exchanges prior to NSE

Until the early 1990s, the trading and settlement infrastructure of the Indian capital market was poor. Trading on all stock exchanges was through open outcry, settlement systems were paper-based, and market intermediaries were largely unregulated. The regulatory structure was fragmented and there was neither comprehensive registration nor an apex body of regulation of the securities market. Stock exchanges were run as "brokers clubs" as their management was largely composed of brokers. There was no prohibition on insider trading, or fraudulent and unfair trade practices.

Yoon Je Cho, (1999) summarized the problems of the Indian securities market before 1992 as follows:

1. Fragmented regulation; multiplicity of administration.
2. Primary markets not in the mainstream of the financial system.
3. Poor disclosure in prospectus. Prospectus and balance sheet not made available to investors.
4. Investors faced problems of delays (refund, transfer, etc.)
5. Stock exchanges regulated through the Securities Contracts (Regulations) Act. No inspection of stock exchanges undertaken.
6. Stock Exchanges run as brokers clubs; management dominated by brokers.
7. Merchant bankers and other intermediaries unregulated.
8. No concept of capital adequacy.
9. Mutual funds—virtually unregulated with potential for conflicts of interest in structure.

10. Poor disclosures by mutual funds; net asset value (NAV) not published; no valuation norms.
11. Private sector mutual funds not permitted.
12. Takeovers regulated only through listing agreement between the stock exchange and the company.
13. No prohibition of insider trading, or fraudulent and unfair trade practices.

## Reforms - Change in Capital Market Regulation

There was a basic change in regulation of capital market from administrative discretionary controls to guidelines/norm-based regulation. The latter eliminated the discretionary element and brought transparency in regulatory provisions. The Controller of Capital Issues was replaced by more independent and autonomous body namely, the Security and Exchange Board of India (SEBI), under the SEBI Act.

### The Controller of Capital Issues

The issue of new stocks was controlled by a government agency, the **Controller of Capital Issues**. With a mission to ensure the quality of new IPOs, the CCI reviewed the financial situation and prospects of the issuing company, and approved the price at which the new issue could be offered. Because of its conservative approach, new issues frequently were sharply under priced. This created great demand for new issues. A refinery offering by the Birla group was oversubscribed 20-fold, and its price rose quickly from 10 to 65 rupees per share after the IPO. Another offering by the Tata group was 80-fold oversubscribed. A lottery was used in such cases, with the lucky bidders winning the right to buy shares that would immediately rise sharply in price. A number of changes since 1993 have strengthened the capital markets. One source characterizes the changes as moving the Indian equity market "from being amongst the backward of the world [as of mid-1993 or so] to one of the most modern in the world."*

**The Securities and Exchange Board of India**

The Securities and Exchanges Board of India (SEBI) was formed in 1988. It has gradually adopted many important roles in the areas of regulation and promotion of capital market in India. It became the catalyst for policy formulation, regulation, enforcement and market development. This is in contrast with conditions prior to SEBI, where exchanges were subjected to little scrutiny or enforcement.

Today, the SEBI vets every element of market design in India's securities markets, it attempts enforcement against problems such as market manipulation and payments crises, and performs oversight of market intermediaries.

In late 1993, SEBI banned badla. This was a major milestone in two respects - this marked the commencement of a major role for SEBI, and it curtailed the market manipulation and systemic risk that accompanied badla. However, these reforms were reversed in 1995 and late 1997 through efforts by SEBI to resuscitate badla.

## The National Stock Exchange of India (NSE)

NSE was established in 1994 as a competitor to the Bombay Stock Exchange (BSE). Major financial institutions, led by the Industrial Development Bank of India, backed the NSE. The exchange introduced nationwide screen-based trading with a dish-to-satellite data transmission system that provides instant trading access to brokers anywhere in India. The system now has instantaneous access through 2888 VSATs from nearly 365 cities spread across the country. NSE forced BSE and other exchanges to adapt by upgrading to computerized systems and by reforming trading rules and procedures, which included increased surveillance over the capital adequacy of brokers. BSE shifted from an "open outcry" trading system to a screen-based system, making major investments in equipment, and revised its own procedures to provide transparency for investors. As a result of these reforms, total transactions costs on India's equity markets dropped from 5 percent in mid-1993 to roughly 2.5 percent in 1997.

**Clearance and Settlement**

The transactions in secondary market pass through three distinct phases viz trading, clearing and settlement. While the stock exchanges provide the platform for trading, the clearing corporation determines the funds and securities obligations of the trading members and ensures that the trade is settled through exchange of obligations. The clearing banks and the depositories provide the necessary interface between the custodians /clearing members for settlement of funds and securities obligations of trading members. The clearing process involves determination of what counter-parties owe, and which counter-parties are due to receive on the settlement date, thereafter the obligations are discharged by settlement.

The National Securities Clearing Corporation (NSCC), a wholly owned subsidiary of the NSE, was created in April 1996. It embarked on the enterprise of requiring collateral in the form of initial margin and mark-to-market margin. It became the legal counter party to the net settlement obligations of each brokerage firm and fulfilled these obligations to the counter parties when a brokerage firm defaulted. This provided an unprecedented regime of reliability in the settlement process in India's equity market.

### The Depositories Act, 1996, the National Securities Depository Limited (NSDL) and the Central Depository Services India Limited (CDSL)

The Depositories Act, 1996 was passed to provide for the establishment of depositories in securities with the objective of ensuring free transferability of securities with speed and accuracy. This act brought in changes by (a) making securities of public limited companies freely transferable subject to certain exceptions; b) dematerializing of securities in the depository mode; and c) providing for maintenance of ownership records in a book entry form. The National Securities Depository Limited (NSDL) was established in August 1996. The NSDL was promoted by the Industrial Development Bank of India (IDBI), the Unit Trust of India (UTI) and the National Stock Exchange (NSE). The Central Depository Services India Limited (CDSL) commenced operations in July 1999. CDSL was promoted by Bombay Stock Exchange Limited (BSE) jointly with leading banks such as State Bank of India, Bank of India, Bank of Baroda, HDFC Bank, Standard Chartered Bank, Union Bank of India and Centurion Bank. At the end of March 2005, the number of companies connected to NSDL and CDSL were 5536 and 5068 respectively. Today demat settlement accounts for over 99.9% of turnover by delivery.

In the depository system, securities are held in depository accounts, which is more or less similar to holding funds in bank accounts. Transfer of ownership of securities is done through simple account transfers. This method does away with all the risks and hassles normally associated with paperwork. Consequently, the cost of transacting in a depository environment is considerably lower as compared to transacting in certificates.

## Foreign Institutional Investors

A Foreign Institutional Investor (FII) means an entity established or incorporated outside India, which proposes to make investment in India.

The entry of FIIs seems to be a follow up of the recommendation of the Narsimhan Committee Report on Financial System. While recommending their entry, the Committee, however did not elaborate on the objectives of the suggested policy. The committee only suggested that the capital market should be gradually opened up to foreign portfolio investments.

From September 14, 1992 with suitable restrictions, FIIs were permitted to invest in all the securities traded on the primary and secondary markets, including shares, debentures and warrants issued by companies which were listed or were to be listed on the Stock Exchanges in India. However, investments by them were first made in January 1993. As of March 2007, there were 996 FIIs registered with SEBI.

Highest net investment in equity by FIIs was seen in 2005-06 of Rs.485,420 million (US $ 11,136 million), However, in 2006-07, net investment in equity dropped by 48.01 % and amounted to Rs.252,360 million (US $ 5,789 million) as compared with net investment of Rs.485,420 million (US $ 11,136 million) in 2005-06. This fall can be attributed to some unfavourable global events like meltdown in global equity and commodities market during May 2006 to July 2006, tightening of capital controls in Thailand during December 2006.

Highest net investment in debt by FIIs was seen in the 2003-04 of Rs.58,050 million (US $ 1,338 million). Net Investment in debt witnessed a huge drop in the year 2005-06 with a net outflow of Rs. 70,650 million, (US $ 1,584 million). However, net investments in debt picked up by a massive 179.33 % during 2006-07 amounting to Rs.56,050 million. (US $ 1,286 million).

During the initial year 1992-93, the FII flows amounted to US $ 1 million and formed only a mere 0.41 % of the total foreign portfolio investments. However, within a year, the FIIs contribution to Foreign Portfolio Investments (FPI) rose sharply to 46.68 % during 1993-94. Thereafter, the FII inflows witnessed a dip of 7.37 %, contributing 39.30 % in the Foreign Portfolio Investments in 1994-95. The year 1995-1996 witnessed a turnaround, gliding up the contribution of FII to a massive of 73.11 %. During 1996-97, there was an increase in portfolio investment mainly because of Indian GDRs which were raised in large amounts due to a number of relaxations regarding issuance of GDRs. Investment by FIIs during 1996-1997 remained almost of the level of the proceeding year. This period was ripe enough for FII Investments because at that time where international capital markets were in the phase of overheating; the Indian economy posted strong fundamentals, stable exchange rate expectations and offered investment incentives and congenial climate for investment of these funds in India.

During 1997-98, FII inflows posted a year -on- year fall of 49 %. This slack in investments by FIIs was primarily due to the South-East Asian Crisis and the period of volatility experienced between November 1997 and February 1998. The net investment flows by FIIs have always been positive from the year of their entry. Only in the year

1998-99, an outflow to the tune of US $ 390 million was witnessed for the first time. This was primarily because of the economic sanctions imposed on India by the US, Japan and other industrialized economies. These economic sanctions were the result of the testing of series of nuclear bombs by India in May 1998. Thereafter, the FII portfolios investments quickly recovered and showed positive net investments for all the subsequent years. FII investments contributed 70.56 % to total foreign portfolio inflows during 1999.

Foreign portfolio investments declined from US $3,026 million during 1999-2000 to US $ 2,760 million during 2000-01. FII inflows had declined to US $ 1,847 million during 2000-01 from US $2,135 million during 1999-2000. FII investment posted a year on year decline of 13 % in 2000-01, 19 % in 2001-02 and 75 % in 2002-03. Investments by FII posted a fall of 80 % in 2002-03 as compared with investments in the period of 2000-01.

Investments by FIIs rebounded from depressed levels from the year 2003-04 and witnessed an unprecedented surge. Portfolio flows were recycled to India following readjustment of global portfolios of institutional investors, triggered by robust growth in Indian economy and attractive valuations in the Indian equity market as compared with other emerging market economies in Asia.

Foreign Investment flows moderated during May-July 2004, but bounced back in the second half of the year. The slowdown in the first half was on account of global uncertainties caused by hardening of crude oil prices and the upturn in the interest rate cycle. The resumption in the net FII inflows to India from August 2004 continued till end 2004-05. The inflows of FIIs during the year 2004-05 were US $ 8,686 million.

Portfolio equity flows increased further during 2005-06 led by higher inflows from foreign institutional investors (FIIs). Net inflows by FIIs in the Indian stock markets increased by 14.28 % to US $ 9,926 million. This rise can be attributed to strong corporate profitability and better growth prospects.

## Primary Market

An aggregate of Rs. 3,951,560 million were raised by the government and corporate sector during 2006-07 as against Rs. 3,165,120 million during the preceding year. Government raised about 51 % of the total resources, with central government alone raising nearly Rs. 1,793,730 million.

**Corporate Securities**

The average annual capital mobilization from the primary market has grown manifold since the last two-three decades. Data in the table shows that there is a high preference for raising resources in the primary market through private placement route. Private placements accounted for 81.80 % of total resources mobilized through domestic issues by corporate sector during 2006-07.

The Indian market is getting integrated with the global market, though in a limited way through Euro Issues, since they were permitted access in 1992. Indian companies have raised about Rs. 170,050 million i.e. US $ 3,901 million during 2006-07 through American Depository Receipts (ADRs)/Global Depository Receipts (GDRs), an increase of 49.80 % as compared with Rs. 113,520 million during 2005-06.

More and more people seem to prefer mutual funds (MFs) as their investment vehicle. This change in investor behavior is induced by the evolution of a regulatory framework for MFs, tax concessions offered by government and preference of investors for passive investing. Starting with an asset base of Rs. 250 million in 1964, the total assets under management at the end of March 2007 has risen to Rs. 3,263,880 million. The resources mobilized by the MFs have increased from Rs. 112,440 million in 1993-94 to Rs. 939,850 million in 2006-07.

**Government Securities**

The primary issues of the Central Government have increased manifold during the decade of 1990s from Rs. 89,890 million in 1990-91 to Rs. 1,793,730 million in 2006-07. The issues by state governments have also increased from Rs. 25,690 million in 1990-91 to Rs. 505,210 million in 2003-04. Thereafter, the issues by the State Government have been witnessing a decrease, mobilizing Rs.208,250 million in 2006-07 against Rs.217,290 million in 2005-06.

The central government mobilized Rs.1,460,000 million through the issue of dated securities and Rs.333,730 million through the issue of 364-day Treasury Bills. After meeting repayment liabilities of Rs. 390,840 million for dated securities and redemption of T-bills of Rs.290,190 million, net market borrowing of Central Government amounted to Rs.1,112,700 million for the year 2006-07.

The state governments collectively raised Rs 208,250 million during 2006-07 as against Rs.217,290 million in the preceding year. The net borrowings of State Governments in 2006-07 amounted to Rs. 142,740 million.

Along with growth of the market, the investor base has also widened. In addition to banks and insurance companies, corporates and individual investors are also investing in government securities. The weighted average cost of borrowing has increased to 7.89 % in 2006-07. The maturity structure of government debt is also changing. About 46 % of primary issues were raised through securities with maturities above 5 years and up to 10 years. As a result the weighted average maturity of dated securities increased to 14.75 years in 2006-07.

**Table 1.1: Resource Mobilization from the Primary Market**

| Issues | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| | (Rs.mn) | (Rs.mn) | (Rs.mn) | (Rs.mn) | (Rs.mn) | (Rs.mn) | (Rs.mn) |
| | | | | | | | |
| Corporate Securities | 783,956 | 744,032 | 752,411 | 748,500 | 1,086,500 | 1,347,650 | 1,949,580 |
| Domestic Issues | 741,986 | 720,612 | 718,147 | 717,520 | 1,052,970 | 1,234,130 | 1,779,530 |
| Public Issues | 63,620 | 71,120 | 48,667 | 78,510 | 218,920 | 269,400 | 323,820 |
| Non-Govt. Public Companies | 48,900 | 56,920 | 18,777 | 36,750 | 134,820 | 211,540 | 316,000 |
| PSU | -- | -- | -- | -- | -- | -- | -- |
| Govt. Companies | -- | 3,500 | -- | 1,000 | 26,840 | 3,730 | -- |
| Banks & FIs | 14,720 | 10,700 | 29,890 | 40,760 | 57,260 | 54,130 | 7,820 |
| Private Placement | 678,360 | 649,500 | 669,480 | 639,010 | 834,050 | 964,730 | 1,455,710 |
| Euro Issues | 41,970 | 23,420 | 34,264 | 30,980 | 33,530 | 113,520 | 170,050 |
| Government Securities | 1,284,830 | 1,525,080 | 1,819,790 | 1,981,570 | 1,456,020 | 1,817,470 | 2,001,980 |
| Central Government | 1,151,830 | 1,338,010 | 1,511,260 | 1,476,360 | 1,065,010 | 1,600,180 | 1,793,730 |
| State Government | 133,000 | 187,070 | 308,530 | 505,210 | 391,010 | 217,290 | 208,250 |
| Total | 2,068,786 | 2,269,112 | 2,572,201 | 2,730,070 | 2,542,520 | 3,165,120 | 3,951,560 |

**Public Issues**

The year 2006-07 witnessed an upsurge in the primary market activity of the total resource mobilization of public issues. This was mainly because of sharp economic recovery, political stability and a buoyant secondary market. The total resources mobilized increased from Rs 273,820 million in 2005-06 to Rs. 335,080 million in 2006-07. The increase in the total resources mobilized was primarily due to an extensive increase in resources raised through IPOs. Though the number of issuers in IPO has dropped to 77 as compared to 79 issuers, the total resource mobilized has increased to Rs. 285,040 million in 2006-07 as against Rs.109,360 million in the preceding year, an increase of 160.64 %.

**Table 1.2: Resource Mobilization from Public Issues (Rs. Million)**

| Issue | 2005-06 | | 2006-07 | |
|---|---|---|---|---|
| | Number | Amount | Number | Amount |
| IPOs | 79 | 109,360 | 77 | 285,040 |
| Issues by Listed Companies | 60 | 164,460 | 47 | 50,040 |
| Public Issues | 24 | 123,580 | 8 | 12,930 |
| Rights Issues | 36 | 40,880 | 39 | 37,110 |
| Total | 139 | 273,820 | 124 | 335,080 |

On the other hand, the public issues of listed companies witnessed a considerable decline of 90 % in the resources mobilized, from Rs.123, 580 million in 2005-06 to Rs. 12,930 million in the current year. The number of issuers dropped to 8 as compared to 24 issuers in 2005-06. In case of Rights issues, the resources mobilized too underwent a decrease from Rs. 40,880 million in the preceding year to Rs. 37,110 million in 2006-07 a drop of 9.22 %.

**Table 1.3: Sector-wise Distribution of Resources Mobilized by Public Equity Issues (Rs. Million)**

| Sector | 2005-06 | | 2006-07 | |
|---|---|---|---|---|
| | Number | Amount | Number | Amount |
| Private | 131 | 201,990 | 122 | 317,280 |
| Joint | -- | -- | -- | -- |
| Public | 8 | 71,830 | 2 | 17,790 |
| Total | 139 | 273,820 | 124 | 335,070 |

Most of the issues were made by private sector companies. Of the 124 issuers which tapped the market in 2006-07, 122 issues were by private sector issuers. They mobilized around 94.69% of the total resources raised. The public sector companies came out with 2 issues mobilizing 5.31% to the total resources mobilized. The joint sector has not been making any issue of capital for the past few years.

During 2006-07, there were 27 mega issues (Rs.3000 million and above), the largest issue being that of Reliance Petroleum Ltd. (Rs. 81,010 million), followed by Cairn India Ltd.( Rs. 52,610 million). The average size of an issue was Rs. 2,702 million in 2006-07 as against Rs 1,970 million in 2005-06.

As per the Prime Annual report 2006-07, the response to public issues has been good in the year 2006-07. Though 26 % of the public issues failed to elicit response (less than 1.5 times) as much as 33% of issues were subscribed over 10 times. The most subscribed issues during 2006-07 was by Shobha Developers Ltd, which was over- subscribed 113.82 times followed by Mindtree Consulting Ltd. which was over subscribed 102.43 times.

**Table 1.4: Response to Public Issues (% of issues)**

| Times Subscribed | 2005-06 | 2006-07 |
|---|---|---|
| | | |
| < 1.5 | 2 | 26 |
| 1.5 - 3 | 12 | 16 |
| 3 - 10 | 28 | 25 |
| > 10 | 58 | 33 |
| Total | 100 | 100 |

In the previous years, debentures have been pre-dominant in the public issues. However, since 2003-04 there has been a reversal in this trend. The share of debt in resource mobilization through public issues was only 16.1% in 2004-05. The year 2005-06 had seen a striking change completely eliminating the share of debt in the resource mobilization through public issue which has also recurred in the year 2006-07. The amount raised through equity issues has been the highest ever in the history of the Indian capital market starting from the year 2005-06 accounting for 100%.

**Table 1.5: Resources Mobilized through Debt and Equity (Public Issues)**

| Year | Percentage Share | |
|---|---|---|
| | Equity | Debt |
| | | |
| 1995-96 | 72.39 | 27.61 |
| 1996-97 | 55.99 | 44.01 |
| 1997-98 | 41.17 | 58.83 |
| 1998-99 | 15.34 | 84.66 |
| 1999-00 | 58.41 | 41.59 |
| 2000-01 | 52.79 | 47.21 |
| 2001-02 | 16.88 | 83.12 |
| 2002-03 | 18 | 82 |
| 2003-04 | 80.47 | 19.53 |
| 2004-05 | 83.96 | 16.04 |
| 2005-06 | 100 | 0 |
| 2006-07 | 100 | 0 |

The Banks and Financial Institutions (FIs) had assumed a dominant role in fund mobilization in the early 2000's. However, the year 2006-07 saw a significant fall in the resources raised from 45.43 % in 2005-06 to 6.53 %. A turnaround in the resources raised through the Telecom industry was noticed in the 2006-07 accounting for 8.94 % in comparison to the previous year where its contribution was nil. The Finance and Cement & Construction industry too witnessed a turnaround, raising 8.25 % and 8.20 % respectively of the total fund mobilization in 2006-07.

**Table 1.6: Industry-wise Resource Mobilization by Public Equity Issues**

| Industry | Percentage Share | |
|---|---|---|
| | 2005-06 | 2006-07 |
| | | |
| Banking/FIs | 45.43 | 6.53 |
| Cement & Construction | 3.73 | 8.2 |
| Chemical | 0.47 | 0.44 |
| Entertainment | 2.59 | 3.64 |
| Finance | 3.01 | 8.25 |
| Information Technology | 3.29 | 6.2 |
| Paper & Pulp | 0.66 | 0.05 |
| Telecom | 0 | 8.94 |
| Textile | 2.82 | 3.17 |
| Others | 38 | 54.58 |
| Total | 100 | 100 |

**Book Building through On-line IPO System**

Book building is basically a process used in IPO for efficient price discovery, wherein during the period when the offer is open, bids are collected from investors at various prices, which are above or equal to the floor price. The offer price is determined after the bid closing date. In its endeavor to continuously improve the

Indian securities market, NSE has offered an infrastructure for conducting online IPOs through book building. It helps to discover prices as well as demand for the security to be issued through a process of bidding. The advantages are: (a) the investor parts with money only after the allotment

(b) it eliminates refunds except in case of direct applications and (c) it reduces the time taken to process the issue. Till March 2007, 199 issuers have used the NSE online IPO system for making IPO issues.

## Banking Sector

After 1992, financial reforms comprised a large part of the economic reforms, given the realization that the government had run out of cash and that to further finance development and growth in the economy, the country needed a healthy and robust banking system. The government's reform agenda for the banking industry was guided largely by the recommendations of the Report of the Committee on Financial System, chaired by former RBI governor M. Narasimham.

The reforms program first concentrated on improving competition in the industry as a means of inculcating efficiency and healthy banking practices. After many years, the private sector was allowed to set up banks again, albeit under the watchful eye of the RBI and subject to a host of prudential guidelines. Foreign bank entry norms were also further liberalized.

The Reserve Bank over the years has successfully brought down SLR to 25 percent, although it is another matter that banks continue to hold government securities well over that requirement. The RBI could certainly bring SLR further down to below 25 percent, but that would require legislative changes. Section 24 of the Banking

Regulation Act mandates that banks should hold a minimum of 25 percent in SLR investments. Any further reduction in SLR also requires the government to consistently pare down its fiscal deficit.

The focus then centered on interest rates. The RBI, over time, collapsed the multitude of interest rates in the system—for both deposits as well as loans—into a few simple rates. In 1992, the RBI started by prescribing only one ceiling rate, against the plethora of rates laid down earlier. Over time, banks were given the freedom to determine what interest rate to offer on their deposits. They were also given the freedom in 1998 to decide on the penalty for premature withdrawal of deposits, as well as the kind of differential rates to offer for bulk deposits.

Even for lending rates, the RBI telescoped the six categories of rates that existed pre-1992 to first three, then in 1994 gave banks freedom to fix their prime lending rate (PLR) for advances over Rs.200,000. By 1998, banks were allowed to charge a maximum of PLR for loans below Rs. 200,000. Banks now have to announce the spread they are charging over their PLR.

The broadest sweep of reforms took place in drawing up critical prudential banking Norms. The first area of focus was asset classification. Earlier, the RBI had devised a health code system which ranked the health of a loan asset under eight categories, of which four were considered as non-performing. In practice, however, classification became a problem, since categorization was left to the subjective choice and discretion of the bank officers. This was later crunched down to four categories: standard, sub-standard, doubtful and loss-making. Basically if interest payment on a loan remained in default for over two quarters (or 180 days), it was categorized as substandard and classified as non-performing asset (NPA). The loan was further classified doubtful if it remained sub-standard for 24 months and beyond that considered as a loss asset. The 24- month threshold was later shrunk to 18 months.

Income recognition was next on the list. In the pre-reform era, banks used to book income from even loans which had gone sour, even though that income was not actually accruing to the bank. This has been stopped post-1992. Banks cannot recognize interest income on loan assets which fall under the new definition of NPA (a loan on which interest is past due for two quarters, or 180 days). There is a recommendation to further tighten this definition to ninety days.

Proper provisioning standards for loss loans were also introduced. Provisioning generally involves making good the impairment inflicted by a loss asset to the balance sheet; it is made good by not distributing the entire profits but keeping some of it back to top up the depleted capital. Earlier, it was left to the discretion of the banks to provide for loans that went sour. However, since banks were irregular in recognizing or classifying non-performing assets, this reflected in their provisioning practices as well. This was one of the first things that were tightened after the reforms process was initiated, since years of non-provisioning had weakened bank balance sheets. In a competitive milieu, banks needed to have some semblance of a strong balance sheet to survive competition.

There were other measures taken, as well, to strengthen bank balance sheets. Valuation of investments were brought in line with market reality (earlier they were valued on the original value paid, without taking into account any diminution in value). Banks were asked to top up capital in line with the risk of the assets they held—in case of the weak public sector banks, the government provided for recapitalization.

The Reserve Bank of India undertook many other measures to bring the Indian banks up to speed to face a new competitive world. Transparency norms were stepped up by improving audit and disclosure rules, so that bank balance sheets reflected the true state of affairs. The RBI is still improving the standards even today. It has also made banks more aware of the multifarious risks in the system and goaded them to proactively manage those risks—apart from credit risk which banks have to deal with daily, the RBI has impressed upon banks the need to actively manage a variety of other risks, such as foreign exchange risk, operating risk, treasury risks and asset-liability mismatch risks, among others.

Many of the other relics of the control regime, such as credit rationing, have also been completely abolished. Earlier, RBI not only used to tell banks how much to lend to whom, it also laid down the rules for the banks on how to calculate eligible bank financing for a corporate, on what was the correct level of receivables or inventory to qualify for financing. All that is now a matter of the past. From 1993, banks were given the freedom to assess their clients' loan requirements.

One area of credit remains that is still regulated to a certain extent and that is directed credit or priority sector lending. And, even though the average credit advanced to priority sector is only around 30-32 percent of total bank credit, the share of priority sector non-performing loans in the total portfolio of NPAs is quite high. According to a report on NPAs prepared by RBI: "The higher proportion of NPAs in priority sector advances was attributed to the directed and pre-approved nature of loans sanctioned under sponsored programmes, absence of any security, lack of effective follow-up due to large number of accounts, legal recovery measures being considered not cost effective, vitiation of repayment culture consequent to loan waiver schemes, etc."

## The Research Problem

The reforms of the Indian capital market provide a unique opportunity to test if reforms affect asset pricing. The reform that is the focus of this study is the establishment of the National Stock Exchange (NSE) in late 1994. The NSE, among other reforms, introduced nationwide screen-based trading with a dish-to-satellite data transmission system that provides instant trading access to brokers anywhere in India. The establishment of the National Stock Exchange (NSE) provides a unique natural experiment in that the NSE resulted in a dramatic reduction in market frictions and a tremendous improvement in market efficiency.

The model that has been employed here to test the asset pricing behavior in the two periods is the Fama-French (1993) three-factor model. We fit the Fama-French model, which is CAPM supplemented by two additional factors, namely the size and the value factor, in the pre-NSE period and the post-NSE period. We test if there is any change in the explanatory power of the Fama-French (1993) model and the sensitivities of the asset returns to the three factors, namely market return, size and value across the two periods.

## Screen Based Trading and Asset Pricing

Grunbichler, Longstaff and Schwartz (1994) identify four ways in which screen trading can affect price discovery. First, screen trading is more cost effective than floor trading. In a competitive market setting, these lower costs will be passed on to traders in the form of lower transaction costs. Therefore, the expected profitability from an informed trade is greater and hence there follows an expectation of increased activity and concentration of informed trading around information. Second, orders can be processed, routed and executed more rapidly in an automated trading environment, thus enhancing the ability of traders to react to information in a timely manner. Third, information capture and dissemination is more rapid under automated trading, thus keeping traders informed on a timelier basis. Fourth, the greater volume and transparency with respect to trade and quote information offered by an electronic open limit order book can also enhance a trader's ability to assimilate and react quickly to information.

Jiang, Tang and Law (2001) of the Market Research Division, Research Department, Hong Kong Monetary Authority in their study titled 'Electronic Trading in Hong Kong and its Impact on Market Functioning' state, "We find evidence that electronic trading (ET) helps to improve market liquidity by reducing bid-ask spreads (BASs), after controlling for the effects of price volatility and trading volume. Furthermore, BASs widen under ET relative to a floor-based trading system when trading volume increases at times of market stress. However, ET will under perform a floor-based system only under extreme market conditions."

NSE forced the Mumbai Stock Exchange (BSE) and other exchanges to adapt by upgrading to computerized systems and by reforming trading rules and procedures, which included increased surveillance over the capital adequacy of brokers. BSE shifted from an "open outcry" trading system to a screen-based system, making major investments in equipment, and revised its own procedures to provide transparency for investors. Thus the NSE directly and indirectly contributed to a dramatic reduction in market frictions and tremendously improving the efficiency of the market. As a result of these reforms, total transactions costs on India's equity markets dropped from 5 percent in mid-1993 to roughly 2.5 percent in 1997. (USAID, 1999).

Pirrong (1996) has shown that automated exchanges can be deeper and more liquid than open outcry exchanges. Shah and Thomas (1996) have studied the impact of automation (introduction of BSE Online Trading BOLT) on the Mumbai Stock Exchange (BSE). They examine two measures of liquidity - aggregate trading volume and trading frequency at the security level - and show that both have improved strongly. Naidu and Rozeff (1994) measure the impact of automation in the Singapore Stock Exchange, which took place in 1989, upon a sample on 28 securities, and note an increase of volatility and liquidity as well as an improvement in efficiency.

The anticipation of both policy makers and practitioners is that the NSE reforms would have had a significant impact on the pricing of stocks in India. The objective here is to test whether the NSE reforms actually did cause changes in asset pricing by using the Fama-French three-factor model.

## The Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM) is the most widely used model for asset pricing. It states that the return on a stock is a linear function of its beta, where beta is the sensitivity of the returns on the stock to the returns on the market portfolio. The CAPM linear relationship is

$k_i = R_f + \beta_i(k_M - R_f)$,

where $k_i$ is the expected return on the ith stock.

$\beta_I$ is the beta of the ith stock.

$k_M$ is the return on the market portfolio and

$R_f$ is the risk-free rate.

$k_M - R_f$ denotes the market risk premium.

## Black Version of the CAPM

Unrestricted risk free borrowing and lending is an unrealistic assumption. Fischer Black (1972) develops a version of the CAPM without risk free borrowing or lending. His version of the CAPM can be stated as follows:

$E(R_i) = E(R_Z) + [E(R_M) - E(R_Z)]\beta_{iM}$

where $E(R_Z)$ is the expected return on a zero-beta portfolio, $E(R_M)$ is the return on the market portfolio, and $\beta i$ is the beta of the ith stock. A zero beta asset is an asset whose returns are uncorrelated with the market.

The relations between expected return and market beta of the Black and Sharpe – Lintner versions of the CAPM differ only in terms of what each says about $E(R_{zM})$, the expected return on assets uncorrelated with the market. The Black version says only that $E(R_{zM})$ must be less than the expected market return, so the premium for beta is positive. In contrast, in the Sharpe – Lintner version of the model, E ($R_{zM}$) must be the risk free interest rate, $R_f$, and the premium per unit of beta risk is E ($R_M$) - Rf.

### Anomalies of the Capital Asset Pricing Model (CAPM)

CAPM has not preformed well in empirical studies. Anomalies have been reported by Basu (1977), Banz (1981) Fama and French (1992, 1993) among others. The anomalies emphasized the fact that firm characteristics like company size, book to market equity ratio and earnings to price ratio have more explanatory power than beta in explaining the cross-sectional variation in returns.

Basu (1977) reported that firms with a low price-earning ratio yielded higher sample return and firms with a higher price-earning ratio produced lower returns than that justified by beta. Banz (1981) finds that average returns on small capitalization stocks are too high given their beta estimates, and average returns on large capitalization stocks are too low. Fama and French (1992) test the existing documented anomalies and narrow down to two variables, size and ratio of book equity to market equity.

## The Fama-French Three Factor Model

### Fama-French Three Factor Model as an Alternative to Correct for the CAPM Anomalies

Fama and French (1993) put forward an alternative model for the CAPM that includes in addition to the market risk factor, size and value factors as additional explanatory variables. This model, hereafter referred to as the Fama French Three Factor model, performs well empirically and is able to explain the anomalies in the

CAPM associated with factors like earnings to price ratio, cash flow to price ratio, past sales growth, long term past return and short term past return (Fama and French, 1996). Fama and French (1998) produce international evidence for a variant of the Fama-French (1993) model. Connor and Sehgal (2001) and Mohanty (2001) produce evidence for the Fama-French Three Factor model in the Indian stock market.

Faff (2004) and Gaunt (2004) provide evidence for the performance of the Fama – French three factor model in the Australian stock market.

Since the Fama-French three-factor model is more general than the CAPM, having CAPM as a special case, and has found empirical support for correcting for the CAPM anomalies, this model has been used to test the impact of financial reforms on Indian financial markets. The model is

$$\mathbf{R_i - R_f = \beta_i(R_m - R_f) + (s_i*SMB) + (h_i*HML)}$$

Where $R_i$ is the rate of return expected by the equity shareholders of the firm i, $R_f$ is the risk-free rate of return, $\beta_i$, $s_i$ , $h_i$ are the regression coefficients for the firm i, $R_m$ is the rate of return on the market portfolio, SMB is the size factor risk premium (Expected return of a portfolio of small stocks minus the expected return on portfolio of large stocks), HML is the distress factor risk premium (value premium) where distress is measured by book equity divided by market equity (Expected return of a portfolio of high book-to-market stocks minus the expected return of a portfolio of low book-to-market stocks).

## Significance of the factors and factor premiums in the Fama-French Three Factor Model

It can be seen that the Fama-French three-factor model is a modification of the CAPM and the two additional factors, size and value, in the model serve to correct for almost all the reported anomalies of the CAPM. [1]

Value premium is the premium enjoyed by high BE/ME (value) stocks over low BE/ME (growth) stocks. Fama and French (1995) state that BE/ME is related to persistent properties of earnings. They provide evidence that BE/ME is associated with long-term differences in profitability. Firms with high BE/ME (a low stock price relative to book value) tend to be persistently distressed. They have low ratios of earnings to book equity for at least 11 years around portfolio formation. Conversely, low BE/ME (a high stock price relative to book value) is associated with sustained strong profitability. The value premium could thus be attributed to higher risk in holding value stocks.

Within book-to-market groups small stocks tend to be less profitable than large stocks. Size premium, the premium enjoyed by small capitalization stocks over large capitalization stocks, could thus be attributed to the higher risk in holding small capitalization stocks.

[1] Fama and French (1996) report that all the CAPM anomalies except for the continuation of short-term returns reported in Jegadeesh and Titman (1993) are accounted for by the Fama-French three factor model (1992,1993).

Jegadeesh and Titman (1993) find that short-term returns tend to continue; stocks with higher returns in the previous twelve months tend to have higher future returns.

## Criticism of the Fama-French Three Factor Model

The Fama French (1993) model is not without, however, controversy and there have been studies which have criticized and rejected it [Berk (1995), Daniel and Titman (1997); Daniel et al (2001)].

Berk (1995), for example, argues that it is misleading to refer to the size effect as an anomaly. No asset-pricing model is expected to hold exactly and the market value is inversely correlated with the risk not measured by the model. The factor for which the market value acts as a proxy would depend on the asset-pricing model being tested. If two different asset-pricing models miss different factors in the risk premium, then size would proxy for different factors in the two tests.

Daniel and Titman (1997) argue that the value premium can be traced to the value characteristic and not risk. The characteristics hypothesis of Daniel and Titman (1997) says that relative distress drives stock returns, and BE/ME is a proxy for relative distress. Low BE/ME (characteristic of strong firms) produces low stock returns, irrespective of risk loadings. Similarly, high BE/ME stocks (distressed firms) have high returns, regardless of risk loadings.

Daniel, Titman and Wei (2001) replicate the Daniel and Titman (1997) tests on a Japanese sample for the 1975 to 1997 period and state that they reject the Fama and French (1993) model but not the characteristic model.

Market inefficiency and market frictions could also play a role in producing anomalies. Fama (1991) elaborates on the joint hypothesis problem and states that since tests of asset pricing models are joint tests of the model as well as market efficiency it would difficult to determine if anomalies were due to a misspecified model or because the market was inefficient. Hsia, Fuller and Chen (2000) express the view that size and value factors are due to market frictions that retard the arbitrage process. Cohen, et al. (1980), Cohen, et al. (1983), Schwartz and Whitcomb (1977a) and Dimson (1979) have elaborated on the bias that non-trading or infrequent trading produces in the beta of stocks. The betas of frequently traded stocks are upward biased and that of infrequently traded stocks are downward biased. It is possible that this bias contributes to the size and value anomalies. Therefore it is expected that in the post-NSE period (which has reduced market frictions and improved market efficiency) the sensitivities of stock returns to the market, size and value factors would undergo a significant change.

## The Previous Indian Studies on the Fama French Model and the Present Study

The Indian studies have some deficiencies. The last decade of the 20th century has seen tremendous changes and reforms in the Indian market like the establishment of the National Stock Exchange, NSE (which first introduced screen based trading in the country), dematerialization of securities, etc. Both Connor and Sehgal (2001) and Mohanty (2001) have treated the whole last decade of the 20th century as one and tested the Fama-French three-factor model without considering the possibility that the asset pricing behavior might have undergone changes due to these reforms and changes. The present study confirms that there is a change in the asset pricing behavior in the aftermath of the establishment of the NSE and substantiates the above reported flaw in the research design of the Indian studies.

More importantly, the objectives of the present study and those of the previous Indian studies on the Fama-French three factor model (Connor and Sehgal (2001) and Mohanty (2001)) are different. The previous Indian studies tested if the Fama-French three-factor model was sufficient to describe the stock returns in India. The present study seeks to establish if there is any change in the explanatory power of the Fama-French (1993) model and the sensitivities of the asset returns to the three factors, namely market return, size and value before and after the establishment of the NSE.

The present study divides the period from 07/07/1990 to 22/03/2003 into two taking into consideration the establishment of NSE and studies the behavior of the Fama-French model in India before and after the establishment of the NSE. This in turn also achieves the purpose of testing for change in the asset pricing behavior in India before and after the establishment of the National Stock Exchange.

# THEORY AND LITERATURE REVIEW

## Risk and Return: History

The behavior of share prices, and the relationship between risk and return in financial markets, has long been of interest to researchers. In 1905, a young scientist named Albert Einstein, seeking to demonstrate the existence of atoms, developed an elegant theory based on Brownian motion. Einstein explained Brownian motion the same year he proposed the theory of relativity. At that time his results were considered completely revolutionary. However, the theory of Brownian motion had been discovered five years earlier by a young French doctoral candidate named Louis Bachelier. He, too, was trying to explain certain complex movements: stock prices on the Paris Bourse. Bachelier was the first to study the fluctuations in the prices of stocks and shares and their probability distributions. His PhD thesis contained remarkable results, which anticipated not only Einstein's theory of Brownian motion but also many of the modern concepts of theoretical finance. Bachelier received a respectable "mention honorable", but his theory did not receive much attention and remained unexplored by researchers.

The full potential of Bachelier's theory was only realized some 50 years later by Mandelbrot (1963) and Fama (1965). Their findings that the variance of returns is not constant over time (heteroscedastic) and that the distribution of price changes were not Gaussian but leptokurtic, are among the foundations of modern financial theory. Fama concluded that the empirical distributions of share prices followed not a Gaussian but a Stable Paretian distribution with characteristic exponent less than 2, that is, with finite mean but infinite variance. However, it was only with the Capital Asset Pricing Model

(CAPM) developed by Sharpe (1964) that one of the important problems of modern financial economics was formalized: the quantification of the trade-off between risk and expected return.

## The Markowitz Model and the Capital Asset Pricing Model (CAPM)

### The Markowitz Model

The CAPM builds on the model of portfolio choice developed by Harry Markowitz (1959). In Markowitz's model, an investor selects a portfolio at time t-1 that produces a stochastic return at t. The model assumes investors are risk averse and, when choosing among portfolios, they care only about the mean and variance of their one-period investment return. As a result, investors choose "mean-variance efficient" portfolios, in the sense that the portfolios: 1) minimize the variance of portfolio return, given expected return, and 2) maximize expected return, given variance. Thus, the Markowitz approach is often called a "mean-variance model."

The portfolio model provides an algebraic condition on asset weights in mean-variance efficient portfolios. The CAPM turns this algebraic statement into a testable prediction about the relation between risk and expected return by identifying a portfolio that must be efficient if asset prices are to clear the market of all assets.

### The Capital Asset Pricing Model (CAPM)

Sharpe (1964) and Lintner (1965) add two key assumptions to the Markowitz model to identify a portfolio that must be mean-variance-efficient. The first assumption is complete agreement: given market clearing asset prices at t-1, investors agree on the joint distribution of asset returns from t-1 to t. And this distribution is the true one, that is, the distribution from which the returns that are used to test the model are drawn. The second assumption is that there is borrowing and lending at a risk free rate, which is the same for all investors and does not depend on the amount borrowed or lent.

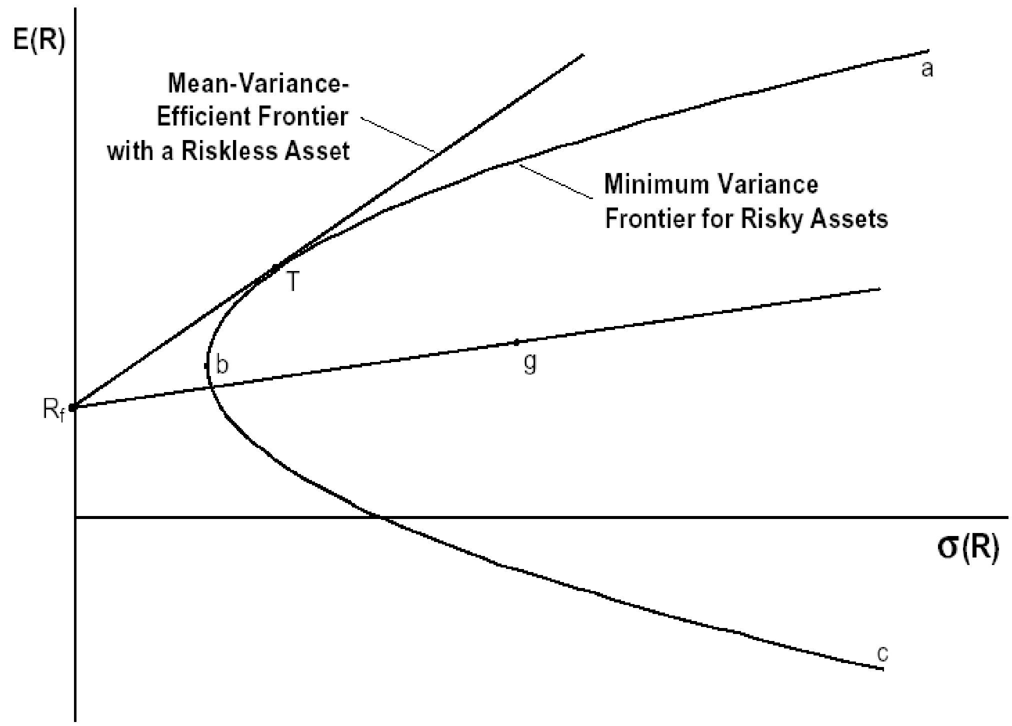



**Figure 2.1 – Investment Opportunities**

Figure 1 describes portfolio opportunities and the derivation of the CAPM. The horizontal axis shows portfolio risk, measured by the standard deviation of portfolio return; the vertical axis shows expected return. The curve abc, which is called the minimum variance frontier, traces combinations of expected return and risk for portfolios of risky assets that minimize return variance at different levels of expected return. (These portfolios do not include riskfree borrowing and lending.) The tradeoff between risk and expected return for minimum variance portfolios is apparent. For example, an investor who wants a high expected return, perhaps at point a, must accept high volatility. At point T, the investor can have an intermediate expected return with lower volatility. If there is no riskfree borrowing or lending, only portfolios above b along abc are mean- variance-efficient, since these portfolios also maximize expected return, given their return variances. Adding riskfree borrowing and lending turns the efficient set into a straight line. Consider a portfolio that invests the proportion x of portfolio funds in a riskfree security and 1-x in some portfolio g. If all funds are invested in the riskfree security – that is, they are loaned at the riskfree rate of interest – the result is the point Rf in Figure 1, a portfolio with zero variance and a riskfree rate of return. Combinations of riskfree lending and positive investment in g plot on the straight line between Rf and g. Points to the right of g on the line represent borrowing at the riskfree rate, with the proceeds from the borrowing used to increase investment in portfolio g.

In short, portfolios that combine riskfree lending or borrowing with some risky portfolio g plot along a straight line from Rf through g in Figure 1.To obtain the mean-variance-efficient portfolios available with risk free borrowing and lending, one draws a line from Rf in Figure 1 up and to the left as far as possible, to the tangency portfolio T. It can then be seen that all efficient portfolios are combinations of the risk free asset (either risk free borrowing or lending) and a single risky tangency portfolio, T. This key result is Tobin's (1958) "separation theorem."

With complete agreement about distributions of returns, all investors see the same opportunity set (Figure 1) and they combine the same risky tangency portfolio T with risk free lending or borrowing. Since all investors hold the same portfolio T of risky assets, it must be the value-weight market portfolio of risky assets. Specifically, each risky asset's weight in the tangency portfolio, which is now called M (for the "market"), must be the total market value of all outstanding units of the asset divided by total market value of all risky assets. In addition, the risk free rate must be set (along with the prices of risky assets) to clear the market for risk free borrowing and lending.

In short, the CAPM assumptions imply that the market portfolio M must be on the minimum variance frontier if the asset market is to clear. This means that the algebraic relation that holds for any minimum variance portfolio must hold for the market portfolio.

Specifically, if there are N risky assets,

(Minimum Variance Condition for M)

$E(R_i) = E(R_{zM}) + [E(R_M) - E(R_{zM})]\beta_{iM}, \; i = 1, \ldots\ldots, N.$

In this equation, $E(R_i)$ is the expected return on asset i and $\beta_{iM}$, the market beta of asset i, is the covariance of its return with the market return divided by the variance of the market return,

$$\text{(Market Beta)} \; \beta_{iM} = \frac{\text{cov}(R_i, R_M)}{\sigma^2(R_M)}$$

The first term on the right-hand side of the minimum variance condition, $E(R_{zM})$, is the expected return on assets that have market betas equal to zero, which means their returns are uncorrelated with the market return. The second term is a risk premium – the market beta of asset i, $\beta_{iM}$, times the premium per unit of beta, which is the expected market return, E ($R_M$), minus E ($R_{zM}$).

Since the market beta of asset i is also the slope in the regression of its return on the market return, a common (and correct) interpretation of beta is that it measures the sensitivity of the asset's return to variation in the market return. But there is another interpretation of beta more in line with the spirit of the portfolio model that underlies the CAPM. The risk of the market portfolio, as measured by the variance of its return (the denominator of $\beta_{iM}$), is a weighted average of the covariance risks of the assets in M (the numerators of $\beta_{iM}$ for different assets). Thus, $\beta_{iM}$ is the covariance risk of asset i in M measured relative to the average covariance risk of assets, which is just the variance of the market return. In economic terms, $\beta_{iM}$ is proportional to the risk each unit of money invested in asset i contributes to the market portfolio.

The last step in the development of the Sharpe – Lintner model is to apply the assumption of risk free borrowing and lending on E($R_{zM}$), the expected return on zero-beta assets. A risky asset's return is uncorrelated with the market return – its beta is zero – when the average of the asset's covariances with the returns on other assets just offsets the variance of the asset's return. Such a risky asset is riskless in the market portfolio in the sense that it contributes nothing to the variance of the market return.

When there is riskfree borrowing and lending, the expected return on assets that are uncorrelated with the market return, E ($R_{zM}$), must equal the riskfree rate, $R_f$ . The relation between expected return and beta then becomes the familiar Sharpe – Lintner CAPM equation,

$E(R_i) = R_f + [E(R_M) - R_f]\beta_{iM}$, i = 1,…….,N.

In words, the expected return on any asset i is the riskfree interest rate, Rf, plus a risk premium, which is the asset's market beta, $\beta_{iM,}$ times the premium per unit of beta risk, $E(R_M) - R_{f.}$

**The Tenets and Assumptions of the CAPM**

According to the CAPM, investors diversify all unsystematic (diversifiable) risk such that the market rewards investors for bearing only systematic (non-diversifiable) risk. The CAPM $\beta$ is taken as the measure of systematic risk. The following are the assumptions of the CAPM (Copeland and Weston, 1988, page 194):

1. The CAPM assumes the market to be in equilibrium (all asset prices be adjusted such that the excess demand for any asset will be zero).
2. Investors are risk-averse individuals who maximize the expected utility of their end of period wealth.
3. Investors are price takers and have homogeneous expectations about asset returns that have a joint normal distribution.
4. There exists a risk free asset such that investors may borrow or lend unlimited amounts at the risk free rate.
5. The quantities of the assets are fixed. Also all assets are marketable and perfectly divisible.
6. Asset markets are frictionless and information is costless and simultaneously available to all investors.

7. There are no market imperfections such as taxes, regulations, or restrictions on short selling.

**Black Version of the CAPM**

Unrestricted risk free borrowing and lending is an unrealistic assumption. Fischer Black (1972) develops a version of the CAPM without riskfree borrowing or lending. He shows that the CAPM's key result – that the market portfolio is mean-variance-efficient – can be obtained by instead allowing unrestricted short sales of risky assets. In short, in Figure 1, if there is no riskfree asset, investors select portfolios from along the mean-variance-efficient frontier from a to b. Market clearing prices imply that when one weights the efficient portfolios chosen by investors by their (positive) shares of aggregate invested wealth, the resulting portfolio is the market portfolio. The market portfolio is thus a portfolio of the efficient portfolios chosen by investors. With unrestricted short selling of risky assets, portfolios made up of efficient portfolios are themselves efficient. Thus, the market portfolio is efficient, which means that the minimum variance condition for M given above holds, and it is the expected return-risk relation of the Black CAPM.

The relations between expected return and market beta of the Black and Sharpe – Lintner versions of the CAPM differ only in terms of what each says about $E\ (R_{zM})$, the expected return on assets uncorrelated with the market. The Black version says only that $E\ (R_{zM})$ must be less than the expected market return, so the premium for beta is positive. In contrast, in the Sharpe – Lintner version of the model, $E\ (R_{zM})$ must be the riskfree interest rate, $R_f$, and the premium per unit of beta risk is $E\ (R_M)$ - Rf.

**Testing Whether Market Betas Explain Expected Returns**

The Sharpe – Lintner and Black versions of the CAPM share the prediction that the market portfolio is mean-variance-efficient. This implies that differences in expected return across securities and portfolios are entirely explained by differences in market beta; other variables should add nothing to the explanation of expected return. This prediction plays a prominent role in tests of the CAPM. In the early work, the method of choice is cross-sectional regressions.

In the framework of Fama and MacBeth (1973), one simply adds pre-determined explanatory variables to the month-by-month cross-section regressions of returns on beta. If all differences in expected return are explained by beta, the average slopes on the additional variables should not be reliably different from zero. Clearly, the idea in the cross-section regression approach is to choose specific additional variables likely to expose any problems of the CAPM prediction that, because the market portfolio is efficient, market betas suffice to explain expected asset returns.

In Fama and MacBeth (1973) the additional variables are squared market betas (to test the prediction that the relation between expected return and beta is linear), and residual variances from regressions of returns on the market return (to test the prediction that market beta is the only measure of risk needed to explain expected returns). These variables do not add to the explanation of average returns provided by beta. Thus, the results of Fama and MacBeth (1973) are consistent with the hypothesis that their market proxy – an equal-weight portfolio of NYSE stocks – is on the minimum variance frontier.

**The Market Proxy Problem**

Roll (1977) argues that the CAPM has never been tested and probably never will be. The problem is that the market portfolio at the heart of the model is theoretically and empirically elusive. It is not theoretically clear which assets can legitimately be excluded from the market portfolio, and data availability substantially limits the assets that are included. As a result, tests of the CAPM are forced to use proxies for the market portfolio, in effect testing whether the proxies are on the minimum variance frontier. Roll argues that because the tests use proxies, not the true market portfolio, we learn nothing about the CAPM.

Stambaugh (1982) states from the results of his empirical study that the inferences about the CAPM are not sensitive to the composition of the market index. His tests on CAPM produce identical results across the various market indices considered. His tests find that the expected return is linearly related to beta and that the risk premium of the market portfolio over the zero beta asset is positive. However, his tests reject the equality of the zero beta return to the T-bill rate. Together these inferences imply that the index portfolios lie on the positively sloped portion of the minimum-variance boundary, but that none of them is the tangency portfolio associated with the risk-free rate. Thus, based on any of the market indexes considered, the tests reject the traditional Sharpe-Lintner CAPM but do not reject the more general Black version.

Stambaugh (1982) however finds that his inferences are sensitive to the set of assets used in the tests. I quote from his paper, "Inferences prove to be sensitive to -the set of assets used in the tests. Inferences based on the most inclusive set of assets - common stocks, bonds, and preferred stocks - reject the Sharpe-Lintner version of the

CAPM but do not reject the more general Black version. Other sets of assets provide different inferences."

The bottom line from the early cross-section regression tests of the CAPM, such as Fama and MacBeth (1973), and the early time-series regression tests, like Stambaugh (1982), is that standard market proxies seem to be on the minimum variance frontier. That is, the central predictions of the Black version of the CAPM, that market betas suffice to explain expected returns and that the risk premium for beta is positive, seem to hold. But the more specific prediction of the Sharpe – Lintner CAPM that the premium per unit of beta is the expected market return minus the risk free interest rate is consistently rejected. The success of the Black version of the CAPM in early tests produced a consensus that the model is a good description of expected returns.

## Recent Tests – Anomalies of the CAPM

Starting in the late 1970s, empirical work appears that challenges even the Black version of the CAPM. Specifically, evidence mounts that much of the variation in expected return is unrelated to market beta.

Researchers began to report patterns that later came to be referred to as the anomalies of the CAPM. Fama and French (1996) define anomalies as below:

*"Previous research shows that average returns on common stocks are related to firm characteristics like size, earnings/price, cash flow/price, book-to-market equity, past sales growth, long-term past return, and short-term past return. Because these patterns in average returns apparently are not explained by the CAPM, they are called anomalies."*

One of the first anomalies was reported by Basu (1977) when he presented evidence for the E/P effect. Using a sample period that stretched from April 1957 to March 1971, Basu showed that stocks with high earnings/price ratios (or low P/E ratios) earned significantly higher returns than stocks with low earnings/price ratios. His results indicated that differences in beta could not explain these return differences.

Banz (1981) and Reinganum (1981 a) describe the size effect, that is, the inverse relation between size (measured by market capitalization) and average stock returns. They discovered that small-capitalization firms earned higher average returns than is predicted by the Sharpe-Lintner capital asset-pricing model (CAPM) and therefore concluded that this was an anomaly. Banz analyses monthly returns over the period 1931-75 on shares listed on the New York Stock Exchange. Over this interval, the fifty smallest stocks outperformed the fifty largest by an average of one percentage point per month, on a risk adjusted basis.

Bhandari (1988) finds that firms with high leverage (high debt/equity ratios) have higher average returns than firms with low leverage for the 1948-1979 period. Although it sounds normal that leverage is associated with risk, in the Sharpe-Lintner model the leverage risk should be fully captured by beta. Bhandari, however, demonstrates that leverage has extra explanatory value for the cross section of average stock returns when size (market equity) and the beta were already included in the model.

Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) find that average returns on U.S. stocks are positively related to the ratio of a firm's book equity, BE, to its market equity, ME. This results in two subdivisions of stocks - value stocks and growth stocks. 'Value' stocks have market values that are small relative to their book value; they have high book value-to-market value ratios and have given high returns. 'Growth' stocks are the opposite of value stocks, thus have low book-to-market values, and have had low average returns. Chan, Hamao, and Lakonishok (1991) find a strong relation between book-to-market equity (B/M) and average return for Japanese stocks. Capaul, Rowley, and Sharpe (1993) observe a similar B/M effect in four European stock markets and in Japan.

DeBondt and Thaler (1985) find a reversal in long term returns; stocks with low long term past returns tend to have higher future returns. They find that when stocks are ranked on three to five-year past returns, past winners tend to be future losers, and vice versa. They attribute these long-term return reversals to investor overreaction. In forming expectations, investors give too much weight to the past performance of firms and too little to the fact that performance tends to mean-revert.

Jegadeesh (1990) found that stock returns tend to exhibit short-term momentum, that is, stocks that have done well over the previous few months continue to have high returns over the next month. In contrast, stocks that have had low returns in recent months tend to continue the poor performance for another month. A study by Jegadeesh and Titman (1993) later confirms these results, showing that the momentum lasts for more than just one month. They found that stocks that do well relative to the market over the last three to twelve months tend to continue to do well for the next few months, and stocks that do poorly continue to do poorly. Chan, et al. (1991) show that high ratio of cash flow to price predicts higher returns.

# The Studies of Fama and French (1992 and 1993)

## Fama and French (1992)

In their 1992 paper, Fama and French challenge the Sharpe-Lintner CAPM. They sum up most of the weaknesses of the CAPM and state the goal of the paper as follows:

"Our goal is to evaluate the joint roles of beta, size, E/P, leverage, and book-to-market equity in the cross-section of average returns on NYSE, AMEX, and NASDAQ stocks."

Fama and French (1992) use ten size portfolios, because of abundant evidence that this produces a wide spread of average returns and betas.

In the below table extracted from Fama and French (1992) the portfolios are only formed on size. With these portfolios both the Sharpe-Lintner model and the size effect are confirmed - portfolios with low betas have low average returns whereas portfolios with high betas have high average returns. Moreover, portfolios with small market equity have high average returns whereas large market equity portfolios have low average returns.

**Table 2.1 : Portfolios uniquely formed on size (source: Fama-French, 1992, table II).**

| Size | Small | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Big |
|---|---|---|---|---|---|---|---|---|---|---|
| Return | 1.64 | 1.29 | 1.24 | 1.25 | 1.29 | 1.17 | 1.07 | 1.10 | 0.95 | 0.90 |
| Beta | 1.44 | 1.39 | 1.34 | 1.33 | 1.24 | 1.22 | 1.16 | 1.08 | 1.02 | 0.90 |

Since size and the betas of size portfolios are highly correlated, Fama and French subdivide each size portfolio into 10 portfolios based on betas for individual stocks to allow for variation in beta that is unrelated to size.

The below table, again extracted from Fama and French (1992), contains data for the subdivided portfolios, that separate the effects of size and market beta.

**Table 2.2: Size and Market Beta for the Subdivided Portfolios**

| | All | Low - β | β - 2 | β - 3 | β - 4 | β - 5 | β - 6 | β - 7 | β - 8 | β - 9 | High - β |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Average Monthly Returns (in Percent) | | | | | | | | | | | |
| All | 1.25 | 1.34 | 1.29 | 1.36 | 1.31 | 1.33 | 1.28 | 1.24 | 1.21 | 1.25 | 1.14 |
| | | | | | | | | | | | |
| Small - ME | 1.52 | 1.71 | 1.57 | 1.79 | 1.61 | 1.5 | 1.5 | 1.37 | 1.63 | 1.50 | 1.42 |
| ME - 2 | 1.29 | 1.25 | 1.42 | 1.36 | 1.39 | 1.65 | 1.61 | 1.37 | 1.31 | 1.34 | 1.11 |
| ME - 3 | 1.24 | 1.12 | 1.31 | 1.17 | 1.70 | 1.29 | 1.10 | 1.31 | 1.36 | 1.26 | 0.76 |
| ME - 4 | 1.25 | 1.27 | 1.13 | 1.54 | 1.06 | 1.34 | 1.06 | 1.41 | 1.17 | 1.35 | 0.98 |
| ME - 5 | 1.29 | 1.34 | 1.42 | 1.39 | 1.48 | 1.42 | 1.18 | 1.13 | 1.27 | 1.18 | 1.08 |
| ME - 6 | 1.17 | 1.08 | 1.53 | 1.27 | 1.15 | 1.20 | 1.21 | 1.18 | 1.04 | 1.07 | 1.02 |
| ME - 7 | 1.07 | 0.95 | 1.21 | 1.26 | 1.09 | 1.18 | 1.11 | 1.24 | 0.62 | 1.32 | 0.76 |
| ME - 8 | 1.10 | 1.09 | 1.05 | 1.37 | 1.20 | 1.27 | 0.98 | 1.18 | 1.02 | 1.01 | 0.94 |
| ME - 9 | 0.95 | 0.98 | 0.88 | 1.02 | 1.14 | 1.07 | 1.23 | 0.94 | 0.82 | 0.88 | 0.59 |
| Large - ME | 0.89 | 1.01 | 0.93 | 1.10 | 0.94 | 0.93 | 0.89 | 1.03 | 0.71 | 0.74 | 0.56 |

Notes on the table:

*The 'All' column shows statistics for equal weighted size-decile (ME) portfolios. The 'All' row shows statistics for equal weighted portfolios of the stocks in each beta group.*

It is observed that the size effect is still valid with an average return of 1.52% and 0.89% for the small and big market portfolio, respectively. However, the beta effect has disappeared. Within a size category a direct relationship between betas and returns is not observed (that is, low betas having low returns and high betas having high returns). On the contrary, there is little variation in returns across different betas and in some cases even a negative relationship between beta and return is seen. For example for the small market equity portfolio, the low beta stocks have a return of 1.71 % whereas the high beta stocks have a return of only 1.42%. This casts serious doubts on the validity of the Sharpe-Lintner CAPM.

Apart from the above Fama and French (1992) study the abilities of the variables size, book to market equity (BE/ME), leverage and earnings to price ratio (E/P) in explaining stock returns. They also study the interaction effects of these variables in explaining stock returns. The main results of Fama and French (1992) are given below:

1. Beta does not seem to help explain the cross-section of average stock returns.

2. The combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns.

3. Size (ME) and book-to-market equity (BE/ME) provide a simple and powerful characterization of the cross-section of average stock returns for the 1963-1990 period.

## Fama and French (1993)

Fama and French (1993) try to build a new model based on the ruins of the CAPM and the conclusions of their 1992 paper. They propose a factor model that explains the expected return on a portfolio in excess of the risk-free rate $R_i - R_f$ by the sensitivity of its returns to the following three-factors:

(i) The excess return on a broad market portfolio, this is the traditional CAPM factor $R_m - R_f$.

(ii) The difference between the return on a portfolio of low market equity stocks and the return on a portfolio of high market equity stocks (SMB, small minus big); and

(iii) The difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low-book-to-market stocks (HML, high minus low).

Thus the model is:

$$\mathbf{R_i - R_f = \beta_i (R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML)}$$

Where $\beta_i$, $s_i$ and $h_i$ are the regression coefficients corresponding to market, SMB and HML respectively.

Fama and French (1993) first test the traditional CAPM, using a time series regression on 25 portfolios, formed as the intersections of five size and five BE/ME portfolios. In their paper Fama-French report the coefficient, the t-statistic, the R-squared and the residual standard error. The $R^2$ values are given in the following table extracted from Fama and French (1993).

**Table 2.3: Time series regression of excess stock returns on the market factor (Source: Fama-French, 1993, table 4).**

| $R_i - R_f = b_i (R_m - R_f) + e_i$ | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| $R^2$ | Low | 2 | 3 | 4 | High |
| | BE/ME | | | | BE/ME |
| Small ME | 0.67 | 0.70 | 0.68 | 0.65 | 0.61 |
| 2.00 | 0.79 | 0.79 | 0.76 | 0.76 | 0.71 |
| 3.00 | 0.84 | 0.84 | 0.80 | 0.79 | 0.74 |
| 4.00 | 0.89 | 0.90 | 0.87 | 0.80 | 0.76 |
| Big ME | 0.89 | 0.92 | 0.84 | 0.79 | 0.69 |

If the $R^2$ values are compared across portfolios in Fama-French table 4 it is seen that they are around 90% for the big, low book-to-market equity portfolios. However, for small, high book-to-market equity portfolios the $R^2$ values are in the neighborhood of 70% or lower. This considerable unexplained variation in stock returns might be accounted for other factors.

**Another table from Fama and French (1993) gives the $R^2$ values of the time series regression of excess stock returns on SMB and HML.**

**Table 2.4: Time series regression of excess stock returns on SMB and HML (Source Fama-French 1993 table 5).**

| **Ri – Rf = a + (si*SMB) + (hi*HML) + $e_i$** | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| $R^2$ | Low | 2 | 3 | 4 | High |
| | BE/ME | | | | BE/ME |
| Small ME | 0.65 | 0.60 | 0.60 | 0.60 | 0.59 |
| 2.00 | 0.59 | 0.53 | 0.49 | 0.42 | 0.44 |
| 3.00 | 0.51 | 0.43 | 0.37 | 0.31 | 0.35 |
| 4.00 | 0.43 | 0.30 | 0.24 | 0.18 | 0.23 |
| Big ME | 0.34 | 0.18 | 0.08 | 0.04 | 0.06 |

**In light of the considerable unexplained variation uncovered in Fama-French (1993) table 4, the results in Fama-French table 5 above are considered. The above table considers a two-factor model with SMB and HML as the explanatory variables for stock returns. Twenty of the 25 $R^2$ values are above 20% and eight are above 50%. The variation of portfolios with a small market equity is captured the best. But the variation of portfolios with big market equity remains largely unexplained by the two-factor model.**

When the Fama-French (1993) tables 4 and 5 are compared, it emerges that while the market factor does a good job of explaining large market capitalization stocks with **low BE/ME, it leaves considerable variation in stock returns unexplained among small market capitalization stocks with high BE/ME. The two-factor model with SMB and HML does a reasonably good job of explaining small capitalization stocks but does poorly with the large capitalization stocks. So the market, SMB and HML are considered together in a three-factor model next. The** $R^2$ **values by the three-factor model for the 25 portfolios are given in the following table extracted from Fama and French (1993).**

**Table 2.5: Time series regression on the market factor, SMB and HML (Source Fama-French 1993, table 6).**

| $R_i - R_f = a + b_i (R_m - R_f) + (s_i*SMB) + (h_i*HML) + e_i$ | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| R2 | Low | 2 | 3 | 4 | High |
| | BE/ME | | | | BE/ME |
| Small ME | 0.94 | 0.96 | 0.97 | 0.97 | 0.96 |
| 2 | 0.95 | 0.96 | 0.95 | 0.95 | 0.96 |
| 3 | 0.95 | 0.94 | 0.93 | 0.93 | 0.93 |
| 4 | 0.94 | 0.93 | 0.91 | 0.89 | 0.89 |
| Big ME | 0.94 | 0.92 | 0.88 | 0.90 | 0.83 |

It can be inferred from the above table that the three-factor model does a really good job of explaining the cross-section of average stock returns. As many as 21 of the 25 portfolios have $R^2$ values greater than 90%. The lowest $R^2$ is 83%.

Thus it is seen that among the three models considered – 1) the CAPM, 2) a two factor model with SMB and HML as factors and 3) a three factor model with market, SMB and HML as factors, the three factor model performs the best in describing the cross-section of average stock returns.

## Post Fama and French 1992 and 1993 Studies

In their 1995 paper that studies the period from 1963 to 1992 Fama and French try to give logic for size and value premiums. They present evidence that size and BE/ME are related to profitability. They state that firms with high BE/ME tend to be persistently distressed. These firms have low ratios of earning to book equity for many years. Conversely low BE/ME is associated with strong profitability. And within book-to-market groups small stocks tend to be less profitable than big stocks.

Fama and French (1996) show that the three-factor model captures the return to portfolios formed on earnings to price (E/P) ratio, cash flow to price (C/P) ratio and past sales growth. Low E/P, low C/P and high sales growth are typical of strong firms that have negative slopes on HML. Conversely, like high BE/ME stocks, stocks with high E/P, C/P, or low sales growth tend to load positively on HML (they are relatively distressed), and they have higher average returns. Fama and French (1998) state that value stocks have higher returns than growth stocks in markets around the world. They find that for the period 1975 through 1995, the difference between average returns on global portfolios of high and low book to market stocks is 7.68 percent per year, and value stocks outperform growth stocks in twelve of thirteen major markets. Fama and French (1998) find that the international CAPM is a good model for the returns on market portfolios of countries (zero intercept test using the F-test of Gibbons, Ross and Shanken, 1989)[1]. However the international CAPM could not explain the high average return on country value portfolios. A two-factor model with market and value factors does a better job of describing returns on the country value portfolios (zero intercept test using GRS 1989).

In their review of the theory behind the CPM and the anomalies that were discovered Fama and French (2004) conclude that the presence of anomalies suffice to prove that the market portfolio (or the beta) is not adequate to explain the cross-section of returns. And they also state that as stated in Fama and French (1996) the Fama-French three factor model is able to account for almost all the discovered CAPM anomalies.

In a more recent paper, Fama and French (2006) provide an indirect support for the Fama-French three factor model. They, among other things, examine if the CAPM explains value premium and more generally, if the beta is adequate to explain the cross-section of returns. They conclude that the CAPM is unable to explain the portion of the variation in the cross-section of returns that is explained by size and value, implying that the CAPM does not adequately explain the cross-section of returns and that the Fama-French model corrects for this inadequacy.

However the Fama-French three-factor model has been criticized in a number of studies. Davis, Fama and French (2000) report that the three-factor model proposed by Fama and French (1993) is inadequate in explaining returns on the stock market. They test the below equation to see if the intercept '**a**' is significantly different from zero.

$$\mathbf{R_i - R_f = a + \beta_i\ (R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML)}$$

---

[1] Suppose the model to be tested is the CAPM which states that $\mathbf{R_i - R_f = \beta_i(R_m - R_f)}$ . The zero intercept test tests if the intercept a in $R_i - R_f = a + \beta_i(R_m - R_f)$ is significantly different from zero using the F-test of Gibbons, Ross and Shanken, 1989 (GRS 1989).

They state that the F-test of Gibbons, Ross and Shanken (1989) rejects the zero intercept hypothesis for the 68 year period from 1929 to 1997 as well as for the two 34 year sub-periods 1929 - 1963 and 1963 to 1997.

There has also been some criticism of the size effect noted by Fama and French (1993). Berk (1995), for example, argues that it is misleading to refer to the size effect as an anomaly. No asset-pricing model is expected to hold exactly and the market value is inversely correlated with the risk not measured by the model. The factor for which the market value acts as a proxy would depend on the asset-pricing model being tested. If two different asset-pricing models miss different factors in the risk premium, then size would proxy for different factors in the two tests.

Despite criticism of the size effect, practitioners seem to appreciate the idea of the size premium, which is one of the components of the Fama-French (1993) model. For example, Ibbotson Associates' Stocks, Bonds, Bills, and Inflation (SBBI) Yearbook lists a size premium of 3.47% for micro-capitalization stocks (small capitalization stocks). SBBI also shows that for very small companies, those falling in the tenth deciles of the New York Stock Exchange, the size premium can approach 5.78%. (Annin and Falaschetti, www.ibbotson.com).

Now let us consider another component of the Fama-French (1993) model, namely, the value premium (the positive relation between book to market equity ratio and average return). Daniel and Titman (1997) argue that the value premium can be traced to the value characteristic and not risk. The characteristics hypothesis of Daniel and Titman (1997) says that relative distress drives stock returns, and BE/ME is a proxy for relative distress. Low BE/ME (characteristic of strong firms) produces low stock returns, irrespective of risk loadings. Similarly, high BE/ME stocks (distressed firms) have high returns, regardless of risk loadings. Davis, Fama, French (2000) however argue that the three-factor risk model (the Fama-French (1993) model) explains the value premium better than the characteristics model of Daniel and Titman (1997). Daniel, Titman and Wei (2001) replicate the Daniel and Titman (1997) tests on a Japanese sample for the 1975 to 1997 period and state that they reject the Fama and French (1993) model but not the characteristic model.

It is interesting to note that in the same study by Daniel, Titman and Wei (2001) one finds some support for the Fama-French model. Daniel, Titman and Wei (2001) state that the value premium in average stock returns is substantially stronger in Japan than in the United States. The maximum observed value premium in Japan was 0.994% per month compared to 0.347% in the United States.

Also when Daniel, Titman and Wei (2001) form portfolios on the basis of intersections of five size and five book-to-market groups the Fama-French three factor model does a very good job of explaining these 25 portfolio returns. However, when they test the Fama-French three factor model for 45 test portfolios loaded on the HML factor, they reject the model.

There is support for the Fama-French three factor model across continents (Fama and French 1998, Daniel, Titman and Wei, 2001). The model factors into it two major anomalies of the CAPM, namely the size and value effect. Fama and French (1996) show that the three-factor model with size and value 'anomaly' factors is enough to capture the return to portfolios formed on other anomaly factors like earnings to price (E/P) ratio, cash flow to price (C/P) ratio and sales growth.

Gaunt (2004) studies the Australian stock market and provides evidence that the Fama-French three factor model provides significantly improved explanatory power over the CAPM and that the value factor (BE/ME factor) plays a role in asset pricing.

In Faff (2004) the Fama and French three-factor model is tested using daily data drawn from the Australian stock market. In general, evidence obtained is quite favorable to the model based on formal asset pricing tests. However, when one takes into account the estimated risk premia, support for the Fama French model is less persuasive. In particular, a negative size premium is uncovered that adds to the recent findings questioning its continued existence over recent years

However, Faff (2004) quotes Dimson and Marsh (1999) in the context of the negative size premium observed. Dimson and Marsh (1999) argue that given the wave of recent evidence, the 'size effect' is best interpreted as a tendency for small companies to perform differently to (as opposed to outperform) large companies. Thus they take the view that '. . . the size premium may have disappeared and gone in reverse, but the size effect lives on . . .'

In their review of the theory behind the CPM and the anomalies that were discovered Fama and French (2004) conclude that the presence of anomalies suffice to prove that the market portfolio (or the beta) is not adequate to explain the cross-section of returns. And they also state that as stated in Fama and French (1996) the Fama-French three factor model is able to account for almost all the discovered CAPM anomalies.

In a more recent paper, Fama and French (2006), among other things, examine if the CAPM explains value premium and more generally, if the beta is adequate to explain the cross-section of returns. They conclude that the CAPM is unable to explain the portion of the variation in the cross-section of returns that is explained by size and value, implying that the CAPM does not adequately explain the cross-section of returns.

Fama and French (2006) examine (1) how value premiums vary with firm size, (2) whether the CAPM explains value premiums, and (3) whether, in general, average returns compensate $\beta$ in the way predicted by the CAPM. They finally state that CAPM's more general problem is that variation in $\beta$ unrelated to size and the value-growth characteristic goes unrewarded throughout 1926 to 2004.

One also finds support for the Fama-French (1993) model in India in Connor and Sehgal (2001) and Mohanty (2001) and these studies are discussed next.

## Evidence from India

Barua et al., (1994) observed that studies on the Indian capital market, in general, and asset pricing theories like CAPM and APT, in particular, are either too little or non-existent. Yalawar (1988) studied a sample of 1922 stocks for the period 1963-1982 and found the CAPM to be a good descriptor of cross-sectional security returns. In addition, Varma (1988) too found results supportive of the CAPM.

On the other hand, Gupta and Sehgal (1993) tested the CAPM using monthly stock returns of 30 securities during the period 1979 to 1989 and found that the CAPM failed to establish a linear risk return relationship. Madhusoodanan (1997) tested a sample of 120 stocks traded on the Mumbai Stock Exchange (BSE) for the period January 1987 to March 1995 and did not find any positive relationship between beta and return. Sehgal (1997) found that the CAPM was not a suitable descriptor of asset pricing on the Indian capital market. The slope is negative but insignificant, implying absence of any significant relationship between beta and average return.

## Connor and Sehgal (2001)

Connor and Sehgal (2001) study the Indian stock market for the period January 1989 to March 1999 and state that the empirical results from their work are reasonably consistent with the Fama-French three factor model. They find a negative relation between size and average return. They also state that the relation between value and average return is positive for small stocks and negative for big stocks. This is different from the U.S. findings (Fama and French, 1992, 1993) of a strong positive relation between value and average returns irrespective of size.

It emerges in the Connor and Sehgal (2001) study that the market factor explains by far the largest fraction of common variation in stock returns for the six test portfolios. Used alone, the market factor produces an adjusted $R^2$ of 70-80%; the adjusted $R^2$ declined to below 25% when the other two factors are used without the market factor. However the other two factors each contribute to explaining these portfolio returns. In all the test portfolios except for one the adjusted $R^2$ in the three-factor regression is higher than in the one-factor market model regression, implying that the Fama-French three-factor model is a better description of returns than the CAPM.

To test if the three factor completely describes the returns on stocks Connor and Sehgal test for the significance of the intercept, $a_j$ in the following multiple regression model:

$$R_{jt} = a_j + b_jMKT_t+s_jSMB_t+h_jHML_t$$

where $b_j$, $s_j$, and $h_j$ are the market, size and value factor exposures of portfolio j, $a_j$ is the abnormal mean return of portfolio j, which equals zero under the hypothesized pricing model.

In the model with a market factor alone (the CAPM) the intercepts of three test portfolios are positive and significant at the 95% confidence level. Thus the CAPM is rejected. Using the Fama-French three-factor model, intercept values for all the test portfolios are indistinguishable from zero at the 95% level. The results show the ability of the three- factor model to capture the cross-section of average returns missed by the standard CAPM.

However the below observation in Connor and Sehgal (2001) is worth noting:

"Note however that evidence for a value factor premium is mixed; the two-factor model with size and market factors (excluding the value factor) does not produce significantly nonzero intercepts, although adding the value factor lowers the magnitude of the point estimates."

Connor and Sehgal (2001) suggest that a two-factor model with market and size factors might be adequate to describe the stock returns in India.

## Mohanty (2001)

In Mohanty (2001) an attempt is made to find out whether the returns generated by small stocks are higher compared to those of large stocks. Using data from the Indian stock market and applying Fama and MacBeth (1973) regression, the study finds that size is negatively related to the average stock return in the sample period. It is found that when returns are regressed on the variables size, market leverage, earnings-to-price ratio and price-to-book value ratio one at a time, all these variables are found to be related to the cross-section of stock returns.

Bi-variate regressions of returns on the following combinations of variables were run: size and market leverage, size and price-to-book value, and size and price-to-earnings ratio. It is found that once size is included in the regression, the other variables, namely price-to-book value ratio, earnings to price ratio and market leverage do not have any incremental explanatory power.

The returns of five size sorted test portfolios are regressed on size premium and market risk premium (each of the two variables taken individually and both of them taken together). The following results emerge:

1. The market risk factor does capture a large part of the variation in stock returns. But it does not explain all.

2. Though size is related to stock returns, it does not explain the variation in excess stock returns adequately.

3. If both market and size risk factors are included in the time series regression, then almost all the variation in excess returns is explained.

When the returns of the test portfolios are regressed on market risk premium, size premium and value premium, the regression results indicate that the value premium is not necessary to capture the stock returns.

### Chen and Zhang (1998), Connor and Sehgal (2001) and Mohanty (2001)

It is interesting to note that the finding of the studies of Mohanty (2001) and Connor and Sehgal (2001) that the value premium may not be necessary to describe the stock returns in India echoes some of the findings of Chen and Zhang (1998). In a study spanning six markets (USA, Japan, Hong Kong, Malaysia, Taiwan and Thailand) they report that the value stock effect is strong in the United States, somewhat less in Japan, Hong Kong and Malaysia and undetectable in Thailand and Taiwan. They justify this pattern as follows:

*"We argue that the reason behind this pattern is different market growth rates in the different countries. For a relatively stable and mature market like the United States, the value investment opportunity captured by size and B/M contains a high proportion of firms suffering from past misfortunes and facing an uncertain future. In contrast for the high growth markets of Thailand and Taiwan, the relatively marginal firms may still enjoy the benefit of a rapidly expanding economy, and the risk, though a bit higher than the prosperous firms', is not so much higher in the absolute sense. Therefore they do not enjoy noticeably higher returns."*

Thus Chen and Zhang suggest that relatively speaking, value stocks are riskier in the mature markets than they are in the growth markets. The higher returns for the value stocks in the mature markets are thus a compensation for their higher risk. Thus it is possible that in a developing (growing) economy like India value premium may not be of much significance.

## Deficiencies of the Indian Studies and Need for the Present Study

The Indian studies have some deficiencies. The last decade of the $20^{th}$ century has seen tremendous changes and reforms in the Indian market like the establishment of the National Stock Exchange, NSE (which first introduced screen based trading in the country), dematerialization of securities, etc. The Indian studies (particularly Connor and Sehgal (2001) and Mohanty (2001)) have treated the whole last decade of the $20^{th}$ century as one and tested the Fama-French three-factor model without considering the possibility that the asset pricing behavior might have undergone changes due to these reforms and changes. The present study confirms that there is a change in the asset pricing behavior in the aftermath of the establishment of the NSE and substantiates the above reported flaw in the research design of the Indian studies.

The present study divides the period from 07/07/1990 to 22/03/2003 into two taking into consideration the establishment of NSE and studies the behavior of the Fama-French model in India in these two periods. This in turn also achieves the purpose of testing for change in the asset pricing behavior in India before and after the establishment of the National Stock Exchange.

# The Arbitrage Pricing Theory (APT)

## A Brief Review of APT

In 1976 Ross introduced the Arbitrage Pricing Theory (APT) as an alternative to the CAPM. The APT begins with an assumption on the return generating factors. Assuming that asset markets are perfectly competitive and frictionless each asset return is linearly related to k factors plus its own idiosyncratic disturbance:

$$R_i = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} + \dots\dots\dots + \lambda_k b_{ik} + \varepsilon_i$$

If there exists a riskless (or a "zero beta") asset, its return will be $\lambda_0$; $\lambda_j$ can be interpreted as the risk premium corresponding to factor j, and $b_{ij}$ is the sensitivity of the return of asset i to the factor j.

The APT has the potential to overcome CAPM weaknesses: its explanatory power is potentially better since it is a multifactor model. However, the power and the generality of the APT are its main strength and weakness: the APT permits the researchers to choose whatever factors provide the best explanation for the data but it cannot explain variation in asset return in terms of a limited number of easily identifiable factors. In contrast, CAPM theory is intuitive and easy to apply.

## APT and Macroeconomic Factors

The APT itself does not provide specific guidance on the choice of macroeconomic factors, and the approach to the choice of factors has usually been to some extent arbitrary and controversial. The economic interpretation of the common factors is probably the most important direction for future research (Chen 1983).

The first real systematic approach to finding significant macroeconomic factors is due to Chen, Roll and Ross (1986). They assumed that the systematic forces that influence returns are those that change the expected cash flows and the discount factors. They identified 5 macroeconomic variables that affected share returns in the NYSE, during the period 1958-84: industrial production, change in expected inflation, unexpected inflation, risk premium and term structure of interest rates. They used, for the first time, factor analysis to analyze the major macroeconomic variables affecting the US economy.

Groenewold and Fraser (1997) chose the macroeconomic variables based on the general hypothesis that returns are influenced by three classes of factors: real domestic activity, nominal domestic influences and foreign variables. They found that securities in the Australian stock markets are affected mainly by inflation rate and by monetary variables.

## Impact of Automation on Stock Market Efficiency

Grunbichler, Longstaff and Schwartz (1994) identify four ways in which screen trading can affect price discovery. First, screen trading is more cost effective than floor trading. In a competitive market setting, these lower costs will be passed on to traders in the form of lower transaction costs. Therefore, the expected profitability from an informed trade is greater and hence there follows an expectation of increased activity and concentration of informed trading around information. Second, orders can be processed, routed and executed more rapidly in an automated trading environment, thus enhancing the ability of traders to react to information in a timely manner. Third, information capture and dissemination is more rapid under automated trading, thus keeping traders informed on a more timely basis. Fourth, the greater volume and transparency with respect to trade and quote information offered by an electronic open limit order book can also enhance a trader's ability to assimilate and react quickly to information.

Jiang, Tang and Law (2001) of the Market Research Division, Research Department, Hong Kong Monetary Authority made a study titled 'Electronic Trading in

Hong Kong and its Impact on Market Functioning.' The findings of their study can be summarized as follows:

1. Electronic trading (ET) is rapidly gaining ground in financial markets, from organized exchanges to a wide variety of instruments in foreign exchange and fixed income markets, at both the wholesale inter-dealer markets as well as the retail markets. This global trend has also been observed in Hong Kong.

2. The introduction of ET platforms has the potential to change the way the market functions. Such platforms increase the operational and informational efficiency of the market through reductions in transaction costs and improvement in market access and transparency. However, increased competition could reduce dealers' incentive to make markets and adversely affect market depth. The overall effect of ET on market liquidity is an unresolved issue.

3. This empirical study, based on intra-day transactable quote prices and trade data in the Hong Kong stock index futures market, finds evidence that ET helps to improve market liquidity by reducing bid-ask spreads, after controlling the effects of price volatility and trading volume. Furthermore, it is found that bid-ask spreads widen under ET platform relative to floor-based trading system, when trading volume increases at time of market pressure. However, ET will under perform floor-based system only under extreme market conditions.

## Shah and Thomas (1996) - Impact of Automation on the Mumbai Stock Exchange (BSE)

Pirrong (1996) has shown that automated exchanges can be deeper and more liquid than open outcry exchanges.

Automated trading on the Mumbai Stock Exchange (BSE), called the BSE Online Trading (BOLT) was launched on 14 March 1995. Shah and Thomas (1996) analyze the impact of BOLT on the performance of the BSE for a pair of six month periods, one before the NSE started trading (01/05/94 to 31/10/94 - Period 1) and the other after BOLT stabilized (01/06/95 to 30/11/95 Period 2).

They examine two measures of liquidity - aggregate trading volume and trading frequency at the security level - and show that both have improved strongly. Aggregate trading volume (the sum of BSE and NSE trading volumes) increased by Rs.1.038 billion per weekday in Period 2 over Period 1 and this increase was statistically significant. Daily trading volumes were even higher in the weeks that followed the end of Period 2.

They discover as strong improvement in the trading frequency for small stocks in Period 2, a segment which had a high degree of non-trading in Period 1. For companies in the smallest quartile by size, the average trading frequency was 48.18% in Period 1 and this had increased to 72.19% in Period 2.

When the standard deviation of daily returns is used to measure volatility Shah and Thomas find that the volatility might have increased in Period 2 when compared to Period 1. They discover that on an average the standard deviation has increased by 0.097 percentage points with a Z statistic of 1.173. In another analysis, a cross-sectional regression model explaining $\sigma$ in terms of log size, trading frequency, an interaction term, a dummy variable for BOLT and NSE (to accounting for cross-listing of BSE stocks on NSE), they find that BOLT had elevated the volatility of stocks by a factor of 0.67 percentage points, while cross-listing on the NSE had the opposite effect of reducing the volatility, by a factor of 0.55 percentage points.

Shah and Thomas report clear gains in market efficiency - the short-term correlations of returns are diminished, as is the skewness of returns. They use the Box-Pierce Q statistic to measure the autocorrelation in returns and find that the Q statistic had dropped in every size decile for both five and ten market day lags. This clearly exhibits that market efficiency has improved in Period 2 as compared to Period 1.

The coefficient of skewness showed a statistically significant decline in every size decile. Again this is clear evidence that market efficiency has improved in Period 2 as compared to Period 1.

## Naidu and Rozeff (1994) - Impact of Automation in the Singapore Stock Exchange

Naidu and Rozeff (1994) measure the impact of automation in the Singapore Stock Exchange, which took place in 1989, upon a sample on 28 securities, and note an increase of volatility and liquidity as well as an improvement in efficiency. They find that improvements in market efficiency appear in the reduced serial correlation of returns. The increased speed with which prices and trading volume are available incites investors likely to trade to exploit the published information, which is likely to improve market efficiency.

They advance that automation speeds up the dissemination of prices, making it likely that volatility will increase, especially when information is hitting the market.

Naidu and Rozeff (1994) state that when the Singapore Stock Exchange got automated the following seemed to have occurred:

1. Substantial increases in trading volume for all stocks.
2. Substantial increases in volatility for all stocks, with larger percentage-wise increases for the stocks that began with lower volatility.
3. Substantial increases in liquidity ratios, as measured by the ratio of volume to volatility, with somewhat larger increases for those stocks that began with lower liquidity.
4. Lower serial correlations of returns without substantially changing the return distributions, although there is some evidence of an increase in skewness.
5. Slight increases in bid-ask spreads and in the variability of daily bid-ask spreads.

The above studies indicate that stock market automation could have the following effects:

1. Improvement in market efficiency as indicated by the reduced serial correlation of returns
2. Improvement in liquidity across all stocks - small, mid-cap and large cap stocks
3. Increase in volatility

## Market Efficiency, Market Frictions and Asset Pricing

Fama (1991) in his review of the literature on efficient capital markets elaborates on the joint hypothesis problem. Market efficiency per se is not testable and it must be tested jointly with some model of equilibrium, an asset-pricing model. If we have to determine if information is correctly reflected in prices it can be done so only in the context of a model that defines the meaning of "correctly." If anomalies are observed in the behavior of returns one cannot tell if they are due to mis-specified asset-pricing models or due to market inefficiency.

There is the argument that the anomalies arise because estimates of market betas are noisy, and the anomaly variables are correlated with true betas. For example, Chan and Chen (1988) find that when portfolios are formed on size, the estimated betas of the portfolios are almost perfectly correlated (-0.988) with the average size of stocks in the portfolios. Thus distinguishing between the roles of size and beta in the expected returns on size portfolios is likely to be difficult.

Fama (1991), in his literature review expresses the view that it is possible that the rejections of the CAPM are due to a bad proxy for the market portfolio and thus poor estimates of market betas. He says that when the beta estimates are poor other variables that were correlated with true betas (like size) could have explanatory power relative to estimated betas when in fact asset pricing was according to the CAPM.

Market frictions could also be the causes of the observed anomalies of the CAPM. Hsia, Fuller and Chen (2000) are of the opinion that if the market is frictionless, as assumed in the derivation of the Capital Asset Pricing Model, the CAPM should hold. They feel that market frictions (e.g., transactions costs, information asymmetry and regulatory restrictions) retard the arbitrage process thus weakening the explanatory power of the betas. The beta then requires help from factors like firm size and book to market equity (BE/ME) ratio to complement it.

Infrequent trading introduces serious biases into the empirical studies of stock prices. The major source of bias is the tendency for prices recorded at the end of the time period to represent the outcome of a transaction that occurred earlier in or prior to the period in question. Fisher (1966) pointed out that this causes an index constructed from such share price data to be an average of the temporally ordered underlying values of shares. Consequently, positive serial correlation is induced into returns that are calculated from the index and the estimated variance of the returns on the index is biased downward.

Stocks, which suffer from non-trading, also have their covariance with the market substantially underestimated. The downward bias in the covariance of frequently traded shares is, however, much smaller. Thus infrequently traded securities have a beta estimate that is biased downwards, while the figure for frequently traded shares is upward biased.

A phenomenon that has been encountered in estimating the parameters of the market model is the intervaling effect. This is a tendency for the explanatory power of the regression equation and the mean value of beta, estimated from value-weighted indexes; to rise as the differencing interval is increased (Dimson 1979). As Schwartz and Whitcomb (1977a) explain, the intervaling effect is indicative of a non-trading problem, though it can be generated by any kind of error in measuring returns. Interestingly Kothari, Shanken and Sloan (1995), Kandel and Stambaugh (1995), and others show that the CAPM is supported if annual returns instead of monthly or daily returns are used as input data. Hsia, Fuller and Chen (2000) express the view that the use of annual returns has an averaging effect that implicitly smoothens some of the market frictions. Smith (1978) found that for a sample of 200 stocks, the coefficient of determination increased monotonically as the differencing interval was progressively lengthened from one to twelve months, and the mean estimated beta against a value weighted index increased in an almost equally consistent way.

Cohen, et al. (1980) argue that the fundamental cause of the intervaling effect bias is friction in the trading process that delays the adjustment of a security's price to informational change. There are studies that give us an idea of the magnitude of the price adjustment delays. In Cohen, et al. (1983), it is observed that the beta bias remains significant for differencing intervals extending up to several weeks. Furthermore the study notes that when securities are ranked according to their market value, it is observed that beta is biased upwards for a few securities with a large value of shares outstanding; that beta is biased downwards for the thinner issues; that across all issues there is a strong monotonic relationship between the bias and the security's market value; and that this cross-sectional relationship is not confined to very short differencing intervals. In Cohen et al. (1980) it is argued that long price adjustment delays might also result from: (1) specialists/dealers impeding quotation price adjustments in the act of satisfying exchange stabilization obligations or redressing inventory balances, and (2) individual traders seeking to trade (and updating limit orders) only periodically, due to information, decision and transaction costs.

The joint hypothesis problem suggests that it is possible that market inefficiency could influence asset pricing. We can also infer from the above studies that market frictions have a role to play in creating a bias in the estimated betas. It is possible that this bias might significantly account for the size and value anomalies. So when there is a improvement in market efficiency and reduction in market frictions it is quite possible that the sensitivities of asset returns to the factors in the Fama-French (1993) model, namely, market return, size and value are influenced.

## Automation and Asset Pricing

The section on the literature review of impact of automation on stock market efficiency suggests that automation could improve stock market efficiency. The previous section suggests that improvement in efficiency could impact the asset pricing behavior (and also the performance of asset pricing models). So we can therefore see that automation could affect asset-pricing behavior.

The last decade of the $20^{th}$ century has seen one of the major reforms of the Indian Stock Market, the launch of an automated stock exchange, the National Stock Exchange (NSE) and also the automation of the other major stock exchange in the country, the Mumbai Stock Exchange (BSE). Today the NSE is the largest stock exchange in the country (in terms of volumes), with BSE a distant second and the share of the rest of stock exchanges becoming negligible. The NSE is thus a major reform in itself.

The automation of Indian stock markets could have an impact on the asset pricing behavior and this is the motivation for the present study.

## Choice of the Fama-French Model

Research across the past three decades has exposed some of the major deficiencies of the Capital Asset Pricing Model (CAPM), which are now popularly referred to as anomalies. It is possible that the Arbitrage Pricing Theory (APT) might be free of these anomalies, but the model does not specify the factors to be used in it, which is a major hurdle in its implementation. The Fama-French three-factor model corrects for almost all the reported anomalies of the CAPM and has found support across the world and in India. The factors of the Fama-French three factor model can be easily estimated and so it is easy to implement. So this model was chosen to test for the change in asset pricing behavior in the present study.

# METHODOLOGY

## The Research Problem

The reforms of the Indian capital market provide a unique natural experiment to test if reforms affect asset pricing. The reform that is the focus of this study is the establishment of the National Stock Exchange (NSE) in late 1994 that introduced screen-based trading in the country. This resulted in a dramatic improvement in market efficiency and a drastic reduction in market frictions.

The model that has been employed here to test the asset pricing behavior in the two periods is the Fama-French (1993) three-factor model. We fit the Fama-French model, which is CAPM supplemented by two additional factors, namely the size and the value factor, in the pre-NSE period and the post-NSE period. We test if there is any change in the explanatory power of the Fama-French (1993) model and the sensitivities of the asset returns to the three factors, namely market return, size and value across the two periods.

## Fama-French Model and the Regression Equation for the Test

### The Fama French Three-Factor Model

The Fama-French three factor model:

$$\mathbf{R_i - R_f = \alpha_i + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML)}$$

Where $R_i$ is the rate of return expected by the equity shareholders of the firm i, $R_f$ is the risk-free rate of return, $\beta_i$, $s_i$ , $h_i$ are the regression coefficients for the firm i, $R_m$ is the rate of return on the market portfolio, SMB is the size factor risk premium (Expected return of a portfolio of small stocks minus the expected return on portfolio of large stocks), HML is the distress factor risk premium (value premium) where distress is measured by book equity divided by market equity (Expected return of a portfolio of high book-to-market stocks minus the expected return of a portfolio of low book-to-market stocks).

## Research Questions

To test for the structural breaks across the two periods the following hypotheses were tested.

Let the subscript i1 for the various items refer to the characteristics of the ith portfolio for the pre-NSE period. Let the subscript i2 for the various items refer to the characteristics of the ith portfolio for the post-NSE period.

Set 1:

Null Hypothesis: The intercept term α in both the pre-break point and post-break point periods is not significantly different from zero.

$H_0: \alpha_{i1} = \alpha_{i2} = 0$

Alternate Hypothesis: There is a difference in the intercept term α in the pre-NSE and post-NSE periods.

$H_1: \alpha_{i1} \neq \alpha_{i2}$

Set 2:

Null Hypothesis: There is no difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-NSE and post-NSE periods.

$H_0$: $\beta_{i1} = \beta_{i2}$

$H_1$: $\beta_{i1} \neq \beta_{i2}$

Here $\beta_{i1}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the pre-NSE period and $\beta_{i2}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the post-NSE period.

Set 3:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-NSE and post-NSE periods.

$H_0$: $s_{i1} = s_{i2}$

$H_1$: $s_{i1} \neq s_{i2}$

Set 4:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-NSE and post-NSE periods.

$H_0$: $h_{i1} = h_{i2}$

$H_1$: $h_{i1} \neq h_{i2}$

### The Dummy Variable Approach to Test for the Change in the Coefficients across the Two Periods

The dummy variable technique was followed to test for the changes in the intercept $\alpha_{i,}$ $\beta_I$ , $s_i$ and $h_i$ . The following equation with dummy variables was fitted for each of the test portfolios.

$$R_i - R_f = \alpha_i + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_\alpha D + d_{\beta i} D (R_m - R_f) + d_{si} D(SMB) + d_{hi} D(HML) \quad (1)$$

**D = 0 for the period before the break point.**

**D = 1 for the period after the break point.**

If the coefficients $\mathbf{d_\alpha}$, $\mathbf{d_{\beta I}}$, $\mathbf{d_{si}}$ and $\mathbf{d_{hi}}$ are significantly different from zero, it means that the intercept $\alpha_I$ and the coefficients $\beta_I$, $\mathbf{s_i}$ and $\mathbf{h_i}$ have changed significantly across the two periods.

Various considerations were made for the choice of date for the break point and finally July 01, 1999 was found to be the ideal choice for the break point. This is discussed later.

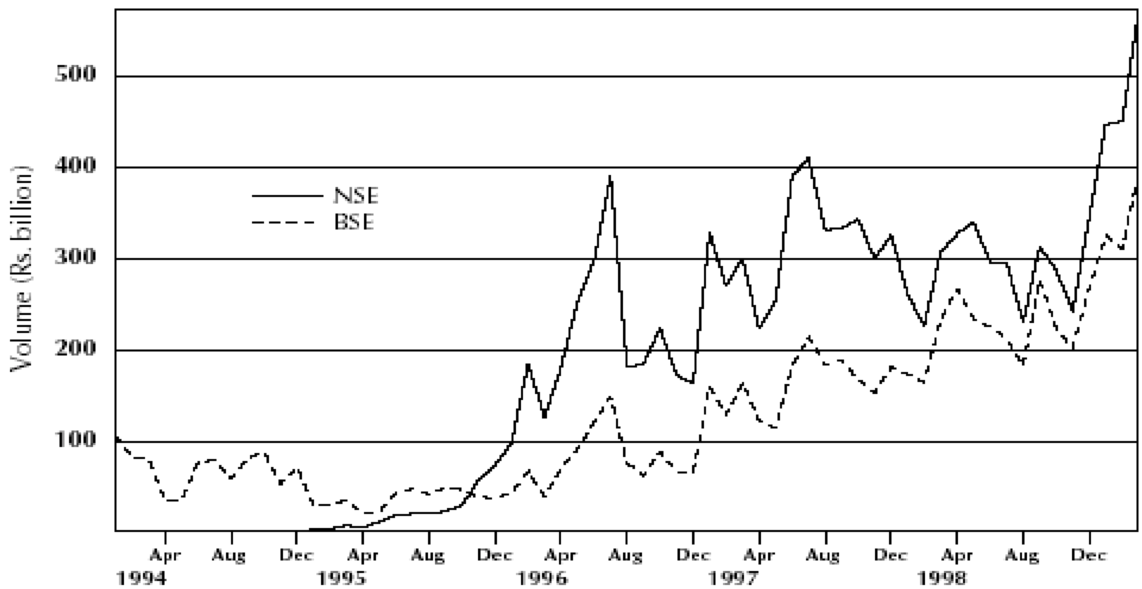
## Data

The share price data considered for the study was weekly share price data and was extracted from Prowess, the CMIE database. The data from 07/07/1990 to 30/06/1996 is from the Mumbai Stock Exchange (BSE) and the index returns for this period are the BSE Sensex returns. The entire universe of stocks has been considered but the criterion for inclusion of stocks in the study was that they have weekly returns data for all the weeks in the year.

Data from 06/07/1996 to 22/03/2003 is from the National Stock Exchange (NSE) and the index returns for this period are the S & P CNX Nifty returns. Though trading in equities started in NSE in November 1994 the data from NSE has been taken only from July 06, 1996.

It might not be appropriate for us to consider NSE data for the period 1994-96 given that trading in NSE picked up slowly in this period and for the initial months BSE was the largest stock exchange in the country and a better representative of the market. It was only in October 1995 that the NSE overtook the BSE in trading volumes to become the country's largest stock exchange (Source of Information: NSE Fact Book 2003 available on NSE's official website http://www.nseindia.com/).

The following graph from Shah and Thomas (2000) illustrates this. It can be seen that somewhere close to December 1995 the NSE volumes overtook that of the BSE and thereafter the NSE volumes far exceeded that of the BSE.




**Graph 3.1: Trading Volume on the NSE and the BSE**

It was initially felt that July 01, 1995 is the appropriate date to break the data into two periods to test for a structural change in the Fama-French three factor asset-pricing model. Screen based trading (called BSE On-Line Trading - BOLT by the BSE) was introduced in BSE on March 14, 1995 and within 50 days all the listed stocks were shifted to BOLT (Source of information: the official website of the BSE, www.bseindia.com). The introduction of BOLT by the BSE was probably in response to introduction of screen based trading by NSE in November 1994.

The analysis of the regression results later indicated that July 01, 1999 could be a better choice for the break point date. This is discussed later in the results section.

## Risk Free Rate

From January 1993 to March 2003 the yield of the 91-day Government of India T-bill was taken as the proxy for the risk free rate. The 91-day T-bill auctions are held weekly and the weekly yields were considered for the study. For the period July 7, 1990 to April 18, 1992, the yield of the 182-day Government of India T-bill was considered as the proxy of the risk free rate. The auctions of the 182-day T-bill were held on a fortnightly basis and the yield dates for these were matched with the nearest weekly dates in the stock price data. For the period April 25, 1992 to December 26, 1992 the yields of the 364-day T-bill were taken as the proxy for the risk free rate. The auctions of the 364-day T-bill too were held on a fortnightly basis and the yield dates for these were matched with the nearest weekly dates in the stock price data.

**Reasons for the choice of proxies for the risk-free rate**

Prior to January 1993, the 91-day T-bill rates were regulated to have a constant yield of 4.6 percent per annum. Effective January 8, 1993, a new auction system for 91-day T-bills was introduced. So it is felt that for the period before January 1993, the 91-day T-bill yield would serve as a poor proxy for the risk free rate. Auction was not held for 182-day T-bills from April 28, 1992 to May 25, 1999. Therefore for the period April 25, 1992 to December 26, 1992 the yields of the 364-day T-bill were taken as the proxy for the risk free rate.

# Construction of the Test Portfolios

Six test portfolios were constructed on the basis of the methodology followed in Davis, Fama and French (2000). The Fama-French model states that:

$$\mathbf{R_i - R_f = \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML)}$$

Where $R_i$ is the return on stock i, $R_f$ is the risk free interest rate, $\beta_i$ is the sensitivity of the return on the ith stock to the return on the market portfolio and $R_m$ is the return on the market portfolio. SMB is the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, constructed to be neutral with respect to BE/ME (book equity to market equity). HML is the difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks, constructed to be neutral with respect to size.

The portfolios were formed on July 1 of every year based on the market capitalization and BE/ME data as at the end of March for the year. Based on the market capitalization and BE/ME data as at the end of March for the year the stocks were allocated into two size and three BE/ME groups. Big stocks (B) are above the median market equity of BSE/NSE firms and small stocks (S) are below. Similarly, low BE/ME stocks (L) are below the 30th percentile of BE/ME for BSE/NSE firms, medium BE/ME stocks (M) are in the middle 40 percent, and high BE/ME stocks (H) are in the top 30 percent. Six portfolios, S/L, S/M, S/H, B/L, B/M, and B/H, were formed as the intersections of the size and BE/ME groups. For example, S/L refers to the portfolio of stocks that are below the BSE median in size and in the bottom 30 percent of BE/ME. The portfolios are formed both on a market capitalization (market capitalization as at the end of March of the year) and equally weighted basis.

## Estimation of the Size Premium, SMB

Davis, Fama and French (2000) define SMB as the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, constructed to be neutral to

BE/ME. In line with this definition Davis, Fama and French (2000) use the below formula to estimate SMB and the same formula has been used in the present study too.

SMB is the difference between the equal-weight averages of the returns on the three small stock portfolios and the three big stock portfolios,

SMB = (S/L + S/M + S/H)/3 - (B/L + B/M + B/H)/3

## Estimation of the Value Premium, HML

Similarly Davis, Fama and French (2000) define HML as the difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks, constructed to be neutral with respect to size. In line with this definition Davis, Fama and French (2000) use the below formula to estimate HML and the same formula has been used in the present study too.

HML = (S/H + B/H)/2 - (S/L + B/L)/2

## The Regression Equation

The following equation with dummy variables was fitted for each of the test portfolios.

$$\mathbf{R_i - R_f = \alpha + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_\alpha D + d_{\beta i}D(R_m - R_f) + d_{si}D(SMB) + d_{hi}D(HML) \quad (1)}$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

## Outline of the Procedure for Detection and Correction for Heteroscedasticity and ARCH

The White's test for heteroscedasticity by White (1980) and Engle's ARCH test by Engle (1982) detected the presence of heteroscedasticity in the model. Gujarati suggests that the remedy for ARCH is the generalized least squares (GLS) procedure. Harvey (1976) and Greene (2000) refer to the GLS procedure that is used here as the Feasible Generalized Least Squares (FGLS). Ramanathan (2002) has elaborately explained the FGLS procedure. The GLS involves multiplying the dependent variable, independent variables and the constant by appropriate weights to transform the data thereby correcting for heteroscedasticity. The weights considered here are the reciprocals of the square roots of the heteroscedastic error variances. The FGLS procedure here uses the auxiliary equation of the White's test for heteroscedasticity by White (1980) for estimating the heteroscedastic error variances. The Chow test for structural change (dummy variable version) is run on the transformed data.

Toyoda (1974) and Toyoda and Ohtani (1985) have suggested that in the presence of heteroscedasticity the data be appropriately transformed to ensure homoscedasticity before running the Chow test.

### White's Test for General Heterocedasticity

The null hypothesis of this test is that there is no heteroscedasticity, that is, variances are constant across observation. The alternative hypothesis simply denies the null, that is, under the alternative hypothesis there is heteroscedasticity of some form.

The test for the Fama-French three factor model was constructed as follows.

The Fama-French three factor model:

$$\mathbf{R_i - R_f = \beta_i (R_m - R_f) + (s_i*SMB) + (h_i*HML) + u_i}$$

The above model and the residuals $\mathbf{u_i}$ were estimated using ordinary least squares for each of the test portfolios.

Now the squares of the residuals $\mathbf{u_i^2}$ were regressed against all their variables and all possible cross products. That is the following regression was run:

$$\mathbf{u_i^2 = a_i + \delta_1(R_m - R_f) + \delta_2(SMB) + \delta_3(HML) + \delta_4(R_m - R_f)^2 + \delta_5(SMB)^2 + \delta_5(HML)^2 + \delta_6(R_m - R_f)(SMB) + \delta_7(R_m - R_f)(HML) + \delta_8(SMB)(HML)}$$

The statistic $nR^2$ is computed, where $R^2$ is the coefficient of determination of the above auxiliary regression and n (here n=9) is the number of variables on RHS of the above equation (excluding the constant). This statistic follows the chi-square distribution with n-1 degrees of freedom.

The White's test statistics for the equally weighted and market cap weighted test portfolios along with the chi square critical values are given below. The chi square critical values are at 5% level of significance and 9 degrees of freedom.

**Table 3.1: White's Test Statistics for Equally Weighted Portfolios**

| Portfolio | n | $R^2$ | Test Statistic, $nR^2$ | Chi-square |
|---|---|---|---|---|
| | | | | Critical value |
| | | | | |
| S_L | 652 | 0.524 | 341.648 | 16.919 |
| S_M | 652 | 0.442 | 288.184 | 16.919 |
| S_H | 652 | 0.552 | 359.904 | 16.919 |
| B_L | 652 | 0.543 | 354.036 | 16.919 |
| B_M | 652 | 0.455 | 296.66 | 16.919 |
| B_H | 652 | 0.518 | 337.736 | 16.919 |

**Table 3.2: White's Test Statistics for Market Capitalization Weighted Portfolios**

| Portfoli o | n | $R^2$ | Test Statistic, $nR^2$ | Chi-square |
|---|---|---|---|---|
| | | | | Critical value |
| | | | | |
| S_L | 652 | 0.161 | 104.972 | 16.919 |
| S_M | 652 | 0.191 | 124.532 | 16.919 |
| S_H | 652 | 0.176 | 114.752 | 16.919 |
| B_L | 652 | 0.224 | 146.048 | 16.919 |
| B_M | 652 | 0.081 | 52.812 | 16.919 |
| B_H | 652 | 0.223 | 145.396 | 16.919 |

We can see that at 5% level of significance the test statistic exceeds the critical value for all the equally weighted and market cap weighted test portfolios. Thus the White's test confirms the existence of heteroscedasticity.

## Engle's Arch Test (Engle (1982))

The residuals from the return series for each of the test portfolios were tested for first, second and third order auto regressive conditional heteroscedasticity (ARCH). The residuals $\mathbf{u_i}$ are obtained by subtracting the Fama-French three factor model return estimates from the actual portfolio return.

The squares of these residuals are regressed on a constant and on the q lagged values $u^2_{t-i}$ where i varies from 1 to q, that is:

$$\mathbf{u^2_t = \alpha_0 + \alpha_1 u^2_{t-1} + \alpha_2 u^2_{t-2} + \cdots + \alpha_q u^2_{t-q}}$$

The above equation is for testing for qth order ARCH.

The test statistic $(t\text{-}q)R^2$ is distributed as chi-square with q degrees of freedom (check this statement). $R^2$ is the coefficient of determination for the above regression.

The residuals for each of the portfolio returns were tested for ARCH of order 1, 2 and 3.

The results for the ARCH tests of order 1, 2 and 3 for the equally weighted and market cap weighted portfolios are given below. The tests are labeled as S_L 1, S_L 2 , S_L 3 and so on. S_L 1 means test for ARCH of order 1 for the portfolio S_L, S_L 2 means test for ARCH of order 2 for the portfolio S_L and so on.

**Table 3.3: Results of ARCH Tests for Equally Weighted Test Portfolios**

| | $R^2$ | n | $R^2$*n | Critical Value 0.05 | Degrees of freedom |
|---|---|---|---|---|---|
| S_L 1 | 0.157 | 651 | 102.207 | 3.84146 | 1 |
| S_L 2 | 0.165 | 650 | 107.25 | 5.99146 | 2 |
| S_L 3 | 0.186 | 649 | 120.714 | 7.81473 | 3 |
| S_M 1 | 0.079 | 651 | 51.429 | 3.84146 | 1 |
| S_M 2 | 0.102 | 650 | 66.3 | 5.99146 | 2 |
| S_M 3 | 0.113 | 649 | 73.337 | 7.81473 | 3 |
| S_H 1 | 0.187 | 651 | 121.737 | 3.84146 | 1 |
| S_H 2 | 0.19 | 650 | 123.5 | 5.99146 | 2 |
| S_H 3 | 0.21 | 649 | 136.29 | 7.81473 | 3 |
| B_L 1 | 0.169 | 651 | 110.019 | 3.84146 | 1 |
| B_L 2 | 0.177 | 650 | 115.05 | 5.99146 | 2 |
| B_L 3 | 0.2 | 649 | 129.8 | 7.81473 | 3 |
| B_M 1 | 0.105 | 651 | 68.355 | 3.84146 | 1 |
| B_M 2 | 0.115 | 650 | 74.75 | 5.99146 | 2 |
| B_M 3 | 0.127 | 649 | 82.423 | 7.81473 | 3 |
| B_H 1 | 0.142 | 651 | 92.442 | 3.84146 | 1 |
| B_H 2 | 0.157 | 650 | 102.05 | 5.99146 | 2 |
| B_H 3 | 0.18 | 649 | 116.82 | 7.81473 | 3 |

**Table 3.4: Results of ARCH Tests for Market Capitalization Weighted Portfolios**

| | $R^2$ | n-p | (n-p)*$R^2$ | Critical Value 0.05 | Degrees of freedom |
|---|---|---|---|---|---|
| S_L 1 | 0.013 | 651 | 8.463 | 3.84146 | 1 |
| S_L 2 | 0.024 | 650 | 15.6 | 5.99146 | 2 |
| S_L 3 | 0.025 | 649 | 16.225 | 7.81473 | 3 |
| S_M 1 | 0.016 | 651 | 10.416 | 3.84146 | 1 |
| S_M 2 | 0.029 | 650 | 18.85 | 5.99146 | 2 |
| S_M 3 | 0.03 | 649 | 19.47 | 7.81473 | 3 |
| S_H 1 | 0.048 | 651 | 31.248 | 3.84146 | 1 |
| S_H 2 | 0.064 | 650 | 41.6 | 5.99146 | 2 |
| S_H 3 | 0.064 | 649 | 41.536 | 7.81473 | 3 |
| B_L 1 | 0.066 | 651 | 42.966 | 3.84146 | 1 |
| B_L 2 | 0.083 | 650 | 53.95 | 5.99146 | 2 |
| B_L 3 | 0.083 | 649 | 53.867 | 7.81473 | 3 |
| B_M 1 | 0.021 | 651 | 13.671 | 3.84146 | 1 |
| B_M 2 | 0.023 | 650 | 14.95 | 5.99146 | 2 |
| B_M 3 | 0.024 | 649 | 15.576 | 7.81473 | 3 |
| B_H 1 | 0.034 | 651 | 22.134 | 3.84146 | 1 |
| B_H 2 | 0.053 | 650 | 34.45 | 5.99146 | 2 |
| B_H 3 | 0.055 | 649 | 35.695 | 7.81473 | 3 |

It can be seen that for all the equally weighted and market capitalization weighted test portfolios the calculated value of the test statistic far exceeds the critical value. Thus the existence of ARCH is confirmed.

## The Feasible Generalized Least Squares (FGLS) Method

Since heteroskedasticity was detected in the model the Feasible Generalized Least Squares (FGLS) method was employed to correct for it. The Fama-French three-factor model is

$$\mathbf{R_i - R_f = \beta_i (R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + u_i}$$

With heteroskedasticity Var ($\mathbf{u_i}$) = $\sigma^2_i$

The model corrected for heteroskedasticity is

$$\frac{\mathbf{R_i - R_f}}{\sigma_i} = \beta_i \frac{\mathbf{(R_m - R_f)}}{\sigma_i} + \mathbf{s_i} \frac{\mathbf{(SMB)}}{\sigma_i} + \mathbf{h_i} \frac{\mathbf{(HML)}}{\sigma_i} + \frac{\mathbf{u_i}}{\sigma_i}$$

Now the White test auxiliary regression is used to estimate $\sigma^2_i$.

$$\hat{}\sigma^2_i = \mathbf{a_i} + \hat{}\delta_1(\mathbf{R_m - R_f}) + \hat{}\delta_2(\mathbf{SMB}) + \hat{}\delta_3(\mathbf{HML}) + \hat{}\delta_4(\mathbf{R_m - R_f})^2 + \hat{}\delta_5(\mathbf{SMB})^2 + \hat{}\delta_5(\mathbf{HML})^2 + \hat{}\delta_6(\mathbf{R_m - R_f})(\mathbf{SMB}) + \hat{}\delta_7(\mathbf{R_m - R_f})(\mathbf{HML}) + \hat{}\delta_8(\mathbf{SMB})(\mathbf{HML})$$

$\hat{}\delta_I$ were obtained from the auxiliary regression run during White's test.

$\hat{}\sigma^2_i$ were obtained for each of the equally weighted and market cap weighted test portfolios. Then the FGLS corrections for all the portfolios were done using $\hat{}\sigma^2_i$ .

## Other Studies involving Dummy Variable Technique for Structural Stability of Parameters in Asset Pricing Models

Chen (1984) used the dummy variable technique as one of the techniques to test for the change in the parameters of the market model, namely alpha and beta, before and after the Three Mile Island accident. The dummy variable technique followed in this research paper is briefly described below.

To estimate alpha and beta the market model by Sharpe (1964) can be expressed as

$$R_{jt} = x_t + \beta_{jt} r_{mt} + u_{jt}$$

Where $R_{jt}$ is the weekly return on stock j in time t, $r_{mt}$ is the market return (proxied by the Standard & Poor 500) and $u_{jt}$ is the random error associated with the model.

Since the stability of beta (alpha) over time was being tested, the entire sample was divided into two sub samples, and alpha and beta were estimated from each sub sample and compared.

Let

$$R_{j1} = x_1 + \beta_{j1} r_{m1} + u_{j1}$$

represent the market model of the first sub sample period and

$$R_{j2} = x_2 + \beta_{j2} r_{m2} + u_{j2}$$

represent the market model of the second sub sample period.

To use the dummy variable technique the two equations were combined as

$$R_j = x_1 + (x_2 - x_1) D + \beta_{j1} r_m + (\beta_{j2} - \beta_{j1}) r_m D + u_j$$

where D=0 before the accident and D= 1 afterwards. The coefficient of D measures the difference in alpha. A positive sign for the coefficient of D indicates an increase in alpha and a negative sign indicates a decrease. The coefficient of $r_m D$ measures the difference in beta, and the sign indicates the direction of changes.

Weekly data from the first quarter of 1978 to the first quarter of 1980 were used in conjunction with the dummy variable test described above; the week of the accident itself was omitted. The weekly rate of return on stocks was based upon the Friday closing price. The first sub sample period ended the Friday preceding the accident, and the second sub sample period began the Friday following the week of the accident. There were 63 observations in the first sub sample and 52 observations in the second sub sample.

# ANALYSIS OF RESULTS

As discussed in the earlier chapter, six test portfolios were formed by intersecting the two size and three value groups and these six portfolios were S_L, S_M, S_H, B_L, B_M and B_H. These portfolios were formed both on an equally weighted as well as market cap weighted basis. The excess returns (returns less risk free rate) of these portfolios are given in the following tables.

**Table 4.1: 1990-2006 Equally Weighted Portfolio Excess Returns Series: Average Weekly Returns**

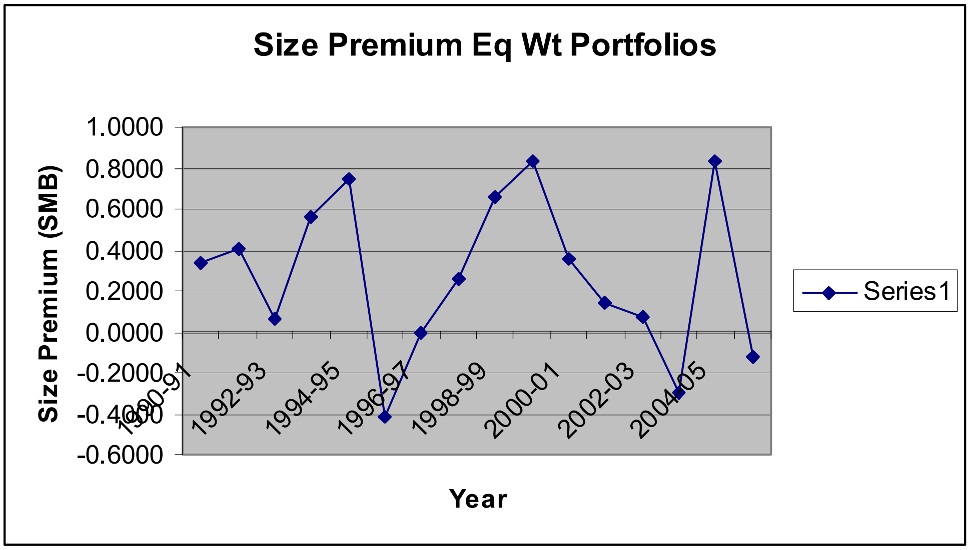
| Year | S_L -Rf | S_M -Rf | S_H -Rf | B_L -Rf | B_M-Rf | B_H -Rf |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1990-91 | 1.0368 | 1.1677 | 1.4392 | 1.0216 | 0.9232 | 0.6791 |
| 1991-92 | 2.9777 | 2.8402 | 3.1249 | 2.3112 | 2.6027 | 2.8126 |
| 1992-93 | -0.04 | -0.435 | -0.614 | -0.133 | -0.619 | -0.535 |
| 1993-94 | 3.0309 | 3.058 | 2.7009 | 2.1517 | 2.553 | 2.4163 |
| 1994-95 | -1.683 | -2.152 | -1.965 | -2.593 | -2.662 | -2.784 |
| 1995-96 | -1.631 | -2.074 | -1.959 | -1.16 | -1.624 | -1.627 |
| 1996-97 | -0.741 | -0.907 | -0.965 | -0.364 | -1.085 | -1.153 |
| 1997-98 | -0.119 | -0.258 | -0.006 | -0.572 | -0.468 | -0.124 |
| 1998-99 | 0.8147 | 1.2662 | 0.833 | 0.8147 | -0.032 | 0.1562 |
| 1999-00 | 1.1053 | 1.1802 | 1.4503 | 0.2706 | 0.2856 | 0.6806 |
| 2000-01 | -1.996 | -0.771 | -0.679 | -2.169 | -1.333 | -0.998 |
| 2001-02 | 0.83 | 1.4234 | 1.5721 | 0.3875 | 1.2549 | 1.7606 |
| 2002-03 | 0.1460 | 0.1394 | 0.3846 | 0.0775 | 0.3323 | 0.0303 |
| 2003-04 | 0.1235 | 0.3084 | 0.7594 | 0.5338 | 0.7479 | 0.8148 |
| 2004-05 | 1.8274 | 1.9209 | 2.4700 | 0.8428 | 1.3176 | 1.5626 |
| 2005-06 | 0.1406 | 0.2380 | 0.5403 | 0.4735 | 0.2677 | 0.5403 |

**Table 4.2: 1990-2003 Market Cap Weighted Portfolio Excess Returns Series: Average Weekly Returns**

| Year | S_L -Rf | S_M -Rf | S_H -Rf | B_L -Rf | B_M-Rf | B_H -Rf |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1990-91 | 0.8475 | 1.0707 | 1.7234 | 0.7572 | 1.0533 | 0.9616 |
| 1991-92 | 3.0429 | 2.7234 | 2.9242 | 2.212 | 2.1793 | 2.5568 |
| 1992-93 | 0.018 | -0.526 | -0.255 | -0.202 | -0.723 | -0.557 |
| 1993-94 | 3.0761 | 2.7292 | 2.5405 | 1.9992 | 2.5692 | 2.2825 |
| 1994-95 | -2.186 | -2.333 | -2.149 | -1.784 | -2.008 | -2.247 |
| 1995-96 | -1.843 | -2.087 | -2.089 | -0.421 | -0.516 | -1.167 |
| 1996-97 | -0.797 | -0.963 | -1.007 | 0.0006 | 0.1307 | -0.958 |
| 1997-98 | -0.086 | -0.338 | -0.084 | -0.929 | -0.781 | -0.103 |
| 1998-99 | 0.8793 | 0.9098 | 0.3646 | 0.2827 | -0.443 | 0.064 |
| 1999-00 | 0.801 | 0.9593 | 1.32 | 0.4101 | 0.3048 | 0.5024 |
| 2000-01 | -1.993 | -0.987 | -0.72 | -2.035 | -0.904 | -0.817 |
| 2001-02 | 0.8499 | 1.4359 | 1.5565 | -0.072 | 1.086 | 1.8499 |
| 2002-03 | 0.1149 | 0.1651 | 0.2966 | 0.2056 | 0.5578 | -0.064 |
| 2003-04 | -0.021 | 0.3441 | 0.8196 | 0.6054 | 0.7365 | 0.5599 |
| 2004-05 | 1.5298 | 1.7186 | 2.1155 | 0.6214 | 0.9984 | 1.0398 |
| 2005-06 | 0.2069 | 0.299 | 0.6258 | 0.517 | 0.3356 | 0.6258 |

**Table 4.3: Average Size Premium 1990-2003 Equally Weighted Portfolio Returns Series**

| Year | Average Small Stock Returns | Average Large Stock Returns | Size Premium |
|---|---|---|---|
| | | | |
| 1990-91 | 1.2146 | 0.8746 | 0.3399 |
| 1991-92 | 2.9809 | 2.5755 | 0.4054 |
| 1992-93 | -0.3632 | -0.4291 | 0.0659 |
| 1993-94 | 2.9299 | 2.3737 | 0.5563 |
| 1994-95 | -1.9331 | -2.6796 | 0.7465 |
| 1995-96 | -1.8879 | -1.4705 | -0.4173 |
| 1996-97 | -0.8710 | -0.8672 | -0.0038 |
| 1997-98 | -0.1276 | -0.3877 | 0.2602 |
| 1998-99 | 0.9713 | 0.3130 | 0.6583 |
| 1999-00 | 1.2453 | 0.4123 | 0.8330 |
| 2000-01 | -1.1485 | -1.4999 | 0.3514 |
| 2001-02 | 1.2752 | 1.1343 | 0.1408 |
| 2002-03 | 0.2233 | 0.1467 | 0.0766 |
| 2003-04 | 0.3971 | 0.6988 | -0.3017 |
| 2004-05 | 2.0728 | 1.2410 | 0.8318 |
| 2005-06 | 0.3063 | 0.4272 | -0.1209 |

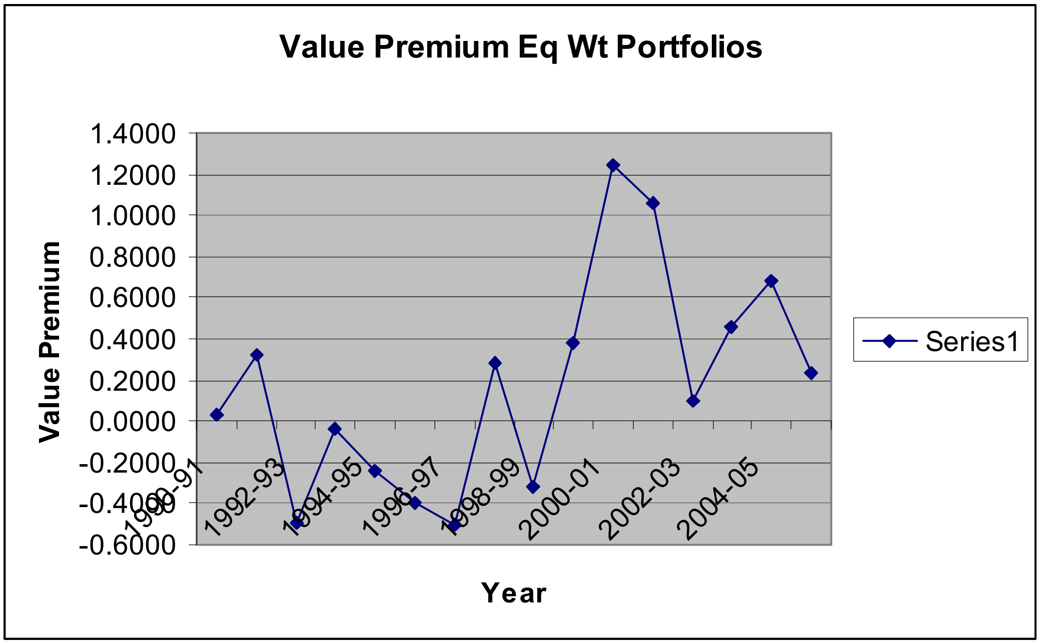



**Graph 4.1: Average Size Premium 1990-2006 Market Cap Weighted Portfolio Returns Series**

The above table and graph depict the size premium calculated on the basis of equally weighted portfolios for the period July 1990 to June 2003. The figure shown for a year is the average weekly return for the year. It can be seen that size premium shows a cyclical pattern. The time period for one half of a cycle varies from 2 to 4 years.

**Table 4.4: Average Value Premium 1990-2006 Equally Weighted Portfolio Returns Series**

| Year | Average High Value | Average Low Value | Value |
|---|---|---|---|
| | Stock Returns | Stock Returns | Premium |
| | | | |
| 1990-91 | 1.0592 | 1.0292 | 0.0300 |
| 1991-92 | 2.9688 | 2.6445 | 0.3243 |
| 1992-93 | -0.5749 | -0.0865 | -0.4884 |
| 1993-94 | 2.5586 | 2.5913 | -0.0327 |
| 1994-95 | -2.3742 | -2.1380 | -0.2362 |
| 1995-96 | -1.7929 | -1.3959 | -0.3971 |
| 1996-97 | -1.0587 | -0.5526 | -0.5061 |
| 1997-98 | -0.0648 | -0.3453 | 0.2805 |
| 1998-99 | 0.4946 | 0.8147 | -0.3201 |
| 1999-00 | 1.0655 | 0.6880 | 0.3775 |
| 2000-01 | -0.8382 | -2.0828 | 1.2447 |
| 2001-02 | 1.6664 | 0.6088 | 1.0576 |
| 2002-03 | 0.2074 | 0.1117 | 0.0957 |
| 2003-04 | 0.7871 | 0.3286 | 0.4585 |
| 2004-05 | 2.0163 | 1.3351 | 0.6812 |
| 2005-06 | 0.5403 | 0.3070 | 0.2332 |

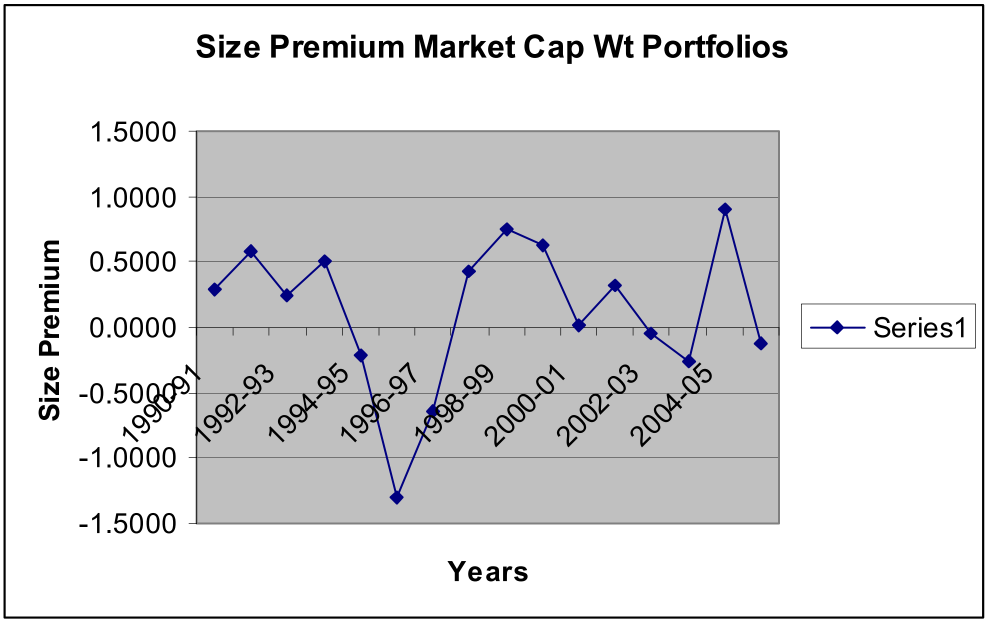



**Graph 4.2: Average Value Premium 1990-2006 Equally Weighted Portfolio Returns Series**

While the average weekly value premium (HML) has risen and fallen throughout the study period there appears to be no definite pattern in its rise and fall. The average reached an all time low in June 97 and then reached an all time high in June 2001. It then started declining and the declining pattern has continued till March 2003. It is also worth mentioning that that the peak of June 2001 was more than twice the earlier peak observed in June 1992.

**Table 4.5: Average Size Premium 1990-2003 Market Cap Weighted Portfolio Returns Series**

| Year | Average Small Stock Returns | Average Large Stock Returns | Size Premium |
|---|---|---|---|
| | | | |
| 1990-91 | 1.2139 | 0.9240 | 0.2898 |
| 1991-92 | 2.8968 | 2.3160 | 0.5808 |
| 1992-93 | -0.2542 | -0.4941 | 0.2399 |
| 1993-94 | 2.7819 | 2.2836 | 0.4983 |
| 1994-95 | -2.2228 | -2.0133 | -0.2095 |
| 1995-96 | -2.0063 | -0.7012 | -1.3051 |
| 1996-97 | -0.9224 | -0.2755 | -0.6469 |
| 1997-98 | -0.1693 | -0.6044 | 0.4351 |
| 1998-99 | 0.7179 | -0.0322 | 0.7501 |
| 1999-00 | 1.0268 | 0.4058 | 0.6210 |
| 2000-01 | -1.2334 | -1.2521 | 0.0187 |
| 2001-02 | 1.2808 | 0.9547 | 0.3260 |
| 2002-03 | 0.1922 | 0.2332 | -0.0410 |
| 2003-04 | 0.3809 | 0.6339 | -0.2530 |
| 2004-05 | 1.7880 | 0.8865 | 0.9015 |
| 2005-06 | 0.3772 | 0.4928 | -0.1155 |

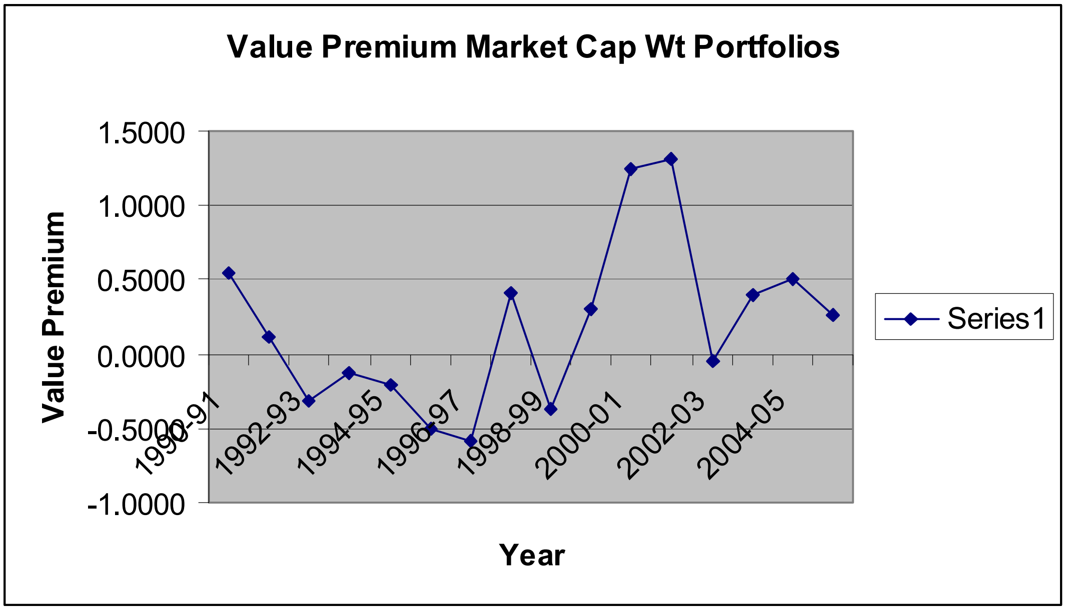



**Graph 4.3: Average Size Premium 1990-2006 Market Cap Weighted Portfolio Returns Series**

For the period of the study the average weekly size premium SMB reached an all time low for the year ending June 1996 and reached an all time high for the period for the year ending June 2005.

**Table 4.6: Average Value Premium 1990-2006 Market Cap Weighted Portfolio Returns Series**

| Year | Average High Value Stock Returns | Average Low Value Stock Returns | Value Premium |
|---|---|---|---|
| | | | |
| 1990-91 | 1.3425 | 0.8024 | 0.5402 |
| 1991-92 | 2.7405 | 2.6275 | 0.1131 |
| 1992-93 | -0.4060 | -0.0922 | -0.3139 |
| 1993-94 | 2.4115 | 2.5377 | -0.1262 |
| 1994-95 | -2.1983 | -1.9853 | -0.2130 |
| 1995-96 | -1.6280 | -1.1320 | -0.4960 |
| 1996-97 | -0.9826 | -0.3983 | -0.5843 |
| 1997-98 | -0.0932 | -0.5079 | 0.4147 |
| 1998-99 | 0.2143 | 0.5810 | -0.3667 |
| 1999-00 | 0.9112 | 0.6056 | 0.3057 |
| 2000-01 | -0.7685 | -2.0140 | 1.2455 |
| 2001-02 | 1.7032 | 0.3891 | 1.3141 |
| 2002-03 | 0.1163 | 0.1602 | -0.0440 |
| 2003-04 | 0.6898 | 0.2922 | 0.3976 |
| 2004-05 | 1.5776 | 1.0756 | 0.5020 |
| 2005-06 | 0.6258 | 0.3620 | 0.2638 |

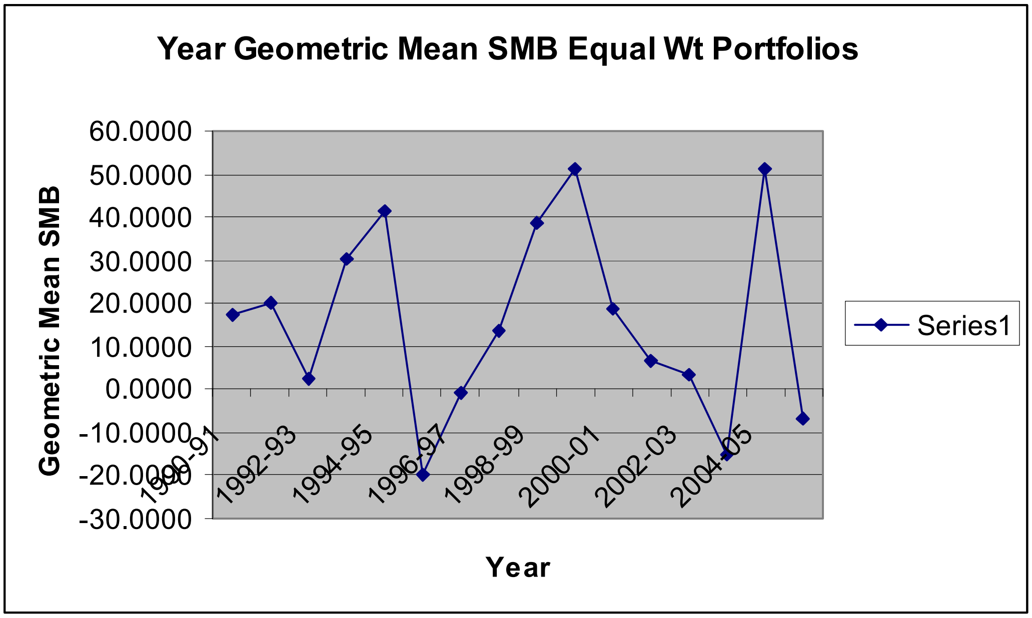



**Graph 4.4: Average Value Premium 1990-2006 Market Cap Weighted Portfolio Returns Series**

For the study period the average weekly value premium has reached an all time low for the year ending June 1997. Then it has shown an increasing trend and reached an all time high for the year ending June 2002. It has then fallen steeply for the year ending June 2003.

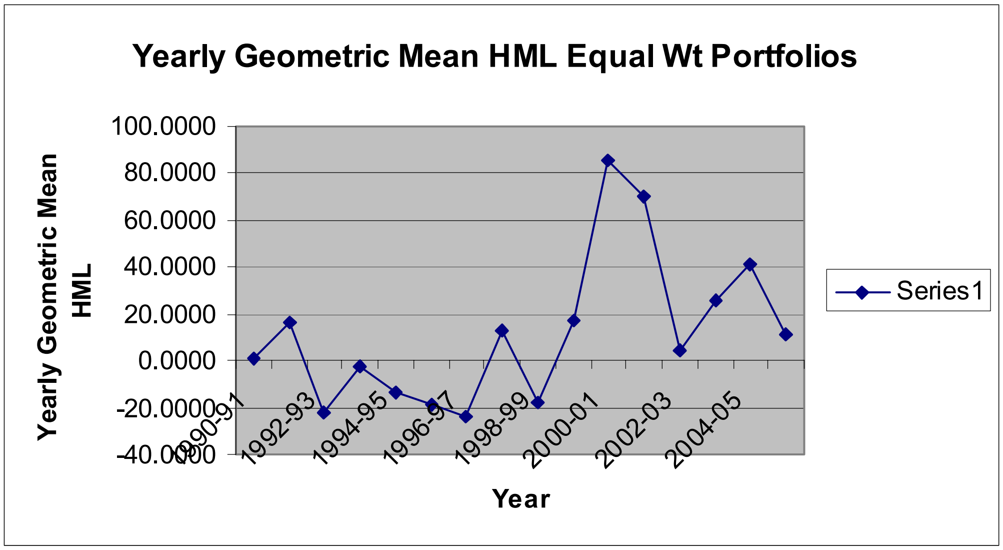
**Table 4.7: Geometric Size Premiums and Geometric Value Premiums derived on the basis of Equally Weighted Portfolios 1990-2006.**

| Year | Yearly Geometric Mean SMB | Yearly Geometric Mean HML |
|---|---|---|
| | | |
| 1990-91 | 17.2654 | 0.7960 |
| 1991-92 | 19.9614 | 16.3759 |
| 1992-93 | 2.3892 | -22.0046 |
| 1993-94 | 30.3613 | -2.2063 |
| 1994-95 | 41.5264 | -13.7588 |
| 1995-96 | -19.9006 | -18.6863 |
| 1996-97 | -0.8038 | -24.1483 |
| 1997-98 | 13.5455 | 13.2722 |
| 1998-99 | 38.7612 | -17.7891 |
| 1999-00 | 51.3508 | 17.1084 |
| 2000-01 | 18.5106 | 85.4876 |
| 2001-02 | 6.4458 | 70.0765 |
| 2002-03 | 3.1706 | 4.0624 |
| 2003-04 | -15.2128 | 25.9619 |
| 2004-05 | 51.3866 | 40.9535 |
| 2005-06 | -6.6090 | 11.5082 |
| SMB/HML over | | |
| the entire period | 685.5287 | 237.3229 |
| SMB/HML per annum | 13.9637 | 8.0154 |




**Graph 4.5: Geometric Size Premiums derived on the basis of Equally Weighted Portfolios 1990-2006.**

The geometric mean SMB has fluctuated widely during the study period. It touched an all time low in June 1996 and then rose to reach a high in June 2000. Then it started to decline and the declining pattern has continued till June 2003. Then it rose to reach a high in June 2005 that was slightly higher than the high of June 2000.



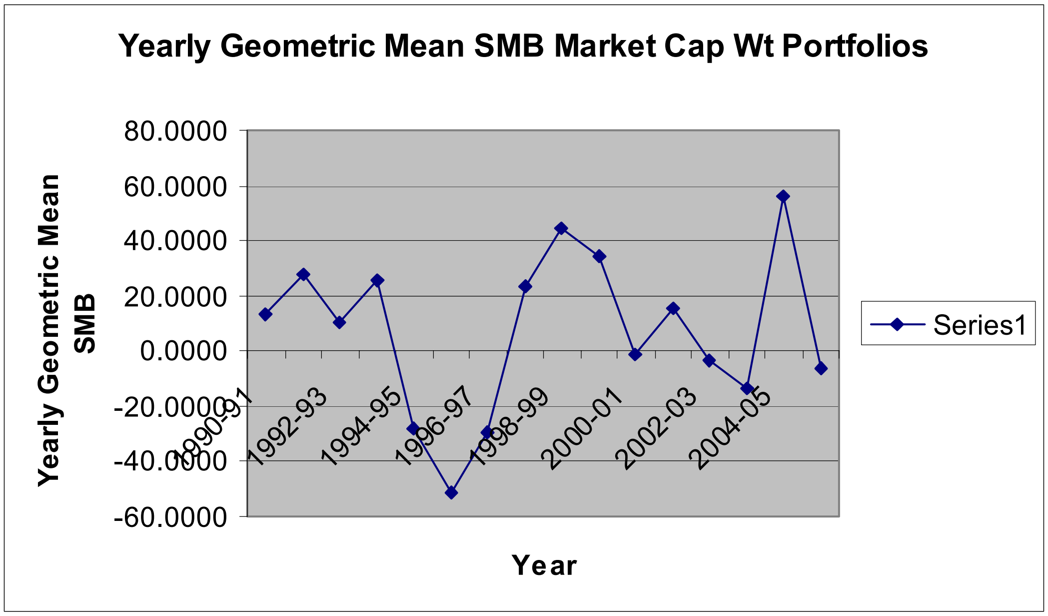

**Graph 4.6: Geometric Value Premiums derived on the basis of Equally Weighted Portfolios 1990-2006.**

The yearly geometric mean HML has fluctuated widely throughout the study period. The geometric mean HML touched an all time low in June 1997 and then later reached an all time high in June 2001. It then steeply declined to the level observed in June 2003. It can be seen that the peak of June 2001 was more than five times the earlier peak observed in June 1992.

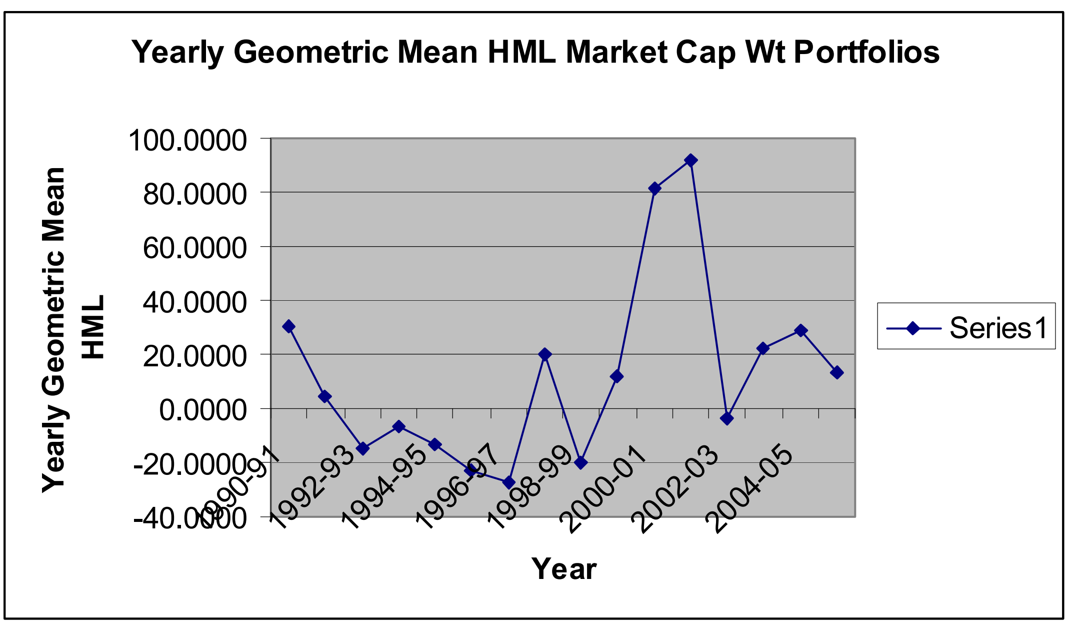
From the low of June 2003 the geometric mean HML reached a high in June 2005 before declining in June 2006.

**Table 4.8: Size Premium and Value Premium derived on the basis of Market Cap Weighted Portfolios 1990-2006.**

| | Yearly Geometric Mean SMB | Yearly Geometric Mean HML |
|---|---|---|
| | | |
| 1990-91 | 13.3585 | 30.0057 |
| 1991-92 | 27.9093 | 4.3333 |
| 1992-93 | 10.5139 | -14.8132 |
| 1993-94 | 25.2873 | -7.0057 |
| 1994-95 | -28.0148 | -13.5595 |
| 1995-96 | -51.4059 | -22.6436 |
| 1996-97 | -29.2844 | -27.3112 |
| 1997-98 | 23.6246 | 20.1030 |
| 1998-99 | 44.5247 | -20.0398 |
| 1999-00 | 34.0949 | 11.5113 |
| 2000-01 | -0.8892 | 81.7359 |
| 2001-02 | 15.6975 | 92.1669 |
| 2002-03 | -3.2238 | -3.3628 |
| 2003-04 | -13.7381 | 21.9678 |
| 2004-05 | 56.0716 | 28.6520 |
| 2005-06 | -6.6616 | 13.5361 |
| SMB/HML over | | |
| the entire period | 65.9198 | 236.2807 |
| SMB/HML per annum | 3.2630 | 7.9943 |




**Graph 4.7: Size Premium derived on the basis of Market Cap Weighted Portfolios 1990-2006.**




**Graph 4.8: Value Premium derived on the basis of Market Cap Weighted Portfolios 1990-2006.**

It can be seen that the geometric mean SMB reached an all time low in June 96 and then rose to reach a high in June 99. It started declining thereafter and the decline has continued till June 2001. It rose a bit the following year but declined steadily later till June 2004 before reaching an all time high in June 2005. It then declined the following year.

Similarly it can be seen that the geometric mean HML touched an all time low in June 1997 but later rose to reach an all time high in June 2002. Thereafter it sharply dropped the following year. It is noteworthy that the peak of June 2002 was slightly more than triple the earlier peak observed in June 1991. It declined the following year but rose a bit later.

Some general patterns in all the graphs (equally weighted as well as market cap weighted portfolios, average weekly averages as well as annual geometric means) of SMB and HML:

1) We see that the SMB has fluctuated throughout the study period but the rise and fall has been gradual throughout. The first peak was observed some time between 1990 and 1999 and the second peak was observed between 1999 and 2006.
2) The HML has fluctuated throughout the study period. The first peak was observed some time between 1990 and 1999 and the second peak was observed between 1999 and 2006.. The second peak was an all time high in all the HML graphs. For all the graphs the second peak was more than double the first peak.

Reasons for the patterns in SMB and HML:

1) One way of describing this pattern is that SMB and HML exhibit cyclical behavior. It has been observed in the US markets that SMB exhibits cyclical behavior (Annin and Falaschetti, www.ibbotson.com). They report that during the twenty-year period from 1977 to 1996, small stocks had actually under performed large stocks for ten of those twenty years.

2) It is also possible to attribute the patterns in SMB and HML to the below:

   The study period has seen many pathbreaking and significant reforms in the Indian stock market and probably the market is still in an adjustment phase. The fluctuations in SMB and HML are probably the symptoms of the adjustment phase. Many more years may have to pass before the market moves out of its adjustment phase and a definite pattern can be established.

3) Yet another reason could be that it takes a very long period to establish patterns in stock markets, particularly in asset pricing behavior. We have reliable stock market data in India for the past 15 or 16 years only and it might take a longer period to establish patterns. So many more years may have to pass before we can establish a definite pattern in SMB and HML.

## Regression Results

### Results of the Regression: Market Capitalization Weighted Test Portfolios with July 01, 1995 as the Break Point

The regression was first performed with July 01, 1995 as the break point for splitting the data into two samples. At 5% level of significance the test indicated significant change in the sensitivities to the three factors in the Fama-French three factor model for all the test portfolios except S_M and B_H. However at 1% level of significance the test indicated no significant change in the regression coefficients of the model for all the test portfolios except B_L. The following six pages give the test statistics for each of the test portfolios.

The results can be presented in greater detail as follows:

**Market Capitalization Weighted Test Portfolios with July 01, 1995 as the break point (5% level of significance)**

1. There was a change in the asset pricing behavior for all the portfolios except S_M and B_H. As regards the changes in sensitivities to factors among the portfolios for which there was a change in the asset pricing behavior, all these portfolios except S_H showed a change in the sensitivity the market factor, and this change was positive for all. For the portfolio S_H there was a positive change to the sensitivity for the size factor (SMB).

2. For the portfolios S_L and B_H there was a significant and negative change in the intercept. For the rest of the portfolios the change in the intercept was

statistically insignificant. For all the portfolios the intercept was statistically insignificant in the pre-break point period.

3. From the above observation it can be inferred that the Fama-French three-factor model provided an adequate description of returns in the pre-break point period. In the post break point period the Fama-French three-factor model provided an adequate description of returns for all the portfolios except S_L and B_H.

4. It is to be noted that at 1% level of significance there is no statistically significant change in the asset pricing behavior for all the portfolios except B_L.

   The following pages give the test statistics for each of the test portfolios.

**Portfolio: S_L          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .843 | .710 | .707 | .9942 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| | Regression | 1966.818 | 8 | 245.852 | 248.718 | .000 |
| | Residual | 802.643 | 812 | .988 | | |
| | Total | 2769.460 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | .224 | .189 | .043 | 1.183 | .237 |
| | RM - RF | .945 | .042 | .656 | 22.241 | .000 |
| | SMB | 1.111 | .060 | .607 | 18.537 | .000 |
| | HML | -4.206E-02 | .102 | -.017 | -.412 | .680 |
| | DX0 | -.540 | .226 | -.086 | -2.392 | .017 |
| | DRM_ RF | .115 | .057 | .058 | 2.011 | .045 |
| | DSMB | 7.657E-02 | .080 | .031 | .961 | .337 |
| | DHML | -5.320E-03 | .118 | -.002 | -.045 | .964 |

1) The adjusted $R^2$ at 0.707 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2) The variables $R_m$-$R_f$, SMB, $DX_0$, D($R_m$-$R_f$) are all significant at 5% level of significance because all their observed significance levels (P-Values) are less than 0.05.

3) The fact that the dummy variables $DX_0$ and D($R_m$-$R_f$) are significant shows that the asset pricing behavior has changed across the periods.

4) The sign of the coefficients for $DX_0$ (negative) and D($R_m$-$R_f$) (positive) shows D($R_m$-$R_f$) that for the period after July 01, 1995 the intercept has decreased and the sensitivity to the market factor has increased. There have been no changes in the sensitivities to the other factors across the periods as their dummy variables are not statistically significant.

5) From the above we can conclude that the asset pricing behavior has changed across periods.

6) The coefficients for the HML and DHML factor are statistically insignificant and this is in line with the conclusions of Connor and Sehgal (2001) and

Mohanty that the value factor may not be necessary to explain stock returns in India.

7) The final asset-pricing model that emerges for the post July 01, 1995 period is not entirely consistent with a Fama-French three-factor model as the portfolio returns have no sensitivity to the value (HML) factor.

8) To sum up the asset pricing behavior for the portfolio has changed across periods.

**Portfolio: S_M Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .861 | .742 | .739 | 1.0463 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2555.784 | 8 | 319.473 | 291.826 | .000 |
| | Residual | 888.927 | 812 | 1.095 | | |
| | Total | 3444.712 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | 4.987E-02 | .174 | .010 | .287 | .774 |
| | RM - RF | .873 | .040 | .661 | 22.083 | .000 |
| | SMB | .969 | .055 | .585 | 17.530 | .000 |
| | HML | .459 | .086 | .217 | 5.336 | .000 |
| | DX0 | -.184 | .206 | -.031 | -.895 | .371 |
| | DRM_ RF | 6.946E-02 | .052 | .039 | 1.337 | .181 |
| | DSMB | 5.055E-02 | .073 | .022 | .695 | .487 |
| | DHML | -8.708E-02 | .098 | -.036 | -.887 | .376 |

1) The adjusted $R^2$ at 0.739 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2) The coefficients of the variables $R_m$-$R_f$, SMB and HML are all significant at 5% level of significance because their observed significance levels (P-Values) are less than 0.05 (5%).

3) $DX_0$ and the coefficients of $D(R_m$-$R_f)$, DSMB and DHML are all statistically insignificant showing that the asset pricing behavior has not changed across the periods.

4) The fact that X0 and $DX_{0\ are}$ statistically insignificant with the coefficients of the variables $R_m$-$R_f$, SMB and HML all statistically significant shows that the Fama-French three factor model fits the portfolio perfectly. The coefficients of the variables $R_m$-$R_f$, SMB and HML are all positive and in line with what are expected with the Fama-French three factor model.

5) The final asset pricing model that emerges for the post July 01, 1995 period is consistent with the Fama-French three-factor model as the sensitivities to the market, size and value factors are statistically significant.

6) There is no change in the asset pricing behavior across the periods.

**Portfolio: S_H          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .964 | .929 | .929 | 1.1818 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 14939.155 | 8 | 1867.394 | 1337.042 | .000 |
| | Residual | 1134.088 | 812 | 1.397 | | |
| | Total | 16073.244 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -5.998E-02 | .183 | -.009 | -.328 | .743 |
| | RM - RF | 1.026 | .043 | .425 | 24.148 | .000 |
| | SMB | 1.105 | .030 | 1.053 | 36.532 | .000 |
| | HML | .727 | .058 | .235 | 12.552 | .000 |
| | DX0 | -7.850E-02 | .219 | -.008 | -.358 | .720 |
| | DRM_RF | 4.813E-02 | .058 | .013 | .824 | .410 |
| | DSMB | 9.835E-02 | .040 | .059 | 2.489 | .013 |
| | DHML | 4.557E-02 | .080 | .011 | .571 | .568 |

1. The adjusted $R^2$ at 0.929 is very high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The variables $R_m$-$R_f$, SMB, and HML are all significant at 5% level of significance because all their observed significance levels (P-Values) are less than 0.05. The coefficients of all the variables are positive and in line with the Fama-French three factor model.

3. The fact that the dummy variable DSMB is significant and positive shows that the asset pricing behavior has changed across the periods. For the intercept and the rest of the factors the dummy variables are significant and this implies that there is no significant change in the post break point period for the intercept and these factors.

4. The final asset-pricing model that emerges for the post July 01, 1995 period is entirely consistent with a Fama-French three factor model.

5. On the whole we can conclude that the asset pricing behavior has changed across periods.

**Portfolio: B_L          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i*SMB) + (h_i*HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .970 | .941 | .941 | 1.2463 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 20287.638 | 8 | 2535.955 | 1632.760 | .000 |
| | Residual | 1261.175 | 812 | 1.553 | | |
| | Total | 21548.813 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.163 | .121 | -.038 | -1.352 | .177 |
| | RM - RF | .802 | .030 | .944 | 27.048 | .000 |
| | SMB | 9.272E-02 | .028 | .168 | 3.347 | .001 |
| | HML | -1.267E-02 | .034 | -.010 | -.368 | .713 |
| | DX0 | -4.943E-02 | .143 | -.010 | -.346 | .730 |
| | DRM_ RF | .172 | .037 | .164 | 4.688 | .000 |
| | DSMB | 4.108E-02 | .033 | .071 | 1.245 | .213 |
| | DHML | -.165 | .060 | -.090 | -2.751 | .006 |

1. The adjusted $R^2$ at 0.941 is very high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than both 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The coefficients of the variables $R_m$-$R_f$ and SMB are all significant at 1% level of significance because all their observed significance levels (P-Values) are less than 0.05 (5%).

3. The coefficients of D($R_m$-$R_f$) and DHML are all statistically significant showing that the asset pricing behavior has changed across the periods.

4. The final asset pricing model that emerges for the post July 01, 1995 period is entirely consistent with the Fama-French three-factor model. The sensitivity of the HML factor turns out to be negative and this is expected as this low value (low B/M) portfolio

5. The asset pricing behavior has changed across the periods.

**Portfolio: B_M Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .771 | .595 | .591 | .9974 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1185.808 | 8 | 148.226 | 149.006 | .000 |
| | Residual | 807.749 | 812 | .995 | | |
| | Total | 1993.558 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | .147 | .201 | .032 | .734 | .463 |
| | RM - RF | .936 | .048 | .694 | 19.431 | .000 |
| | SMB | -1.382E-02 | .060 | -.009 | -.232 | .816 |
| | HML | .407 | .102 | .212 | 3.985 | .000 |
| | DX0 | -.262 | .237 | -.048 | -1.105 | .270 |
| | DRM_RF | .133 | .063 | .074 | 2.110 | .035 |
| | DSMB | -5.222E-03 | .077 | -.003 | -.067 | .946 |
| | DHML | -2.349E-03 | .115 | -.001 | -.020 | .984 |

1. The adjusted $R^2$ at 0.595 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The coefficients of the variables $R_m$-$R_f$ and HML are all significant at 5% level of significance because their observed significance levels (P-Values) are less than 0.05 (5%). The coefficient of the variable SMB is not statistically significant and not in line with the Fama-French three factor model.

3. DX0 and the coefficients of the DSMB and DHML are all statistically insignificant.

4. The coefficient of D ($R_m$-$R_f$) is positive and statistically significant at 5% level of significance indicating that the sensitivity to the market factor has increased across the periods.

5. The final asset pricing model that emerges for the post July 01, 1995 period is not entirely consistent with the Fama-French model since the sensitivity to the size factor is statistically insignificant.

6. The asset pricing behavior has changed across the periods.

**Portfolio: B_H          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_{\alpha i} DX_0 + d_{\beta i} D(R_m - R_f) + d_{si} D(SMB) + d_{hi} D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .860 | .740 | .737 | 1.0366 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2480.258 | 8 | 310.032 | 288.542 | .000 |
| | Residual | 872.475 | 812 | 1.074 | | |
| | Total | 3352.733 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | .137 | .184 | .026 | .746 | .456 |
| | RM - RF | .909 | .038 | .679 | 23.894 | .000 |
| | SMB | .108 | .056 | .061 | 1.925 | .055 |
| | HML | .999 | .098 | .389 | 10.160 | .000 |
| | DX0 | -.482 | .221 | -.075 | -2.185 | .029 |
| | DRM_RF | 7.699E-02 | .052 | .039 | 1.469 | .142 |
| | DSMB | .105 | .076 | .042 | 1.384 | .167 |
| | DHML | -5.984E-02 | .115 | -.019 | -.520 | .603 |

1. The adjusted $R^2$ at 0.737 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The coefficients of the variables $R_m$-$R_f$ and HML are positive and statistically significant at 5% because all their observed significance levels (P-Values) are less than 0.05 (5%).

3. The coefficients of D($R_m$-$R_f$) DSMB and DHML are all statistically insignificant.

4. The final asset pricing model that emerges for the post July 01, 1995 period is not entirely consistent with the Fama-French three-factor model as the sensitivity to the size factor is statistically insignificant.

5. The asset pricing behavior has changed across the periods as $DX_0$ is significant.

## Equally Weighted Test Portfolios: Results of the Regression with July 01, 1995 as the Break Point

The regressions were then run with equally weighted test portfolios. Both at 5% and 1% levels of significance there is no significant change in the asset pricing behavior (significant change in the coefficient/s of at least one of the three factors) for three test portfolios namely S_L, B_L and B_H.

**Equally Weighted Test Portfolios: Results of the Regression with July 01, 1995 as the break point (5% level of significance)**

1) The results indicate no significant change in the asset pricing behavior (significant change in the coefficient/s of at least one of the three factors) for three test portfolios S_L, B_L and B_H.

2) There is a significant change in the intercept only for one test portfolio, namely S_M.

3) All the portfolios except S_H and B_H have a statistically significant intercept in both the pre and post break point periods. From this we can infer that the Fama-French three-factor model cannot adequately describe the returns for these portfolios in both the pre and post break point periods.

The following pages give the test statistics for each of the test portfolios.

**Portfolio: S_L          Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .995 | .991 | .991 | 1.3640 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| | Regression | 163865.651 | 8 | 20483.206 | 11009.470 | .000 |
| | Residual | 1510.732 | 812 | 1.861 | | |
| | Total | 165376.383 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.391 | .073 | -.101 | -5.332 | .000 |
| | RM - RF | .998 | .018 | .921 | 56.263 | .000 |
| | SMB | 1.643 | .084 | .531 | 19.667 | .000 |
| | HML | 1.100E-02 | .054 | .005 | .205 | .838 |
| | DX0 | 7.705E-02 | .078 | .019 | .988 | .323 |
| | DRM_RF | -1.888E-02 | .019 | -.017 | -1.001 | .317 |
| | DSMB | 1.202E-02 | .086 | .004 | .139 | .889 |
| | DHML | 2.993E-02 | .056 | .015 | .536 | .592 |

1. The adjusted $R^2$ at 0.991 indicates that 99.1% of the variation in the dependent variable, that is, the returns is being explained by the independent variables which are the factors in the Fama-French three factor model. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$ and SMB are positive and statistically significant at 5% and 1% level of significance. The regression coefficient for HML is statistically insignificant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 and all the other independent variables are statistically insignificant at 5% level of significance.

4. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a regular Fama-French model as the sensitivity to HML factor is statistically insignificant. The final picture is consistent with the findings of Connor and Sehgal (2001) and Mohanty (2001) who suggest that the value factor might not be necessary to describe the security returns in India.

5. The asset pricing behavior for the portfolio has not changed across the periods.

**Portfolio : S_M        Weight : Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | 2.0629 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 29437395.292 | 7 | 4205342.185 | 988218.409 | .000 |
| | Residual | 3459.704 | 813 | 4.255 | | |
| | Total | 29440854.996 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.677 | .129 | -.158 | -5.238 | .000 |
| | RM - RF | .888 | .002 | .901 | 565.292 | .000 |
| | SMB | 1.727 | .097 | .200 | 17.765 | .000 |
| | HML | .575 | .053 | .029 | 10.852 | .000 |
| | DX0 | .359 | .130 | .084 | 2.771 | .006 |
| | DSMB | -.196 | .098 | -.023 | -1.996 | .046 |
| | DHML | 1.193E-02 | .054 | .001 | .222 | .824 |

**Excluded Variables**

| | | Beta In | t | Sig. | Partial Correlation | Collinearity Statistics |
|---|---|---|---|---|---|---|
| Model | | | | | | Tolerance |
| 1 | DRM_ RF | -.039 | -.885 | .376 | -.031 | 7.486E-05 |

1. The adjusted $R^2$ has attained it maximum value of 1. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ and the dummy variable corresponding to it are statistically significant at 5% level of significance. The regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The coefficient of the dummy variable corresponding to the size factor DSMB is statistically significant at 5% level of significance. The coefficient of the dummy variable corresponding to the value factor DHML is statistically insignificant at 5% level of significance.

4. The final picture that emerges for the post July 01, 1999 period is a Fama-French three factor model with all the three factors market, size and value having statistically significant sensitivities.

5. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio : S_H Weight : Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_{\alpha i} DX_0 + d_{\beta i} D(R_m - R_f) + d_{si} D\,(SMB) + d_{hi} D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .999 | .998 | .998 | 2.4647 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2620529.302 | 8 | 327566.163 | 53922.961 | .000 |
| | Residual | 4932.662 | 812 | 6.075 | | |
| | Total | 2625461.963 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.196 | .123 | -.028 | -1.590 | .112 |
| | RM - RF | .880 | .025 | .316 | 35.794 | .000 |
| | SMB | 1.500 | .065 | .406 | 23.111 | .000 |
| | HML | 1.164 | .050 | .674 | 23.275 | .000 |
| | DX0 | -.142 | .139 | -.020 | -1.019 | .309 |
| | DRM_RF | .106 | .028 | .037 | 3.766 | .000 |
| | DSMB | 8.471E-02 | .070 | .023 | 1.218 | .224 |
| | DHML | -.117 | .051 | -.067 | -2.293 | .022 |

1. The adjusted $R^2$ at 0.998 indicates that 99.8% of the variation in the dependent variable, that is, the returns is being explained by the independent variables which are the factors in the Fama-French three factor model. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% and 1% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor and the value factor are statistically significant at 5% level of significance. The coefficient of the dummy variable corresponding to the size factor is statistically insignificant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1995 period is consistent with a Fama-French three factor model.

6. From the above we can infer that the asset pricing behavior for the portfolio has changed across the periods.

**Portfolio : B_L Weight : Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | .999 | .999 | 1.2103 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2065871.254 | 8 | 258233.907 | 176276.859 | .000 |
| | Residual | 1189.526 | 812 | 1.465 | | |
| | Total | 2067060.780 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.285 | .100 | -.072 | -2.864 | .004 |
| | RM - RF | .897 | .021 | .971 | 43.526 | .000 |
| | SMB | .530 | .054 | .079 | 9.861 | .000 |
| | HML | .116 | .050 | .031 | 2.334 | .020 |
| | DX0 | 1.686E-02 | .102 | .004 | .166 | .868 |
| | DRM_RF | 2.379E-02 | .021 | .026 | 1.135 | .257 |
| | DSMB | 3.898E-02 | .055 | .006 | .708 | .479 |
| | DHML | -4.027E-02 | .050 | -.011 | -.810 | .418 |

1. The adjusted $R^2$ at 0.999 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is negative and statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$ , SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to intercept is statistically insignificant at 5% level of significance. The regression coefficients of the dummy variables corresponding to the market, size and value factor are all statistically insignificant at 5% level of significance.

4. The final picture that emerges for the post July 01, 1995 period is not entirely consistent with a Fama-French three factor model. While all the three factors market, size and value have statistically significant sensitivities for the post July 01, 1995 period, there is a statistically significant intercept which indicates that there is some amount of variation in the portfolio returns that is not explained by the Fama-French three factor model.

5. The asset pricing behavior for the portfolio has not changed across the periods.

**Portfolio : B_M        Weight : Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .999 | .998 | .998 | 1.4512 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 765077.836 | 8 | 95634.730 | 45410.689 | .000 |
| | Residual | 1710.069 | 812 | 2.106 | | |
| | Total | 766787.905 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.332 | .019 | -.117 | -17.137 | .000 |
| | RM - RF | .919 | .005 | 1.221 | 173.615 | .000 |
| | SMB | .552 | .016 | .341 | 35.023 | .000 |
| | HML | .598 | .016 | .177 | 36.518 | .000 |
| | DX0 | -3.680E-02 | .051 | -.009 | -.721 | .471 |
| | DRM_RF | 9.267E-05 | .010 | .000 | .009 | .993 |
| | DSMB | -3.157E-03 | .039 | -.001 | -.081 | .935 |
| | DHML | -.103 | .026 | -.021 | -3.933 | .000 |

1. The adjusted $R^2$ at 0.998 indicates that 99.8% of the variation in the dependent variable, that is, the returns is being explained by the independent variables which are the factors in the Fama-French three factor model. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor and size factor are statistically insignificant at 5% level of significance. The coefficient of the dummy variable corresponding to the value factor is statistically significant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1995 period is not entirely consistent with a Fama-French three factor model. While all the three factors market, size and value have statistically significant sensitivities for the post July 01, 1995 period, there is a statistically significant intercept which indicates that there is some amount of variation in the portfolio returns that is not explained by the Fama-French three factor model.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio : B_H Weight : Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1995.**

**D = 1 for the period from July 01, 1995.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .994 | .988 | .988 | 1.7093 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 189329.098 | 8 | 23666.137 | 8100.103 | .000 |
| | Residual | 2372.427 | 812 | 2.922 | | |
| | Total | 191701.525 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.232 | .166 | -.061 | -1.400 | .162 |
| | RM - RF | .965 | .035 | .724 | 27.967 | .000 |
| | SMB | .514 | .104 | .153 | 4.953 | .000 |
| | HML | .936 | .085 | .373 | 10.978 | .000 |
| | DX0 | -.115 | .169 | -.030 | -.677 | .499 |
| | DRM_RF | -2.227E-02 | .035 | -.016 | -.633 | .527 |
| | DSMB | .122 | .109 | .036 | 1.127 | .260 |
| | DHML | .149 | .086 | .059 | 1.723 | .085 |

1. The adjusted $R^2$ at 0.988 indicates that 98.8% of the variation in the dependent variable, that is, the returns is being explained by the independent variables which are the factors in the Fama-French three factor model. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically insignificant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor DRM-RF, size factor DSMB and the value factor DHML are all statistically insignificant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1995 period is consistent with a Fama-French three factor model. All the three factors market, size and value have statistically significant sensitivities for the post July 01, 1995 period and the intercept is statistically insignificant.

6. The asset pricing behavior for the portfolio has not changed across the periods.

**Comparison of the Results for Market Capitalization Weighted and Equally Weighted Test Portfolios with July 01, 1995 as the break point**

1. For the market capitalization weighted portfolios and at 1% level of significance the tests showed no significant change in asset pricing behavior for all the test portfolios except one. However, for the equally weighted portfolios and at 1% level of significance the tests showed significant change in the asset pricing behavior for three of the six test portfolios.

2. For the market capitalization weighted portfolios and at 5% level of significance the tests showed significant change in the asset pricing behavior for four of the six test portfolios. For the equally weighted portfolios and at 5% level of significance the tests showed significant change in the asset pricing behavior for three of the six test portfolios.

## Market Cap Weighted Portfolios: Results of the Regression with July 01, 1999 as the Break Point

The regression was then performed with July 01, 1999 as the break point. At 5% level of significance the test indicated a significant change in the regression coefficients in all the test portfolios. At 1% level of significance the test indicated significant change in the regression coefficients for only three portfolios, namely S_M, S_H, and B_M.

The above results can be presented in greater detail as follows (at 5% level of significance):

1. There has been a negative increment to the sensitivity to the HML factor for all the portfolios except S_H where it has remained constant.

2. The sensitivity to the SMB factor has remained constant except for the portfolio S_H where there has been a positive increment.

3. For all the test portfolios except two the final picture that emerges in the post break point period is entirely consistent with the Fama-French three factor model with statistically significant sensitivities to the market size and value factors.

The following pages give the test statistics for each of the test portfolios.

**Portfolio: S_L** **Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_{\alpha i} DX_0 + d_{\beta i} D(R_m - R_f) + d_{si} D(SMB) + d_{hi} D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .843 | .710 | .707 | .9946 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1966.205 | 8 | 245.776 | 248.451 | .000 |
| | Residual | 803.255 | 812 | .989 | | |
| | Total | 2769.460 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -1.582E-02 | .137 | -.003 | -.116 | .908 |
| | RM - RF | .989 | .034 | .687 | 28.816 | .000 |
| | SMB | 1.111 | .050 | .608 | 22.054 | .000 |
| | HML | 6.961E-02 | .069 | .028 | 1.003 | .316 |
| | DX0 | -.271 | .209 | -.035 | -1.295 | .196 |
| | DRM_ RF | 2.366E-02 | .061 | .009 | .386 | .700 |
| | DSMB | .124 | .080 | .041 | 1.546 | .122 |
| | DHML | -.256 | .102 | -.071 | -2.505 | .012 |

1. The adjusted $R^2$ at 0.7130 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The coefficients of the variables $R_m$-$R_f$ and SMB are positive and statistically significant at 5% because all their observed significance levels (P-Values) are less than 0.05 (5%). The coefficient of HML is statistically insignificant.

3. $DX_0$ and the coefficients of D ($R_m$-$R_f$) and DSMB are insignificant indicating that there has been no change in the intercept and the sensitivities to the market and size factor across the periods. The coefficient of DHML is statistically significant.

4. The final asset pricing model that emerges for this portfolio in the post July 01, 1999 period is a Fama-French model with statistically significant sensitivities to the market, size and value factors.

5. There is a change in the asset pricing behavior across the periods.

**Portfolio: S_M          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .863 | .745 | .742 | 1.0406 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2565.372 | 8 | 320.671 | 296.114 | .000 |
| | Residual | 879.340 | 812 | 1.083 | | |
| | Total | 3444.712 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.103 | .124 | -.021 | -.835 | .404 |
| | RM - RF | .865 | .031 | .655 | 27.909 | .000 |
| | SMB | .961 | .046 | .581 | 21.059 | .000 |
| | HML | .512 | .056 | .242 | 9.085 | .000 |
| | DX0 | 7.860E-02 | .190 | .010 | .415 | .678 |
| | DRM_RF | .119 | .057 | .045 | 2.099 | .036 |
| | DSMB | 8.270E-02 | .073 | .029 | 1.137 | .256 |
| | DHML | -.247 | .084 | -.077 | -2.945 | .003 |

1. The adjusted $R^2$ at 0.742 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically insignificant at 5% level of significance. The regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance. The coefficients of the dummy variable corresponding to the size factor DSMB is statistically insignificant at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor D(Rm - Rf) and the value factor DHML are statistically significant at 5% level of significance. While the sensitivity to the market factor has increased in the post July 09, 1999 period the sensitivity to the value factor has decreased for the post July, 01, 1999 period.

5. The final picture that emerges for the post July 01, 1999 period is a Fama-French three factor model with all the three factors market, size and value having statistically significant and sensitivities.

The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: S_H          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i*SMB) + (h_i*HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .964 | .930 | .929 | 1.1775 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 14947.442 | 8 | 1868.430 | 1347.631 | .000 |
| | Residual | 1125.802 | 812 | 1.386 | | |
| | Total | 16073.244 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| | X0 | -.153 | .134 | -.022 | -1.145 | .253 |
| | RM - RF | 1.032 | .035 | .428 | 29.916 | .000 |
| | SMB | 1.127 | .024 | 1.073 | 47.809 | .000 |
| | HML | .786 | .047 | .255 | 16.747 | .000 |
| | DX0 | .145 | .205 | .012 | .708 | .479 |
| | DRM_RF | 1.561E-02 | .065 | .003 | .241 | .810 |
| | DSMB | .104 | .037 | .061 | 2.781 | .006 |
| | DHML | -.156 | .084 | -.033 | -1.861 | .063 |

1. The adjusted $R^2$ at 0.929 is very high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically insignificant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance. The coefficients of the dummy variables corresponding to the market factor D(Rm - Rf) and size factor DHML are statistically insignificant at 5% level of significance.

4. The coefficient of the dummy variable corresponding to the size factor DSMB is statistically significant at 5% level of significance. The sensitivities to both the market factor and the size factor have increased in the post July 09, 1999 period.

5. The final picture that emerges for the post July 01, 1999 period is a Fama-French three factor model with all the three factors market, size and value having statistically significant sensitivities.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: B_L Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .969 | .940 | .939 | 1.2631 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 20253.287 | 8 | 2531.661 | 1586.776 | .000 |
| | Residual | 1295.526 | 812 | 1.595 | | |
| | Total | 21548.813 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| | X0 | -.160 | .072 | -.037 | -2.217 | .027 |
| | RM - RF | .924 | .016 | 1.087 | 57.552 | .000 |
| | SMB | 9.529E-02 | .021 | .173 | 4.450 | .000 |
| | HML | -.133 | .024 | -.103 | -5.464 | .000 |
| | DX0 | 5.101E-02 | .156 | .009 | .327 | .744 |
| | DRM_RF | 9.840E-02 | .053 | .036 | 1.873 | .061 |
| | DSMB | 6.474E-02 | .033 | .108 | 1.957 | .051 |
| | DHML | -.137 | .068 | -.065 | -2.000 | .046 |

1. The adjusted $R^2$ at 0.939 is very high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically significant at 5% level of significance. The regression coefficients for $R_m - R_f$, SMB and HML are statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance. The coefficients of the dummy variables corresponding to the market factor D(Rm - Rf) and the size factor DSMB is statistically insignificant at 5% level of significance.

4. The coefficient of the dummy variable corresponding to the market factor the value factor DHML is statistically significant both at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with the Fama-French three factor model even though all the three factors market, size and value have statistically significant sensitivities. This is because the intercept is statistically significant.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: B_M          Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .773 | .597 | .593 | .9944 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1190.652 | 8 | 148.831 | 150.517 | .000 |
| | Residual | 802.906 | 812 | .989 | | |
| | Total | 1993.558 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -5.824E-02 | .143 | -.013 | -.406 | .685 |
| | RM - RF | .993 | .038 | .736 | 25.938 | .000 |
| | SMB | -5.206E-02 | .050 | -.036 | -1.049 | .294 |
| | HML | .538 | .065 | .281 | 8.277 | .000 |
| | DX0 | .130 | .217 | .019 | .601 | .548 |
| | DRM_RF | 4.103E-03 | .066 | .002 | .062 | .951 |
| | DSMB | 9.735E-02 | .076 | .043 | 1.281 | .201 |
| | DHML | -.317 | .094 | -.116 | -3.364 | .001 |

1. The adjusted $R^2$ at 0.593 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically insignificant at 5% level of significance and the regression coefficients for $R_m - R_f$ and HML are positive and statistically significant at 5% level of significance. The regression coefficient SMB is statistically insignificant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at both 5% level of significance. The coefficients of the dummy variables corresponding to the market, D(Rm - Rf) and the size factor DSMB are statistically insignificant at 5% level of significance.

4. The coefficient of the dummy variable corresponding to the value factor DHML is statistically significant at 5% level of significance.

5. The final picture that emerges in the post July 01, 1999 period is not a regular Fama-French model as the sensitivity to the size factor is statistically insignificant as against a statistically significant sensitivity that is expected in a regular Fama-French model.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: B_H Weight: Market Cap Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .860 | .740 | .737 | 1.0363 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2480.715 | 8 | 310.089 | 288.747 | .000 |
| | Residual | 872.018 | 812 | 1.074 | | |
| | Total | 3352.733 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -7.056E-02 | .134 | -.014 | -.528 | .597 |
| | RM - RF | .922 | .031 | .689 | 29.966 | .000 |
| | SMB | .121 | .047 | .068 | 2.556 | .011 |
| | HML | 1.061 | .069 | .413 | 15.407 | .000 |
| | DX0 | -.266 | .207 | -.033 | -1.288 | .198 |
| | DRM_RF | 5.219E-02 | .059 | .019 | .888 | .375 |
| | DSMB | .130 | .077 | .043 | 1.687 | .092 |
| | DHML | -.228 | .104 | -.057 | -2.196 | .028 |

1. The adjusted $R^2$ at 0.737 is fairly high. The observed significance level (P-Value of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically insignificant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor DRM-Rf and the size factor DSMB are statistically insignificant at 5% level of significance. The coefficients of the dummy variable corresponding to the value factor DHML is statistically significant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is a Fama-French three factor model with all the three factors market, size and value having statistically significant sensitivities.

6. The asset pricing behavior for the portfolio has changed across the periods.

## Equally Weighted Portfolios: Results of the Regression with July 01, 1999 as the Break Point

Results of the regression with July 01, 1999 for the equally weighted test portfolios are summarized below:

1. At 5% level of significance the results indicate a significant change in the asset pricing behavior (significant change in the coefficient/s of at least one of the three factors) for three test portfolios.

2. In the final model that emerges in the post break point period all the portfolios except two have statistically significant sensitivities to the three factors, market, size and value. For these two exceptions the sensitivity to the value factor is statistically insignificant. However, for none of the portfolios the final model that emerges in the post break point period is entirely consistent with the Fama-French model as there is a statistically significant intercept in all the portfolios.

The following pages give the test statistics for each of the test portfolios.

**Portfolio: S_L          Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .995 | .991 | .991 | 1.3662 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 163860.837 | 8 | 20482.605 | 10974.180 | .000 |
| | Residual | 1515.546 | 812 | 1.866 | | |
| | Total | 165376.383 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.334 | .047 | -.086 | -7.157 | .000 |
| | RM - RF | .983 | .013 | .906 | 75.783 | .000 |
| | SMB | 1.657 | .063 | .536 | 26.094 | .000 |
| | HML | 5.524E-02 | .030 | .028 | 1.848 | .065 |
| | DX0 | 5.932E-02 | .067 | .011 | .881 | .378 |
| | DRM_RF | -6.794E-03 | .015 | -.005 | -.450 | .653 |
| | DSMB | -1.469E-03 | .068 | .000 | -.021 | .983 |
| | DHML | -2.551E-02 | .036 | -.012 | -.718 | .473 |

1. The adjusted $R^2$ at 0.991 is high. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is negative and statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$ and SMB are positive and statistically significant at 5% level of significance. The regression coefficient for HML is statistically insignificant at 5% level of significance.

3. The dummy variable corresponding to intercept $DX_0$ is statistically insignificant both at 5% and 1% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor D(Rm - Rf), the size factor DSMB and the value factor DHML are all statistically insignificant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a Fama-French three factor model. There is a statistically significant intercept and senstivity to the value factor is statistically insignificant.

6. The asset pricing behavior for the portfolio has not changed across the periods.

**Portfolio: S_M Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_{\alpha i} D X_0 + d_{\beta i} D (R_m - R_f) + d_{si} D(SMB) + d_{hi} D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | 1.000 | 1.000 | 2.0707 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 29437373.270 | 8 | 3679671.659 | 858164.541 | .000 |
| | Residual | 3481.726 | 812 | 4.288 | | |
| | Total | 29440854.996 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.428 | .071 | -.100 | -6.004 | .000 |
| | RM - RF | .898 | .013 | .911 | 67.830 | .000 |
| | SMB | 1.653 | .081 | .192 | 20.401 | .000 |
| | HML | .639 | .037 | .032 | 17.286 | .000 |
| | DX0 | .109 | .072 | .025 | 1.509 | .132 |
| | DRM_ RF | -9.973E-03 | .014 | -.010 | -.738 | .461 |
| | DSMB | -.124 | .083 | -.014 | -1.495 | .135 |
| | DHML | -5.362E-02 | .038 | -.002 | -1.407 | .160 |

1. The adjusted $R^2$ is 1.00. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is negative and statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$ , SMB and HML are all positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to intercept DX0 is statistically insignificant both at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market, size and value factors DRM-RF, DSMB and DHML are all statistically insignificant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a Fama-French three factor model. While all the three factors market, size and value have statistically significant sensitivities for the post July 01, 1999 period, there is a statistically significant intercept which indicates that there is some amount of variation in the portfolio returns that is not explained by the Fama-French three factor model.

6. The asset pricing behavior for the portfolio has not changed across the periods.

**Portfolio: S_H          Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .999 | .998 | .998 | 2.2805 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2621239.022 | 8 | 327654.878 | 63002.477 | .000 |
| | Residual | 4222.941 | 812 | 5.201 | | |
| | Total | 2625461.963 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.452 | .073 | -.064 | -6.176 | .000 |
| | RM - RF | .931 | .014 | .334 | 64.873 | .000 |
| | SMB | 1.674 | .032 | .453 | 53.002 | .000 |
| | HML | 1.112 | .025 | .644 | 44.555 | .000 |
| | DX0 | .293 | .134 | .028 | 2.176 | .030 |
| | DRM_RF | 3.784E-02 | .029 | .012 | 1.283 | .200 |
| | DSMB | -.682 | .073 | -.022 | -9.338 | .000 |
| | DHML | -7.546E-02 | .027 | -.043 | -2.828 | .005 |

1. The adjusted $R^2$ at 0.998 is very high. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is negative and statistically significant at 5% level of significance. The regression coefficients for $R_m - R_f$ , SMB and HML are all positive and statistically significant at 5% and 1% level of significance.

3. The dummy variable corresponding to intercept DX0 is statistically significant at 5% level of significance.

4. The coefficient of the dummy variable corresponding to the market factor DRM-RF is statistically insignificant at 5% level of significance. The coefficients of the dummy variables corresponding to the size and value factors, DSMB and DHML are both statistically significant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a Fama-French three factor model. While all the three factors market, size and value have statistically significant sensitivities for the post July 01, 1999 period, there is a statistically significant intercept which indicates that there is some amount of variation in the portfolio returns that is not explained by the Fama-French three factor model.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: B_L          Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 1.000 | .999 | .999 | 1.2033 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2065885.023 | 8 | 258235.628 | 178342.466 | .000 |
| | Residual | 1175.757 | 812 | 1.448 | | |
| | Total | 2067060.780 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.292 | .049 | -.074 | -5.928 | .000 |
| | RM - RF | .900 | .008 | .974 | 106.561 | .000 |
| | SMB | .521 | .038 | .078 | 13.774 | .000 |
| | HML | 4.818E-02 | .028 | .013 | 1.710 | .088 |
| | DX0 | -3.753E-02 | .059 | -.009 | -.639 | .523 |
| | DRM_ RF | 3.248E-02 | .010 | .035 | 3.106 | .002 |
| | DSMB | 6.507E-02 | .040 | .009 | 1.614 | .107 |
| | DHML | 3.457E-02 | .029 | .009 | 1.208 | .228 |

1. The adjusted $R^2$ at 0.999 is very high. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is negative and statistically significant at 5% level of significance. The regression coefficients for $R_m - R_f$ and SMB are positive and statistically significant at 5% and 1% level of significance. The regression coefficient for HML is statistically insignificant at 5% level of significance.

3. The dummy variable corresponding to intercept DX0 is statistically insignificant at 5% level of significance.

4. The coefficient of the dummy variable corresponding to the market factor DRM-RF is statistically significant at 5% level of significance while the coefficients of the dummy variables corresponding to the other two factors, DSMB and DHML are statistically insignificant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a Fama-French three factor model. There is a statistically significant intercept and the sensitivity to the value factor is statistically insignificant.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: B_M Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .999 | .998 | .998 | 1.4479 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 765085.533 | 8 | 95635.692 | 45616.463 | .000 |
| | Residual | 1702.372 | 812 | 2.097 | | |
| | Total | 766787.905 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.335 | .018 | -.118 | -18.343 | .000 |
| | RM - RF | .920 | .005 | 1.221 | 195.734 | .000 |
| | SMB | .555 | .015 | .343 | 37.963 | .000 |
| | HML | .597 | .014 | .177 | 42.444 | .000 |
| | DX0 | 3.455E-03 | .053 | .001 | .065 | .948 |
| | DRM_RF | 3.495E-03 | .011 | .002 | .320 | .749 |
| | DSMB | -3.451E-02 | .041 | -.014 | -.844 | .399 |
| | DHML | -.124 | .027 | -.024 | -4.587 | .000 |

1. The adjusted $R^2$ at 0.998 is very high. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 1% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor DRM-RF and the size factor DSMB are statistically insignificant at 5% level of significance. The coefficient of the dummy variable corresponding to the value factor DHML is negative and statistically significant at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a Fama-French three factor model. While all the three factors market, size and value have statistically significant sensitivities for the post July 01, 1999 period, there is a statistically significant intercept which indicates that there is some amount of variation in the portfolio returns that is not explained by the Fama-French three factor model.

6. The asset pricing behavior for the portfolio has changed across the periods.

**Portfolio: B_H      Weight: Equally Weighted**

**Regression Equation Fitted:**

$$R_i - R_f = \alpha_i X_0 + \beta_i(R_m - R_f) + (s_i{*}SMB) + (h_i{*}HML) + d_{\alpha i}DX_0 + d_{\beta i}D(R_m - R_f) + d_{si}D\,(SMB) + d_{hi}D(HML)$$

**D = 0 for the period before July 01, 1999.**

**D = 1 for the period from July 01, 1999.**

**FGLS Correction for heteroscedasticity done.**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .994 | .988 | .987 | 1.7106 |

**ANOVA**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 189325.435 | 8 | 23665.679 | 8087.459 | .000 |
| | Residual | 2376.090 | 812 | 2.926 | | |
| | Total | 191701.525 | 820 | | | |

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | | |
| 1 | X0 | -.322 | .074 | -.085 | -4.343 | .000 |
| | RM - RF | .968 | .017 | .726 | 58.050 | .000 |
| | SMB | .627 | .063 | .186 | 9.894 | .000 |
| | HML | 1.069 | .042 | .426 | 25.250 | .000 |
| | DX0 | -1.743E-02 | .083 | -.004 | -.209 | .834 |
| | DRM_RF | -3.009E-02 | .018 | -.021 | -1.633 | .103 |
| | DSMB | 8.480E-03 | .073 | .002 | .117 | .907 |
| | DHML | 2.058E-02 | .046 | .008 | .452 | .651 |

1. The adjusted $R^2$ at 0.987 is high. The observed significance level (P-Value) of the F-statistic is 0.00 which is less than 0.05 (5%). So the regression as a whole is significant at 5% level of significance.

2. The intercept $X_0$ is statistically significant at 5% level of significance and the regression coefficients for $R_m - R_f$, SMB and HML are positive and statistically significant at 5% and 1% level of significance.

3. The dummy variable corresponding to the intercept DX0 is statistically insignificant at 5% level of significance.

4. The coefficients of the dummy variables corresponding to the market factor DRM-RF, size factor, DSMB and the value factor DHML are all statistically insignificant both at 5% level of significance.

5. The final picture that emerges for the post July 01, 1999 period is not entirely consistent with a Fama-French three factor model. While all the three factors market, size and value have statistically significant sensitivities for the post July 01, 1999 period, there is a statistically significant intercept which indicates that there is some amount of variation in the portfolio returns that is not explained by the Fama-French three factor model.

6. The asset pricing behavior for the portfolio has not changed across the periods.

**Comparison of the Results for Market Capitalization Weighted and Equally Weighted Test Portfolios with July 01, 1999 as the break point**

1. For the market capitalization weighted test portfolios the test indicated a significant change in the asset pricing behavior at 5% level of significance for all the test portfolios. For the equally weighted test portfolios the test indicated a significant change in the asset pricing behavior at 5% level of significance for three of the six test portfolios.

2. In the case of market capitalization weighted test portfolios for all the test portfolios except two the final picture that emerges in the post break point period is entirely consistent with the Fama-French three factor model with statistically significant sensitivities to the market, size and value factors. In the case of equally weighted portfolios all the test portfolios have a statistically significant intercept and so the final model that emerges in the post break point period cannot be said to be consistent with the Fama-French three factor model.

## Equally Weighted Portfolios: Results of the Regression with July 01, 1995 as the break point with data from July 01 1990 to June 30, 1999

Both at 5% and 1% level of significance the results indicate no significant change in the asset pricing behavior (significant change in the coefficient/s of at least one of the three factors) for all the test portfolios. Both at 5% and 1% levels of significance there is a significant change in the intercept for only one test portfolio, namely B_M. This gives support to the consideration of July 01,1999 as the appropriate break point.

### Market Cap Weighted Portfolios: Results of the Regression (1) with July 01, 1995 as the break point with data from July 01 1990 to June 30, 1999

Now we consider the data from July 01 1990 to June 30, 1999 with July 01, 1995 as the break point. At 5% level of significance the Chow test detected no structural change for all the test portfolios except S_H. This gives support to the consideration of July 01, 1999 as the appropriate break point.

## Summary of the Results of all the Regressions and Consideration of July 01, 1999 as the Appropriate Choice for the Break Point

### Regressions for the whole period July 01, 1990 to June 30, 2006

1. For the market capitalization weighted portfolios with July 01, 1995 as the break point there was no significant change in the asset pricing behavior for all the test portfolios at 1% level of significance. For the equally weighted portfolios with July 01, 1995 as the break point there was a significant change in the asset pricing behavior only for three of the six portfolios at both 5% and 1% level of significance.

2. For the market capitalization weighted portfolios with July 01, 1995 as the break point there was a significant change in the asset pricing behavior for four of the six test portfolios at 5% level of significance.

3. For the market capitalization weighted portfolios with July 01, 1999 as the break point there was a significant change in the asset pricing behavior for all the test portfolios at 5% level of significance. For the equally weighted portfolios with July 01, 1999 as the break point there was a significant change in the asset pricing behavior for three of the six test portfolios at 5% level of significance.

## Regressions for the period July 01, 1990 to June 30, 1999

1. When the regression was run with July 01, 1995 as the break point for the period July 01, 1990 to June 30, 1999 there was no change in the asset price behavior for all the test portfolios in the case of equally weighted portfolios at 5% level of significance.
2. When the regression was run with July 01, 1995 as the break point for the period July 01, 1990 to June 30, 1999 for market cap weighted portfolios only one test portfolio showed a significant change in asset pricing behavior (at 5% level of significance).

## Consideration of July 01, 1999 as the appropriate choice for the break point

1. It was observed in the case of the market capitalization weighted portfolios that for the period July 01, 1990 to June 30, 1999 with July 01, 1995 as the break point only one test portfolio showed a significant change in asset pricing behavior at 5% level of significance. In the case of equally weighted portfolios for the period July 01, 1990 to June 30, 1999 with July 01, 1995 as the break

point none of the six test portfolios showed any significant change in asset pricing behavior at 5% level of significance. This suggests that the July 01, 1995 might not be an appropriate choice for the break point.

2. When the test was run for the period July 01, 1990 to June 30, 2006 with July 01, 1999 as the break point for the market capitalization weighted portfolios, all the six test portfolios showed a significant change in the asset pricing behavior at 5% level of significance.

3. So the above suggest that July 01, 1999 is an appropriate choice for the break point.

## Possible Reasons for July 01, 1999 to emerge as the better choice for the break point

The reason for this result could be that it took time for the effects of the reform that is the consideration of this study, namely the emergence of the National Stock Exchange (NSE), and also other ones, to sink in. One could consider the fact that the geographical spread of the NSE increased tremendously over the period till July 01, 1999 and beyond. The exact facts are reproduced from the NSE Fact Book on the official NSE website - The number of VSATs on the NSE increased from less than 500 in July 1995 to more than 2000 in July 1999. The number of cities having NSE terminals too increased from less than 50 to 250 or more across the same period.

Another major reform that could have contributed to this result is dematerialized trading. Compulsory dematerialized trading for individual investors commenced in January 1999. The percentage of trading volume in dematerialized form increased significantly in 1999-2000.

# INTERPRETATION OF RESULTS

## Results and their Interpretation

As discussed in the earlier chapter July 01, 1999 emerged as the better choice for the break point. It was felt that between equally weighted and market cap weighted test portfolios the choice should favor the latter as they are a better representative of the market. It is noteworthy in this context that Davis, Fama and French (2000) too used market cap weighted test portfolios in their tests. The results and interpretation for the market cap weighted test portfolios with the break point July 01, 1999 are discussed in detail below.

**Table 5.1: Coefficients of Factors and Dummy Variables for Market Cap Weighted Portfolios with July 01, 1999 as the break point**

| | X0 | RM - RF | SMB | HML | DX0 | D (RM - RF) | DSMB | DHML |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| S_L | -0.0158 | 0.9890 | 1.1110 | 0.0696 | -0.2710 | 0.0237 | 0.1240 | -0.2560 |
| Sig. | 0.9080 | 0.0000 | 0.0000 | 0.3160 | 0.1960 | 0.7000 | 0.1220 | 0.0120 |
| | | | | | | | | |
| S_M | -0.1030 | 0.8650 | 0.9610 | 0.5120 | 0.0786 | 0.1190 | 0.0827 | -0.2470 |
| Sig. | 0.4040 | 0.0000 | 0.0000 | 0.0000 | 0.6780 | 0.0360 | 0.2560 | 0.0030 |
| | | | | | | | | |
| S_H | -0.1530 | 1.0320 | 1.1270 | 0.7860 | 0.1450 | 0.0156 | 0.1040 | -0.1560 |
| Sig. | 0.2530 | 0.0000 | 0.0000 | 0.0000 | 0.4790 | 0.8100 | 0.0060 | 0.0630 |
| | | | | | | | | |
| B_L | -0.1600 | 0.9240 | 0.0953 | -0.1330 | 0.0510 | 0.0984 | 0.0647 | -0.1370 |
| Sig. | 0.0270 | 0.0000 | 0.0000 | 0.0000 | 0.7440 | 0.0610 | 0.0510 | 0.0460 |
| | | | | | | | | |
| B_M | -0.0582 | 0.9930 | -0.0521 | 0.5380 | 0.1300 | 0.0041 | 0.0974 | -0.3170 |
| Sig. | 0.6850 | 0.0000 | 0.2940 | 0.0000 | 0.5480 | 0.9510 | 0.2010 | 0.0010 |
| | | | | | | | | |
| B_H | 0.0706 | 0.9220 | 0.1210 | 1.0610 | -0.2660 | 0.0522 | 0.1300 | -0.2280 |
| Sig. | 0.5970 | 0.0000 | 0.0110 | 0.0000 | 0.1980 | 0.3750 | 0.0920 | 0.0280 |
| Note: Sig. Stands for observed significance level of the t statistic. | | | | | | | | |

For the convenience of the reader the research questions put forward in Chapter 3 are reproduced below:

## Research Questions

To test for the structural breaks across the two periods the following hypotheses were tested.

Let the subscript i1 for the various items refer to the characteristics of the ith portfolio for the pre-break point period. Let the subscript i2 for the various items refer to the characteristics of the ith portfolio for the post-break point period.

Hypotheses Set 1:

Null Hypothesis: There is no difference in the intercept term α in both the pre-break point and post-break point periods.

$H_{0:}\ \alpha_{i1} = \alpha_{i\,2}$

Alternate Hypothesis: There is a difference in the intercept term α in the pre-break point and post-break point periods.

$H_1{:}\ \alpha_{i1} \neq \alpha_{i\,2}$

Hypotheses Set 2:

Null Hypothesis: There is no difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-break point and post-break point periods.

$H_0{:}\ \beta_{i1} = \beta_{i2}$

Alternate Hypothesis: There is a difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-break point and post-break point periods.

$H_1$: $\beta_{i1} \neq \beta_{i2}$

Here $\beta_{i1}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the pre-break point period and $\beta_{i2}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the post-break point period.

Hypotheses Set 3:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-break point and post-break point periods.

$H_0$: $s_{i1} = s_{i2}$

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-break point and post-break point periods.

$H_1$: $s_{i1} \neq s_{i2}$

Hypotheses Set 4:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-break point and post-break point periods.

$H_0$: $h_{i1} = h_{i2}$

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-break point and post-break point periods.

$H_1$: $h_{i1} \neq h_{i2}$

**Summary of the Results for the Market Capitalization Weighted Test Portfolios with July 01, 1999 as the Break Point:**

1. Hypotheses Set 1: We cannot reject the null hypothesis for all the test portfolios.

   The intercept is insignificant for all the portfolios except one. There is no significant change in the intercept in the post break point period for all the portfolios. Thus we can conclude that we cannot reject the null hypothesis that there is no difference in the intercept term $\alpha$ in the pre-break point and post-break point periods.

2. Hypotheses Set 2: We cannot reject the null hypothesis in favor of the alternative hypothesis for five of the six test portfolios.

   The coefficient for the market factor is significant (and positive) for all the portfolios. For all the portfolios except one there has been no significant change in the coefficient for the market factor. Thus for all the test portfolios except one we cannot reject the null hypothesis.

3. Hypotheses Set 3: We cannot reject the null hypothesis for four of the six test portfolios.

   For all the portfolios except one the coefficient for the size factor, SMB, is significant (and positive). For all the portfolios except one, there is no significant change in the sensitivities to SMB in the post break point period. Thus for all the portfolios except one we cannot reject the null hypothesis that there is no difference in the sensitivities of the portfolio returns to the size factor, SMB, in the pre-break point and post-break point periods.

4. Hypotheses Set 4: We reject the null hypothesis in favor of the alternate hypothesis for five of the six test portfolios.

In the pre-break point period, the coefficient for the value factor, HML, is significant for all the portfolios except one. And among the portfolios for which the coefficient is significant, it (the coefficient) is positive for all the portfolios except one.

In the post break point period there has been a significant (and negative) change in the coefficient for the value factor for all the portfolios except one. The coefficient of the value factor is negative for two of the six test portfolios in the post break point period.

Thus for five of the six test portfolios we reject the null hypothesis in favor of the alternate hypothesis that there is a difference in the sensitivities of the portfolio returns to the value factor, HML, in the pre-break point and post break point periods.

**Table5.2: Results Summary Hypotheses Set Wise**

| S.No. | Hypotheses | | No. of test portfolios for which $H_0$ is rejected. | No. of test portfolios for which $H_0$ cannot be rejected. | Test portfolios for which $H_0$ cannot be rejected. |
|---|---|---|---|---|---|
| | | | | | |
| 1 | Null: | $\alpha_{i1} = \alpha_{i2}$ | Zero | Six | All six test portfolios |
| | Alternate: | $\alpha_{i1} \neq \alpha_{i2}$ | | | |
| | | | | | |
| 2 | Null: | $\beta_{1\iota} = \beta_{2\iota}$ | One | Five | S_L, S_H, B_L, B_M, B_H |
| | Alternate: | $\beta_{1\iota} \neq \beta_{2\iota}$ | | | |
| | | | | | |
| 3 | Null: | $s_{i1} = s_{i2}$ | One | Five | S_L, S_M, B_L, B_M, B_H |
| | Alternate: | $s_{i1} \neq s_{i2}$ | | | |
| | | | | | |
| 4 | Null: | $h_{i1} = h_{i2}$ | Five | One | S_H |
| | Alternate: | $h_{i1} \neq h_{i2}$ | | | |

Interpretation of the results:

1. For all the portfolios there has been a significant change in the asset pricing behavior across the pre and post break point periods. We can infer this because there has been a significant change in the coefficients of at least one of the factors (market, size, SMB and value, HML) for all the test portfolios in the post break point period.
2. In the pre-break point period the Fama-French model is a perfect descriptor of returns for three of the six test portfolios. In the post break point period the

Fama-French model is a perfect descriptor of returns for four of the six test portfolios.

3. It is interesting that the there has been a significant (and a negative) change in the coefficient for the value premium in the post break point period for all the test portfolios except one. Chen and Zhang (1998) state that the value premium may not be of much significance in rapidly expanding (developing) economies in describing stock returns. Mohanty (2001) and Connor and Sehgal (2001) suggest that the value premium may not be necessary to describe stock returns in India. Maybe the Indian market is moving from the Fama-French three factor model to a two-factor model with market and size (SMB) factors.

4. For most test portfolios the sensitivity (coefficient) to the market factor has remained constant and positive across the pre and post break point periods (It could be noted that the sensitivity to the market factor is positive for all the portfolios in the post break point period). For most portfolios the sensitivity to the size factor has remained more or less constant while the sensitivity to the value factor has decreased. This could be interpreted as the movement of the market towards CAPM for reasons that are discussed below.

Reasons for the interpretation that the market might have moved closer to the CAPM:

1) The market has moved closer to satisfying the some of the conditions of CAPM in the aftermath of the establishment of the NSE. These are listed below:

(i) The CAPM assumes the market to be in equilibrium (all asset prices be adjusted such that the excess demand for any asset will be zero).

(ii) The quantities of the assets are fixed. Also all assets are marketable and perfectly divisible.

(iii) Asset markets are frictionless and information is costless and simultaneously available to all investors.

The NSE provided a much faster and a more convenient interface between the buyers and sellers. NSE terminals were located across the country and matched the supply and demand of stocks by investors across the country. NSE would have thus facilitated the establishment of a countrywide equilibrium in the stock market. One could compare this with the situation in the pre NSE era when it took a few months for a sale or buy to materialize. Also there was a lot of unsatisfied demand and supply. Thus the market moved closer to satisfying condition 1.

With the onset of dematerialized trading one can buy or sell even a single share. Thus the market has moved closer to satisfying condition 2.

Market frictions such as transaction costs have got drastically reduced in the aftermath of the establishment of the NSE. Thus the market has moved closer to satisfying condition 3.

2) Another viewpoint is the school of thought that the CAPM anomalies are due to market inefficiency. Hsia, Fuller and Chen (2000) express the view that the CAPM anomalies are due to market frictions that retard the arbitrage process. They are of the opinion that if the market is frictionless, as assumed in the derivation of the Capital Asset Pricing Model, the CAPM should hold. They feel that market frictions (e.g., transactions

costs, information asymmetry and regulatory restrictions) retard the arbitrage process thus weakening the explanatory power of the betas. The beta then requires help from factors like firm size and book to market equity (BE/ME) ratio to complement it.

It is clear that the establishment and the geographical spread of the NSE have facilitated the arbitrage process by reducing transaction costs and by increasing the speed of the transactions. This might have contributed to a reduced role for the value factor – which was reflected through the decrease in the sensitivity to the value factor.

Another paper that provides evidence supporting the view that anomalies could be a result of market frictions is Ibbotson, Kaplan, and Peterson. It has been well documented in the finance literature that nonsnynchronous trading and other market frictions can cause positive autocorrelation in stock returns. Ibbotson, Kaplan, and Peterson adjust estimates of systematic risk, betas, for cross-autocorrelations in security returns and also show that substantial positive adjustments to beta are necessary for small firms. Traditional estimates of beta are unrelated to future returns over the 1931 through 1994 time period, whereas adjusted estimates are positively correlated with future returns. In addition, adjusted beta estimates partially account for the size effect in common stock returns.

The adjustment for beta in the above paper is done by estimating beta as the sum of the slope coefficients from a regression of excess security returns on contemporaneous and lagged excess market returns.

## The Correct Model: Fama-French Three Factor Model or the CAPM

While the market might have moved closer to satisfying some of the conditions of the CAPM, this cannot be taken as evidence to predict that in future the CAPM would emerge as the perfect descriptor of stock returns (or the perfect model for cost of equity) in the future in the Indian markets.

Firstly, as it has been mentioned elsewhere in this work, it takes a fairly long period (at least a few decades) to establish firm conclusions about asset pricing behavior in a market. We presently do not have even two decades of reliable data for the Indian market.

Improvements in market efficiency facilitate the working of asset pricing models, that is, asset pricing models work better in an efficient market. If the CAPM were the perfect descriptor of returns, it would work better in an efficient market. If the Fama-French three-factor model were the perfect descriptor of returns, it would work better in an efficient market. It is too early to say which is the better model for the Indian market, and probably even far ahead into the future, it would be difficult to answer this question with certainty. Internationally, the Fama –French three-factor model has been well documented to correct for most of the anomalies of the CAPM. In India too the Fama-French model has found support. Substantial evidence in favor of the Fama-French model was the reason for this model being employed in the present study.

## Implications of the Results for Investors, Firms and Regulators

### Implications for Investors

It is clear that in the post NSE period the Fama-French three-factor model is able to do a good job of explaining returns implying that size and value factors have a role to play in stock returns. Across the globe investment strategies focusing on size and value factors have been suggested by academia and also offered to investors by investment managers to generate good returns for them. Size and value strategies imply that we invest atleast a portion of our funds in small capitalization and high value (that is high ratio of book equity to market equity (BE/ME)) stocks to generate superior returns.

Piotroski (2002) suggests a very interesting refinement of value strategies where he provides evidence that fundamental analysis among high BE/ME stocks generates returns superior to a pure value strategy. He adds that within the portfolio of high BM firms, the benefits to financial statement analysis are concentrated in small and medium-sized firms, companies with low share turnover, and firms with no analyst following and the superior performance is not dependent on purchasing firms with low share prices. This suggests an interaction between size and value strategies. He gives the rationale for these phenomena as follows:

> "The evidence instead supports the view that financial markets slowly incorporate public historical information into prices and that the "sluggishness" appears to be concentrated in low volume, small, and thinly followed firms."

## Implications for Firms

Given that the Fama-French three-factor model is able to describe the stock returns in India fairly well, this model could be used by firms for estimating their cost of equity capital.

The cost of equity capital is a crucial input to project/company evaluation by firms. It can also be a crucial input to dividend decisions.

### Issues in the use of Fama-French Model by Firms/Investors

Some of the issues in the use of the Fama-French three factor model are obvious. While the employment of CAPM requires knowledge of the beta and the excess returns for the market (market returns less risk free rate), the use of the Fama-French three factor model requires the knowledge of a few more parameters - the size premium (SMB), value premium (HML) and the coefficients of SMB and HML. In the USA and other parts of the developed world some of these parameters are published by well investment firms and financial institutions.

## Implications for Regulators

1. Given the existence of size and value premium and their role in stock returns, due consideration should be given to these factors in the regulation of the pricing of public issues, particularly those of small cap and high BE/ME (ratio of book equity to market equity) stocks. Given that small cap and high BE/ME stocks are riskier (than large cap and low BE/ME stocks) their pricing should also be conducive to generating higher returns to investors.

2. To promote trading and investment in small cap and high BE/ME stocks suitable incentives could be given to fund managers to develop mutual funds focusing exclusively on these categories. Suitable incentives could be given to investors (income tax benefits for example) for investing in such funds.
3. Any other measures to promote trading in small cap and high BE/ME stocks could be considered.

# CHAPTER 6 – SUMMARY AND CONCLUSIONS

The reforms of the Indian capital market provide a unique natural experiment to test if reforms affect asset pricing. The reform that is the focus of this study is the establishment of the National Stock Exchange (NSE) in late 1994 that resulted in a dramatic improvement in market efficiency and a drastic reduction in market frictions.

The model that is employed here to test the asset pricing behavior is the Fama-French (1993) three-factor model. We fit the Fama-French model, which is the Capital Asset Pricing Model (CAPM) supplemented by two additional factors, namely the size and the value factor, in the pre-NSE period and the post-NSE period. We test if there is any change in the explanatory power of the Fama-French (1993) model and the sensitivities of the asset returns to the three factors, namely market return, size and value across the two periods.

## The Fama French Three-Factor Model

The Fama-French three factor model:

$$\mathbf{R_i - R_f = \alpha_i + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML)}$$

Where $R_i$ is the rate of return expected by the equity shareholders of the firm i, $R_f$ is the risk-free rate of return, $\beta_i$, $s_i$ , $h_i$ are the regression coefficients for the firm i, $R_m$ is the rate of return on the market portfolio, SMB is the size factor risk premium (Expected return of a portfolio of small stocks minus the expected return on portfolio of large stocks), HML is the distress factor risk premium (value premium) where distress is measured by book equity divided by market equity (Expected return of a portfolio of high book-to-market stocks minus the expected return of a portfolio of low book-to-market stocks).

### CAPM Anomalies and the Fama-French Three-Factor Model

Researchers have long reported that the CAPM has anomalies – anomalies imply the phenomenon that the market factor or the beta is inadequate to explain the variation in stock returns and factors other than the market factor explain a portion of the unexplained return variation. Some of the noteworthy anomalies include the earnings-price effect (Basu 1977, 1983), size effect (Banz 1981, Reinganum 1981 a), book-equity to market equity ratio effect (Stattman 1980, Rosenberg, Reid, and Lanstein 1985), debt/equity ratio effect (Bhandari 1988), cash flow to price ratio (Chan, et al. 1991), etc.

The Fama-French three-factor model (Fama and French, 1992, 1993) corrects for almost all the reported anomalies in the CAPM and has found empirical support across the globe and in India. This is the reason this model was employed in this study.

## The National Stock Exchange

The NSE was established in 1994 as a competitor to the Bombay Stock Exchange (BSE). The exchange introduced nationwide screen-based trading with a dish-to-satellite data transmission system that provides instant trading access to brokers anywhere in India. The system now has instantaneous access through 2888 VSATs from nearly 365 cities spread across the country. NSE forced BSE and other exchanges to adapt by upgrading to computerized systems and by reforming trading rules and procedures, which included increased surveillance over the capital adequacy of brokers. BSE shifted from an “open outcry” trading system to a screen-based system, making major investments in equipment, and revised its own procedures to provide transparency for investors.

## Exchange Automation and Market Efficiency

Pirrong (1996) has shown that automated exchanges can be deeper and more liquid than open outcry exchanges. Shah and Thomas (1996) have studied the impact of automation (introduction of BSE Online Trading - BOLT) on the Mumbai Stock Exchange (BSE). They examine two measures of liquidity - aggregate trading volume and trading frequency at the security level - and show that both have improved strongly. Naidu and Rozeff (1994) measure the impact of automation in the Singapore Stock Exchange, which took place in 1989, upon a sample on 28 securities, and note an increase of volatility and liquidity as well as an improvement in efficiency.

## Market Efficiency and Asset Pricing

Fama (1991) in his review of the literature on efficient capital markets elaborates on the joint hypothesis problem. Market efficiency per se is not testable and it must be tested jointly with some model of equilibrium, an asset-pricing model. If we have to determine if information is correctly reflected in prices it can be done so only in the context of a model that defines the meaning of “correctly.” If anomalies are observed in the behavior of returns one cannot tell if they are due to mis-specified asset-pricing models or due to market inefficiency.

The joint hypothesis problem implies that given a correct equilibrium asset-pricing model, improvement in market efficiency would improve the performance of the model. Since there is evidence that automated exchanges could improve market efficiency it can be inferred that exchange automation would impact asset pricing.

The argument that improvement in market efficiency could impact asset pricing can also be drawn from the school of thought which states that the CAPM anomalies owe their existence to market inefficiency. Since stock exchange automation improves market efficiency it implies that exchange automation could impact the sensitivities to the size and value factors. This in turn would affect the performance of both the Fama-French three-factor model and the CAPM in the post-NSE era.

## Testing for the Change in Asset Pricing Behavior

The Fama-French model described earlier has three factors, market, size and value. Testing for the change in the asset pricing behavior across two periods basically implies testing for the changes in the intercept $\alpha_I$ and the sensitivities (coefficients) to the three factors across the two periods. The specific sets of null and alternate hypotheses that were tested are detailed later in this chapter.

## Data and Methodology

### The Dummy Variable Approach to Test for the Change in the Coefficients across the Two Periods

The dummy variable technique was followed to test for the changes in the intercept $\alpha_{i,}$ $\beta_I$ , $s_i$ and $h_i$ . The following equation with dummy variables was fitted for each of the test portfolios.

$$R_i - R_f = \alpha_i + \beta_i (R_m - R_f) + (s_i * SMB) + (h_i * HML) + d_\alpha D + d_{\beta i} D (R_m - R_f) + d_{si} D(SMB) + d_{hi} D(HML) \quad (1)$$

**D = 0 for the period before the break point.**

**D = 1 for the period after the break point.**

If the coefficients $\mathbf{d_{\alpha}}$, $\mathbf{d_{\beta I}}$, $\mathbf{d_{si}}$ and $\mathbf{d_{hi}}$ are significantly different from zero, it means that the intercept $\alpha_I$ and the coefficients $\beta_I$, $s_i$ and $h_i$ have changed significantly across the two periods.

Various considerations were made for the choice of date for the break point and finally July 01, 1999 was found to be the ideal choice for the break point.

## Data

The share price data considered for the study was weekly share price data and was extracted from Prowess, the CMIE database. The data from 07/07/1990 to 30/06/1996 is from the Mumbai Stock Exchange (BSE) and the index returns for this period are the BSE Sensex returns. Data from 06/07/1996 to 30/06/2006 is from the National Stock Exchange (NSE) and the index returns for this period are the S & P CNX Nifty returns.

The entire universe of stocks has been considered but the criterion for inclusion of stocks in the study was that they have weekly returns data for all the weeks in the year.

From January 1993 to June 2006 the yield of the 91-day Government of India T-bill was taken as the proxy for the risk free rate. The 91-day T-bill auctions are held weekly and the weekly yields were considered for the study. For the period July 7, 1990 to April 18, 1992, the yield of the 182-day Government of India T-bill was considered as the proxy of the risk free rate. For the period April 25, 1992 to December 26, 1992 the yields of the 364-day T-bill were taken as the proxy for the risk free rate.

## Construction of the Test Portfolios

Six test portfolios were constructed on the basis of the methodology followed in Davis, Fama and French (2000). The Fama-French model states that:

$$\mathbf{R_i - R_f = \beta_i(R_m - R_f) + (s_i * SMB) + (h_i * HML)}$$

Where $R_i$ is the return on stock i, $R_f$ is the risk free interest rate, $\beta_i$ is the sensitivity of the return on the ith stock to the return on the market portfolio and $R_m$ is the return on the market portfolio. SMB is the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, constructed to be neutral with respect to BE/ME (book equity to market equity). HML is the difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks, constructed to be neutral with respect to size.

The portfolios were formed on July 1 of every year based on the market capitalization and BE/ME data as at the end of March for the year. Based on the market capitalization and BE/ME data as at the end of March for the year the stocks were allocated into two size and three BE/ME groups. Big stocks (B) are above the median market equity of BSE/NSE firms and small stocks (S) are below. Similarly, low BE/ME stocks (L) are below the 30th percentile of BE/ME for BSE/NSE firms, medium BE/ME stocks (M) are in the middle 40 percent, and high BE/ME stocks (H) are in the top 30 percent. Six portfolios, S/L, S/M, S/H, B/L, B/M, and B/H, were formed as the intersections of the size and BE/ME groups. For example, S/L refers to the portfolio of stocks that are below the BSE median in size and in the bottom 30 percent of BE/ME. The portfolios are formed both on a market capitalization (market capitalization as at the end of March of the year) and equally weighted basis.

### Estimation of the Size Premium, SMB

Davis, Fama and French (2000) define SMB as the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, constructed to be neutral to BE/ME. In line with this definition Davis, Fama and French (2000) use the below formula to estimate SMB and the same formula has been used in the present study too.

SMB is the difference between the equal-weight averages of the returns on the three small stock portfolios and the three big stock portfolios,

SMB = (S/L + S/M + S/H)/3 - (B/L + B/M + B/H)/3

### Estimation of the Value Premium, HML

Similarly Davis, Fama and French (2000) define HML as the difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks, constructed to be neutral with respect to size. In line with this definition Davis, Fama and French (2000) use the below formula to estimate HML and the same formula has been used in the present study too.

HML = (S/H + B/H)/2 - (S/L + B/L)/2

## Research Questions

To test for change in asset pricing behavior across the pre and post break point periods four sets of null and alternate hypotheses were tested, each set concerning the intercept.

To test for the structural breaks across the two periods the following hypotheses were tested.

Let the subscript i1 for the various items refer to the characteristics of the ith portfolio for the pre-NSE period. Let the subscript i2 for the various items refer to the characteristics of the ith portfolio for the post-NSE period.

Set 1:

Null Hypothesis: There is no difference in the intercept term α in the pre-NSE and post-NSE periods.

$H_{0:}\ \alpha_{i1} = \alpha_{i2}$

Alternate Hypothesis: There is a difference in the intercept term α in the pre-NSE and post-NSE periods.

$H_1:\ \alpha_{i1} \neq \alpha_{i2}$

Set 2:

Null Hypothesis: There is no difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivities of the returns of the ith portfolio to the market returns in the pre-NSE and post-NSE periods.

$H_0:\ \beta_{i1} = \beta_{i2}$

$H_1:\ \beta_{i1} \neq \beta_{i2}$

Here $\beta_{i1}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the pre-NSE period and $\beta_{i2}$ refers to the sensitivity of the ith portfolio to the return on the market portfolio in the post-NSE period.

Set 3:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the size factor risk in the pre-NSE and post-NSE periods.

$H_0$: $s_{i1} = s_{i2}$

$H_1$: $s_{i1} \neq s_{i2}$

Set 4:

Null Hypothesis: There is no difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-NSE and post-NSE periods.

Alternate Hypothesis: There is a difference in the sensitivity of the returns of the ith portfolio to the value factor risk in the pre-NSE and post-NSE periods.

$H_0$: $h_{i1} = h_{i2}$

$H_1$: $h_{i1} \neq h_{i2}$

## Summary of Results

**Summary of the results for the market cap weighted test portfolios with July 01, 1999 as the break point:**

1. Hypotheses Set 1: We cannot reject the null hypothesis for all the test portfolios.

   The intercept is insignificant for all the portfolios except one. There is no significant change in the intercept in the post break point period for all the portfolios. Thus we can conclude that we cannot reject the null hypothesis that there is no difference in the intercept term $\alpha$ in the pre-break point and post-break point periods.

2. Hypotheses Set 2: We cannot reject the null hypothesis in favor of the alternative hypothesis for five of the six test portfolios.

   The coefficient for the market factor is significant (and positive) for all the portfolios. For all the portfolios except one there has been no significant change in the coefficient for the market factor. Thus for all the test portfolios except one we cannot reject the null hypothesis.

3. Hypotheses Set 3: We cannot reject the null hypothesis for four of the six test portfolios.

   For all the portfolios except one the coefficient for the size factor, SMB, is significant (and positive). For all the portfolios except one, there is no significant change in the sensitivities to SMB in the post break point period. Thus for all the portfolios except one we cannot reject the null hypothesis that there is no difference in the sensitivities of the portfolio returns to the size factor, SMB, in the pre-break point and post-break point periods.

4. Hypotheses Set 4: We reject the null hypothesis in favor of the alternate hypothesis for five of the six test portfolios.

   In the pre-break point period, the coefficient for the value factor, HML, is significant for all the portfolios except one. And among the portfolios for which the coefficient is significant, it (the coefficient) is positive for all the portfolios except one.

   In the post break point period there has been a significant (and negative) change in the coefficient for the value factor for all the portfolios except one. The coefficient of the value factor is negative for two of the six test portfolios in the post break point period.

Thus for five of the six test portfolios we reject the null hypothesis in favor of the alternate hypothesis that there is a difference in the sensitivities of the portfolio returns to the value factor, HML, in the pre-break point and post break point periods.

## Results and Interpretation

There has been a significant change in the asset pricing behavior in the post NSE period as all the test portfolios have at least one statistically significant dummy variable coefficient. In the post-break point period the Fama-French three factor model appears to be a perfect descriptor of returns as:

- For almost all the test portfolios all the factors in the model have statistically significant coefficients.

- The intercept has been insignificant for all the test portfolios except one.

For all test portfolios except one the sensitivity (coefficient) to the market factor has remained constant. For all the portfolios except one the sensitivity to the size factor has remained constant. The sensitivity to the value factor has decreased for all the portfolios except one. This could be interpreted as the movement of the market towards CAPM in light of the fact that in the post NSE era the market has moved closer to satisfying some of the conditions of the CAPM.

The interpretation that the market has moved closer to the CAPM could also be made if one considers the school of thought that the anomalies owe their existence to market inefficiency. As the market became more efficient (in terms of reduced market frictions) in the post NSE era this could have contributed to an increased role for beta and a reduced role for one of the 'anomaly' factors in the description of stock returns.

The interpretation that the market has moved closer to CAPM does not necessarily imply that the CAPM would turn out to be best descriptor of stock returns in India in the future. As the market becomes more efficient the 'true' asset-pricing model performs better. Whether the true asset pricing model is the CAPM or the Fama-French three factor model would be revealed to us in the distant future as it takes fairly long periods to establish patterns in asset pricing behavior.

## Importance of the Study and Implications

Two major studies of the Fama-French model in the Indian context (Connor and Sehgal (2001) and Mohanty (2001)) have a major deficiency in that they have ignored the possibility that there could have been structural changes in the asset pricing behavior in the Indian market in the last decade of the $20^{th}$ century because of the wide-ranging reforms (a major reform being the establishment of the NSE). This study overcomes this deficiency and achieves three objectives – 1) it identifies the break point in the asset pricing behavior 2) it identifies the direction of change in the individual factors of the Fama-French model in the post break point period and 3) It tests for the performance of the Fama-French model in the pre and post break point periods.

The results of the study have important implications for investors, firms and regulators. The finding that size and value factors have a role to play in stock returns in India implies that investment strategies based on size and value factors would yield superior returns in India. Since the Fama-French model has emerged to be a good descriptor of stock returns in India firms could use this model to estimate their cost of equity.

Regulators could give due consideration to the existence of size and value premium in the regulation of the pricing of public issues. Suitable incentives could be given to fund managers to develop mutual funds based on size and value strategies. Suitable incentives could be given to investors (income tax benefits for example) for investing in such funds. These measures would achieve two things - 1) Generate superior returns for investors and 2) Considering the school of thought that the anomalies are due to market inefficiency, these measures would contribute to reducing market inefficiency.

## Limitations of the Study and Areas for Future Research

One limitation of the study, which was unavoidable by the author, is that it studies only about thirteen years of data. This was because reliable stock market data in India was available only from 1990-91. This could be overcome if the study is replicated sometime in the future.

Replication of the study in the future would achieve another objective. Since it takes fairly long periods to establish firm conclusions in asset pricing behavior, the future studies could draw more definite conclusions regarding the asset pricing behavior and trends in the factors of the Fama-French model.

Two alternative break points were examined in the study and one of them was chosen after sufficient evidence emerged in its favor. However, since the last decade of the 20th century and the initial years of the 21st century have seen many path breaking reforms in the Indian market, the existence of more than one break point could be examined in future studies.

The view that the Fama-French model factors (size and value) or CAPM anomalies in general owe their existence to stock market inefficiency could be exclusively studied in the Indian context in future studies.

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