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Testing the capm in the Indian market

*A study that investigates the validity of the CAPM in
Bombay Stock Exchange SENSEX30*

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Mazen Diwani
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Lund

Abstract

This paper is designed to examine the validity of the CAPM model in the emerging markets. I took the Indian market to be the case in which we examine the applicability of this model and therefore I decided to perform the study on one of the biggest Indian markets; Bombay Stock Exchange. The SENSEX30 was chosen as the examined index and I performed the study on the 28 listed companies in the market (BSE30 or SENSEX30).

I used weekly stocks' returns for the period Nov04 to OCT09. To eliminate the measurement bias which will be incurred during the study, a window of 53 weeks was taken to regress the weekly returns of the listed stocks on the weekly returns of the SENSEX30 index at the same period, this will result in 53 betas for each stock in the first period, and then we started to move the window week by week.

When testing the CAPM model for the whole five-year period hasn't showed any strong evidence that support the validity of this model and in order to get better estimates, we divided the whole sample into 5 subsamples of one year each. We have examined three tests for each year of the whole 5 year sample and the results have shown some better estimates for some of the years but still did not support the CAPM hypothesis

When running the non-linearity test, it was proven that the model explains the excess returns which-in return-supports the linear structure of the CAPM equation.

This paper is solely based on the fact that in order for the model to be valid and strong academically, the alpha (the intercept) should equal to zero and the beta (the slope) should equal the excess returns on the market portfolio. This was a pure prediction of the CAPM, therefore we tested the above hypotheses but the results failed to prove or provide any evidence that coincide with the null hypotheses!

The second part of this investigation was to examine the ability of the CAPM model to provide a non-linearity relationship between the return and betas. Conducting the test has shown that the expected return-beta relationship is linear.

In fact, this paper has gone too far by also including a brief investigation over what's called "the non-systematic test". The idea behind this was to investigate whether the CAPM can include all the components of the stocks' returns including the residual variance of the stocks. Our results-based on the test for the non-systematic risk-show that the residual risk has no effect on the expected returns of the listed stocks!

Key words: CAPM, Bombay Stock Exchange, stocks' returns, beta, risk free rate, stocks

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-Chapter one-

Introduction and purpose of the study

The preliminary chapter presents the background to the CAPM and its position within the financial literature. Furthermore the chapter presents a problem discussion leading to my problem statement and the purpose of this study.

Background

Academics and researchers in the Finance area have been always keen on improving the understanding of how investors value risky cash flows.

In fact, there exists a rule of thumb-for those who are not familiar with this field of study- that investors demand a higher expected return for investments in riskier project or securities.

However, it's still unclear how investors assess the riskiness of the cash flow on a project and how they determine what risk premium to demand!

In the shadow of the emerging of new equity markets around the globe, the large and—in some cases-extraordinary return performance shown by these markets and the necessity for investors to base their portfolio selection on a scientific bases and attempting to evaluate the exposure to risk over many different assets, Sharpe [1964], Lintner [1965] and Mossin [1966] have developed the Capital Asset Pricing Model or as it's known “the CAPM model”.

The CAPM model is based on the idea that the highly expected stocks' returns will always be triggered (or accompanied) by a phenomenon of high levels of risks

The CAPM model predicts that the component of the expected return exceeding the risk-free rate will be linearly related to the idiosyncratic risk which is- in this case- measured by the asset's beta. The fact that this model which has been existent in the modern economics research and the modern portfolio theory for the past 4 decades, academics and practitioner have been always questioning the ability of this model to explain the actual movements of assets' returns

From the very early days of the CAPM introduction in the 1960's, this model has been one of the most controversial topics in the field of financial economics. In fact, any manager who bears in mind to undertake a project must justify his/her decision partly based on CAPM application.

The application of the CAPM model was and has been always prompted by the need of investors to be able to calculate the return they are seeking on the proposed projects.

Measuring the riskiness of the cash flows on these projects, the estimation of the cost of the capital and-therefore-its methodology and projecting the expected rate of return are all what feature this model.

In fact, this model was constructed in the first place to provide a reasonable explanation behind the differences in the risk premiums across different assets and what could explain these differences-from the literature point of view- is due to the differences between the riskiness of the returns these assets yield!

In fact, we can say that the testing of the CAPM has two reasons:

- i. In this category, we can claim that testing the CAPM is based on accepting or rejecting the theory itself.
- ii. As we all know, the use of the CAPM model is justified in the first place to provide financial information for all managers which could help them potentially in their financial decisions regarding the construction and the composition of their portfolios.

Regarding (i), we will run a series of tests which will reveal the validity and the power of the CAPM model. The model will hold to be valid if it's not possible to reject the null hypotheses.

Regarding (ii), this paper will exploit the empirical work to use the literature based on this theory as a way through organizing the data without attempting to reject the theory!

1.2 Choice of Subject

As discussed above, this model has been shadowed by a great debate among researchers, academics and practitioners so I believe that there is a real need to test the validity of CAPM.

A lot of papers were conducted on financial data which belong to western markets including the US, the UK and Europe.

Before the decision to choose the geographical scope of this paper- which is believed to be an important matter to any researcher- a crucial question was raised in this particular: “Is the CAPM valid if we apply it on emerging markets which prove to be highly different from developed markets?”

After this question, I realized that I’m going to devote my research on the emerging markets, and since many papers were conducted on data from China and Russia, I decided to have a good potential adventure over the Indian market and particularly the Bombay Stock Exchange BSE30. What attracted me most about the Indian market is that India -today- is considered to be one of the most powerful forces in the global economy which –in addition to China- can constitute a strong spot in the global economy map.

Later in chapter two, I will be presenting in details the facts about the Indian economy and Bombay stock exchange BSE 30 so the reader can understand the characteristics of this interesting market which seem to be in a highly appraised transition in its economy’s opening towards the western economies.

By investigating the validity of the CAPM, I believe that the results are of interest for financial managers in India who have some suspicion about using the CAPM and its validity in their decision making.

1.3 Purpose of Study

The purpose of this paper is to examine whether the CAPM holds true in BSE30, and below we can see the important factors that I’m going to focus on while conducting this study:

- Whether a higher/lower risk will yield higher/lower expected rate of return
- Whether the expected rate of return is linearly related with the stock’s beta, i.e. its systematic risk.
- Whether the non-systematic risk affects the stocks’ returns. (CAPM predicts that only the systematic risk has the explanation power on the rate of return).

1.4 Delimitations

This paper will be focusing on the emerging markets, thus one country or a set might be chosen to fulfill the goal of this paper.

In fact, going through the past and the recent literature regarding this subject (the matter of this thesis!), I noticed that many authors have focused on one perspective; testing for one country.

The reason behind choosing one country and one index is that testing the validity of a model can be satisfied by applying this model in a sole country since the model has been already examined in many other countries which have common features; economic ground, political life, social bases, industrial growth, transitionary movements and finally opening up their economies. Therefore, there's no need to test in a set of different countries as long as many studies have done this part already!

Many countries can constitute a homogenous set and below some examples can be shown such as: Russia, Brazil, China and India.

There has been a heavy literature of testing the CAPM in these countries but it seems rare to find any piece of work done on the Indian market!

This paper will restrict the testing procedures upon the Indian markets and particularly the SENSEX30, therefore my data will be drawn from the listed companies on the SENSEX30 or BSE30

1.5 Disposition

The aim of this section is to give the readers a general outline of the main parts of this paper:

- i. **Chapter one** introduced the general background of the topic, the choice of the subject and the purpose of this study.
- ii. **Chapter two** will be devoted entirely to give the reader an introduction about the emerging markets and the Indian Market.

- iii. **Chapter three** introduces the research philosophy, research approach and the theoretical framework. This Chapter will introduce the CAPM and the support and debate about this theory.
- iv. **Chapter four** will include the methodology used in testing the CAPM, how the data and the sample were collected is also describe in this Chapter.
- v. **Chapter five** will present the empirical results which are obtained by applying the methodology used in the previous chapter. Then this chapter will summarize the detailed outcomes of the findings from the empirical analysis, and concludes the results from these findings.
- vi. **Chapter six** will present the conclusions from the previous chapter, thus the readers will be aware of what this paper has come to in its findings

-Chapter two-

An introduction to the emerging markets and particularly the Indian market

In this chapter, the readers will be introduced to the term “Emerging markets” including the terminology; this will help to create the criteria necessary for describing an economy to be one of the emerging markets. After this, the readers will be introduced to the Indian market which is the center of this paper.

2.1 What do we mean by the “Emerging markets”?

There’s a popular and broad distinction between two set of countries all over the globe, this distinction is based on a set of criteria that measure the political, economic and social position of the country thus deciding whether this country belongs to the *developed* world or *the developing* world.

The emerging markets are the flip coin of what we call “the developing” countries, and therefore, this term describes a nation’s phase of social and economic transition which coincides with the opening of its economy and the progress in which its business and social activities are advancing.

Many countries can meet these criteria and we can say that Russia, China, India and Brazil among the top economies or “markets” which comply with these criteria

2.2 Terminology

This term has first existed in the 1980’s by World Bank economist Antoine van Agtmael which can be referred to the emerging economies and thus the term could work both for markets and economies as well. In fact and as mentioned above, the term captures the transitional phase in which the country’s economy is witnessing a major shift towards advancements in its business environment and social base as well.

Many authors have attempted to capture a pure definition for the emerging markets, political scientist Ian Bremmer was among these when he triggered this idiom by giving this definition "a country where politics matters at least as much as economics to the markets."¹

One of the most challenging jobs is to construct a list of these emerging markets, and we can say that our guide into attempting a trial could be –as many researchers and observers tend to use- ISI Emerging Markets and The Economist or market index makers (such as Morgan Stanley Capital International)

We can consider these sources to be dependable and reliable although the information drawn from these databases can lead to two potential problems.

The first part of the problem is what we can call as the *historicity*; Market indices in the emerging economies might be in a transitional phase therefore the data related to the investments carried in those economies might be biased due to the pre-opening phase which the economy had gone through before entering the transitional phase. Possible examples of this are South Korea and Taiwan.

Regarding the second component, we can clearly acknowledge the fact that there's a simplification involved in the construction of the index; those small countries and countries with limited liquid assets are usually not considered while their rich neighbors are considered to be an appropriate role model!

2.3 The Indian market

The securities market is divided into two interdependent and inseparable sectors, firstly we have the primary market where all the new securities are issued for the first time and secondly the regular stock (secondary) market. Either public limited companies or the governmental agencies are responsible for issuing the new securities in the primary market.

¹ Emerging Economy Report

In fact, two vehicles are held responsible for mobilizing (channeling the involved funds from the surplus units in the society to the shortage units!) this issue; one of these methods is the public issue which is open for anyone to participate in it.

The second method stands for the private placement which is devoted to a selective group of individual and corporate investors.

2.4 Key strengths of the Indian securities markets

This market stands to have many features on its own making it one of the most distinguishable markets among its likes in the wide Asian region.

An enormous progress and an outstanding development were applied to this market where it's been in the process of modernizing its market mechanisms and developing new sophisticated instruments for this need.

A few might know a lot about the Indian securities markets and what could be impressive about this market is the highly perceived quality of its regulations controlling the market.

As in every country on the surface of the earth, there should be a regulatory body which is held responsible for controlling the market and assuring the existence of the system as to protect both funds suppliers (investors, stockholders..) and funds seekers (corporate, mutual funds, hedge funds..) and therefore the strength of the market comes from the power of its regulatory body over the whole market, in India, this body is represented by the Securities and Exchange Board of India (SEBI) which is an independent and effective regulator.

It's a long list of features which could be mentioned here in the favor of this market, but as we should move on to other points, we must mention that the NSE and the BSE have the most advanced and scientific risk management systems.

2.5 Bombay Stock Exchange

Bombay Stock Exchange is one of the oldest stocks which exist in the region due to the rich heritage of 133 years of existence.

It used to have a different name in the old days "when it was first established" as "The Native Share and Stock Brokers' Association" in the year 1875

In 1995, BSE has witnessed an outstanding development by shifting from the open outcry system to an online screen-based order driven trading system.

Over its existence which goes back into the 19th century, the BSE was and still the dominant hub which has always satisfied the growth needs of the Indian corporate sectors by supplying it with a great access to the different resources.

BSE has an enormous amount of companies on its list making it the globe's number 1 in terms of the listed companies with over 4700 stocks giving investors a wide selection to invest in a promising and –from the point view of many observers- a leading market in the near future. The BSE index-SENSEX30- is a market with a unique stature which makes it the first among Indian indices to enjoy the independence.

The SENSEX has 30 listed stocks representing 12 different major sectors in the national economy of India. The SENSEX is constructed on a 'free-float' methodology, and is sensitive to market sentiments and market realities. In fact, the SENSEX has constructed an agreement to enter a cooperation agreement with Deutsche Börse which made the market (SENSEX and other Indian indices) accessible to investors in Europe and America.

In fact, the BSE is well-known for supplying the investors with the transparency they need in the equity, debt instruments and the derivatives market. It covers almost the whole nation with a presence in more than 359 cities and towns in India.

Awards gained by the BSE

Bombay stock Exchange has won many prizes over its delicate and outstanding performance through the long years of its existence, and below we will list some of the awards which have been awarded to the BSE:

- The Golden Peacock Global CSR Award for BSE for its outstanding performance in the field of the Corporate Social Responsibility or the CSR. This award was given by the World Council of Corporate Governance.
- The excellence in financial reporting ICAI for 06/07 respectively.
- won the Asia - Pacific HRM awards for the unique performance shown by the Human Resource Management at BSE

After presenting this information in this chapter and much more information yet to be covered by different other sources-other than this paper- due to the need of focusing on the core of this thesis, we can conclude that the Bombay Stock Exchange is obviously a leading stock exchange in the whole Asian region.

-Chapter three-

The Theoretical framework

This is the central part of the paper where I aim to provide the readers with the details of the CAPM, its support and the debate around this theory is described here as well. Also this chapter will start with a brief explanation of the plan of the research and its direction.

3.1 Research philosophy

There are two kinds of research philosophy: positivism and phenomenology. The precondition of positivism is that the subject cannot affect the researcher and hence the researcher is independent. The research assumes the role of an objective analyzer; the methods used are highly structured and end in quantifiable that can be statically. The phenomenologist argues for the reality situation of the research subject; they prefer working in an observable social reality². In relation to my purpose of this paper, this study is positivism. I collected the individual stocks data from companies listed in the SENSEX30, then I used a window of one year and moved it gradually until I got my sample of the betas, we'll see this in details later.

2.2 Research approaches: Deduction and Induction

The induction approach is building theory through the research process. Particularly, it concerns affairs that have happened. Hereby, it is better to study a small sample of subjects, get a feel of what is going on and comprehend the problem³.

Usually, the deduction approach is going to test or develop the theory. There are three major characteristics of deduction approaches. First, the researchers will explain causal relationships of variables data. Second, the researchers are independent. Third, it usually uses quantitative data. The general idea behind this thesis is to verify the CAPM model that is to see if it successfully

² Remenyi, D. Williams, B., Money, A. and Swartz, E. (1998) Doing resource in Business and Management: an International to Process and Method, London: SAGE. P.94

³ Saunders, M., Lewis, P and Thornhill, T. (2000) Research Methods for Business Students, 2nd edition. p92-93

works in the Bombay Stock Exchange (SENSEX30) during the period 2004.11.12 to 2009.10.9. In this paper, I chose to analyze the data to test the validity and the applicability of CAPM; therefore, I have chosen the deductive approach.

3.3 The classic theory - CAPM

The Capital Assets Pricing Model, denoted CAPM, describes the relationship between risk and expected return and is used in the pricing of risky securities. This relationship was first proposed independently by John Lintner, William F. Sharpe and Mossin, J, which can be represented by the following linear equation:

$$E [R_i] = R_f + \beta_i (E [R_m] - R_f)$$

Where:

R_f = Risk free rate of return

B_i = Beta of the security i

$E [R_m]$ = Expected return on market

$(R_m - R_f)$ = Market premium

The CAPM introduced that the expected return of a security or a portfolio equals the rate of return on a risk-free rate plus a risk premium⁴. This model offers a simple tool for investors to evaluate their investments. If this expected return does not meet or beat the required return, then the investment should not be undertaken.

The CAPM is a ceteris paribus model. It is only valid within a special set of assumptions, which are mainly listed below⁵:

- All the investors are risk averse; they will maximize the expected utility of their end of period wealth. Implication: The model is a one period model.

⁴ Ross, S. A., Westerfield, R. W. and Jaffe, J. (2005) corporate finance. 7th edition. McGraw-Hill/Irwin. p.285

⁵ Bodie, Z., Kane, A., Marcus, A.J. (2005) Investment. 6th edition. The McGraw-Hill/Irwin series in

- All the investors use the same expected return and covariance matrix of stock return to form the optimal risky portfolio. That is referred to as homogenous expectations (beliefs) about asset returns. Implication: All the investors use the same information at the same time.
- A fixed risk-free rate exists, and allows the investors to borrow or lend unlimited amounts to the same interest rate.
- There are a definite number of stocks and their quantities are fixed within the one period world.
- All stocks are perfectly divisible and priced in a perfectly competitive market.
- There are no market imperfections. Implication: there are no taxes, regulations, or trading costs.

These assumptions are all hard to fulfill in reality, but as a financial theory, it may still describe reality in a reasonably way.

3.4 The support of the theory

The earliest empirical studies which found supportive and conclusive evidence for CAPM is written by Black, Jensen and Scholes (BJS)⁶. They used monthly return data and portfolios instead of the individual stocks. Black *et al* tested whether the cross-section of expected returns is linearly related the portfolio betas. In order to enhance the accuracy of the beta estimates and the expected rate of return, the authors have constructed different portfolios containing these securities since they aimed at diversifying away a high percentage of the firm-specific component of the returns. The authors found that their results were consistent with what CAPM predicted, i.e. the association between the average rate of return and beta is very close to linear with each other and the portfolios with high/low betas have high/low average rate of returns. Another empirical study that supports the theory was written by Fama and McBeth (FM)⁷ in 1973; they found that there is a positive linear relationship between average return and beta.

⁶ Black, F., Jensen, M. C. and Scholes, M. (1972) *The Capital asset pricing model: Some empirical tests. Studies in the theory of capital markets*. New York: Praeger. p.79-121

⁷ Fama, E. F. and MacBeth, J. (1973) "Risk, return and equilibrium: Empirical tests". *Journal of Political Economy* 81: 607-636.

In this paper, I chose to start with a window of one year which included the first 52 weeks of the weekly stocks returns and then I regressed them over the weekly market index to get the weekly betas for the individual stocks.

This will be explained later in the methodology section in chapter 4.

3.5 Challenges to the theory

In the early 1980s, several studies have dug deeply to investigate that there was a serious diversion from the linear CAPM risk return trade-off due to the affection of some other variables on this tradeoff. Some empirical studies found out that there are some contradictions to the CAPM, such as the “Size effect”. Banz⁸ published one of the earliest articles on the “Small-firm effect”, which is also known as the “Size-effect”. It states that over long periods of time, small firms (small part of capitalization or assets) tend to generate larger returns than large-company stocks. Many studies have shown that small firms tend to outperform large ones. According to the empirical data, the size of the firms and the return of the common stocks are inversely related, while CAPM states that only systematic risk is a factor that affects expected returns. Thus CAPM fail to predict the expected return in this case.

In 1992, Fama and French used the same method as Fama and McBeth did in 1973 but they have reached to very different conclusions, Fama and McBeth found the positive relationship between average return and its beta, while Fama and French found the CAPM could not fully prove the positive relationship between each other. Black⁹ argued that data are too noisy to invalidate the CAPM.

Ning and Liu¹⁰ use the time-series test and cross-sectional regression testing CAPM in the Shanghai Stock Exchange during 1996.1.1 to 2002.12.31. They found that there is no linear relationship between beta and the expected rate of return, however, the non-systematic risk has significant effect on the return.

⁸ Banz, R. (1981) “The relationship between returns and market value of common stock.” *Journal of Financial Economics* 9: 3-18

⁹ Black, F. (1993) “Beta and return”. *Journal of Portfolio Management* 20: 8-18

¹⁰ Ning, G.R. and Liu, P. (2004) “Empirical Test of CAPM in Shanghai Stock Market” *Journal of Shijiazhuang University of Economics* Vol.27 2:194-197.

Xue and Zhou¹¹ has applied the same methods to test CAPM from 1995.6.1 to 2001.6.2, and found out that the CAPM did not hold true in the first three periods (the first period from 1995.6.9 to 1998.6.5; the second period from 1996.6.7 to 1999.6.4 and the third period from 1997.6.6 to 2000.6.2) but held true in the fourth period (from 1998.6.5 to 2001.6.2). They argued that this is because the investors are becoming more and more rational.

3.6 The academic debate continues

In fact, when we investigate academically and heavily in many sources, we'll find that Fama and French were criticized for their own paper which was published in 1992.

Many researchers have cast a careful doubt on the findings of Fama and French which were in relation to how the statistical findings are interpreted.

In fact, those researchers have agreed upon the fact that the data are too noisy when it comes to invalidate the CAPM model.

Amihudm, Christensen and Mendelson [1992] and Black [1993] have suggested a more efficient way of improving the methodology used by Fama and French which depends partially upon using an efficient statistical method, saying that, the estimated relationship between the average return and beta is held to be positive and significant.

Drawing an attention to the size effect noticed by Banz [1981], Black suggests that this size effect could be the effect of one sample period "i.e. the size effect is observed in some periods and not in others."¹²

In fact, when we investigate academically and heavily in many sources, we'll find that Fama and French were criticized for their own paper which was published in 1992.

¹¹ Xue, H. and Zhou, H. (2001) "Empirical Test of CAPM in Shanghai Stock Exchange" *Research on the Financial and Economics Issues* 11: 33-37.

¹² Testing the Capital Asset Pricing Model (CAPM): The Case of the Emerging Greek Securities Market by Grigoris Michailidis, Stavros Tsopoglou, Demetrios Papanastasiou and Eleni Mariola

Many researchers have cast a careful doubt on the findings of Fama and French which were in relation to how the statistical findings are interpreted.

The reason behind the criticism of Fama and French comes from the fact that alternative asset pricing models should be considered as well.

Jagannathan and Wang [1993] argue that the failure of the empirical findings to support the CAPM was mainly due to basic assumptions which were made to facilitate the empirical analysis. One of those assumptions is the consideration of the return on the market indices as a very close proxy for the return on the market portfolio containing all the assets which exist in the national economy. One could argue that these market indices cannot capture the whole assets in the economy such as the human capital!

3.7 Critique

In this brief subsection, I intend to present a short description on what might be referred to as the “Disadvantages of the CAPM”. It’s well-known that we can spot a number of disadvantages and unrealistic limitations imposed by the CAPM model. In order to work with the CAPM model, we need to substitute the relative values to the risk-free rate of return, the return on the market and the securities’ beta.

It’s obvious for those who has an unlimited knowledge in the way the market is operating (Academics, Practitioners and Researchers) that the yield on the treasury bills (which makes up the use of a risk-free rate) is a variable rather than fixed due to the daily changes in the economic circumstances which are the dynamic cause of the risk-free rate’s changes, thus we can see clearly how complicated could that be!

In fact, smoothing out this volatility will be dependent upon using a short-term average value and what makes it much harder is to find a value for the ERP. The literature shows that in order to stand for the return on the stock market, we are required to obtain the sum of the average capital gain across the market and the average dividend yield of the listed companies.

Negative returns will be present rather than positive values in the short run if the impacts of the falling stocks’ prices outweigh the dividend yield.

“It is therefore usual to use a long-term average value for the ERP, taken from empirical research, but it has been found that the ERP is not stable over time”¹³

Academics and researchers might face some unreality in capturing the exact expected return, and this unreality could be due to the fact that beta is not constant but changes over time!

¹³ CAPM: theory, advantages, and disadvantages, student accountant, June/July 2008

-Chapter four-

Data approach and testing methodology

In this chapter, the readers will be introduced to the methodology that was applied in testing the validity of the CAPM, also the sample selection and the data selection. This chapter will be the center point of this thesis as regard the importance of its results.

4.1 Sample Selection

The study covers the period from 2004.11.12 to 2009.10.9; the selection of the data covers the companies listed in the Bombay Stock Exchange (SENSEX30), these companies count to be 30 stocks but the actual study has covered only 28 stocks instead of 30 because there were two stocks missing from the data of DataStream, the returns of these two stocks couldn't be identified that's why it was decided to apply the testing on the 28 stocks listed in the SENSEX30. These stocks represent different categories of different industries in the Indian market (i.e. Automobile, Financial services, Oil and gas, construction ...).

4.2 Data Selection

The study uses weekly stock returns for the sampled 28 companies listed on the SENSEX30 for the period of 2004.11.12 to 2009.10.9.

The data were obtained from the DataStream at Lund University, School of Economics and Management (LUSEM).

Aiming at accurate estimates of the beta coefficients, the study was designed to include weekly stock returns. The reason why I chose the weekly returns is that returns obtained using a longer time period (e.g. monthly) might result in changes in estimates of beta. This would lead to a measurement biases in beta estimation over the examined period. On contrary, data with an intensive frequency such as daily returns might result in the use of very noisy data leading to inefficient estimation.

The weekly return of the SENSEX30 Share Index is used as a proxy for the market portfolio.

Furthermore, the one year Indian Treasury-Till was used as a proxy for the risk free rate

4.3 Methodology

The first step was to estimate a beta coefficient for each stock using weekly returns during the period of November 2004 to October 2009. The beta was estimated by regressing each stock's weekly return against the market index according to the following equation:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_{it} \quad (1)$$

Where:

R_{it} is the return on stock $i = (1, 2, \dots, 28)$

R_{ft} is the rate of return on a risk-free asset

R_{mt} is the rate of return on the market index

β_i is the estimate of beta for stock i

ε_{it} is the corresponding random disturbance term in the regression equation

The above equation could be expressed by the equation:

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it} \quad (2)$$

Where:

$R_{it} - R_{ft} = r_{it}$ and $R_{mt} - R_{ft} = r_{mt}$

r_{it} is the excess return of stock i

r_{mt} is the average risk premium

The intercept α_i is the difference between the estimated expected return by time series average and the expected return predicted by CAPM. If CAPM describes expected returns and a correct market portfolio proxy is selected, the regression intercepts of all stocks are zero.

In *the first step*, I took a window of 53 weeks to regress the weekly returns of the listed stocks on the weekly returns of the SENSEX30 index at the same period, this will result in 53 betas for each stock in the first period, and then I started to move the window week by week, eventually, I will have 205 betas for each stock during the period from November 2004 to October 2009, this method was used to eliminate the measurement bias that would be created by such test. In this way, we will have 4 periods running from Nov 04 to Oct 09.

This is the *first step* and was devoted to estimate the beta coefficients for the listed stocks.

In the second step is to estimate the ex-post Security Market Line (SML) for each week, this will be done by regressing the stocks' returns against the stocks' beta coefficients which were obtained in step one.

If we view $E [R_i] = R_f + \beta_i (E [R_m] - R_f)$ as the Security Market Line (SML), we can estimate γ_0, γ_1 in the following equation and use the estimated beta from the last step;

$$r_i = \gamma_0 + \gamma_1 \beta_i + \varepsilon_i \quad (3)$$

Where:

r_i is the average excess return on the stock,

β_i is beta of stock i,

ε_i is random disturbance term in the regression equation.

.

If the CAPM is true, γ_0 should be equal to zero and the slope of SML, γ_1 , is the market portfolio's average risk premium.

This step will be performed by running a weekly cross-sectional regression of the weekly stocks' returns on the betas estimated in step one.

In each week, we will get a value of the intercept γ_0 and the coefficient γ_1 ; this cross-sectional regression will be run from the first week till the last week in our time horizon.

Eventually, we will get 205 values for both the intercept γ_0 and the coefficient γ_1 .

The motive behind this step is to test the hypothesis that the intercept γ_0 should equal to 0 and the coefficient γ_1 should equal to the market portfolio's average risk premium.

The third step is to test for nonlinearity between stocks' returns and the estimated betas in the first step; a weekly cross-sectional regression was run on stocks' returns, calculated stocks' betas, and beta-square from equation:

$$r_i = \gamma_0 + \gamma_1 \cdot \beta_i + \gamma_2 \cdot \beta_i^2 + \varepsilon_i \quad (4)$$

Finally in order to examine whether the residual variance of stocks affects its returns, an additional term was included in equation (5), to test for the explanatory power of non-systematic risk:

$$r_i = \gamma_0 + \gamma_1 \cdot \beta_i + \gamma_2 \cdot \beta_i^2 + \gamma_3 \cdot \mathbf{RV}_i + \varepsilon_i \quad (5)$$

Where:

\mathbf{RV}_i is the residual variance of stocks' returns (Equation 2),

$$\mathbf{RV}_i = \sigma^2 \varepsilon_i$$

This test will allow us to examine whether the expected excess return on securities are determined only by systematic risk and are independent of the non-systematic risk, as measured by the residuals variance¹⁴

After conducting these three cross sectional regressions by applying equations (1) to (5), we will end up with 4 estimates of the coefficients and therefore the null hypotheses can be tested according to the following criteria:

- i) $\gamma_3 = 0$ or residual risk does not affect return,
- ii) $\gamma_2 = 0$ or there are no nonlinearities in the security market line,
- iii) $\gamma_1 > 0$ that is, there is a positive price of risk in the capital markets (Elton and Gruber [1995], p.336).

4.4 t-tests

In order to statistically test the CAPM, *t*-tests will be used. I chose a significance level of 95%, which means that a significant result at the 95% probability level tells us that the data are good enough to support a conclusion with 95% confidence. Hence, there is also a 5% chance of being wrong. The 95% critical value from the *t*-distribution is 1.96. Thus we will use 1.96 in a later analysis in order to verify the precision of the estimation results.¹⁵

¹⁴ Bodie, Z., Kane, A., Marcus, A.J. (2005) *Investment*, 6th edition. The McGraw-Hill/Irwin series in finance, insurance and real estate. p.418.

¹⁵ http://en.wikipedia.org/wiki/Student's_t-test 2006-10-26.

-Chapter five-

The empirical results and analysis

This chapter is devoted to document the results of testing the CAPM by using the methods mentioned in the last chapter; furthermore, we will analyze the failure of the CAPM in the whole period and its success in the subsample periods, short interpretations are followed at each section

5.1 Estimation of stocks' betas

In the first step as mentioned in chapter 4, we run a time series regression of the weekly stocks' returns over the weekly index (SENSEX30) returns to estimate the beta for each stock, this method was done by taking a window of 1 year comprised of 53 weeks, then moving the window week by week until we get 205 betas for each stock, the motive behind this is to eliminate the measurement error that could be produced during the process of beta estimation.

After conducting the time series regression as in step one, the range of betas estimated varies between **0.174** (i.e. the minimum) and **2.171** (i.e. the maximum) for the listed stocks from Nov04 to Oct09.

5.2 Running the cross-sectional regression and the estimation of the regression coefficients

Now after estimating the betas for these stocks in the market (β 's), our mission is to sort these values with the excess returns on the stocks ($\mathbf{R}_i - \mathbf{R}_f$) and run the cross-sectional regression in order to estimate the intercept γ_0 and the coefficient γ_1 for which we test our hypotheses.

In the next step-as mentioned in the theoretical framework- we add a new variable (β^2) into our regression analysis in order to estimate the coefficient γ_2 .

Finally we add the residual variance of stocks (RV^2) to estimate the last coefficient γ_3 .

Adding two additional variables into our regression will result in three cross-sectional regressions.

Running these regressions will result in 205 different values for each coefficient including the intercept γ_0 varying from week to another; therefore we will list the average values for these coefficients and the intercepts for the whole period with each executed test:

	γ_0	γ_1
Average	-0.000858245	0.002535868
t-value	-0.300246743	0.846771883
p-value	0.764296197	0.39811942

Table 5.1 the first cross-sectional regression (Estimation of SML)

	γ_0	γ_1	γ_2
Average	0.004407	0.005081	-0.007320448
t-value	0.921197	1.216774	-0.832254002
p-value	0.358041	0.225103	0.406248414

Table 5.2 the second cross-sectional regression (Test for Non-Linearity)

	γ_0	γ_1	γ_2	γ_3
Average	0.000978	-0.05137	0.000662	0.00070
t-value	0.178831	-0.04487	0.138434	0.07264
p-value	0.858251	0.964259	0.890036	0.942165

Table 5.3 the third cross-sectional regression (Test for Non-Systematic risk)

We can see clearly based on what we had in these tables that the CAPM model could not be explained by applying the model on the whole period, and the following conclusions can be drawn from tables 1 to 3:

- The absolute t -value (0.300246743) of the intercept, γ_0 , is within the 1.96 brackets. Thus it's insignificant and not different from zero. The parameter γ_1 is not significant different from zero because the absolute t -value (0.846771883) is smaller than 1.96, thus no main conclusion can be drawn from these results leading to question the power of these data to explain the validity of this model in the first cross-sectional test (Estimation of SML). .
- The test of the non-linearity between stocks' returns and the estimated betas, absolute t -value (0.921197) of the intercept γ_0 is within the 1.96 brackets, thus it is not significant different from zero, which is consistent with the CAPM hypothesis. The parameter γ_1 is not significant different from zero because the absolute t -value (1.216774) is smaller than 1.96, which is inconsistent with the CAPM hypothesis. The absolute t -value (0.832254002) of γ_2 is smaller than 1.96, i.e. it is not significant different from zero, which is consistent with the CAPM hypothesis. Thus, the CAPM cannot clearly be rejected here according to the tests but still this test shows the weakness of the data to explain the validity of the CAPM.
- When testing the non-systematic risk, the absolute t -value (0.178831) of the intercept, γ_0 is smaller than 1.96, which is not significant different from zero. This is consistent with the CAPM. While γ_1 is not significant different from zero since the absolute t -value (0.04487) is smaller than 1.96, that is inconsistent with the CAPM hypothesis. The absolute t -value (0.138434) of γ_2 is smaller than 1.96, it is not significant different from zero. The parameter γ_3 is also not significant different from zero since the absolute t -value (0.07264) is smaller than 1.96, both the results of γ_2 and γ_3 are consistent with the CAPM hypothesis. Thereby, we conclude that non-systematic risk appears not to be important to the returns during the whole period. CAPM cannot clearly be rejected in this period.

From the analysis above, the results couldn't fully support CAPM. The positive relationship between expected return and beta indicated by the CAPM hypothesis is still rejected when estimate the SML in whole period, but the expected return-beta relationship is linear and non-systematic risk has no effect on the return. Thereby, we conclude CAPM isn't fully valid in the

whole period sample and the above results show that this model has serious problems during the whole period due the shortages of the data to explain the validity of this model.

The viewer will approach the previous results as conclusive evidence that the validity of the CAPM cannot be identified or determined by the data in the whole sample running from Nov 04 to Oct 09.

Therefore, we shall divide the data sample into 5 subsamples of 1 year each to test for the validity of the CAPM.

5.2 The subsamples tests

To sum up so far, we have three different tests to run when testing for the CAPM:

- The estimation of the security market line (SML)
- The test for Non-Linearity
- Finally, the test for Non-Systematic Risk

Running these different tests to examine whether we can reach any conclusive evidence in favor of the CAPM model has failed to provide us with what we aimed at, therefore we followed the same approach but on an annual-basis this time.

After applying this approach, we had some better results in some years but still did not support the CAPM hypothesis. As mentioned above, the data for the whole period (5 year data) do not explain whether the CAPM is valid in the Bombay stock exchange or not, therefore we decided to do subsamples tests in order to analyze the weakness of these data in the whole period sample. In our sample, we'll divide the data into 5 subsamples of 1 year each and test for the intercept γ_0 and the other coefficients in each subsample. After conducting these subsamples' tests, in the following section, we will embody the results and their interpretations so the readers can understand properly the bottom-line of this paper and stand by the power of the CAPM in the BSE. Below we have four tables which show the testing results for each cross sectional regression and these tables will represent the average value, the t-value and finally the p-value for the cross-sectional regressions done.

Table 5.4 the test for Non-Linearity (γ_2)

γ_2	value	t-value	p-value
04-05	-0.01873	0.69558	0.490923
05-06	-0.00265	0.12161	0.903851
06-07	-0.0151	0.89597	0.37591
07-08	0.013126	0.988558	0.329133
08-09	-0.01325	0.76978	0.446191

Table 5.5 the estimation of SML (γ_0)

γ_0	average	t-value	p-value
04-05	0.013184529	2.4609643	0.01838706
05-06	-0.008848	1.14804783	0.25794221
06-07	0.00326145	0.42696627	0.67175183
07-08	0.00812903	1.25099615	0.21838877
08-09	0.002762728	0.38864282	0.69965409

Table 5.6 the estimation of SML (γ_1)

γ_1	average	t-value	p-value
04-05	-0.00468093	0.71221858	0.48056872
05-06	0.011867802	1.465935923	0.15068263
06-07	0.00216057	0.502550892	0.61810617
07-08	0.023660614	4.185571132	0.00015661
08-09	0.02032872	20.1299083	3.31353E22

Table 5.7 the test for Non-Sys risk (γ_3)

γ_3	value	t-value	p-value
04-05	-0.00628	0.21337	0.83221
05-06	0.020927	0.75725	0.45371
06-07	0.01812	1.17383	0.24793
07-08	0.015068	1.12832	0.26649
08-09	0.00807	-0.4394	0.66291

In fact, we have run three different cross sectional regressions to test for each of the coefficients we have, and below detailed explanations are presented to summarize the results of those regressions.

5.3 Interpreting the results of the subsamples' tests

As mentioned before, the reason behind this section is to give the readers the outline of what was done in the subsamples' tests, therefore, the results will be interpreted and much light will be shed on the results of cross-sectional regressions.

I. SML Test for γ_0, γ_1 :

- **2004-2005:** The absolute t -value (2.4609643) of the intercept, γ_0 , is greater than 1.96, thus it's significantly different from zero which contradicts the foundation of the CAPM hypothesis that the intercept γ_0 should equal to zero. The parameter γ_1 is not significant different from zero because the absolute t -value (0.71221858) is smaller than 1.96 which is inconsistent with the CAPM hypothesis, thus the CAPM was clearly rejected in the first period of the subsamples' tests due to the inconsistencies of the testing results to the null hypotheses, this will lead us to comprehend the failure of the model in the first subsample period.
- **2005-2007:** We can notice clearly that the this period consists of two subsamples (05/06 and 06/07), and if we go back to the results concerning γ_0 in this period, we'll find no inconsistencies in this period contradicting the CAPM since the t -values (1.14804783, 0.42696627) for the intercept γ_0 are smaller than 1.96 for the two periods 05/06 and 06/07 respectively, thus γ_0 proves to be insignificantly different from zero. As for the parameter γ_1 , the t -values (1.465935923, 0.502550892) are smaller than 1.96 which tells us that γ_1 is not significant different from zero leading to an inconsistent result with the CAPM model, again the data proves that the CAPM is still rejected in this period.
- **2007-2009:** Again, this period has two subsamples 07/08 and 08/09, and what differentiates this period from other periods is that the data does not seem to reject the CAPM and below a reasonable explanation for this:

The absolute t-values (0.21838877, 0.69965409) for γ_0 are smaller than 1.96 which is consistent with the CAPM hypotheses that we imposed before; say γ_0 is not significantly different from zero.

Another reason behind the acceptance of the CAPM (at least not to reject) in this period is that the t-values in the two periods (07/08) and (08/09) for γ_1 are respectively (0.00015661, 3.31353E22) have shown up consistency with the alternative hypothesis (H1 :) that γ_1 should be greater than zero; γ_1 is significantly different from zero which approves the acceptance of the CAPM along with the acceptance of the (H0 :) for γ_0 .

In conclusion, the CAPM was rejected in three subsamples which are (04/05, 05/06 and 06/07) due to the fact that both γ_0 and γ_1 were insignificantly different from zero.

In the later subsamples (07/08 and 08/09), the CAPM was not rejected because γ_0 proves to be insignificantly different from zero and γ_1 was significantly different from zero; γ_1 was greater than zero which has provided the solid ground on which not to reject the CAPM.

II. Non-Linearity test for γ_2 :

Running this test all over the 5 subsamples that we have, the results have shown that in each subsample (04/05 to 08/09) the beta square coefficient γ_2 was insignificantly different from zero implying that there is a linear relationship between expected returns and market beta. In this linear relationship, beta explains fully the cross-sectional variation in expected returns. In addition to beta, there is no other variable (or “factor”¹⁶) which can explain expected returns.

In conclusion, γ_2 is not significantly different from zero which is consistent with the CAPM model.

¹⁶ To be precise: The word “factor” is usually reserved for variables like the market or other time series, usually portfolio returns, and not the sensitivity of expected returns to them. Actually, this is also a matter of whether we regress returns on betas or on the market. But we are getting ahead of ourselves but for the time being; just note that “factor” will later take a particular meaning. hence the word “variable” is more appropriate here

Non-Systematic Risk Test for γ_3 :

In the previous context, there was no clear definition of the non-systematic risk and, therefore, we decided to include a brief discussion about this factor, and this is for its merely importance in the CAPM model so the readers can understand the role of such factor in the power of the CAPM.

We can say that there are two components for the risk of any portfolio; these components are:

- I. Systematic Risk are can be called sometimes as “Undiversifiable Risk”
- II. Unsystematic Risk or as it’s known “the idiosyncratic or diversifiable risk”

The systematic risk is the risk that all securities in the market are exposed to i.e. the market risk. On the other hand, the unsystematic risk is the risk which is linked or tied with the individual assets in the portfolio, and to decrease the level of this risk, investors should increase or raise the number of assets in their portfolios such that the effect of this risk will be induced to decrease by higher levels of assets inclusions within the portfolios. We call this in the literature as “The average out”.

In fact, the average out will not have the same effect on the Systematic risk in one market. Within the framework of developed markets i.e. US or the UK, an approximate number of 30 to 40 securities will construct a portfolio which is diversified to limit exposure to the systematic risk only whereas in developing markets the case is quite different since larger volumes required due to higher asset volatilities.

“In the CAPM context, portfolio risk is represented by higher variance i.e. less predictability. In other words the beta of the portfolio is the defining factor in rewarding the systematic exposure taken by an investor”¹⁷.

Back to the test results, and testing for γ_3 all over the subsamples, we found that γ_3 was insignificantly different from zero implying that non-systematic risk appears not to be important to the returns for each of the tested subsample.

¹⁷ www.edinformatics.com/investor_education/capital_asset_pricing_model.htm

-Chapter 6-

The concluding remarks

In this brief chapter, the author will present the findings from this article regarding the matter of this paper; these findings will be presented in a thorough and useful order.

The article examined the validity of the CAPM for the Bombay stock exchange. The study has used weekly stock returns from 28 companies listed on the Bombay stock exchange from November 2004 to October 2009.

Running three different tests on the entire 5 year period haven't given any conclusive evidence in favor of the CAPM validity therefore we decided to apply the subsamples statistics methods. Dividing the data into 5 subsamples has given us better results but still not supportive in favor of the CAPM in the BSE.

In fact, The CAPM's implies that the intercept (γ_0) should be equal to zero and the slope should equal the excess returns on the market portfolio. The results of the empirical testing have contradicted the above hypothesis and have shown evidence against the CAPM.

The paper has attempted to test for the non-linearity between stocks' returns and betas by inserting or including a beta square coefficient and we have reached the conclusion that supports this made hypothesis and therefore the expected return-beta association is linear.

On the other hand, the paper has gone through an additional matter to investigate by attempting to prove whether the residual risk has any effect on the expected return on the stocks.

This test was done by including the residual variance of the stocks and we found that the test for Non-Systematic risk is insignificant meaning that the residual variance has no effect on the expected return.

Since the study couldn't reach any conclusive evidence regarding the validity and the applicability of the CAPM model, I decided to take a yearly data and investigate this matter in what's called as "the subsamples statistics".

The results according to this new methodology have proven to be statistically better than the findings from the previous methodology in some years but still no conclusive evidence has been brought to light once again leading to the conclusion that the CAPM hypothesis couldn't be verified.

The results of the tests conducted on data from the Bombay stock exchange for the period of November 2004 to October 2009 do not appear to clearly reject the CAPM. This does not mean that the data do not support CAPM

In his well-known explanation, Black [1972] attempted to explain these findings by the following:

- i. As regarding the measurement and model specification errors, these errors were created by using an alternative to the actual market portfolio, rather we used a proxy which is the return on the market index.
This error will attempt to shift the regression line estimated slope towards zero and divert its estimated intercept away from zero.
- ii. The CAPM model does not anticipate an intercept equals to zero if there's no risk-free asset
- iii. Finally, Black has implied that these tests might be interpreted as an evidence against the CAPM hypotheses but do not necessarily build up any conclusive evidence supporting any alternative model.

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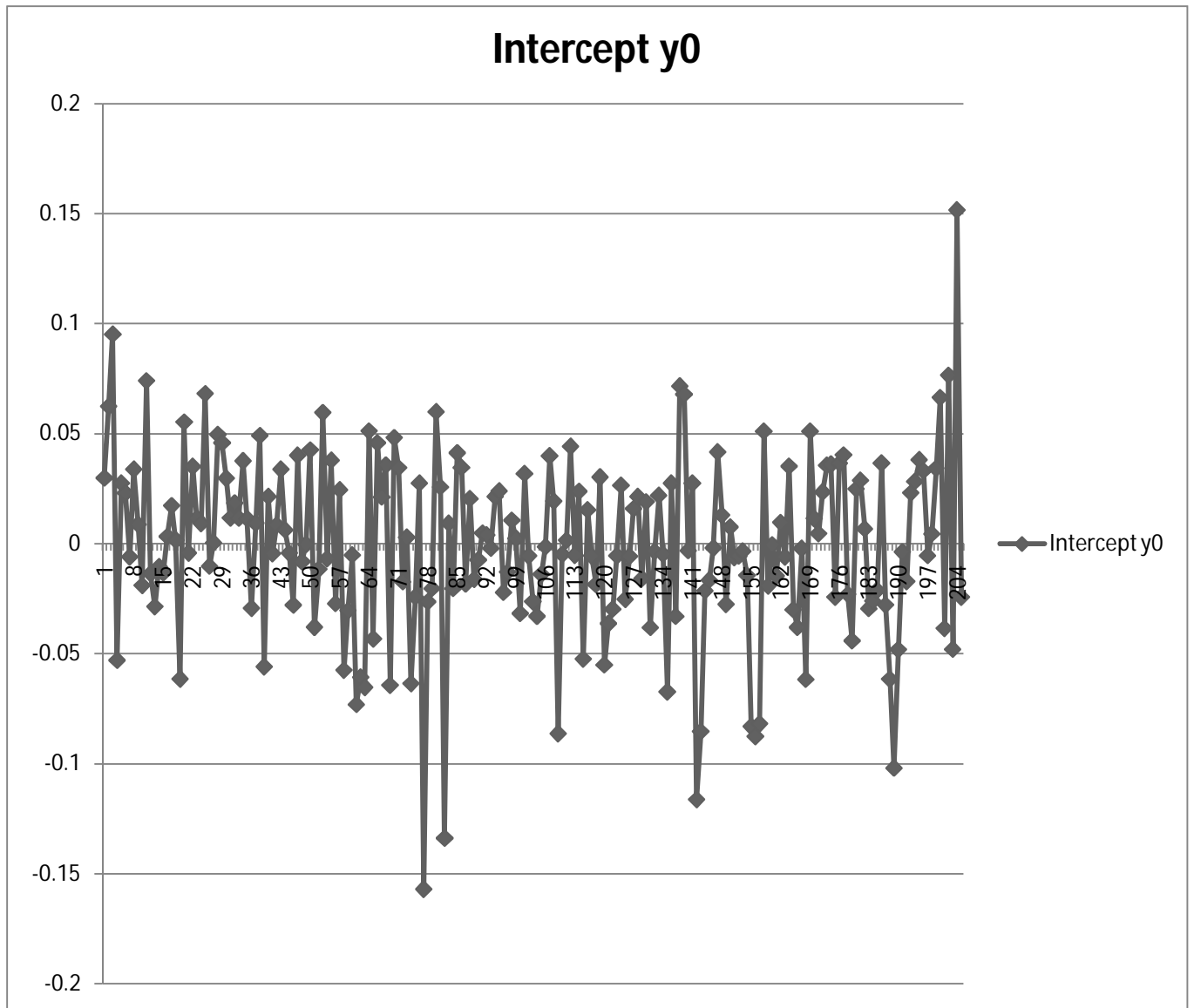
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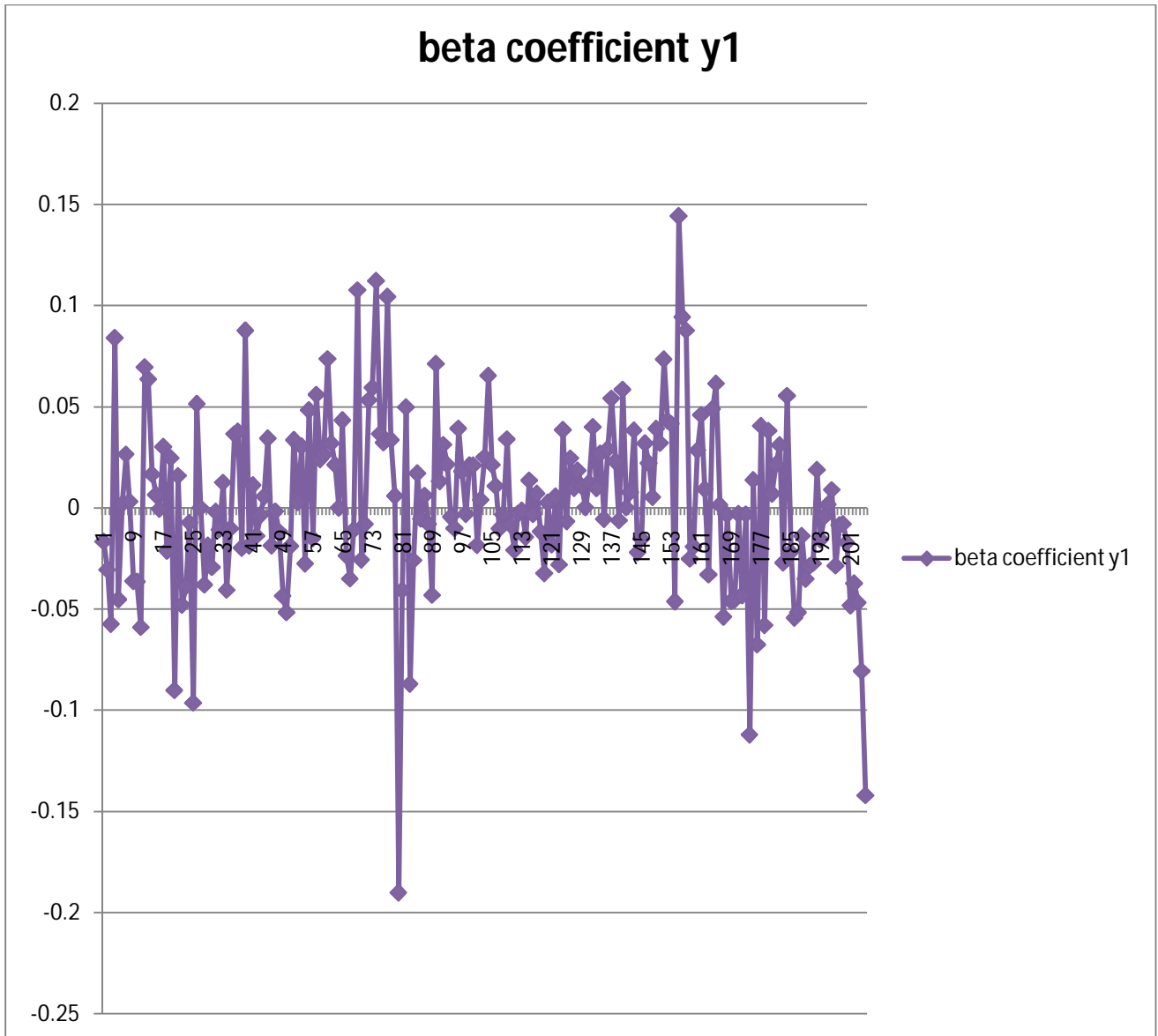
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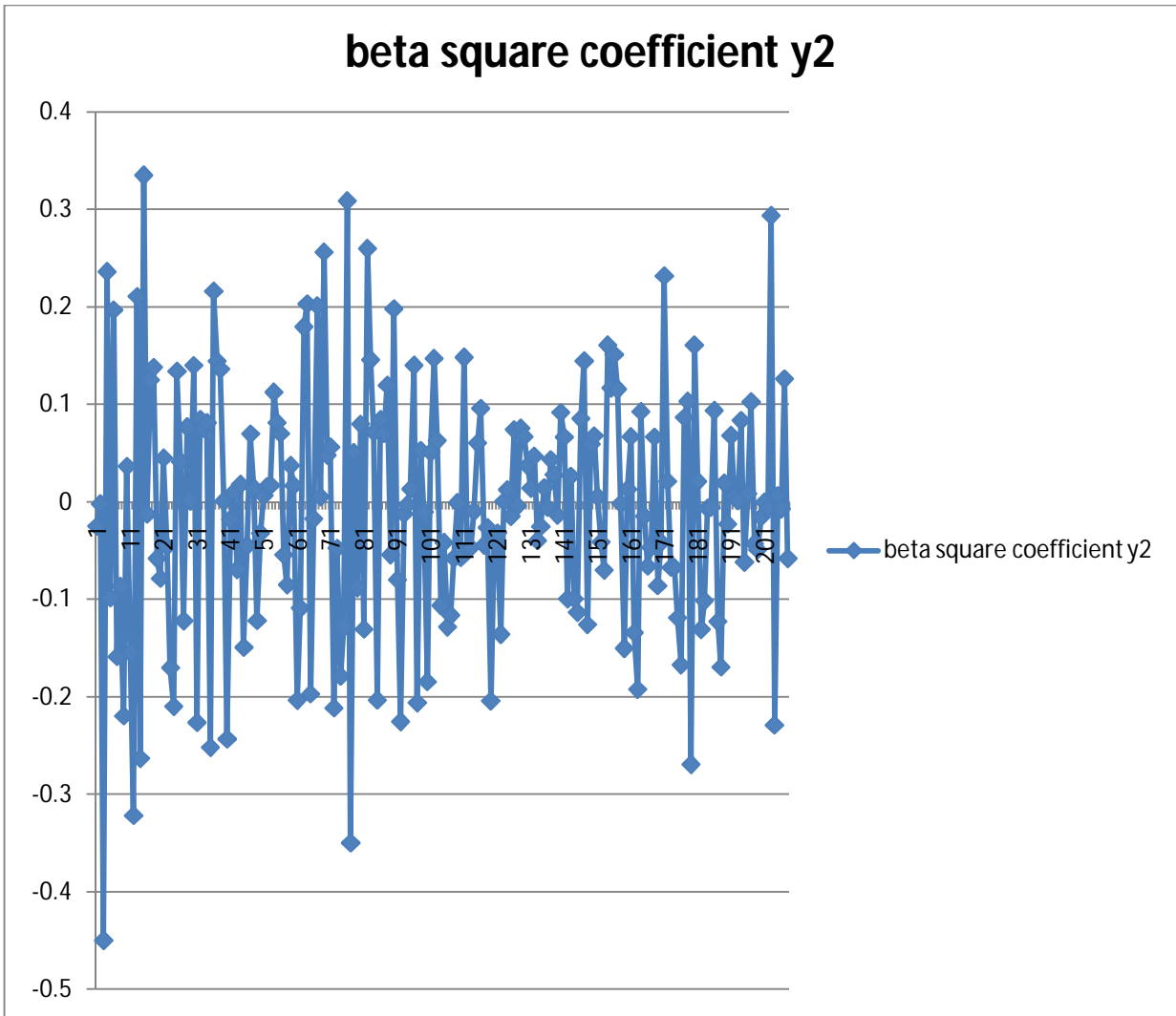
Appendix table 1: SML (y_0, y_1)



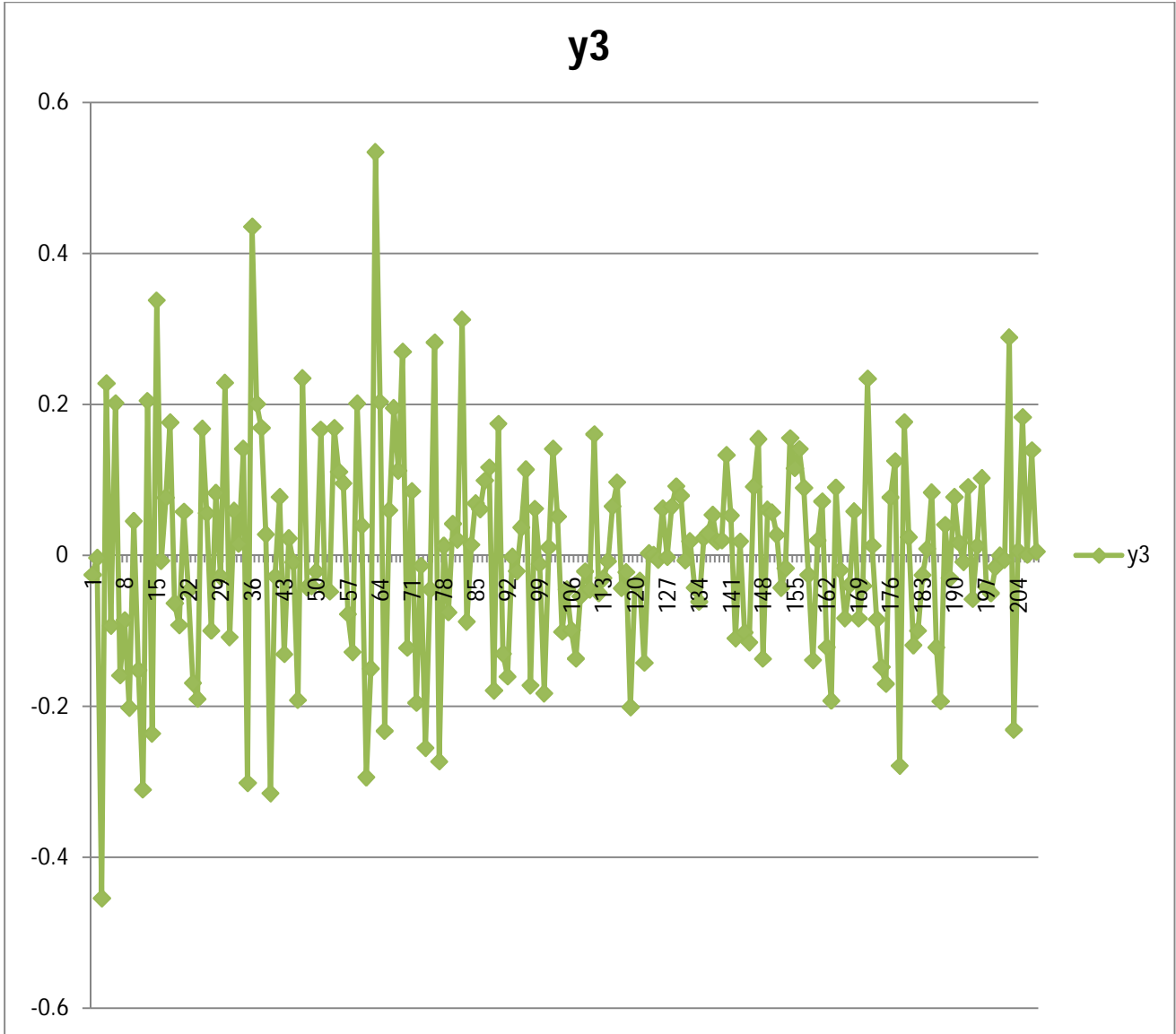
Y0 from period 1 to period 5 (Estimating the SML)



Y1 from period 1 to period 5 (Estimating the SML)

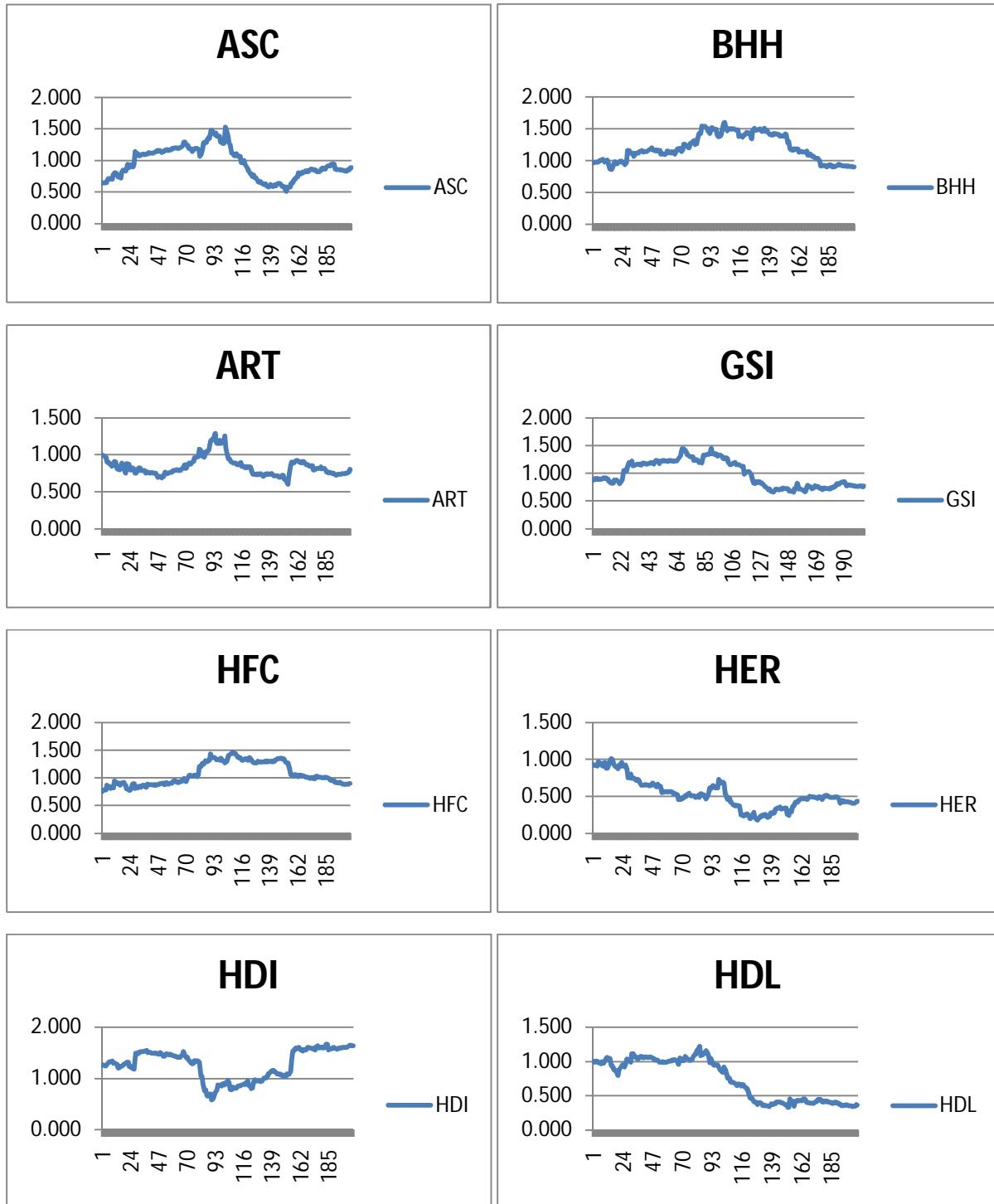


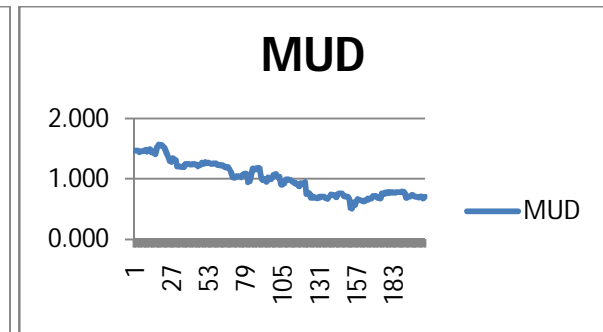
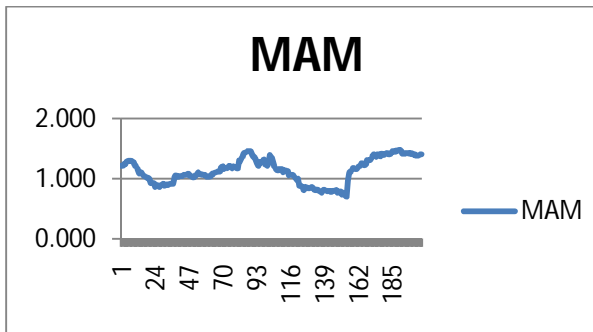
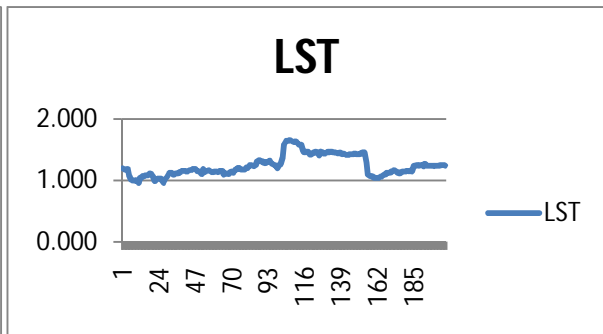
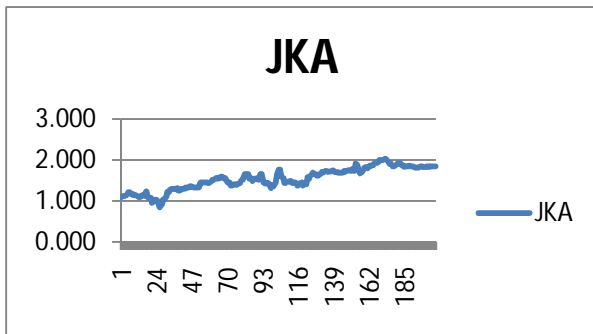
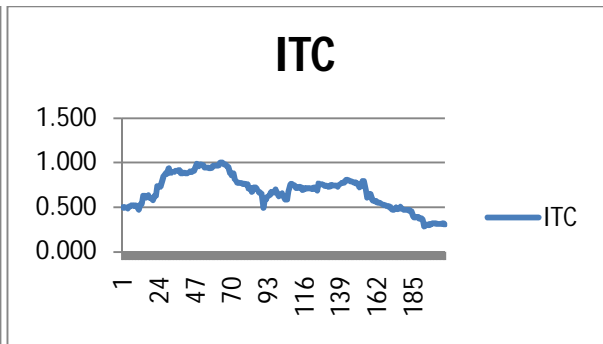
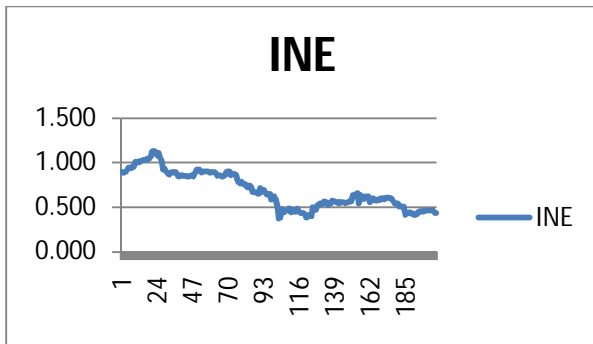
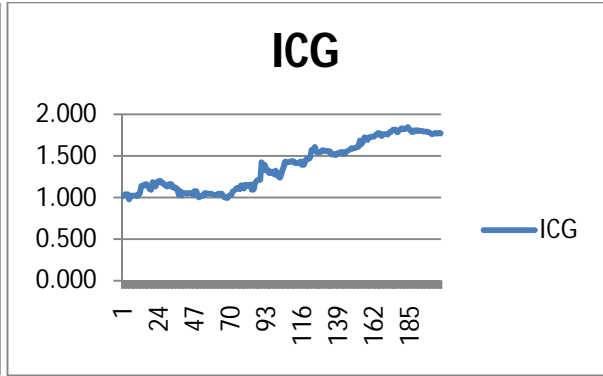
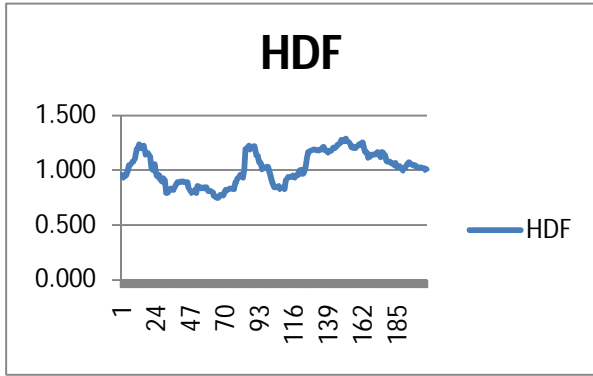
Y2 from period 1 to period 5 (Testing for Non-Linearity)

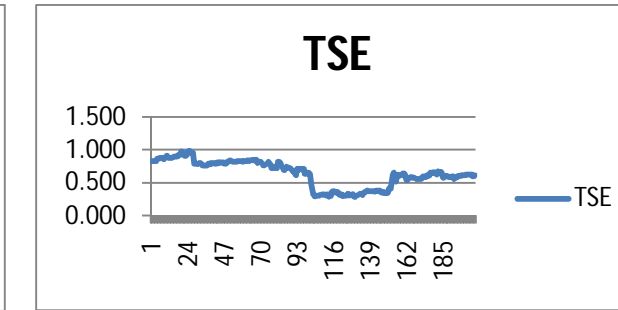
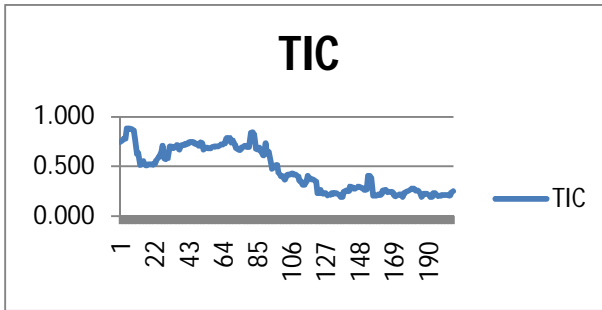
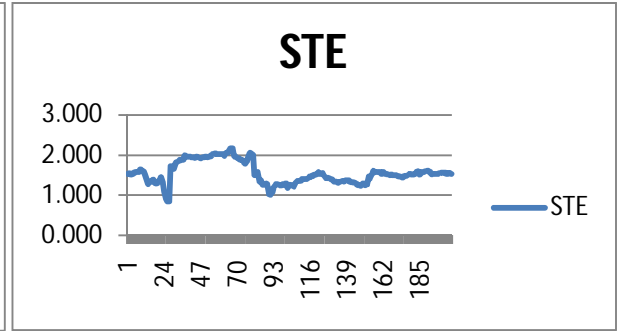
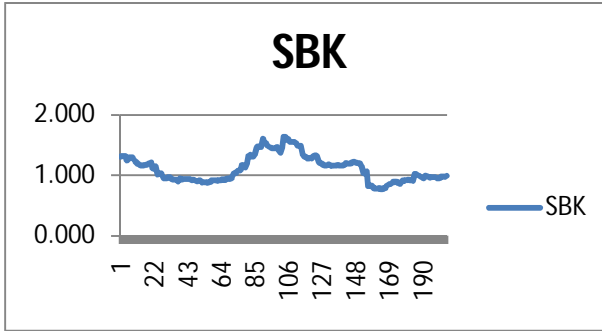
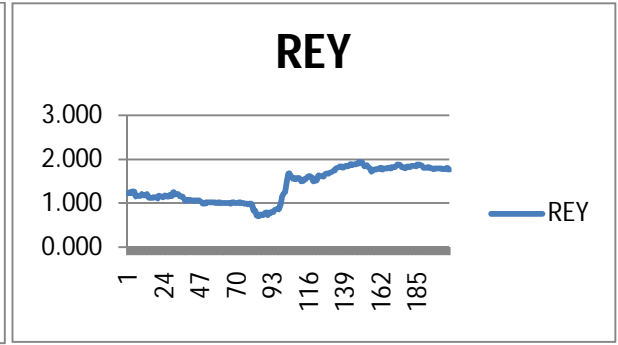
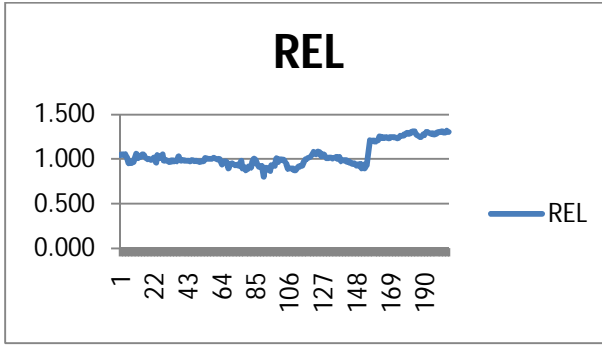
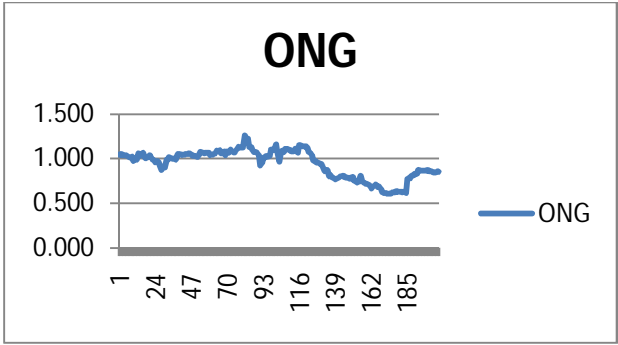
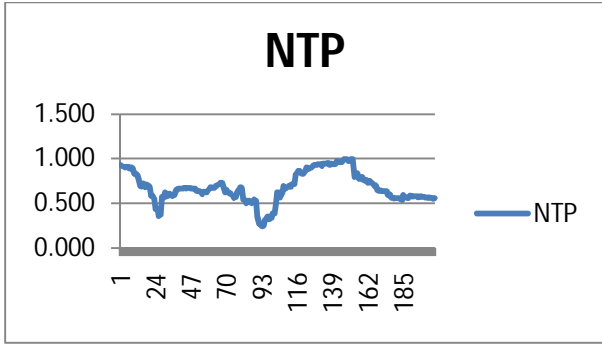


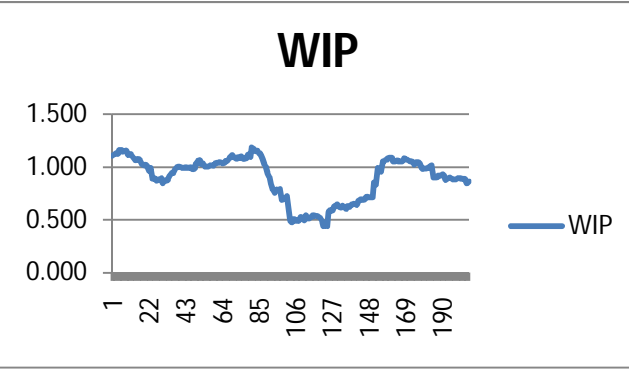
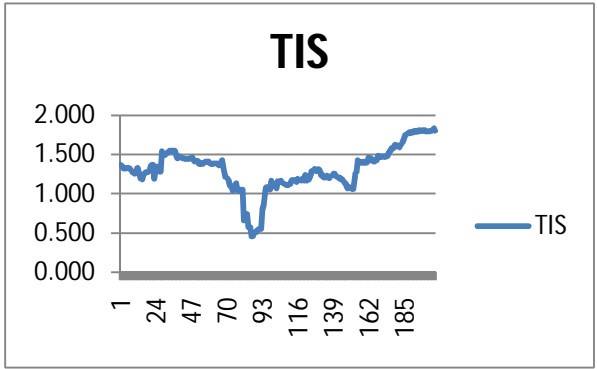
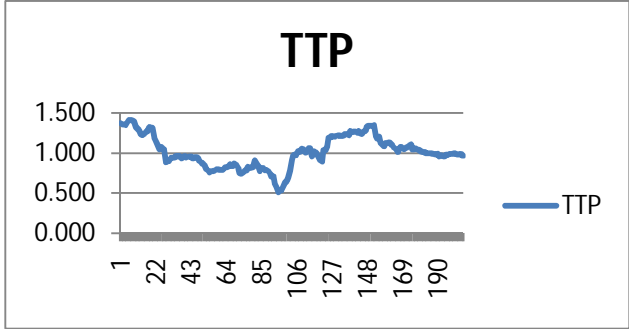
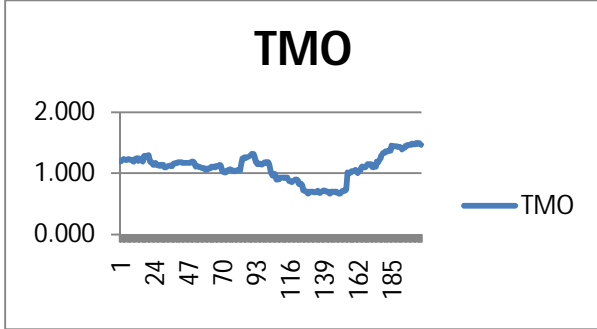
Y3 from period 1 to period 5 (Testing for Non-Systematic Risk)

Appendix table 2: stocks' betas plots over the period 04-09









Appendix table 4: Listed companies (stocks) on the SENSEX (Bombay Stock Exchange)¹⁸

Code	Name	Sector
500410	ACC	Housing Related
500103	BHEL	Capital Goods
532454	Bharti Airtel	Telecom
532868	DLF Universal Limited	Housing related
500300	Grasim Industries	Diversified
500010	HDFC	Finance
500180	HDFC Bank	Finance
500182	Hero Honda Motors Ltd.	Transport Equipments
500440	Hindalco Industries Ltd.	Metal, Metal Products & Mining
500696	Hindustan Lever Limited	FMCG
532174	ICICI Bank	Finance
500209	Infosys	Information Technology
500875	ITC Limited	FMCG
532532	Jaiprakash Associates	Housing Related
500510	Larsen & Toubro	Capital Goods
500520	Mahindra & Mahindra Limited	Transport Equipments
532500	Maruti Udyog	Transport Equipments
532555	NTPC	Power
500312	ONGC	Oil & Gas
532712	Reliance Communications	Telecom
500325	Reliance Industries	Oil & Gas
500390	Reliance Infrastructure	Power
500112	State Bank of India	Finance
500900	Sterlite Industries	Metal, Metal Products, and Mining
524715	Sun Pharmaceutical Industries	Healthcare
532540	Tata Consultancy Services	Information Technology
500570	Tata Motors	Transport Equipments
500400	Tata Power	Power
500470	Tata Steel	Metal, Metal Products & Mining
507685	Wipro	Information Technology

¹⁸ http://en.wikipedia.org/wiki/BSE_Sensex

- DLF replaced Dr. Reddy's Lab on November 19, 2007.
- Sterlite Industries replaced Ambuja Cements on July 28, 2008.
- Tata Power Company replaced Cipla Ltd. on July 28, 2008.
- Sun Pharmaceutical Industries replaced Satyam Computer Services on January 8, 2009
- Hero Honda Motors Ltd. replaced Ranbaxy on June 29, 2009

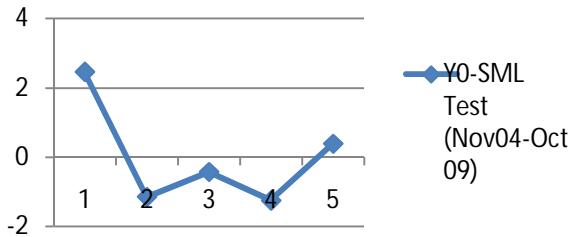
Appendix table 5: stocks' betas

stock	ACS	BHH	ART	GSI	HFC	HER	HDI	HDL	HDF	ICG	INE
Max β	1.528	1.293	1.455	1.465	1.010	1.670	1.221	1.286	1.845	1.135	1.001
Min β	0.507	0.860	0.604	0.659	0.756	0.174	0.583	0.331	0.748	0.974	0.369

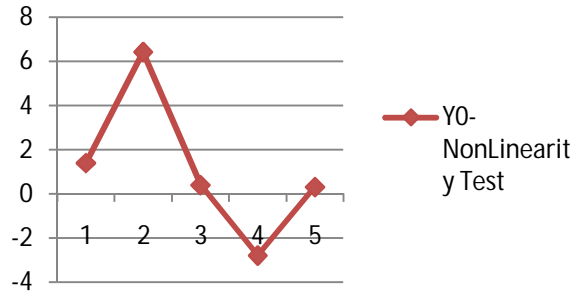
stock	ITC	JKA	LST	MAM	MUD	NTP	ONG	REL	REY	SBK	STE
Max β	1.001	1.475	1.649	1.475	1.568	0.999	1.260	1.316	1.929	1.642	2.171
Min β	0.282	0.838	0.952	0.699	0.510	0.245	0.607	0.805	0.701	0.770	0.842

stock	TIC	TSE	TMO	TTP	TIS	WIP
Max β	0.886	0.981	1.493	1.410	1.838	1.183
Min β	0.190	0.281	0.666	0.513	0.461	0.439

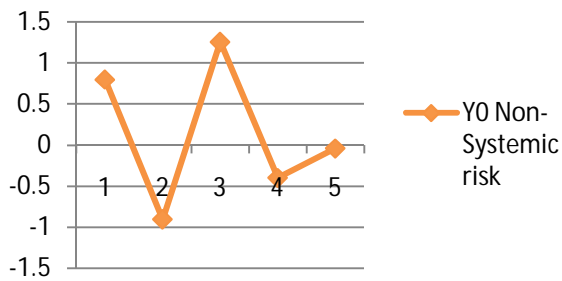
Y0-SML Test (Nov04-Oct09)



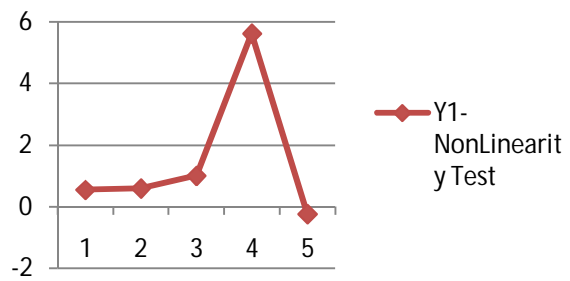
Y0-NonLinearity Test



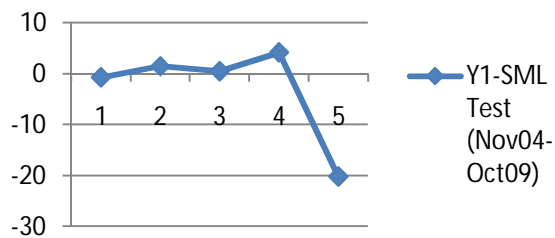
Y0 Non-Systemic risk



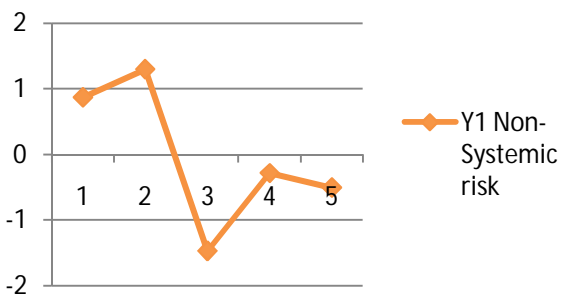
Y1-NonLinearity Test

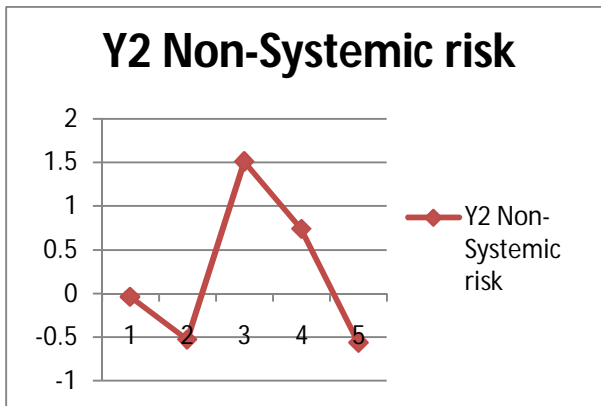
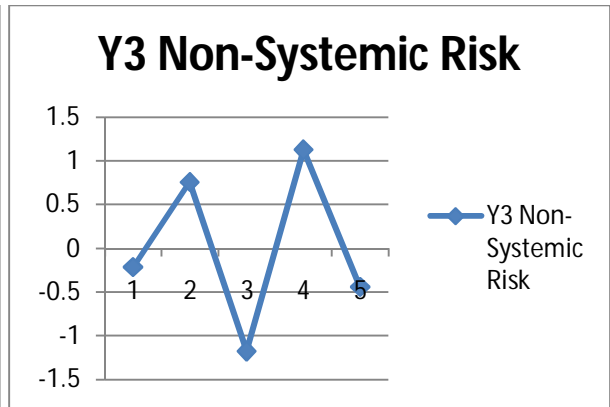
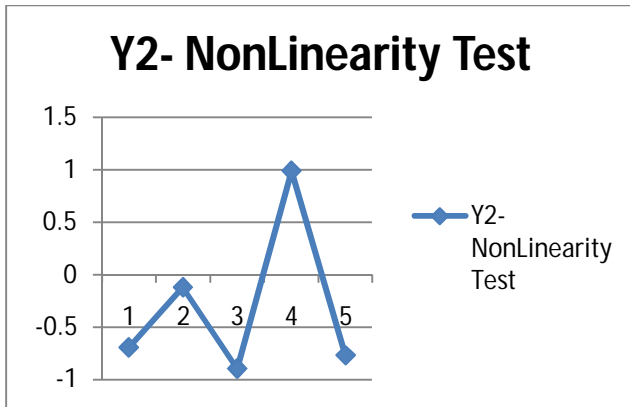


Y1-SML Test (Nov04-Oct09)



Y1 Non-Systemic risk





Appendix table 6: the plotting of the different coefficients