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# Excess Returns with Black Swan Investing on the Indian Stock Market

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**Abstract**: Previous studies have shown a significant relation between the beta value and return of a stock. In our study we show that excess returns on the National Stock Exchange in India can be obtained by using a Black-Swan investment strategy, with beta as a portfolio-building tool. A Black Swan is an unpredicted event that causes major market fluctuations. Observing daily return movements on the CNX Nifty index in India, we implement and evaluate our strategy looking at three different definitions of Black Swans, a daily increase/decrease of ± 4%, 5% and 6%, respectively. The investment strategy yields up to 558% excess returns to the index, a result we have not seen in previous studies.

**Key words**: Black Swan, Mean Reversion, Beta, Excess Returns, Emerging Markets, India

# 1. Introduction

## 1.1 Background

Originating from the belief that the people of the Old World thought all swans were white, the concept of the Black Swan illustrates the limitation to learning from observations and experience. It illustrates how one general statement can be formed based on millions of observations and then being hastily declared false and looses all credibility as a Black Swan appears. An event is called a Black Swan if it fulfills the following three attributes:
A Black Swan is rare and in econometrical and statistical terms it's an outlier where nothing in the past can predict its possibility. It also comes with an extreme impact and after the occurrence of the Black Swan humans tends to make it explainable and predictable (Taleb, 2010).

When examining the history of the stock market in the light of Black Swan events, it is inevitable to see how much impact a few days of extreme movements has on the long-run performance. Looking at the Standard & Poor's 500 Stock Index between 1950 and 2008, the value has gone from 17 US dollars to 1,540 US dollars, a roughly 9000 percent increase. Excluding the top 40 days of highest percentage gains on the market, however, would decrease the value in 2008 by 70 percent. If we instead were to eliminate the 40 worst days between 1950 and 2008, the result would be even more remarkable - instead of 1,540 US dollars, the value of the S&P 500 index would be 11,235 US dollars in 2008 (Bogle, 2008).

The impact of outliers has proven to be massive also on emerging markets. A long-term successful performance can be eliminated by just a few days of extreme negative movements. Investigating 16 emerging equity markets over a period of 28 years on average, Estrada shows in the article *"Black Swans in Emerging Markets"* (2009), that if we were to exclude the ten best market days, the aggregated value of the stock market would be 69.3 percent less valuable than holding a passive portfolio, i.e. investing in the world market index, while excluding the 10 worst market days would yield a portfolio value of 337.1 percent higher than a passive investment. Taking these Black Swan events into account when investing in the stock market, an investor could obtain massive excessive returns. Unfortunately this is impossible to achieve, since such a rare event as a Black Swan is highly unpredictable, leaving investor's success in the hands of the ugly bird (Estrada, 2009).

## 1.2 Purpose

In this thesis we are investigating whether there is a correlation between the beta value and return on stocks listed on the CNX Nifty index[1] on the National Stock Exchange (NSE) in India. The aim of the study is to show that the index can be outperformed using an active investment strategy where Black Swan events are the starting-point. We have seen similar research being done on the Nasdaq OMX30 and S&P 500 index but have found very few studies or results from any emerging market which is also the main reason for focusing our research in that direction. Further, the Indian stock market has shown great resilience with lower outflows compared to other emerging markets (Biswajit, 2014). As of 2007 the Indian rupee had shown stability and the inflation had somewhat declined where it adjusted towards a corrective mode which compared to many emerging markets made India relatively safe when considering trading. With India also being one of the BRIC countries and one of the fastest growing emerging markets during the first half of our study period (2002-2007) (O'Neill, 2007) it makes neither less to say the stock market interesting for investments. Within India there are a number of stock markets to choose from where the NSE is the largest, with approximately 1600 listed companies, concluding the background for our research area (National Stock Exchange India, n.d.).

## 1.3 Research Questions

We aim to answer the following questions:

- Is beta a good measure of risk for stocks listed on the CNX Nifty index?
- Is beta a valid tool when building portfolios in accordance to our strategy on the CNX Nifty index?
- Is it possible to outperform the CNX Nifty index using an active Black Swan investment strategy?

[1] Nifty is short for *National index of fifty*, and CNX stands for *CRISISL NSE INDEX* where CRISIL stands for *Credit Rating Information Services of India Limited*, which is a global Standard & Poor's company that provides ratings- and risk-analysis

### 1.4 Investment Strategy

The main idea behind our investment strategy is to use Black Swan events in our portfolio strategy instead of considering them as an exception. That is, instead of creating a portfolio based on the non-occurrence of these events, as is usually the case (Taleb, 2010), we will not just consider them in our portfolio strategy but also try to benefit from them by exploiting the market's reactions to such events. By using the concepts of mean reversion, the beta value and Black Swan events, a portfolio strategy can be created that might outperform the market. By creating different portfolios based on the beta value of the underlying assets and investing in these based on the category of the Black Swan (negative or positive) we believe that excess returns can be achieved. As the occurrence of a positive Black Swan takes place we will the following day invest in a portfolio consisting of low-beta stocks in order to minimize the decline of market returns as a result of mean reversion. As a negative Black Swan occurs we will invest in a portfolio consisting of high beta stocks, in order to benefit from the ascendance in the stock market due to mean reversion (Estrada & Vargas, 2010). Should this investment strategy be successful we can show that beta is a good measure of risk for the stocks on the CNX Nifty index, and a valid tool when building portfolios as in our strategy. In order to evaluate the impact of how a Black Swan is defined and since there is no clear definition of a Black Swan for daily returns from previous studies, this study will test three different levels of Black Swans. To see how the results may vary across the definitions we will evaluate how the investment strategy performs when a Black Swan is defined as a 4%, 5% and 6% daily increase/decrease on the CNX Nifty index, respectively. The results obtained from our investment strategy will be compared to a passive portfolio following the CNX Nifty index to where the first investment will be made at the same date as the occurrence of the first Black Swan. The invested amount in both portfolios will be 10,000 INR. The passive portfolio will be held until the end-date of the study period without any additional investments.

### 1.5 Main Results

Our results show that there is an evident correlation between the beta value and the return of a stock for each definition of a Black Swans investigated in this study. We can therefore conclude that beta is a good measure of risk for stocks listed on the CNX Nifty index. Moreover, using beta as a tool in our active portfolio strategy the final results obtained has been consistently positive, indicating that beta is a valid tool when building portfolios. Finally we find that the benchmark index can be outperformed using the active portfolio strategy.

# 2. Theory

## 2.1 The definition of a Black Swan

There is no clear definition of how to evaluate when a Black Swan occurs. In previous studies, different technical definitions of a Black Swan have been used when testing portfolio strategies in the light of Black Swans. Estrada & Vargas define a Black Swan as a monthly return movement of 5 % in absolute values, when comparing the MSCI (Morgan Stanley Capital International) world equity market index with a world market portfolio consisting of both developed and emerging markets around the world as well as different industries, between January 1974 and December 2009 (Estrada & Vargas, 2010). In this thesis, we implement our investment strategy looking at the NSE over the years between 2002 and 2014, using a similar definition as Estrada & Vargas. Instead of monthly returns, we define the occurrence of a Black Swan event as a daily market return of ± 4%, 5% and 6% in absolute values, respectively. We implement our investment strategy in the light of this definition of a Black Swan event, so that we can see how much impact the level of market movements has on the overall performance of our strategy. The spectrum of the definitions used has been chosen in order to find a balance between an event significant enough to be labeled as a Black Swan and sufficiently low to retrieve enough data for this study to be relevant.

## 2.2 Mean reversion

The behavior of stock return movements is often divided into two views. One where the general belief is that returns cannot be predicted based on historical information and thus follows the so-called random walk hypothesis. This hypothesis is consistent with the efficient market hypothesis (Cootner , 1966), where asset prices fully and instantly reflects information, which makes prices unpredictable (Hiremath & Kamaiah, 2010). Basically, the theory states that stock returns are generated by random walks, what can be compared to flipping a coin, where the results are completely random. The trends are generated by a Geometric Brownian motion that is a continuous time stochastic process and thus makes both short- and long term stock return movements impossible to predict based on past information (Fama, 1965).

The other view implies that future stock market return movements actually can be predicted based on past information since the stock returns tend to return to its trend path, a so called mean-reverting tendency, where the degree of mean-reversion is believed and have been proved to increase as the investment horizon increases (Graflund, 2000). This latter view has been empirically proved to dominate the random walk hypothesis in the long term perspective where stock prices tend to rise after the market prices has fallen and decline as the market prices has risen. In the long-term perspective stock returns tend to move in the direction of an average mean for the stock market returns (Metcalf & Hasset, 1995).

Numerous studies have shown the existence of mean-reversion in different stock markets in different countries and over different time periods. Fama & French show that large negative autocorrelations, which is a mean reverting component in returns, exists on the New York Stock Exchange for the time period between 1926-1985, which implies that stock prices are predictable to a large fraction due to mean reversion (Fama & French, 1988). Hiremath & Kamaiah have shown that also the stock returns in India exhibits a mean-reverting tendency. In their study 14 indices on both the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) are investigated over a period between 2000-2008 that covers some major structural changes yielding various, both positive and negative, results in the different indices (Hiremath & Kamaiah, 2010).

For our research this study carries great relevance in a number of aspects. First, it shows that mean-reversion is an existing factor not only on the Indian stock market but also specifically on the National Stock Exchange and the CNX Nifty index, which is the benchmark index that we use in our investment strategy. Further it also takes major structural breaks and changes into account, covering a majority of our study period, which also carries great value to our study since we are investigating stock returns in the light of Black Swan events.

We do not aim to show the existence of mean-reversion on the Indian stock market. For research within the area we remit to studies by Graflund (2000), Metcalf & Hasset (1995), Fama & French (1988) and Hiremath & Kamaiah (2010). In all studies, proof of negative autocorrelation that implies mean-reversion is presented on different assets over longer time periods. This indicates an existence of mean-reversion in the stock markets' prices and returns.

## 2.3 Beta and the Capital Asset Pricing Model

The Capital Asset Pricing Model (CAPM) is one of the most widely used, implemented and discussed models for asset pricing since the early years of the 1960s. Given a number of variables the model aims to determine the rate of return of an asset along with predictions about how to measure risk (Fama & French, 2004). The non-diversifiable risk, also known as market risk, can be measured with beta, a variable that will carry great significance in this thesis.

Assuming risk-averse investors choosing mean-variance-efficient portfolios, the Capital Asset Pricing Model states that investors aim to (Markowitz , 1952):

i) Minimize the variance in their portfolios and
ii) Maximize their expected portfolio return.

Further, for the portfolio to be mean-variance-efficient, Sharpe (1964) and Lintner (1965) add the assumptions that the investor must agree to a joint distribution of asset returns for the investment period and that borrowing is obtainable for all investors and for all amounts lent or borrowed to some risk-free rate. The investor then selects a portfolio at time t-1 that produces some non-constant return at time t (Fama & French, 2004).

Investing in a financial asset is always associated with some risk that often is defined as the volatility in the expected return of the asset. In the CAPM the risk is divided into two sub-categories: the systematic risk, or market risk, that cannot be eliminated by diversification, and the non-systematic risk, that can be reduced by holding a well diversified portfolio. (Bodie et al., 2011)

In this thesis we do not aim to debate, prove or discuss the empirical merits and results of the CAPM and beta that has been discussed in previous studies. Here we will investigate whether the beta value is a useful tool in the measurement of risk and if it is valuable in portfolio selection for this study.

The expected return of some asset *i* can be estimated as

$$E(r_i) = r_f + \beta_i(E(r_M) - r_f) \tag{2.1}$$

Where $E(r_i)$ is expected return of asset *i*, $r_f$ is the risk-free rate, $\beta_i$ is the beta value of asset *i* and $E(r_M)$ is the expected average market return.

Beta can be seen as a measure that reflects to what extent an asset moves with the market and how sensitive an asset is relative to the overall market. Beta is typically referred to as the measure of systematic risk – the non-diversifiable risk. However, beta does not measure the volatility of an asset in relation to that of the market, but the co-movement. A stock, for example, can have a zero beta (no correlation with the market) but still have a significant volatility compared to the market (Nasdaq, n.d.).

Many studies have shown that there is a significant relation between beta and returns. More specifically, when markets go up (e.g. after a negative Black Swan), a positive relation between beta and returns has been found. Likewise, when markets go down (e.g. after a positive Black Swan), there is a negative relation between beta and returns (Pettengill et al., 1995). The study also concludes that a positive tradeoff between beta and average portfolio returns has been observed. Taking this into consideration, we will use beta in our investment strategy to see whether it is a good measure of risk, and as a tool when building portfolios depending on market fluctuations.

The stock beta can be estimated as the covariance between the market return and the return of some stock *i* divided by the variance of the market return. A beta of 1 indicates that the asset moves perfectly with the market, a perfect correlation. If beta is higher than 1, the price movement of the asset is higher than the market. If beta is less than 1, the opposite holds. Higher beta value implies a higher expected return, but at the cost of more risk. A zero beta value means there is no correlation with the market, and a beta value of minus 1 implies a perfect negative correlation, that is, the asset moves in the complete opposite direction compared to the market (Investopedia, n.d.).

The existence of mean reversion on the National Stock Exchange in India is crucial for the portfolio strategy used in this study to be successful. In our investment strategy we will use the fact that stocks with high (low) beta values tend to move more (less) relative to the market, and build portfolios based on the beta values of each stock in the light of the current market situation. According to the theory of mean reversion, after a negative Black Swan hits the market, it will tend to revert to a long-term mean (Fama & French, 1988). Since stocks with high beta values tend to move more relative to the market, we will then invest in a portfolio consisting of ten of the stocks with the highest average beta values hoping for a higher portfolio return than that of the market index. We will hold the portfolio until the next Black Swan occurs. After a positive Black Swan we will invest in a new portfolio consisting of ten of the stocks that have had the lowest correlation with the market, i.e. low beta stocks, to minimize the losses as the market declines. Since beta is a relative measure that is under constant change, we will recalculate the beta values looking back over a period of 60 days before the occurrence of every Black Swan, excluding the actual day of the Black Swan. Based on the recalculated beta values, new portfolios will be created and investments will be made after every new Black Swan, in accordance to our investment strategy.

The study will answer the question to whether beta is a sufficient tool in these portfolio strategies, and if the value of the market index can be outperformed with an active portfolio, using beta as a measure of risk.

### 2.4 Stocks and Stock Markets

A stock or capital stock is a share in a corporation that constitutes ownership in a specific company and offers a share from that company's earnings and profits. Owning a stock signifies the right to participate and vote at the annual general meeting of the company and qualifies the owner of the shares to equal distributions of the profits, should these be given in the form of dividends, something that is only possible when the company is making a profit and decides to issue dividends (Lundberg et al., 2011)

The value of a share is based on the value of the company's expected future cash flows and the number of shares issued. Various shares are valued based on different principles on different markets, usually with the same concept of the share having the value equal to the price it can be sold at in a financial market (Coleman, 2006). The share value is also highly dependent on the liquidity of the market where it is sold. A higher liquidity implies smoother transactions and a more accurate and higher value of the share. A less liquid market indicates that the shares might be harder to sell, which can lead to a lower share price (Investopedia, n.d.).

Buying and selling shares implies some transaction costs for the seller and buyer usually in the form of brokerage that is the fee or cost that a financial institution charges in order to finalize the transaction. The degree of brokerage differs between different financial institutions and is amongst other variables dependent on liquidity and geography of different markets. Brokerage can be fixed or flexible, usually as a percentage of the amount bought or sold of shares (Walavalkar, 2012).

Compared to trading assets following some specific index, the transaction costs when trading shares are higher due to brokerage for all trades made. The risks associated with buying and selling stocks and shares are also generally believed to be higher compared to trading index funds or other well-diversified assets due to higher beta value and standard deviation (Investment Company Institute, 2014). Potentially this implies that a greater possibility exists in outperforming the market by using some active portfolio strategy. The impact of transaction costs must be taken into consideration when evaluating the level of excess returns that can be achieved by using an active portfolio strategy, compared with a passive portfolio strategy, in which the degree of transaction costs will be significantly lower.

The CNX Nifty index in India covers 22 sectors of the Indian economy in one portfolio that consists of the 50 largest and most liquid Indian companies. The largest sectors represented in the index are financial services, IT and energy where the top three companies by weightage are IT C Ltd. (8.58%) Infosys Ltd. (8.14%) and Reliance Industries Ltd. (7.12%). Representing around 69% of the free float market capitalization of the stocks listed on NSE, it constitutes a majority of the traded value of stocks on the National Stock Exchange (National Stock Exchange India, n.d.).

The CNX Nifty index is frequently used to benchmark the market for Indian investments and must, similar to other major stock indices, satisfy certain rules and requirements regarding for instance liquidity and market capitalization (Investopedia, n.d.).

# 3. Data & Methodology

## 3.1 Data

This section of our study will investigate whether beta is a valuable tool when evaluating portfolios consisting of stocks listed on the CNX Nifty index and investigate if beta is a useful and valuable measure of risk for our strategy. We will evaluate and investigate data for all companies listed on this index as of the current time being (March 2014). Both the company specific data and the daily-based data for the index and has been collected from Thomson Financial Datastream. The main reason for using daily- and not weekly- or monthly-based data is due to a vast greater amount of data that can be observed and evaluated and hopefully yield more accurate and relevant observations over our study period.

In addition to the reasons already discussed in the theory section, the limitation in using stocks only from the CNX Nifty index is partly due to the NSE being the largest stock exchange in India and one of the largest stock exchanges in Asia and partly due to the high liquidity for the stocks within the index.

The data we are investigating reaches over a study period of twelve years from March 1, 2002 to Feb 28, 2014. This study period has been chosen due to the availability of data for a majority of the companies that are listed on the CNX Nifty index. Twelve out of the 50 companies on the index today has had a listing date later than 2002 (appendix 2), where the latest company being listed in the index is COAL INDIA (2010). The variety of listing dates for the companies listed on the CNX Nifty index today implies that we will not consistently have data from all 50 stocks during our study period. This is however something that will have little or no impact on the overall result of this study, nor the performance of the different portfolios, since we are not investigating company specific results originating from variables such as valuation or dividends, but instead the beta values of the companies. More importantly, however, to get an accurate and measurable result, the number of stocks in our high- or low beta portfolios will be ten throughout the investing period. The different listing dates to the index is hence something that will not affect the final results since the index is more of a guidance to where the stocks has been collected from and something we compare our results against. The comparing of results will be left unaffected by different listing dates across the companies since the potential effects are the same within the benchmark index. Should we calculate for these variables the study would be of a vastly greater magnitude and complexity with a considerably low impact to the final result.

For our study period we note 3130 daily returns on the index, an average daily closing rate of 3794.89 and an average daily return of 0.068%. All prices used in this study are the daily closing prices for each stock listed on the CNX Nifty index and all prices are in Indian rupees (INR). From our data we observe a total of 144 606 daily returns from all companies investigated.

### 3.2 Methodology

As found in previous studies, implementing an investment strategy that accounts for Black Swans can outperform a benchmark index. By constructing a portfolio consisting of industry- and country-based data, Estrada & Vargas (2010) provides an investment strategy that gives guidance to how investing in the right portfolio based on the beta value at the right time can yield excess returns compared to the benchmark index. Firstly, the study evaluates whether beta is a good measure of risk for the indices in the study by looking at how different assets behave in the light of different (positive or negative) Black Swans. The assumption is that, on average, high beta assets should decline more than low beta assets while a negative Black Swan occurs and rise more than the low beta assets during a positive Black Swan. In their study this proves to be true. Further, Estrada & Vargas evaluates if beta can be a useful tool when building portfolios in order to outperform the benchmark MSCI index. Together with the assumption of mean-reversion even this proves to be successful (Estrada & Vargas, 2010).

In this study we define a Black Swan as a daily change of ≥ ± 4%, 5% and 6%, respectively, on the CNX Nifty index. During our 12-year long study period we observe various number of days that meet the requirements for our definitions of Black Swans. The days when Black Swans occur represent only a small fraction of the total daily returns and hence very few investment occasions relative to the total number of daily returns over the study period.

In this study we will use an investment strategy similar to the one developed by Estrada & Vargas. Instead of comparing indices over countries and industries to the MSCI index we will focus on another asset, stocks, in a more specified geographical area.

In order to evaluate whether beta is a good measure of risk on the Indian stock market we analyze the movements in the portfolios of the investment strategy and how they perform in the light of positive and negative Black Swans. Looking at the equally weighted portfolios with the high- and low beta stocks we aim to show that the return of a high beta portfolio will decline more on average, compared to that of a low beta portfolio, when a negative Black Swan takes place, and increase more when a positive Black Swan occurs. Furthermore we aim to show that the low beta portfolio will increase less on average than the high beta portfolio, when a positive Black Swan takes place. Should this prove to be true, we have shown that beta is a useful measure of risk on the Indian stock market, and that the relationship is consistent with the assumption of the security market line that reflects how expected portfolio returns increase as beta increases (Investopedia, n.d.).

By implementing a similar strategy as Estrada & Vargas to the CNX Nifty index we aim to show that beta is a valuable tool for portfolio selection on the Indian stock market. By first analyzing and identifying different Black Swan events for our study period we will then calculate the beta values based on the 60 days (excluding the day when a Black Swan occurs) prior to the day of the Black Swan for all available stocks in our portfolio. We then choose ten of the high- or low beta stocks to invest in, depending on the nature of the Black Swan (positive or negative). After each negative Black Swan we invest in a high beta portfolio whose value, according to the theory, should yield greater ascendance relative to the index. This portfolio will be held until the occurrence of the next Black Swan. At the appearance of the next Black Swan, we recalculate the beta values for every stock and reinvest our money into a new portfolio with ten of the stocks best suited for the new Black Swan. If the Black Swan is categorized as positive, we invest in ten of the stocks with the lowest beta values in order to minimize the expected decline in stock market prices as a result of mean-reversion. The estimation-period of 60 days has been chosen in order to obtain the most accurate approximation possible for the beta values. A “too short” estimation-period could possibly yield beta values not significant enough for the period between the Black Swans since the beta values typically tend to alter over time. On the other hand, if we were to estimate the beta values over a period that is “too long”, there is a possibility that the difference between the beta values of the active portfolios and the index would be too low to get a relevant comparison between the active and the passive portfolio. By using this active portfolio strategy we believe that excess returns can be obtained compared to a passive portfolio following the CNX Nifty index.

### 3.2.1 Normal distribution

When we look at the data of daily returns it is important to take the distribution into consideration. A set of data that is normally distributed suggests that both sides of the mean are symmetric which implies that the frequencies of average values are high compared to extreme values. When a population is normally distributed it typically takes the shape of a bell, a so-called bell shaped curve. This shape of the normal distribution can be altered by skewness and kurtosis that forces the distribution towards another shape depending on the degree of extreme values and whether they are weighted towards more positive or negative values (Bodie et al., 2011). We will use a Jarque-Bera test to see if our data suffers from skewness and/or kurtosis and hence non-normality.

### 3.2.2 Skewness

A perfectly normally distributed set of data implies that both sides of the mean, positive and negative, are illustrated as the exact mirror images of one another. The measure of symmetry between each side of the mean, or more accurately the lack of symmetry, is called skewness. A set of data that is positively skewed has a longer tail extending towards higher values in the positive domain or to the right in the bell-shaped curve compared to the left hand side or negative domain of the mean. A negatively skewed set of data has a longer tail extending towards more negative values on the left hand side of the mean compared to the right hand side or positive domain of the mean (Information Technology Laboratory, n.d.). By analyzing the skewness of a data set, better estimations can be obtained upon whether some given point in the data set will take a higher or lower value than the mean. Positively skewed data takes a positive value and negatively skewed data takes a negative value whereas a standard normally distributed set of data has zero skewness (Bodie et al., 2011).

Skewness is computed as follows:

$$Skewness = \frac{1}{n}\sum_{i=1}^{n}\frac{\left[(r_i - \tilde{r})\right]^3}{\sigma^3} \quad (3.1)$$

Where n is the total number of observations, $r_i$ are the individual daily returns, $\tilde{r}$ is the overall average return and $\sigma^3$ is the standard deviation to the power of 3.

### 3.2.3 Kurtosis

Another measure that also alters the shape of a data set compared to the uniform distribution is called kurtosis. A set of data that suffers from positive excess kurtosis, called leptokurtic distributions, typically takes the shape of having fat- or heavy tails combined with a distinct peak around the mean. Data sets with low kurtosis or platykurtic distributions do not have a narrow peak around the mean but instead a flat top combined with thinner tails extending towards each side of the mean. Assuming normal distribution for a leptokurtic distribution is typically referred to as "fat-tail risk" and implies that the data set that suffers from higher kurtosis are mistaken or ignored for the normal distribution, which may yield vast consequences since the probabilities of extreme values of outcomes are ignored or underestimated (Bogleheads, n.d.).

### 3.2.4 Jarque-Bera Test

To test whether our data suffers from non-normality as a consequence of skewness and/or kurtosis we use the Jarque-Bera test for normality that is a goodness-to-fit test that summarizes the discrepancy between the sample of observations in our study compared to a normal distribution. Under the Jarque-Bera test for normality the following null hypothesis is tested against the alternative hypothesis (Faculty Arts UBC, n.d.):

H0: Normal distribution where skewness is zero and excess kurtosis is zero.
H1: Non-normal distribution

A value from the computed Jarque-Bera test higher than the significance points implies that the null hypothesis should be rejected, while a value of the JB statistic lower than the significance points implies that our sample of data is normally distributed.

The Jarque-Bera test for normality is computed as follows:

$$JB = \frac{n}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right) \tag{3.2}$$

Where n is the number of observations, S= skewness that is raised to the power of two and K=kurtosis.

Since a normal distribution typically has a kurtosis of 3 the statistic computed for the JB test should equal zero for a normally distributed data sample (Newbold et al., 2013).

### 3.3 Performance evaluation

#### 3.3.1 Arithmetic mean

The arithmetic mean is what is commonly referred to as "mean" or "average" and is simply computed by taking the sum of all observed values divided by the number of values observed. Computing the arithmetic mean will yield a comparison between the daily return of the portfolio strategy and the benchmark index.

The arithmetic mean is calculated as:

$$\bar{X} = \frac{\Sigma X}{N} \tag{3.3}$$

Where $\bar{X}$ is the arithmetic mean, X is observed value and N is total number of values observed.

#### 3.3.2 Beta

As described in the theory section (section 2.3), we will use beta as a tool in our investment strategy. The beta values for the active and passive portfolio will also be a part of the performance evaluation, where we will discuss beta as a measure of risk, and compare the beta values between the active and passive portfolio strategy.

The beta of a stock can be estimated as

$$\boldsymbol{\beta_{i}} = \frac{\boldsymbol{Cov(R_{M}, R_{i})}}{\boldsymbol{Var(R_{M})}} \tag{3.4}$$

Where $Cov(R_M, R_i)$ is the covariance between the market return and returns of asset $i$, and $Var(R_M)$ is the variance of the market return.

#### 3.3.3 Standard deviation

Standard deviation measures how much a data population deviates from its mean, both on the positive and negative side. A higher spread from the mean implies a higher standard deviation. The measure is based on historical volatility and is calculated by taking the square root of the variance.

# 4. Results

## 4.1 Hypothesis

In this study we have aimed to outperform the Indian CNX Nifty index by using an investment strategy that is based on Black Swan events greater or equal to daily ≥ ± 4%, 5% and 6% returns, respectively, on the index. In our portfolio strategy the main source of decision that indicates how the portfolios should be built and invested in is the beta value. As part of our study we have also investigated whether beta is a valid tool for building these portfolios. Finally we have examined whether beta is a good measure of risk for stocks listed on the CNX Nifty index.

Based on previous studies we have found that similar research based on the same principals as in our study has obtained excess returns when compared to some benchmark index. Estrada & Vargas have, based on the beta value when investigating 47 emerging and developed equity markets, managed to outperform the MSCI index. In absolute numbers, if 100 USD would be invested in the portfolio strategy at the end of 1973 and held until the end of 2009 the 100 USD would have turned into 12.834 USD compared to the 3210 USD that investing in the benchmark index would yield, i.e. a near 400% excess return (Estrada & Vargas, 2010). Nordqvist & Brunåker have, based on a similar background when investigating the NASDAQ OMX30 index with standard deviation as a measure of risk, achieved an excess return over the index by 45% over a 20 year a study period between 1992-2012 (Nordqvist & Brunåker , 2013). Finally Petrovic & Baltaev have, based on the measures of the beta value when investigating the same NASDAQ OMX30 index, managed to outperform the benchmark index with an excess return of 105% over a study period of eleven years between 2001-2012 (Petrovic & Baltaev, 2012).

Based on the observations made on previous studies we attempt and believe that excess returns can be obtained by using a similar active portfolio strategy that we have benchmarked against the CNX Nifty index on the National Stock Exchange in India. As seen in the Data & Methodology section we rely on the already proved theory of mean reversion on the Indian stock market in order to yield excess returns against the benchmark index. We also want to examine to what degree the results obtained will depend on the definition of a Black Swan, and whether they will imply that we manage to outperform the index.

### 4.2 Observed Black Swans

The table below shows all Black Swans for the study period between 2002-2014 when we define a Black Swan as a ≥ ±4% daily return on the CNX Nifty index.

**Table 1. Dates of Black Swans**

Black Swans ≥ ±4 %

| Date | Return | Date | Return | Date | Return | Date | Return |
|---|---|---|---|---|---|---|---|
| 2003-04-10 | -4,24% | 2007-04-02 | -4,92% | 2008-03-25 | 5,81% | 2008-11-03 | 5,48% |
| 2004-01-23 | 4,35% | 2007-08-01 | -4,04% | 2008-03-31 | -4,20% | 2008-11-05 | -4,68% |
| 2004-05-14 | -7,87% | 2007-08-16 | -4,38% | 2008-06-27 | -4,15% | 2008-11-10 | 5,89% |
| 2004-05-17 | -12,24% | 2007-09-19 | 4,09% | 2008-07-02 | 5,05% | 2008-11-11 | -6,66% |
| 2004-05-18 | 8,30% | 2007-10-09 | 4,76% | 2008-07-03 | -4,09% | 2008-11-18 | -4,16% |
| 2004-05-19 | 4,25% | 2007-10-15 | 4,46% | 2008-07-09 | 4,23% | 2008-11-21 | 5,50% |
| 2004-05-28 | -4,89% | 2007-10-23 | 5,59% | 2008-07-15 | -4,42% | 2008-12-04 | 4,95% |
| 2006-05-15 | -4,03% | 2007-11-14 | 4,26% | 2008-07-23 | 5,58% | 2008-12-10 | 5,18% |
| 2006-05-18 | -6,77% | 2007-12-17 | -4,48% | 2008-09-19 | 5,13% | 2009-01-07 | -6,18% |
| 2006-05-19 | -4,19% | 2008-01-21 | -8,70% | 2008-10-06 | -5,66% | 2009-03-23 | 4,73% |
| 2006-05-22 | -5,10% | 2008-01-22 | -5,94% | 2008-10-10 | -6,65% | 2009-03-30 | -4,20% |
| 2006-06-02 | 4,36% | 2008-01-23 | 6,21% | 2008-10-13 | 6,43% | 2009-04-02 | 4,92% |
| 2006-06-08 | -4,76% | 2008-01-25 | 6,95% | 2008-10-15 | -5,12% | 2009-05-04 | 5,18% |
| 2006-06-09 | 5,21% | 2008-02-11 | -5,14% | 2008-10-17 | -5,96% | 2009-05-18 | 17,74% |
| 2006-06-13 | -4,09% | 2008-02-14 | 5,53% | 2008-10-22 | -5,25% | 2009-07-06 | -5,84% |
| 2006-06-15 | 6,31% | 2008-03-03 | -5,18% | 2008-10-24 | -12,20% | 2009-08-17 | -4,20% |
| 2006-06-30 | 4,35% | 2008-03-13 | -5,10% | 2008-10-28 | 6,35% | 2011-09-22 | -4,08% |
| 2007-03-05 | -4,03% | 2008-03-17 | -5,11% | 2008-10-31 | 6,99% | 2013-08-16 | -4,08% |

A total number of 72 Black Swans are observed for the lowest definition of a Black Swan in our study. From the day that the first investment is made on 2003-04-10 to the end-date of 2014-02-28, a total number of 2842 daily returns are observed. This implies that 2.53% of the total daily returns are categorized as Black Swans and hence there are 72 days on which investments will be made in our portfolio strategy. Since the first Black Swan is negative with a -4.24% return, our initial investment will consist of a portfolio with ten of the stocks on the CNX Nifty index that has had the highest average beta values the previous 60 days prior to the Black Swan.

The table below shows all Black Swans for the study period between 2002-2014 when a Black Swan is defined as a ≥ ±5 % daily return on the CNX Nifty index.

**Table 2. Dates of Black Swans**

Black Swans ≥ ±5 %

| Date | Return | Date | Return | Date | Return | Date | Return |
|---|---|---|---|---|---|---|---|
| 2004-05-14 | -7,87% | 2008-01-23 | 6,21% | 2008-09-19 | 5,13% | 2008-11-03 | 5,48% |
| 2004-05-17 | -12,24% | 2008-01-25 | 6,95% | 2008-10-06 | -5,66% | 2008-11-10 | 5,89% |
| 2004-05-18 | 8,30% | 2008-02-11 | -5,14% | 2008-10-10 | -6,65% | 2008-11-11 | -6,66% |
| 2006-05-18 | -6,77% | 2008-02-14 | 5,53% | 2008-10-13 | 6,43% | 2008-11-21 | 5,50% |
| 2006-05-22 | -5,10% | 2008-03-03 | -5,18% | 2008-10-15 | -5,12% | 2008-12-10 | 5,18% |
| 2006-06-09 | 5,21% | 2008-03-13 | -5,10% | 2008-10-17 | -5,96% | 2009-01-07 | -6,18% |
| 2006-06-15 | 6,31% | 2008-03-17 | -5,11% | 2008-10-22 | -5,25% | 2009-05-04 | 5,18% |
| 2007-10-23 | 5,59% | 2008-03-25 | 5,81% | 2008-10-24 | -12,20% | 2009-05-18 | 17,74% |
| 2008-01-21 | -8,70% | 2008-07-02 | 5,05% | 2008-10-28 | 6,35% | 2009-07-06 | -5,84% |
| 2008-01-22 | -5,94% | 2008-07-23 | 5,58% | 2008-10-31 | 6,99% | | |

When defined as a ≥ ±5 % daily return on the benchmark index, 39 Black Swans are observed. Out of a total number of 2556 daily returns for the study period between 2004-05-14 and 2014-02-28, 1.53% of the daily returns are categorized as Black Swans. There will therefore be 39 investments occasions for the portfolio strategy at this definition of Black Swans, where the initial investment will consist of a high beta portfolio since the first Black Swan is negative with a -7.87% return.

The table below shows all Black Swans for the study period between 2002-2014 when the Black Swan is defined as a ≥ ±6 % daily return on the CNX Nifty index.

**Table 3. Dates of Black Swans**

Black Swans ≥ ±6 %

| Date | Return | Date | Return | Date | Return | Date | Return |
|---|---|---|---|---|---|---|---|
| 2004-05-14 | -7,87% | 2006-06-15 | 6,31% | 2008-10-10 | -6,65% | 2008-10-31 | 6,99% |
| 2004-05-17 | -12,24% | 2008-01-21 | -8,70% | 2008-10-13 | 6,43% | 2008-11-11 | -6,66% |
| 2004-05-18 | 8,30% | 2008-01-23 | 6,21% | 2008-10-24 | -12,20% | 2009-01-07 | -6,18% |
| 2006-05-18 | -6,77% | 2008-01-25 | 6,95% | 2008-10-28 | 6,35% | 2009-05-18 | 17,74% |

With 16 observed Black Swans between 2004-05-14 and 2014-02-28 and a total number of 2545 daily returns, we note that the number of daily returns that can be categorized as Black Swans on a 6% level constitutes as little as 0.63% of the total number of daily returns. In other words, investments are made only at 16 occasions over the investment period. Since the initial investment date is the same when we define a Black Swan on a 6% level as on a 5% level, the first portfolio invested in at 2004-05-14 will also consist of high beta stocks.

### 4.2.1 Beta as a measure of risk

When evaluating the results of the first research question, i.e. if beta is a good measure of risk for stocks listed on the CNX Nifty index, we investigate the movements in our portfolios based on the beta value and whether a Black Swan is positive or negative. The day after the occurrence of a Black Swan we calculate the beta values based on the past 60 days, for all stocks listed on the CNX Nifty index, excluding the day of the Black Swan, and assemble the ten stocks with the highest beta value into a high beta portfolio and the ten stocks with the lowest beta value into a low beta portfolio. Investments will not be made for the remaining stocks with beta values in-between the high- and low beta portfolio. Since we are excluding the day of the Black Swan and hence hold portfolios with beta values estimated previous to the day of the Black Swan we are able to evaluate the impact of the Black Swan on existing portfolios. If a negative Black Swan occurs the theory says that the value of the high beta portfolio should decline more than the benchmark index and at the occurrence of a positive Black Swan the value of the high beta portfolio should increase more compared to the benchmark index. Contrary to the high beta portfolio the value of the low beta portfolio should according to the theory decline less during a negative Black Swan and increase less during a positive Black Swan compared to the benchmark index.

The table below illustrates a comparison between how three portfolios, consisting of the CNX Nifty index, high beta stocks and low beta stocks, respectively, on average react to a positive or negative Black Swan when such is defined as a ≥ ±4% daily return on the CNX Nifty index.

**Table 4. Average Beta & Return at a 4% Black Swan Definition**

**Positive Black Swans**

| | Index | Low-beta portfolio | High-beta portfolio |
|---|---|---|---|
| Beta | 1,00 | 0,44 | 1,46 |
| Return | 5,75% | 2,76% | 7,79% |

**Negative Black Swans**

| | Index | Low-beta portfolio | High-beta portfolio |
|---|---|---|---|
| Beta | 1,00 | 0,43 | 1,46 |
| Return | -5,43% | -3,24% | -7,11% |

For the first definition of a Black Swan in this study we observe 72 Black Swans where 32 are positive and 40 are negative. Further we note identical beta values for the high beta portfolio on average, whether the Black Swan is negative or positive. By calculating the arithmetic mean of the three portfolios we note that the return of the high beta portfolio rise more on average compared to the CNX Nifty index and low beta portfolio when a positive Black Swan occurs and decline more when a negative Black Swan occurs. Contrary, the return of the low beta portfolio rise less on average when a positive Black Swan occurs and decline less with a negative Black Swan, compared to the index and the high beta portfolio. When a positive Black Swan appears the return of the high beta portfolio increases 7.79% on average and after a negative Black Swan the return of the same portfolio declines with -7.11% on average. These returns differ from the return of the passive portfolio, consisting of the benchmark index, with an excess average daily return of 2.04% for a positive Black Swan and -1.68% for a negative Black Swan. The index increases with 5.75% with a positive Black Swan on average and declines with -5.43% with a negative Black Swan on average. When evaluating the impact of the low beta portfolio we note less sizable returns compared to both the index and the high beta portfolio. At the occurrence of a positive Black Swan the return of the low beta portfolio increases with 2.76% on average. This is a positive return 2.99% lower than the index. During a negative Black Swan the return of the low beta portfolio declines -3.24% on average, a return 2.19% higher compared to that of the index.

The table below illustrates how three portfolios, consisting of the CNX Nifty index, the high and the low beta stocks, on average react to a positive or negative Black Swan when such is defined as a ≥ ±5% daily return on the CNX Nifty index.

**Table 5. Average Beta & Return at a 5% Black Swan Definition**

**Positive Black Swans**

| | Index | Low-beta portfolio | High-beta portfolio |
|---|---|---|---|
| Beta | 1,00 | 0,46 | 1,47 |
| Return | 6,52% | 3,12% | 9,00% |

**Negative Black Swans**

| | Index | Low-beta portfolio | High-beta portfolio |
|---|---|---|---|
| Beta | 1,00 | 0,43 | 1,46 |
| Return | -6,67% | -4,13% | -8,52% |

When defined as a ≥ ±5 % daily return on the CNX Nifty index 39 Black Swans are observed for the study period, where 19 are negative and 20 positive. For positive Black Swans the high beta portfolio has an average beta value of 1.47 while the low beta portfolio has an average beta value of 0.46. Near identical beta values are observed for negative Black Swans where the high beta portfolio has a value of 1.46 and the low-beta portfolio has an average beta-value of 0.43.

Looking at the high beta portfolio, the average return after a positive Black Swan is 9%, which is 2.48% higher than that of the benchmark index, whereas the average decline in the high beta portfolio after a negative Black Swan is -8.52%, which is -1.85% less than that of the benchmark index. When looking at the low beta portfolio we observe that the portfolio return is 3.12 % on average during a positive Black Swan, which is a return 3.4% lower compared to the return of the benchmark index. After a negative Black Swan the portfolio decreases -4.13% on average, which compared to the benchmark index is a decline 2.54% lower.

The table below illustrates how three portfolios, consisting of the CNX Nifty index, the high- and the low beta stocks, on average react to a positive or negative Black Swan, respectively, when such is defined as a ≥ ±6% daily return on the CNX Nifty index.

**Table 6. Average Beta & Return at a 6% Black Swan Definition**

**Positive Black Swans**

| | Index | Low-beta portfolio | High-beta portfolio |
|---|---|---|---|
| Beta | 1,00 | 0,55 | 1,46 |
| Return | 8,16% | 4,56% | 11,04% |

**Negative Black Swans**

| | Index | Low-beta portfolio | High-beta portfolio |
|---|---|---|---|
| Beta | 1,00 | 0,40 | 1,45 |
| Return | -8,41% | -5,53% | -10,91% |

On the highest of our definitions of a Black Swan we observe the biggest outturns in average returns for the three portfolios. When the Black Swan is defined as a ≥ ±6% daily return on the CNX Nifty index, it can first be noted that the beta values are very similar to the ones obtained by the earlier definitions. At the occurrence of a positive Black Swan the high beta portfolio has an average beta value of 1.46 while the low beta portfolio has an average value of 0.55. When a negative Black Swan transpires, the average beta value of the high beta portfolio is 1.45, while the low beta portfolio has an average value of 0.40.

From the definition of a Black Swan as a ≥ ±6% daily return on the CNX Nifty index we observe 16 Black Swans over the 12-year long study period, of which eight are positive and the remaining eight negative. The average return in the high beta portfolio after a positive Black Swan is 11.04%, a value 2.88% higher compared to the passive portfolio consisting of the index. During a negative Black Swan the average high beta portfolio returns are -10.91%, which is a -2.5% larger decline in returns compared to the index. The index returns are 8.16% on average during a positive Black Swan, which is 3.6% higher than the low beta portfolio, whose returns are 4.56% on average. After a negative Black Swan the low beta portfolio has returned -5.53% on average, which is 2.88% higher compared to the index. Like earlier definitions, in the final definition of a Black Swan, the high beta portfolio proves to be more volatile on average compared to the index while the low beta portfolio on average shows to be less volatile.

Based on the results obtained from all definitions of a Black Swan there is a clear indication of a correlation between the beta value and the return of an asset or a portfolio. A Black Swan that yields extreme positive daily returns on the CNX Nifty index is related to an even higher return in the high beta portfolios compared to the low beta portfolios and the benchmark index. On the contrary, a Black Swan that yields extreme negative returns is correlated with a higher decline in the high beta portfolios compared to the benchmark index and the low beta portfolios. The correlation between the beta value and return of a portfolio can hence be concluded as evident.

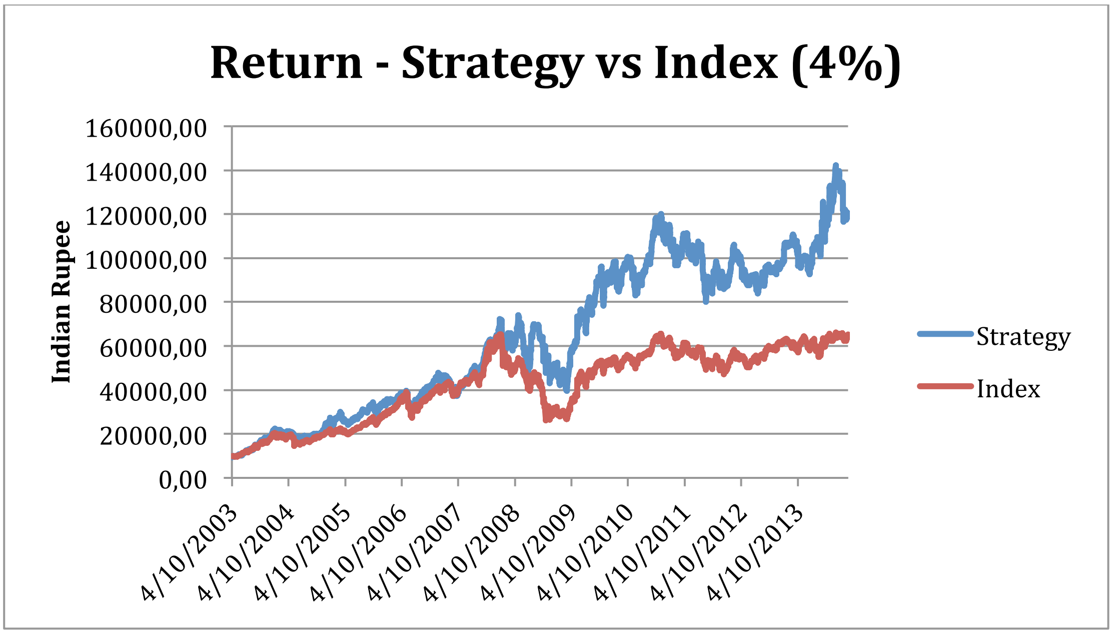
### 4.2.2 Beta as a tool for portfolio selection & benchmark index outperformer

The second research question that we aim to answer in this thesis is whether beta can be used as a valuable tool for building portfolios and thereby yields excess returns compared to the CNX Nifty index. If the active portfolio yields excess returns compared to the passive portfolio one can draw the conclusion that beta is a valuable tool for portfolio selection for stocks listed on the CNX Nifty index.

When a Black Swan is defined as a ≥ ±4 % daily return on the CNX Nifty index, the first date of a Black Swan and hence the date when the first investment is made in both the active and passive portfolio is 2003-04-10. At this date 10,000 INR is invested in both portfolios. The Black Swan that appears at the given day is negative with a return of -4.24%. Based on the theories and principles for our investment strategy, the initial investment in the active portfolio has been invested in the ten stocks with the highest beta value in order to gain excess returns when the market ascends and reverts to it's long term mean according to the theory of mean reversion. When the second Black Swan occurs at 2004-01-23, the return is instead positive with a 4.35% daily return on the CNX Nifty index. The high beta portfolio is thereby sold and the current portfolio value of 21.294 is instead invested in a low beta portfolio in order to hedge against the market decline as it reverts to its long-term mean according to the theory. The same active portfolio investment strategy is applied for all Black Swans over the 12-year long study period and evaluated at the end-date 2014-02-28.

The figure illustrates the value movements of the active portfolio and the passive portfolio over the study period when the Black Swan is defined as a ≥ ±4% daily return on the CNX Nifty index.

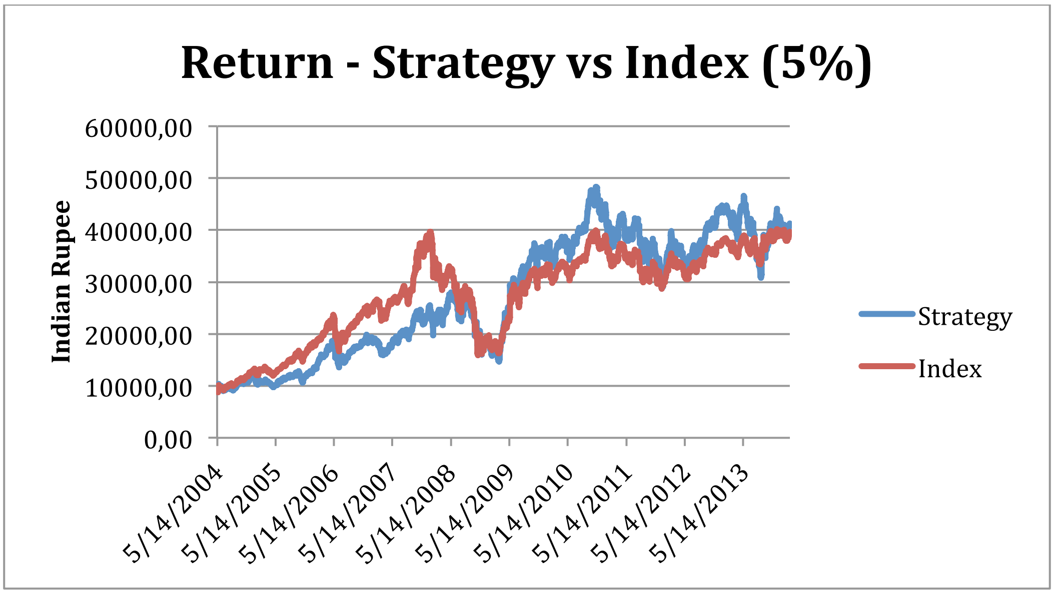
**Figure 1. Active vs. Passive portfolio Returns (Black Swan definition: 4%)**




Across the three definitions, the earliest Black Swan is observed when such is defined as a ≥ ±4% daily return on the CNX Nifty index. This means that the study period when evaluating the active portfolio on the first definition is almost one year longer compared to when we define a Black Swan as a ≥ ±5% and 6 % daily return on the benchmark index. The first Black Swan appeared 2003-04-10. At the end of this day the index declined -4.24%. This implies that the first active portfolio in which the investment were made consisted of high beta stocks. At the end-date of 2014-02-28 the passive portfolio had a value of 65.235 INR, which is a positive return of 552%. The active portfolio had on the same end-date obtained a value of 120.261 INR, a positive return of 1103%. The results obtained indicate that the active portfolio outperformed the benchmark index with an excess return of 551% over the investment period.

The figure illustrates the value movements for the active portfolio and the passive portfolio over the study period when the Black Swan is defined as a ≥ ±5 % daily return on the CNX Nifty index.

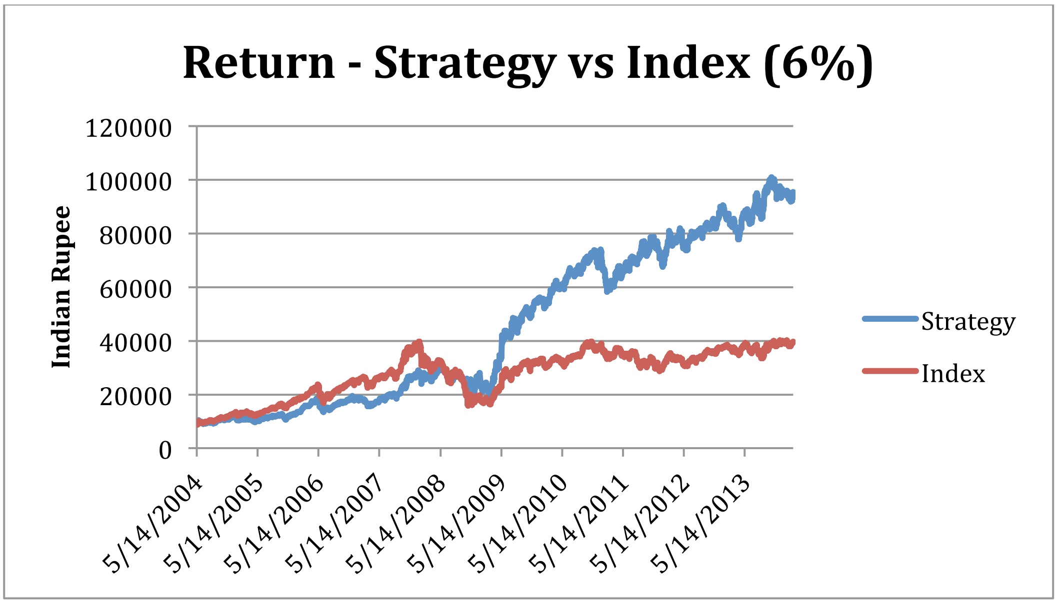
**Figure 2. Active vs. Passive portfolio Returns (Black Swan definition: 5%)**




The first Black Swan and hence the first investment occurred 2004-05-14 and was negative with a decline of -7.87%, closely followed by another negative Black Swan at 2004-05-17 where the CNX Nifty Index declined -12.24% during the day. At the end-date of 2014-02-28 when both portfolios were sold the active portfolio had a value of 41.322 INR, which is a positive return of 313%. The passive portfolio on the other hand had a value of 39.667 INR, which is a total positive return of 297%. This implies that the active portfolio outperformed the passive portfolio by 16% or 1655 INR in absolute values.

The figure illustrates the value movements in the active portfolio and the passive portfolio over the study period when the Black Swan is defined as a ≥ ±6 % daily return on the CNX Nifty index.

**Figure 3. Active vs. Passive portfolio Returns (Black Swan definition: 6%)**




When defined as a ≥ ±6 % daily return on the CNX Nifty Index the first Black Swan also appears 2004-05-14 where the initial investment of 10,000 INR invested in the active portfolio strategy is put in high beta stocks. With substantially fewer Black Swans far fewer investments are made in the active portfolio strategy at this definition of Black Swans. At the end date of 2014-02-28 the passive portfolio had a value of 39,667 INR a 297% return, which is identical to the value when the Black Swan is defined as a ≥ ±5 % daily return on the benchmark index, since the day of the first Black Swan is the same. The active portfolio, on the other hand, had a value of 95,519 INR, which is a positive return of 855%. Compared to the passive portfolio, the active portfolio yields a near 558% excess return or 55,852 INR in absolute numbers.

## 4.3 Performance evaluation

**Table 7. Performance Results: Strategy vs. Index**

| Performance Evaluation - Black Swan Definition: 4% | | | | | | | |
|---|---|---|---|---|---|---|---|
| | AM | SD | Beta | Min | Max | Kurt | Skew |
| CNX Nifty Index | 0,08% | 1,58% | 1 | -12,24% | 17,74% | 10,31 | 0,03 |
| Strategy | 0,11% | 1,90% | 1,01 | -13,04% | 15,27% | 6,05 | 0,15 |

| Performance Evaluation - Black Swan Definition: 5% | | | | | | | |
|---|---|---|---|---|---|---|---|
| | AM | SD | Beta | Min | Max | Kurt | Skew |
| CNX Nifty Index | 0,067% | 1,59% | 1 | -12,24% | 17,74% | 11,01 | 0,10 |
| Strategy | 0,071% | 1,77% | 0,95 | -13,04% | 15,27% | 6,92 | 0,37 |

| Performance Evaluation - Black Swan Definition: 6% | | | | | | | |
|---|---|---|---|---|---|---|---|
| | AM | SD | Beta | Min | Max | Kurt | Skew |
| CNX Nifty Index | 0,07% | 1,59% | 1 | -12,24% | 17,74% | 11,01 | 0,10 |
| Strategy | 0,10% | 1,60% | 0,95 | -10,29% | 20,78% | 16,61 | 1,06 |

Where AM is the arithmetic mean, SD is the standard deviation, Min is the minimum daily return, Max is the maximum daily return, Kurt is the excess kurtosis and Skew is the skewness of the data.

Table 7 illustrates the performance evaluation between the benchmark index and our investment strategy. On all definitions of a Black Swan, the strategy has a higher arithmetic mean for daily returns. The maximum daily return for the index is higher than that of the strategy at the 4- and 5% level, but lower than the strategy at the 6% level. The index also has a lower minimum return for the two first definitions while the strategy yields a lower minimum return at the 6% level. The CNX Nifty index is positively skewed when evaluated at all definitions, which is true also for the strategy that has a higher skewness on all three definitions. Both the index and the strategy suffer from excess kurtosis on all definitions. The data of the index has a similar degree of excess kurtosis on all levels of Black Swans. The strategy has a lower degree of excess kurtosis at the 4- and 5% level, whilst it is significantly higher on the 6% level. This implies that the distribution of the data of returns for the strategy has the fattest tails on the 6% level. When comparing the risk measures, the index has a lower standard deviation for all three definitions. The average beta value for the strategy is slightly higher than the index for the lowest definition but lower when compared to the index on the 5- and 6% level.

### 4.4 Test for normality

To see if our set of data is normally distributed we use the Jarque-Bera test. When testing for normality on a 5% significance level, we use the following test interpretation:

H0: The data follows a *normal* distribution
H1: The data does *not* follow a *normal* distribution

The critical JB-value is 5.99 on a 5% significance level. For the null-hypothesis not to be rejected and hence the data to be considered as normally distributed, the observed JB-value for the data must be lower than the critical JB-value.

When testing the data of daily returns on the CNX Nifty index, when defining a Black Swan as a 4% daily increase/decrease, we observe a JB-value of 12,648. For the data of daily returns in our strategy we obtain an observed JB-value of 4,330. This implies that the null-hypothesis is rejected in both cases and thus the data is non-normally distributed. The observed p-value is < 0.0001 in both tests. The risk to reject the null-hypothesis H0 while it is true is lower than 0.01%.

The results obtained from the JB-test when defining a Black Swan as a 5% daily increase/decrease are quite similiar to those above. Observed JB-value when testing the data of the index is 12,851, while the JB-value of our strategy is 5,137. Once again we reject the null-hypothesis, and with a p-value < 0.0001, the risk to reject the null-hypothesis H0 while it is true is lower than 0.01%.

At a 6% Black Swan definition the observed JB-value for the data of the index is 12,851, and for our strategy we observe a JB-value of 29,715. Even at this level of a Black Swan we reject the null-hypothesis and conclude that the data is non-normally distributed.

# 5. Analysis

### 5.1 Is beta a good measure of risk for stock listed on the CNX Nifty Index?

As presented in the previous chapter we have found a correlation between the beta value and the return of a portfolio. This correlation holds for all definitions of a Black Swan tested in the study. For all Black Swans categorized as positive there is a positive relationship between the beta value and return. On the contrary there is a negative relationship between the beta value and the return of a stock for all negative Black Swans. This implies a higher volatility for high beta stocks compared to low beta stocks and indicates both greater returns associated with a positive Black Swan and greater declines associated with negative Black Swans. The movements in the low beta portfolios are on average substantially less evident in the light of both positive and negative Black Swan events.

The results obtained suggest that the theory within Capital Asset Pricing Model holds for this study. Assets with a low average beta value (less than one) moves on average with lower volatility over the study period while assets with a high beta value (higher than one) on average moves with higher volatility over the study period. This positive relation between the volatility and the beta value holds for all definitions of a Black Swan investigated in our study.

It should be noted that the results obtained are outcomes from stocks listed on the National Stock Exchange in India and are also results from portfolios of ten stocks from the CNX Nifty Index. It is both possible and probable that the beta value could not be considered as a good measure of risk for individual stocks and/or assets within another market. This thesis do not test the degree of significance in the relationship between beta and the return of a portfolio but instead tests if a beta-based Black Swan investment strategy can outperform a passive investment following a benchmark index. From the results obtained in our study we can conclude that beta is a good measure of risk.

## 5.2 Is beta a good tool for portfolio selection and is it possible to outperform a passive investment following the CNX Nifty index?

The second research question in this study is if beta is a good tool for portfolio selection, a question that merges with the third and final research question, i.e. if it is possible to outperform the CNX Nifty index, a strategy in which the beta value is used as the tool that points to the selection of stocks in which the investments should be made. In order to significantly being able to benchmark the results of the investment strategy we have compared the results obtained to a passive portfolio that follows the CNX Nifty index. As seen in the tables in the previous section of this study we have managed to outperform the benchmark index in all three cases.

When we define a Black Swan as a ≥ ±4 % daily return on the CNX Nifty index we have managed to outperform the passive portfolio with an excess return of 551%, which implies that our investment strategy has produced a positive return of 1103% over the near eleven-year long period from the first investment to the end-date. The returns produced by the passive investment yield a positive return of 552% over the same period.

For the one percent higher definition of a Black Swan, a ≥ ±5 % daily return on the CNX Nifty index, the investment strategy outperforms our passive portfolio with 16%. This means that the results obtained in the active portfolio reaches a 313% positive return, whereas the passive portfolio yields 297% positive return over the same period.

On the third and final definition of a Black Swan that is defined as a ≥ ±6 % daily return on the CNX Nifty index, the active portfolio outperforms the benchmark index once again. The passive portfolio obtains a positive return of 297%, which is identical to the return of the previous definition of a Black Swan due to the same date for the first investment. The active portfolio on the other hand yields a positive return of 855%, which is a near 558% excess return compared to the passive portfolio.

The impact on the results originating from how a Black Swan is defined is highly noticeable. By raising the definition with just 1% from 4% to 5% we notice a drop in excess returns by a near 790% for the strategy. When investigating the results on the 6% definition of a Black Swan we notice a difference in excess return compared to that obtained from the previous definition by a near 572%.

When examining our strategy as it produced the least satisfactory results, i.e. when a Black Swan is defined as a ≥ ±5 % daily return on the CNX Nifty index, we note that the level of outperformance is far less substantial compared to the other definitions. This can partly be explained by one single event. The third Black Swan by the prevalent definition occurred 2004-05-18 as an increase in the CNX Nifty index by 8.30%. As our strategy suggests, in our active portfolio we invested everything in low beta stocks after which there was a period of exactly two years until the next Black Swan occurred. According to the assumption of mean-reversion, the value of the low beta portfolio held during this period should be less volatile than that of the index. However, since there are no Black Swans for a period of two years and hence no new investments are made during this time, and since the market continued to grow during these years, the value of the index increases to a greater extent compared to the low beta portfolio. This implied that the active portfolio gained 71.88% in positive return over the period while the benchmark index gained 125.33%. In absolute numbers the active portfolio had a value of 17,253 INR while the passive portfolio had obtained a value of 21,416 INR, a difference that the active portfolio just managed to catch up and slightly exceed over the study period. If we would exclude the first three Black Swans and hence make our first investment at the fourth (2006-05-18) we would obtain a quite different result. If we were to exclude the first two years and hence the first three Black Swans in the study the active portfolio would yield a 140% positive return while the passive portfolio would yield an 85.22% positive return, numbers that would imply that the active portfolio would outperform the passive portfolio with nearly 55%.

The reason for just encountering this problem when a Black Swan is defined on the 5% level is that when defined on the 4% level, a negative Black Swan appears 2004-05-28 that implies a drop on the CNX Nifty index by -4.89%, after which investments are made in a high beta portfolio. When that portfolio is sold almost 2 years later it has returned 103.27% which implies that the active portfolio has a higher value over the passive portfolio with 37,400 INR over 36,406 INR after which it on average continues to yield excess returns that results in the returns declared above.

The most evident result on the portfolio strategy for beta as a measure of risk is found when a Black Swan is defined on the 6% level. On almost every occasion when a negative Black Swan occurs and a low beta portfolio is held, the decline in the active portfolio is lower compared to the passive portfolio. When a positive Black Swan occurs, the ascendance in the high beta portfolio is on average higher than the rise in the passive portfolio. This strong relationship between the beta value and return for the active portfolio can be one main reason for the excess returns obtained when the Black Swan is defined as a ≥ ±6 % daily return on the CNX Nifty Index. It should be noted that the last Black Swan that appears on the 6% definition occurs on 2009-05-18, which is almost 5 years before the end-date and the portfolio is sold. The last Black Swan is positive which implies that the last portfolio bought consists of low beta stocks. Since the beta values of the portfolio are estimated for the 60 days before the Black Swan and no later estimations are made it is safe to say that the beta values of the assets in the portfolio shifts over the remaining 5 years until the portfolio is sold. This implies that the final result obtained might not be the result of a sole low beta portfolio but instead a portfolio consisting of stocks with varying beta values.

The investment strategy evaluated relies to a high degree on the theory of mean reversion in being the key-to-success for the active portfolio. This however, is something we do not prove in the study. Due to two unknown factors we cannot exclude other external parts as being the explanation or part in the explanation for the investment strategy to be successful. First, we do not know the speed of reversion on the Indian stock market, which implies that the estimation period of 60 days for the beta values, and the definitions of Black Swan are not certain to be optimal. If the speed of reversion is faster than we assume, there could be a possibility to gain greater excess returns in lowering the definition of a Black Swan and thereby obtain more investment occasions. Should the speed of reversion instead be longer than what we assume, a higher definition of a Black Swan could possibly yield greater excess returns due to a longer reverting period between the investment occasions. The other unknown factor is the impact of mean reversion and how it is related to the magnitude of a Black Swan. It is possible that the speed of reversion is faster after a large Black Swan compared to a small Black Swan or the other way around. This is something that we have not calculated for.

Since we have not proven mean reversion ourselves we cannot exclude other factors as explanatory variables for the success of the investment strategy and we cannot exclude simple luck as being the reason for the successfulness when choosing the estimation period for the beta values.

### 5.3 Data analysis

The average beta values for the active portfolios are 1.01 at the 4% Black Swan level, 0.95 at the 5% Black Swan level and 0.97 at the 6% Black Swan level. These beta values mirrors a balance between the number of high- and low beta portfolios and their respective beta values within. While beta as a measure of risk is a fairly reliable measure it does not come without disadvantages. For one thing it does not integrate new information that emerges over time, which implies that it is not necessarily a reliable tool when estimating future risk. Another limitation to the beta measure is that it is based solely on past information and tends to alter over time (Investopedia, n.d.). To overcome these potential biases we have estimated the beta values based on the 60 days prior to every Black Swan to get a shorter, and hopefully more accurate estimate of the present beta values, integrating new information in our calculations.

In both the case of the index and the strategy we observe excess kurtosis for all definitions of a Black Swan. This implies that the data has so-called fat-tails, which is expected since we are examining an investment strategy that proceeds from Black Swans or outliers on a data set that is not normally distributed. Since the data suffer from kurtosis, the standard deviation measure will underestimate the degree of outliers in both the case of the investment strategy and the index. On the 4% level the index has an excess kurtosis of 10.31 while the strategy has an excess kurtosis of 6.05. Very similar numbers for excess kurtosis are obtained on the 5- and 6% level where the index has a value of 11.01. For the same definitions the strategy has an excess kurtosis of 6.92 and 16.61, respectively. With a higher excess kurtosis, there is a larger probability for extreme high- or low returns. For all definitions, when looking at the excess kurtosis, the data implies a leptokurtic distribution, which suggests that the probability for large fluctuations or extreme daily returns are more likely compared to a data set that is normally distributed. Since a leptokurtic distribution implies that small changes in daily returns are concentrated around the mean it is more likely to have a relatively low degree of future variance (Bogleheads, n.d.). This comes however at a cost of high unpredictable swings in extreme values which implies an investment that the risk-averse investor would typically not prefer.

Positive skewness is observed for all definitions on the index. This implies that the standard deviation measure underestimates the risk for positive returns, or overestimates the risk for negative returns (Bodie et al., 2011). Compared to the strategy we note that the data is positively skewed on all definitions. This means that the measure of standard deviation overestimates the risk for negative returns on all three definitions. The risk is overestimated since standard deviation assumes normal distribution on a data set where extreme positive/negative returns deviates from the mean.

Another measure of risk that is worth mentioning is standard deviation. The investment strategy has a higher standard deviation compared to the index. This holds for all three definitions of Black Swans. Standard deviation as a measure of risk carries some issues for these sorts of investments. Since it measures deviations from the mean and hence both positive and negative divergences it considers positive returns as a risk, which could be misleading for the long-term investor (Bodie et al., 2011). Another limitation in solely using standard deviation as a measure of risk is that it lacks usefulness with asymmetric payoffs. Since the measure of standard deviation assumes normal distribution, applying it to a data set with payoff profiles that are not normally distributed but instead positively or negatively skewed can be more or less misguiding. Additional aspects that should be considered when using standard deviation as a measure of risk is that it is based solely on historical information, just like the beta value, which might just be an indication of future returns. Further, it says nothing about returns or expected returns when comparing two investments, which implies that an investment with a high standard deviation but high expected return can yield smaller losses compared to another investment with lower standard deviation and lower expected return (Wilson, n.d.).

An alternative measure that has not been considered in this study is downside deviation, also known as lower partial standard deviation (LPSD). The measure differs from standard deviation in the aspect that it only considers the downside risk or returns below some target return. By dividing the return of the active portfolio and passive portfolio with their respective downside deviation a ratio known as the Sortino ratio is produced. This ratio differs from the Sharpe ratio where the return is instead divided by the standard deviation (Bodie et al., 2011).

# 6. Conclusion

This study evaluates the usefulness of beta as a measure of risk for stocks listed on the CNX Nifty index in India. The positive correlation found between the beta value and return of a stock points to the fact that beta can be used as a measure of risk for the assets over the study period between 2002-2014 investigated. In order to obtain a higher robustness for the evaluation of beta as a risk measure, we have tested our strategy on three different levels of Black Swans, which all yield similar results in terms of a positive relationship between the beta value and the return of a stock during a positive (negative) Black Swan. This suggests a safe and satisfactory conclusion for the first research question in our study.

Previous similar evaluations of beta have been done on several large stock exchanges over several different markets, both developed and emerging, where beta has been concluded as a satisfying measure for risk. The conclusion, both from previous studies and ours, should however be interpreted with some caution, since the results are highly dependent on the market data used, which can be significantly variant between different markets. It should also be taken into consideration that even if the relationship shows to be significant in the study, it is based on historical information and does not guarantee a future positive relationship between beta and the return of a stock on the market.

Testing beta as a tool for portfolio selection also yields satisfactory and significant results. On all three definitions of Black Swans, excess returns over the benchmark index have been obtained, with a similar risk when such is measured in the terms of the beta value. To get a broader comparison we have also considered the differences in standard deviation between the strategy and the index. This measure suggests that the risk is somewhat higher in the strategy than in the index, a result that should also be interpreted with some caution since standard deviation measures divergences in both positive and negative values from the mean. Positive divergences are typically not unwanted or of particular interest for the long-term investor since she generally is more concerned with downside risk.

When considering the transaction costs associated with the active portfolio strategy, it is safe to say that they are negligible when the strategy is tested on the 4%- and 6% level. On the 5% level, however, the excess return obtained over the benchmark index is not necessarily enough for the strategy to be more profitable than the passive investment.

The impact of how a Black Swan is defined has a vast substantial effect on the final result of our investment strategy. By altering the definition with just 1 percent, we note final results that differs several hundred percent over the same investment period. We believe that the key in finding the most accurate definition lies in identifying mean reversion on the market, primarily the speed of reversion and the relationship between the mean reversion and magnitude of the Black Swan.

We conclude that beta is a valid tool when building portfolios with stocks on the National Stock Exchange in India, and that it is a useful measure of risk for the data in our study. We note that the highest returns are obtained when implementing our strategy defining a Black Swan as a 4% daily increase/decrease on the CNX Nifty index. At the end of the period our portfolio had a return of 1103%, or 110,261 INR in absolute values. The highest level of outperformance against the passive portfolio following the index is obtained at the 6% level, where our strategy yields a 558% excess return compared to the benchmark index. This is the highest outturn we have seen compared to any similar previous research, signifying the successfulness of our investment strategy.

# 7. Suggestions for further research

To possibly gain excess returns of even greater magnitude than obtained in this study, it would be interesting to study the effects of incorporating risk-free assets to a similar investment strategy. That is, instead of investing in low beta stocks after a positive Black Swan to hedge against market declines, following as a result of mean reversion, investments could be made into risk-free assets such as bonds and/or cash. The risk-free assets will then be held until the next negative Black Swan occurs after which investments would be made in a high beta portfolio.

We assume mean reversion but do not prove or investigate it further which opens an opportunity to broaden the study and possibly gain excess returns over the results obtained in this study. If mean reversion could be proved on a market, and thereby the exact speed of reversion and relation to the magnitude of a Black Swan were known, it would raise a possibility to more accurately find a sophisticated definition of a Black Swan and an estimation period for the beta values that satisfies the investment horizon of the investor.

Since this study focus entirely on stocks, it would be interesting to see how the same Black Swan investment strategy would perform with another underlying asset. The same strategy could, for example, be applied to trading within foreign exchange with the same principles as in this study. This application to the study could possibly also evaluate the performance of the investment strategy on a shorter time horizon.

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### 8.1.4 Databases

Thomson Reuters Financial Datastream

XLSTAT

# 9. Appendix

## 9.1 Appendix 1 (Companies on the CNX Nifty index as of March 2014)

| Company Name | Branch/Industry |
|---|---|
| ACC | Cement |
| AMBUJA CEMENTS | Cement |
| Asian Paints Ltd | Chemicals |
| Axis Bank Ltd | Banking/Financial Services |
| Bajaj Auto Ltd | Automotive |
| Bank Of Baroda | Banking/Financial Services |
| Bharat Heavy El. | Electrial equipment |
| Bharat Petroleum Corp Ltd | Oli & Gas |
| Bharti Airtel Ltd | Telecommunications |
| Cairn India Ltd | Oil & Gas |
| Cipla Ltd | Pharmaceuticals |
| Coal India Ltd | Metals & Mining |
| DLF Ltd | Real Estate |
| Dr. Reddy's Lab Ltd | Pharmaceuticals |
| GAIL (India) Ltd | Energy, Petrochemicals |
| Grasim Industries Ltd | Building materials |
| HLC Technlogies Ltd | IT services & consulting |
| HDFC Bank Ltd | Banking/Financial Services |
| Hero Motocorp Ltd | Automotive |
| Hindalco Industries Ltd | Metals |
| Hindustan Unilever Ltd | Consumer goods |
| HDFC Ltd | Financial services |
| ICICI Bank Ltd | Banking/Financial Services |
| IDFC Limited | Finance/Infrastructure |
| INDUSIND BANK | Banking/Financial Services |
| INFOSYS | IT services & consulting |
| ITC Ltd | Conglomerate |
| JAIPRAKASH ASSOCIATES | Conglomerate |
| JINDAL STEEL & POWER | Steel, Energy |
| KOTAK MAHINDRA BANK | Financial services |
| LARSEN & TOUBRO | Conglomerate |
| LUPIN | Pharmaceuticals |
| MAHINDRA & MAHINDRA | Automotive |
| MARUTI SUZUKI INDIA | Automotive |
| NMDC | Mining |
| NTPC | Electric utility |
| OIL & NATURAL GAS | Oil & Gas |
| POWER GRID CORP.OF INDIA | Electric utility |
| PUNJAB NATIONAL BANK | Banking/Financial Services |
| RANBAXY LABS. | Pharmaceuticals |
| RELIANCE INDUSTRIES | Conglomerate |
| SESA STERLITE | Mining |
| STATE BANK OF INDIA | Banking/Financial Services |
| SUN PHARM.INDUSTRIES | Pharmaceuticals |
| TATA CONSULTANCY SVS. | IT services & consulting |
| TATA MOTORS | Automotive |
| TATA POWER | Electric utility |
| TATA STEEL | Steel |
| ULTRATECH CEMENT | Cements |
| WIPRO | IT services & consulting |

## 9.2 Appendix 2 (Companies with later listings than 2002)

| Company Name | Date of listing on CNX Nifty |
|---|---|
| Bajaj Auto Ltd | 2008-05-27 |
| Cairn India Ltd | 2007-01-10 |
| Coal India Ltd | 2010-11-05 |
| DLF Ltd | 2007-07-06 |
| IDFC Limited | 2005-08-16 |
| JAIPRAKASH ASSOCIATES | 2004-06-15 |
| MARUTI SUZUKI INDIA | 2003-07-10 |
| NTPC | 2004-11-08 |
| POWER GRID CORP.OF INDIA | 2007-10-08 |
| PUNJAB NATIONAL BANK | 2002-04-29 |
| TATA CONSULTANCY SVS. | 2004-08-26 |
| ULTRATECH CEMENT | 2004-08-25 |