Bachelor thesis in Financial Economics
Department of Economics

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

All or Nothing

A Study of Optimal Investment Behavior with Regards to Risk and Return

Ingrid Andelid Hjort and Shasa Husein

Tutor:
Hans Bjurek

Date: 7 June 2016

Abstract

The financial crisis of 2007 and 2008 lead to great instability on the financial market as stock prices fell rapidly to then progressively increase again. Further on, in February 2015, Sweden experienced a negative repo rate for the first time. Under these rare economic circumstances, the evaluation of risk and return is crucial and private investors are presumed to pay attention to both. Hence, this thesis will evaluate the investment pattern among Swedish investors and determine if it has been efficient according to chosen financial theories. The thesis will contribute to the discussion of weather Swedish investors can be considered as rational and if the private capital is accurately allocated. The methods consisted of collecting data and processing it with relevant tools and programs. Data stretches from 2007 to 2016 and results were calculated with approaches taken from the modern financial theories. The study came to the conclusion that Swedish investors cannot be considered as rational when managing their private investments. The investments in risky assets are overexposed towards fluctuations in the stock market while bank deposits, which are the most common form of saving, can be considered as both risk-free and non-profitable. Stocks and bank deposits are the two most common financial investments, which leads to an “all or nothing” condition where investors either take on too much risk or none at all.

JEL Classification: G11

Keywords:
Behavioral finance, Capital allocation line, CAPM, Efficient market, Minimum variance, Portfolio selection, Security market line, Sharpe Ratio

Acknowledgements

We would like to give thanks to our tutor Hans Bjurek, associate professor at School of Business Economics and Law in Gothenburg for his valuable advice when constructing this bachelor thesis. In addition we would also like to acknowledge Jian Hua Zhang, professor at School of Business Economics and Law in Gothenburg for time he spent aiding us with calculations.

Abbreviations:

B&MM funds – Bond and money market funds
CAL – Capital allocation line
CAPM – The Capital Asset Pricing Model
OMRXT30 – 30-day Treasury bill index
OMRX – OMRXTBOND (Treasury bond)
OMXSGI – The Stockholm Stock Exchange all-share Gross Index
RF – Risk-free interest rate
SML – Security market line

Table of Contents

1. Introduction

1.1 Purpose and Background

The aim of this thesis is to examine the key factors that affect the allocation of private capital in different financial assets. In addition to the financial studies in the same area, this paper will contribute to an further aspect of financial behavioral, since the assumptions made in the classic financial theories tend to overlook some of the true underlying factors that affect investment behavior. For instance, the most common measurement of risk and return is the Capital Asset Pricing model (Sharpe 1964; Lintner 1965) more known as the CAPM. This model is used to establish the trade-off between risk and return where different assets are compared.

Furthermore, there are three assumptions underlying this model, stated by Markowitz (1959) in his development of the Portfolio Choice Theory. The first is that investors have access to all securities on the market to no additional tax or transaction cost. The second assumption is that investors only trade with efficient portfolios meaning that investors experience the maximum rate of expected return on their investments at the given level of risk. The third assumption concerns the behavioral aspects where investors are presumed to have the same expectations with regards to expected returns, volatilities and correlations between the securities. Nevertheless, the underlying assumptions of the CAPM have been widely criticized since the assumptions are strong in reference to the real market.

Over the last decade, the financial markets have been affected by several macroeconomic shocks leading to instability and uncertainty. The 18th of February 2015 the Swedish Central Bank, Riksbanken, announced that the repo rate would be set to a negative figure, which is the first time in history. This is further bolstering the fact that the financial market is on an unusual course. According to a survey constructed by the bank Nordea (2015), which is one of the largest banks in Sweden, approximately 80% of the respondents had not changed their composition of savings as a reaction to the historically low interest rate in Sweden. Moreover, a large majority of the investors did not reflect nor did they notice any change in risk, which is a direct contradiction towards the assumptions made in the CAPM.

Therefore, the purpose of this thesis is to examine if Swedish investors are allocating their capital in an optimal way and in line with the traditional financial models.

Regarding the disposition of this thesis, the paper will continue as follows. The ensuing section is treating the theories that underlie the results of this paper. Thereafter, a model specification will explain the details of each financial theory where mathematical formulas will be presented and clarified. The third section includes the overall methodology, counting for the collection of relevant data and further description of how data was processed in order to obtain the results. The fourth section will present the results and will furthermore give an intuition of the explanatory factors to them with interpretations of the values obtained. The last section will cover the main conclusions of this paper as well as a discussion of the shortcomings and possible developments.

1.2 Research Question

Are private investors in Sweden acting according to the classic financial models and are they rational when considering return in relation to risk?

2. Theory

2.1 The Efficient Market Hypothesis

"*The Efficient Market Hypothesis (EMH), popularly known as the Random Walk Theory, is the proposition that current stock prices fully reflect available information about the value of the firm, and there is no way to earn excess profits, (more than the market overall), by using this information.* "(Clarke, Jandik & Mandelker 2001 p.2)

A market is considered efficient when prices adjust to new information instantly, since prices fully reflect information about the value of the firm. Furthermore, Clarke, Jandik and Mandelker (2001) argue that the efficiency of a market can be divided into three main stages; the weak form efficiency, the semi-strong form efficiency and the strong form efficiency.

The weak form of efficiency suggests that current stock prices reflect historical prices only. Hence, no investor can ''beat'' the market by analyzing historical prices. Consequently, there is no reason for technical analysis as all investors have access to prior prices of the stocks.

The semi-strong form of efficiency is rather different from the weak form of efficiency. In this market, the prices reflect all public information about the value of the firm. However, in order to make a profit, investors must be able to analyze prices based on financial economics, macroeconomics and other essential attributes of the stock.

The third and last form of efficiency is the strong form of efficiency where prices fully incorporate all existing information meaning that no investor can make a profit on the stock market. This would also suggest that insiders have no further advantage in information as prices most accurately reflect all existing information (Clarke, Jandik & Mandelker 2001).

Therefore, in reference to the main principles in "The Efficient Market Hypothesis", Fama and French (2012) claim that it is unlikely to outperform the market unless investors increase the share of risk in their investments. Market analysts tend to search for mispriced stocks with an underestimation of its future performance. This implies that investors would like to believe that it is possible to possess information that the market does yet not have.
Nevertheless, the efficient market theory suggests that the market cannot be outperformed by collecting information regarding the stocks, since it assumes that there is always complete

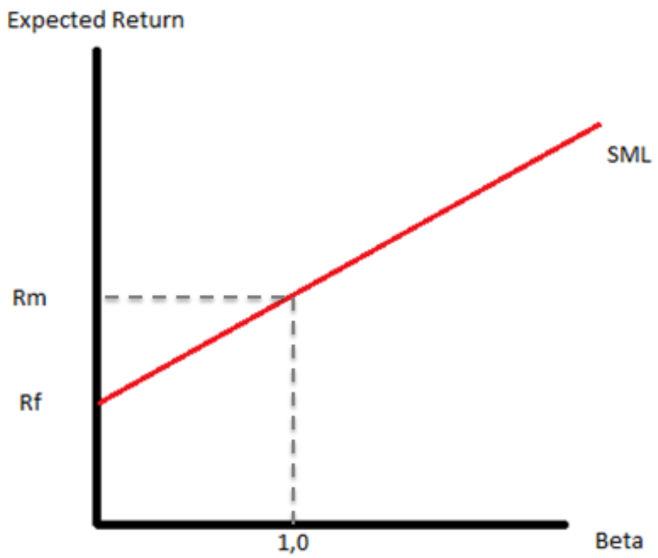
information symmetry on the market. For that reason, the theory of an efficient market advises investors to base their decisions on risk since prices of stocks already reflects all existing information.

2.2 The Capital Asset Pricing Model and the Security Market Line

According to Markowitz (1959), investors would require a risk premium if they were to take on risk, since investors are risk-averse and would rather sell off their risky assets than carry them without reward. The volatility, also called standard deviation, of stocks is a measure of risk. This risk is formerly separated into two types - systematic and diversifiable risk (Berk & DeMarzo 2014). Diversifiable risk is also called firm specific risk and will in a well-structured portfolio be diversified away. For that reason, investors do not receive any risk premium to bear this type of risk. In contrast to diversifiable risk, it is not possible to avoid systematic risk by diversifying the portfolio. Hence, investors would demand a premium in order to take on this type of risk. This premium can be determined with the help of The CAPM: $market\ risk\ premium = e[r_m] - e[r_f]$ where r_m is referred to as the market return and r_f as the risk free return, (Ross 1976).

However, to calculate the return of the investment, the market premium must be multiplied by the investment's systematic risk since higher risk would mean higher return. In this case, the firm specific risk has been minimized through diversification, leaving only systematic risk. By multiplying each investment's systematic risk with the market risk premium, a security line can be developed. This line is more known as the Security Market Line or the SML, which displays the linear relationship between the return and systematic risk of an asset. Under The CAPM assumptions, all possible investment opportunities should lay on the Security Market Line since the return of an investment depends on the level of risk it is associated with. The vertical axis represents the expected return while the horizontal axis is measuring the beta of each investment. The positive slope of the Security Market Line represents the market premium the investors would demand as compensation for taking on risk.

Figure 1. The Security Market Line



Berk and DeMarzo (2014) argue that the Security Market Line is applicable to all types of investments and it is therefore possible to measure the average risk and return of the different financial objects in order to determine how these assets perform on average. By plotting in the average returns in a graph and including the SML, the over and undervaluation of an asset can be determined. If the security is to be found above the line, the investment is interpreted as undervalued since it should yield a lower return for the inherent risk. Likewise, a security plotted below the Security Market Line is considered overvalued as the investment should transmit higher return for the amount of risk it carries.

2.3 The Sharpe Ratio

The Sharpe Ratio, developed by William F. Sharpe in 1966, is a measure of the portfolio's performance in relation to the risk-free interest rate. The optimal portfolio that is the most desirable for an investor is the one with the highest Sharpe Ratio since it reflects the most efficient trade-off between risk and return. In comparison to the Capital Asset Pricing Model where risk is defined as beta and non-diversifiable, the Sharpe Ratio assumes that portfolios are not to be considered as completely diversified, which suggests that firm specific risk cannot be completely diversified out.

The model suggests that portfolios with multiple assets might still contain some firm specific risk and for that reason, the standard deviations of the investments are rather preferred as a risk measure. The main components of the Sharpe Ratio are the average return of the Treasury bill (T-bill), the average return of the portfolios and the standard deviation for each of those returns. The T-bill is set to be a proxy for the return of the risk-free investments since *"while the T-bill is not constant over the entire period, we still know with certainty what nominal rate we will earn if we purchase a bill and hold the maturity''* (Bodie, Kane & Marcus 2014, p.134). The other investments are those with risk included, which arises when the investment has a higher expected rate of return. The return of the investments is then put in comparison to the return of the risk-free investment and divided by the standard deviation of each return. Therefore, the described relation between the excess return of the investments and their standard deviations demonstrates how much one additional unit of risk would give in return. The Sharpe Ratio is consequently a relevant reward-to-risk measure where the main object is to compare the return opportunities for different investments without having to bear too much risk.

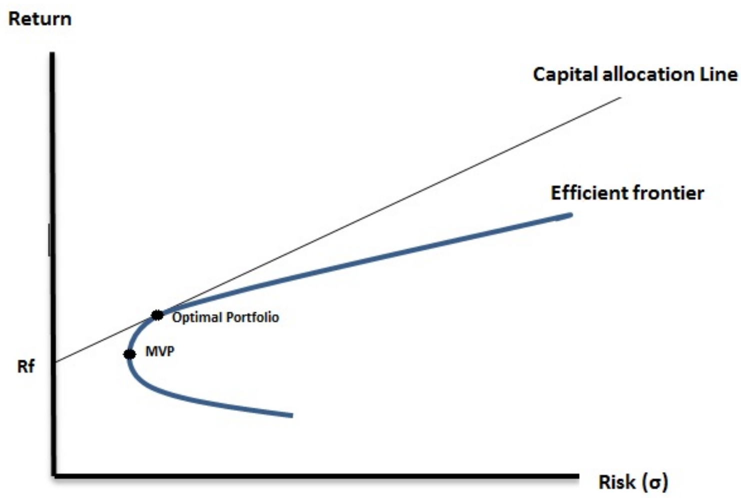
2.4 Portfolio Selection

"Not only does the E-V hypothesis imply diversification; it implies the right kind of diversification for the right reason" (Markowitz 1952, p.89). The E-V does in this case stand for Return-Variance that in the theorem are the only elements affecting investors behavior.

Harry Markowitz developed the Mean Variance Theorem in 1952, and for his contribution to the field, he was awarded a Nobel Prize in 1990. The theorem consists of a method on how to find the best allocation of assets in an optimal portfolio that will produce the highest expected return at each level of volatility. According to Markowitz (1952), a good prediction of investment behavior is that investors value the expected return as a desirable thing and variance of return as an undesirable thing. The investor has an option on how to vary different combinations of return and variance where some solutions are efficient whereas some are not.

The theorem considers the variance and the correlation of assets as key determinants of portfolio performance. When maximizing the expected return and minimizing the variance, there is no use in holding large number of assets within the same market and with the same firm exposure, because these assets are highly correlated and thus the variance will not be decreased notably. Firms operating in different economic environments are more desirable as diversification material since they are not sensitive towards the same type of shocks in the market (Markowitz 1952).

Figure 2. The Capital Allocation Line and the Efficient Frontier



Every point on the Efficient Frontier is a compilation of different portfolio combinations (Fama & French 2004). The portfolio that carries the least amount of risk is referred to as the Minimum Variance Portfolio or MVP. All portfolios below this point in *figure 2* are inefficient while all portfolio combinations above are efficient, meaning that these portfolios continuously produce a higher rate of return at any given level of risk. The reason why the portfolios under the MVP are termed as inefficient is that the relationship between risk and return is not constant. These portfolios do not award their owner with a higher return for the increased amount of risk. Instead, as the volatility of these portfolios rises, the return diminishes.

2.5 Behavioral Finance

In addition to the classic financial models, this thesis will process and account for some behavioral aspects of finance. The theory of investor behavior will contribute to a wider interpretation of the variables that influence the share of capital invested in the financial assets.

According to recent studies in the field of behavioral finance, it has been discovered that investors are more sensitive to losses than to gains. Barberis and Huang (2001) argue that risk aversion seems so depend on prior gains and losses whereas some losses are believed to be more "painful" than the overall gains. Other predictions suggest that an investor is loss averse towards fluctuations in portfolio performance. This theory explains why the ratio of capital in one financial asset does not remain constant over a long period of time, even if the expected return and therefore its future performance is high.

The same could be said for investments that are inefficient. If the asset has produced gains in prior periods, the investor becomes less risk averse. "*If a stock has had good recent performance, the investor gets utility from this gain, and becomes less concerned about future losses on the stock because any losses will be cushioned by the prior gains. In effect, the investor perceives the stock to be less risky than before and discounts its future cash flows at a lower rate.*" (Barberis & Huang 2001, p.3)

However, an investor can invest in risky assets without having experienced prior gains. Forbes (1959) research in the field provides an additional factor to the aspect. An investor can become overconfident in the sense of selecting a portfolio with a high return and believing that the portfolio will continue to produce returns. Nevertheless, Forbes (1959) specifies his means by differentiating optimism from overconfidence and suggests that the terms should be separated. Optimism can lead to the same outcomes as overconfidence, as a misplaced trust is concentrated to the investment, but the investor is rather optimistic about the future outcome, than in the ability of outperforming the market. The speculative investment behavior will therefore disturb the pricing mechanisms and influence the risk evaluations of portfolios. Thus, these approaches of behavioral finance will offer some alternative explanations to deviations from the standards in the classic financial theories.

2.6 Model Specification

Variable	***Sign***
Risk-free return	r_f
Variance	σ^2
Standard deviation	σ
Asset beta	β_i
Market beta	β_{im}
Return on portfolio	r_p
Covariance	cov
Return on market	r_m
Expected return	$e[r]$
Average return	$\bar{r}$
Sum of	Σ
Number of observations	n
Return on investment	r_i
Return of time period	r_t
Index in a time period	i_t

Risk measure

Models have been chosen based on generally accepted financial theories that commonly appear in financial literature. The following are the models used in this paper to measure the risk of financial assets.

Volatility

$$\sigma = \sqrt{\frac{\sum(r_i - \bar{r})^2}{n-1}}$$

The total risk of an asset is commonly referred to as volatility. The mathematical specification for that risk is the standard deviation, which reflects how much the asset varies over time as expressed by the deviation from its mean value.

Beta

The total risk of an investment is composed of two main types of risk; the systematic risk and the firm specific risk, which is also called unsystematic risk or diversifiable risk. The systematic risk is often referred to as beta, which is a measurement of an investment's exposure to macroeconomic risk. The firm specific risk is the type of risk that only affects parts of the market or certain companies. The risk can therefore be eliminated through diversification while the unsystematic shock cannot, as it accounts for the volatility caused by the macroeconomic instabilities. The beta of an individual investment is then compared with the market beta so that the volatility from the market fluctuations can be calculated.

$$\beta_i = \frac{cov(r_i, r_m)}{\sigma^2(r_m)}$$

(Berk & DeMarzo 2014, p. 355)

Risk adjusted return

In this section, the models presented contain specifications of the financial objects based on two factors, risk and return.

The Sharpe Ratio

$$S = \frac{r_i - r_f}{\sigma\, r_i}$$

The Sharpe Ratio is a measure of both systematic and unsystematic risk. It is calculated by computing the difference of the returns between the investments of interest and the risk-free asset and then by dividing this difference by the standard deviation of the investment. The Sharpe Ratio for a portfolio is calculated based on the same principles.
(Berk & DeMarzo 2014, p.373)

The Capital Asset Pricing Model (CAPM)

As mentioned above, the systematic risk of an asset is often referred to as the beta, which is a measure of an investment's variance caused by macroeconomic shocks. Beta is for that reason a measure of the sensitivity to systematic risk of a security, in other words it estimates how exposed the security is to market wide risk.

Estimating the cost of capital of an investment from its beta can therefore be settled with the market security line. The Security Market Line is a linear relationship between the return and beta of an individual security, in other words it illustrates the trade-off between systematic risk and return (*see figure 2*). The slope of the line is equal to the risk premium in the market and the intercept of the vertical axis is equal to the risk-free interest rate. The closer to origo a security plots in the graph, the less market risk and return does it carry.

$r_i = r_f + (\beta_i * market\ risk\ premium)$. (Berk & DeMarzo 2014, p. 341)

The market risk premium is determined by the difference between the expected return of the market and the expected return of the risk free asset which is equal to $e(r_m) - e(r_f)$ in the market security equation. According to this model, an investor would not invest in a stock if the risk premium is not satisfactory enough. Additionally, the same could be said for investors' way of saving. If capital is kept in bank accounts with zero interest rate, it would suggest that there is no better way of dispensing the capital.

The Capital Allocation Line (CAL)

The capital allocation line is a linear relationship between return and volatility. Thus in contrast to the SML, it illustrates the trade-off between the *total* risk and return for a combined portfolio. The optimal portfolio is the tangency point of the CAL and the Efficient Frontier and is termed optimal since this portfolio reflects the highest possible Sharpe Ratio attainable. The line intercepts the vertical axis at the rate of the risk-free security. Under CAPM assumptions the market portfolio should lie on the CAL (*See figure 2).*

3. Methodology

The method section contains a description of the chosen approach in order to disentangle the research question. Descriptions of the scientific methods and means are presented along with the material and data processed. This section also extends to the course of action and the implementation of the study and a critical examination of the data used.

3.1 Data Collection

The paper has been constructed using data collected from databases, such as Morningstar, Bloomberg, Nasdaq OMX Nordic and the Swedish Financial Supervisory Authority. The data contains aggregate information on how Swedish households distribute their private capital into different types of financial securities. The collected data contains the historical return of the repo rate, the risk free interest rate, OMXSGI, OMRXTBOND, OMRXT30 and all funds available to Swedish investors, separated into equity funds and bond and money market funds. Both monthly and quarterly data of the historical prices in SEK was assembled for all the variables, except for the repo rate and the savings barometer where only quarterly data was published.

The collected data has a range between 070130 and 160331, thus for each of the variables that contains monthly data, there are 110 observations. Since the data treated is in aggregate form, it was possible to combine the empirical aspect of the study with the theoretical models and determine the relation between these models and the actual behavior of private investors in Sweden, ex post.

3.2 Research Approach

The study is first and foremost quantitative but the explanatory part of the result contains elements of behavioral finance that has a qualitative nature. Financial theory and statistical programs were used to calculate the risk-return reward and optimal portfolio allocation of the financial objects studied. An inductive research approach has been taken on where the theories and models were applied to empirical data in order to investigate their predictive power in recent real world settings.

3.3 Material

In this section, the financial objects will be explained in detail followed by an explanation of the limitations of chosen data. The data collected for this paper consists of mainly historical prices of different financial assets and aggregate data of the capital allocated in each respective asset.

Bank Deposits

The most common form of saving in Sweden, in order to receive a floating interest rate on the capital, is bank deposits (Beckman 2009). This kind of placement is completely liquid since it instantly can be converted into cash. Another benefit is that the deposit is guaranteed by the Swedish state with an amount of up to 100 000€ per institution or individual (the Swedish National Debt Office 2016). The Deposit Insurance (SFS 1995:1571) specifies all conditions regarding this guarantee where the purpose is to ensure the financial stability and enhance the security of the public's deposits. The repo rate has however been negative whilst the interest that is paid by traditional banks, has never gone below zero. For that reason, the negative values were in this thesis corrected for by replacing them with a zero to get a more realistic measure. This will be referred to as the adjusted repo rate. As mentioned above, only quarterly data was attainable for the repo rate. However, the repo rate remains unchanged over the quarters and it is therefore possible to create monthly data by duplicating the repo rate for the three following months.

Treasury Bills (OMRXT30)

All securities are associated with some risk, but the T-bills, which are issued by the state, have the lowest credit and liquidity risk which is why the return on these assets are referred to as the risk-free interest rate (Hansson 2009). Short term T-bills are associated with the smallest amount of risk. The shortest time of maturity issued by the Swedish National Debt Office is 30 days. The security will also be referred to as the risk-free interest rate or RF. Bloomberg holds information regarding historical prices of OMRXT30, which is the risk-free security as described above.

Treasury Bonds (OMRX-TBOND)

OMRX-TBOND is a family of fixed income indexes which all have the purpose of illustrating the price development of a certain type of passively managed portfolio. The portfolio subsists of liquid Swedish interest-bearing securities with a time of maturity of maximum one year (NASDAQ OMX Nordic 2016). The Swedish National Debt Office issues official statistics of emitted volumes, which is the basis for the composition of the index. The data was downloaded from Bloomberg and the OMRX-TBOND will further on be referred to as OMRX.

Funds

Morningstar holds information on all funds available to Swedish investors. The Morningstar fund index that is used for the comparison of fund performance shows the average return of the funds that are included in the index. This is a valuable tool when analyzing different investment strategies as historic returns of different assets can be compared.
By including funds available on the Swedish market only, it is possible to use this data to compare with the statistics of the Swedish Financial Supervisory Authority. The two major categories are equity funds and bond and money market funds.

Bond and Money Market Funds

According to Beckman (2009), a bond and money market fund engages a large number of depositors where the accumulated amount obtained are invested on the bond- and money market. This approach allows an improved yield as well as a well-diversified risk. This type of security will also be referred to as B&MM funds.

Equity Funds

Equity fund, also called stock fund, is a mutual fund where the capital is primarily fixed to the stock market and thus an option that avoids the maintenance of cash, cash equivalents and bonds (Hansson 2009). It is therefore the individual investor that decides if they want to retain the position in stocks since an investment in equity fund would mean that the capital is fully invested in stocks and with high exposure towards market risk.

Swedish Listed Shares

The Stockholm all-share Gross Index is a market capitalized weighted share index that contains both share prices and reinvested dividends and reflects the development of the Stockholm Stock Exchange. In this study, this index will be used as a proxy for the market portfolio as Ross (1976) argues it fulfills the criterion of an efficient portfolio with all Swedish stocks traded on the market. The data was collected using Bloomberg and the financial object will henceforth be referred to as OMXSGI or the market portfolio.

Savings Barometer

Every quarter, the Swedish Financial Supervisory Authority publishes a compilation of the households' total financial savings and wealth, labeled as the Savings Barometer. The Barometer is a part of the Financial Accounts of the National accounts system and it treats the national financial activities (Statistics Sweden 2016). The statistics is branched into different financial objects of which the selected ones for this study are listed above. The motive for this division subsists on that the study covers the flexibility of the capital of private investors and it is therefore only relevant to include assets with high liquidity. Therefore, assets such as real-estate were excluded. Moreover, only quarterly data was available for this variable.

3.4 Limitations

As previously mentioned, the index OMXSGI was used as a proxy for the market portfolio. However, this category of assets listed at the Swedish Financial Supervisory Authority contains all Swedish listed shares, which is the aggregate form of listed shares that Swedish investors hold. It is implausible that the portfolios of individual investors are as well diversified as OMXSGI. John Y. Campbell (2006) quantified this in his study where he concluded that about 50% of the risk in Swedish portfolios is due to unsystematic risk, which in extension means lack of diversification. The reader should have in mind that when refereeing to actual behavior in the result section, it only reflects Swedish listed share as an aggregate. It does not disclose anything about individual portfolio stock composition.
Some portfolios are possibly inefficient whereas some are not while the results from this study should be interpreted as how an average Swedish investor has managed his or her portfolio. Factors such as gender, household income and education might influence individual investment behavior.

3.5 Empirical Method

The following section consists of empirical framework used to obtain the results. The hypothesis is stated along with all the measures and methods that were used to test it.

The monthly prices of each security along with the quarterly data of the Swedish central bank and the Swedish Financial Supervisory Authority were imported into an Excel spreadsheet. The repo rate was only available in quarterly data but when the return was compared to the 30-day Treasury bill (OMRXT30), it was possible to define the OMRXT30 as a proxy for the repo rate under the duration studied. Thereon, the percentage changes of all the financial objects were calculated and exported into Stata where average monthly returns, standard deviations and betas were retrieved.

Hypothesis

Do private investors in Sweden hold optimal portfolios and is the financial market efficient? Testing the hypothesis of efficient markets and optimal portfolios will involve calculations on measures of volatility, market beta, asset beta and the Sharpe Ratio in order to arrive at the Capital Asset Pricing Model and the Mean Variance Theorem. The empirical testing of these models will be based on the data retrieved from the Swedish Financial Supervisory Authority and the monthly prices of the financial objects from Bloomberg, NASDAQ OMX Nordic and Morningstar. The authors will with these means clarify how private investors in Sweden have de facto allocated the capital in comparison to what is considered optimal according to the chosen models.

As the theory suggests, investors should allocate their capital based on both risk and return. However, we expect Swedish investors to focus mostly on return rather than risk when optimizing their portfolio. Hence, the correlations between the different assets should have a negative correlation in return meaning that when the return of the risk-free assets decreases, the investment ratio in risky assets as stocks should increase. In addition, the weights of the assets are presumed to be non-optimized in Swedish portfolios.

Volatility

The standard deviation of each investment is referred to as the volatility. The volatility is an approximation of the investment's deviation from its average return and is therefore a measure of how much the return of the investment fluctuates. In order to receive the volatility of the financial objects, the data of the monthly returns were exported into Stata where a summary statistics was retrieved.

Beta

Once again, Stata was used to obtain the results of interest. However, regressions were necessary to construct. The average return of each investment, which would represent the dependent values of the regression, was set in relation to the average returns of the market, the independent values. The constants reflect the investments deviation from the market return, which is equal to the beta of each asset. Further on, this regression was not used to compute the beta for OMXSGI because if the average return for the OMXSGI was set against the average return of itself, the constant for OMXSGI would equal to one. This is accurate based on the fact that the OMXSGI index reflects the market as a whole and so contains all systematic risk in the Swedish economy with perfect diversification and therefore no unsystematic risk.

The Sharpe Ratio

The Sharpe Ratio was computed using the information obtained in the Stata summary statistics which contained all necessary components. For each financial object the formula for the Sharpe Ratio (presented in the model specification) was applied to recover the ratio. Nonetheless for the risk-free security a Sharpe Ratio is not feasible since the numerator of the equation equals to zero.

The Security Market Line

The Security Market Line was obtained by first calculating the market risk premium, which is the difference between the market return and the return of the risk-free investment. The line intersects the vertical axis at the rate of return of risk-free investment and the linear relationship of the SML was drawn using this intercept value and the slope, the market risk premium. A table was then constructed in Excel where the horizontal axis values are the individual betas of all securities and the vertical axis values are their return respectively.

From the table, a scatter plot to represent the risk/return trade-off of each security could be fabricated and plotted around the SML.

The Minimum Variance Portfolio

The Minimum Variance Portfolio was calculated in Excel where the assets where all given random values of their weights in the portfolio that all would sum up to one. The next step involved calculating the expected return, standard deviation and Sharpe Ratio of the portfolio with the help of relevant Excel commands. In order to calculate the minimum variance point, the Solver tool was used where changing the weight values minimized the standard deviation.

The Mean Variance Theorem - Optimal weights

The first step involved calculations of expected return, variance and standard deviation for the ensemble of investments, meaning that the performance for the investments as a group was calculated. A variance-covariance matrix was constructed using the data analysis tool. The Sharpe Ratio was then calculated and maximized with the Solver tool. Excel was then used to achieve the capital allocation line and the Efficient Frontier of portfolios. Optimal weights were collected by using the Solver tool to maximize the Sharpe Ratio by varying the values of the portfolios' weights.

Index

A nine-year return index with the base date 070130 and the finish date 160331 was constructed in Excel by using the monthly prices of each financial object. The percentage change in the price for each month was calculated using the following formula: $\%\ Change = (r_t) - (r_t - 1)/(r_t - 1)$. This series was the foundation for the return index where the base number was set to 100 SEK. The index was then calculated with respect to the effect of the compound interest by the formula: $i_t = (1 + r_t) * (r_t - 1)$.

The percentage change of the repo rate cannot be calculated the same way since it is not a financial instrument in the sense that it is prices that fluctuate; instead a floating interest rate is received. An index is a useful tool when comparing different securities since they are all transformed so that they have the same base number and are therefore set in relation to each other.

Savings Barometer

Once again, Excel was used to illustrate the proportion invested into each financial object. For every historic quarter, the amount invested in the collection individual assets was added up to a total. To obtain the fraction invested into the specific security, the amount invested into each investment was divided by the overall total. This procedure was then repeated for all assets and time periods. A graph was then constructed in Excel in order to illustrate the development over time and it can be found in the result section.

4. Results and Analysis

In this section, the results will be presented and discussed where the results are illustrated in graphs and tables to delineate the information. These results are analyzed by explaining the underlying reasons and then connected to the theories brought forth in the paper along with the hypothesis.

4.1 Return, Risk and Sharpe Ratio

The monthly average return has been the best for OMXSGI (0.64%) followed by equity funds (0.45%) and OMRX (0.41%) that performed similarly. After follows bond and money market funds (0.24%) and the risk-free interest rate (0.11%). These results are to be as expected except for one remark. OMRX has achieved a surprisingly adequate return in relation to the other financial assets. The beta for the OMRX does however have a negative sign and displays the largest magnitude, -0.08 that may partly explain this fact. When other assets fell in value, the OMRX reacted oppositely and in effect rose in value, which is illustrated by the index in *figure 5*. Another explanatory fact is that the price of bonds is to a great extent determined by the current interest rate (Brennan & Schwartz 1979), which in Sweden has been in a negative trend since the second quarter of 2008.

Table 1. Return, Risk and Sharpe Ratio

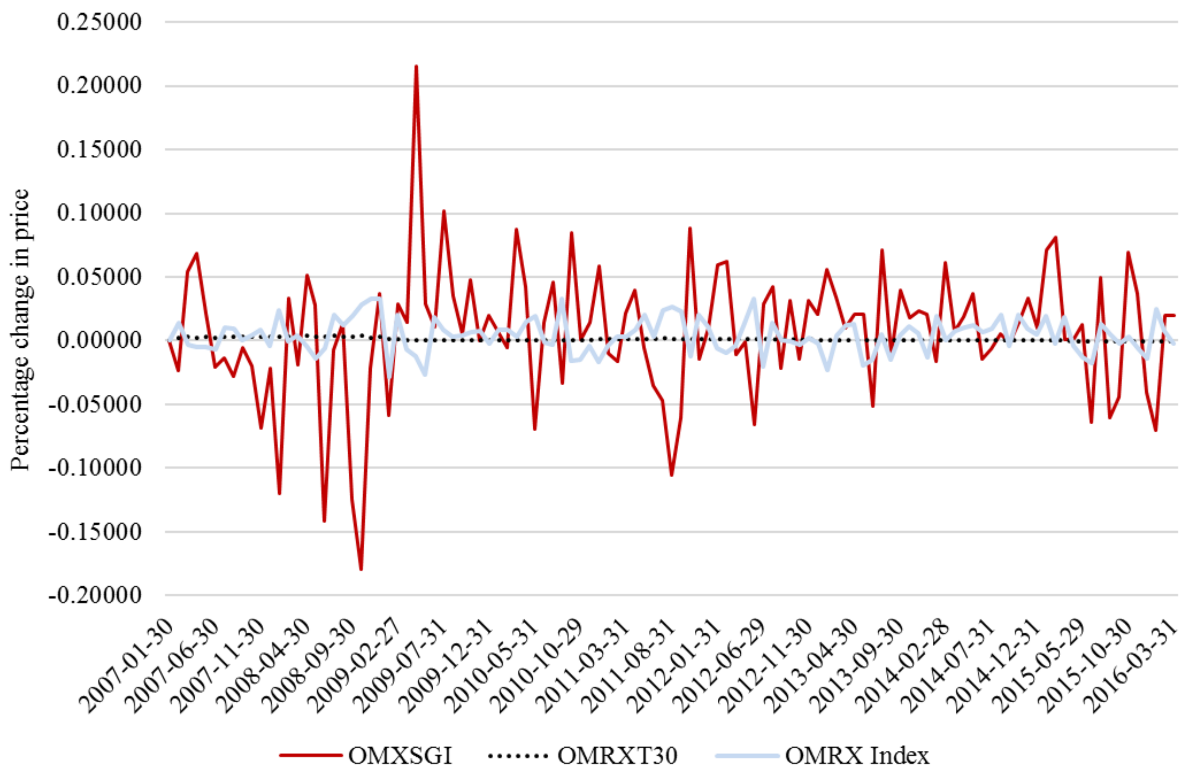
	OMXSGI	**Equity funds**	**B&MM funds**	**OMRX**	**RF (OMRXT30)**
Average monthly return	0.64%	0.45%	0.24%	0.41%	0.11%
Risk (Volatility)	5.27%	4.21%	0.39%	1.35%	0.12%
Sharpe Ratio	0.10%	0.08%	0.33%	0.22%	-
Beta	1.00	0.77	-0.01	-0.08	-0.01

The beta of equity funds is relatively close to one (0.77). This value is also as to be expected since it is highly exposed towards the stock market. In theory, the beta for the risk-free security should be equal to zero but empirically it does hold a small amount of risk due to the inflation expectations, which is reflected in the study where the risk-free investment has a beta of -0.01.

By taking a look at the table, it implies that the beta of the bond and money market funds has the same value as the risk-free security but with a higher yield - indicating that it is superior to the risk-free investment.

Considering the Sharpe Ratio, it is the bond and money market funds that has the highest ratio and so the best risk adjusted return. The reason for this lies in the fact that these types of funds have had the least volatile return next after the risk-free interest rate. In the financial environment that has been prevailing over the last decade, the bond and money market funds has been the most secure option in relation to the rate of return it has produced. It does also have a negative signed beta, which despite its modest value, works as a hedge towards market wide risk. These results are not in line with the Efficient Market Hypothesis or the CAPM which both states that the market portfolio (in this case OMXSGI) should display the highest Sharpe Ratio. OMXSGI has only produced a Sharpe Ratio of 0.10, which positions this investment on the third best investment, with four investments being compared. *Figure 3.* below demonstrates the instability in the prices of the securities during the time span studied. The considerable fluctuations, in especially the stock market, are reason behind the low Sharpe Ratio of the financial objects highly exposed towards this particular market.

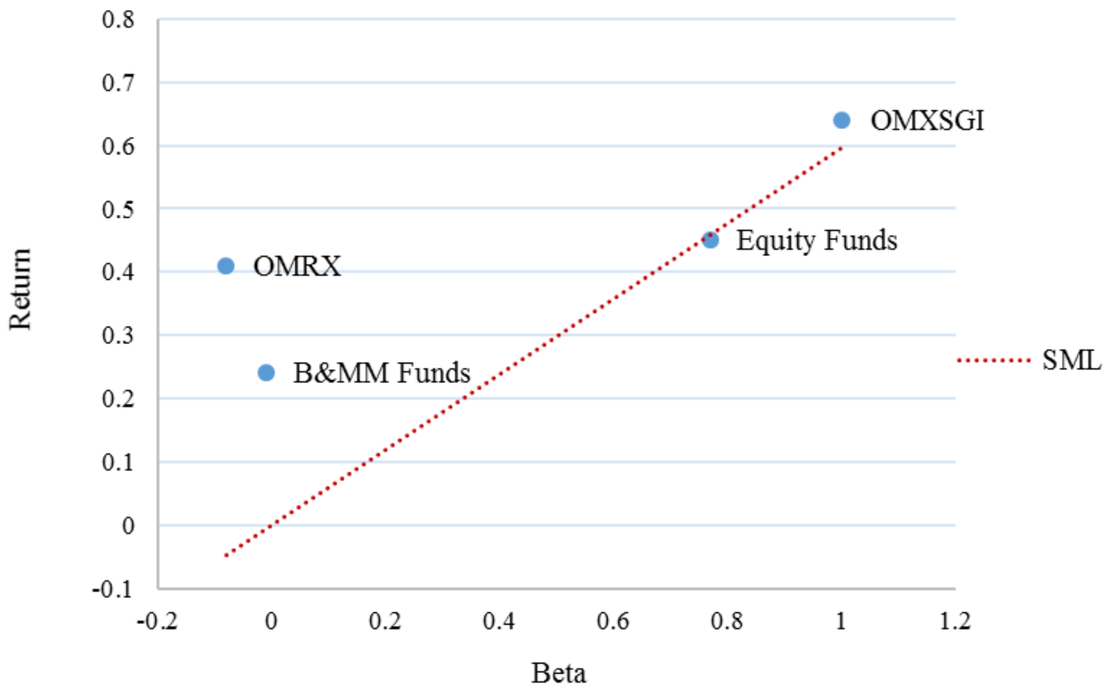
Figure 3. Percentage change in price of securities



4.2 The Security Market Line

Running the regression with calculations of the return in the security market line theory and comparing the line with actual returns, several results can be obtained for the investments' profit. When measuring the relationship between risk, here referred to as beta, and the return of the investments in *figure 4.*, the conclusion can be drawn that almost all investments are undervalued or highly undervalued. The exception is equity funds where it seems like the risk adjusted return has followed the Security Market Line. This particular asset is therefore efficiently priced since an investor has received the expected return.

Figure 4. The Security Market Line



Nonetheless, the risk-term in the security market line is described as beta, which refers to the systematic risk. This would require a condition of no firm specific risk and complete diversification, which is a strong assumption since an elimination of risk is never guaranteed. Our assets evaluated can therefore carry a firm specific risk that affects the beta since the firm specific risk is assumed to be none. The overall share of risk, which is the standard deviation, is accounted as beta, which in turn could vary in error due to the variation in diversification. Some assets' beta would be more accurate than others since the unsystematic hence firm specific risk varies over the assets and over different periods of time.

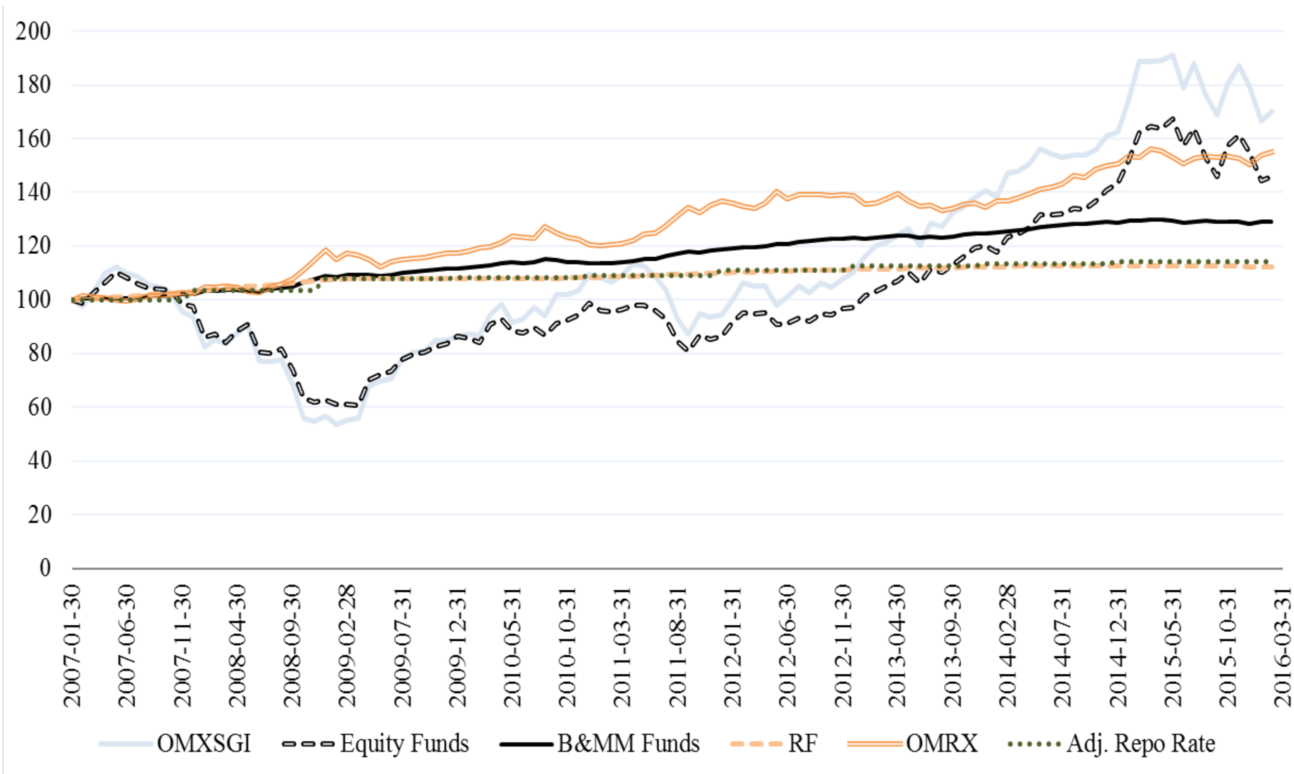
However, the majority of the assets have been strongly undervalued which would suggest that even if the betas are slightly overrated, the significance of its deviation from the Security Market Line remains noteworthy. The OMRX is the most overvalued asset of the investments examined. This means that as an investor, one has received more in return in relation to the risk one has carried for the asset.

These results imply that the Swedish market, during the nine-year period studied, is not the strong form of market that the efficient market hypothesis describes. The strong market condition would not make it possible to make a profit out of investments and prices would contain all information there is to a financial object. However, these results demonstrate how inefficiently the prices of the investments have reflected the true value of the asset. Thus, the market is not to be considered as efficient but rather as semi-strong to weak.

4.3. Return Index

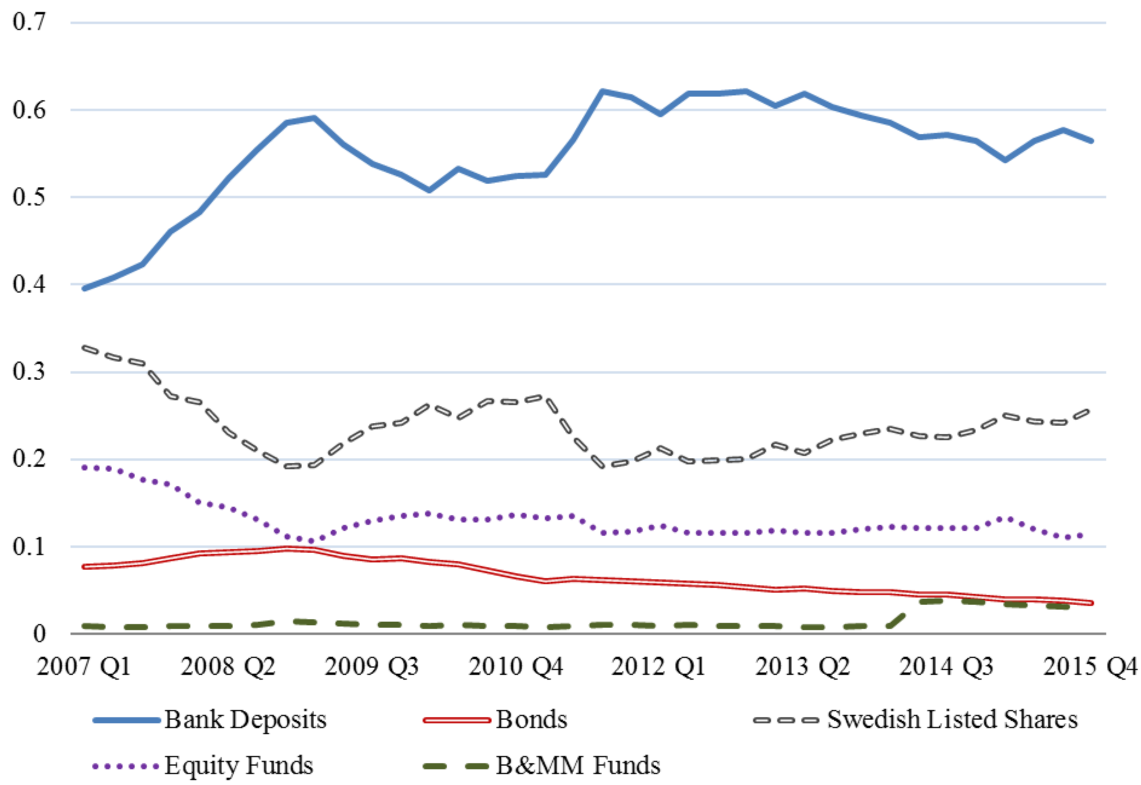
An index was created for each of the securities in order to be able to explain the cumulative return for an investment made in 070130.

Figure 5. Return Index, Monthly data



As illustrated by *figure 5*, OMXSGI has provided the highest return for the period, followed by OMRX, equity funds, bond and money market funds and lastly the risk-free interest rate. However, during the financial crisis of 2008, OMXSGI and the equity funds lost approximately 40-50% of their respective values, the worst of the two being the first mentioned. This reaction is indicating their sensitivity towards systematic risk where OMXSGI performed slightly worse reasoned by that it is associated with a beta of 1 which means that it moves in complete relation to the market. Bond and money market funds and the risk-free interest rate have had a steady but more modest yield whereas OMRX exhibited a more volatile growth but outperformed all other assets except for OMXSGI, if seen to the entire time span studied. The volatility of selected securities, as measured by the percentage change in price over time is also depicted in *figure 3.* to better apprise the reader. In retrospect, OMXSGI has, as mentioned above, still provided the best return but many investors are both risk and loss averse which results in a withdrawal of their capital in market declines. As the financial crash of 2008 also resulted in consequences for the real sectors of the economy, investors may furthermore need the capital to finance their living. Barberis and Huang's (2001) report adds an intuition of how investors reacted to the crisis. Since the investor is loss averse towards fluctuations of portfolio performance, a major reduction in the portfolio value will cause investors to become more aware of the risk associated with that particular type of investment. The financial crisis was a huge economic downturn which made investors change their way of thinking when it came to saving. The results find evidence for the condition of a redistribution of private capital where capital, even until this day, is mainly located in bank deposits *(see figure 6.),* which can be explained by prior losses from risky investments.

Figure 6. Fraction of savings invested into each type of security



Bank deposits have by far been the option where the most part of the capital has been allocated in. The graph also illustrates the negative correlation between bank deposits and investments in the Stockholm all-shares Gross Index (OMXSGI). This condition coheres with the hypothesis of this thesis, which would suggest that when the return of the risk-free asset decreases, the investment-ratio in risky assets increases. Furthermore, investors have focused on the risk-free option - bank deposits and the riskiest option - stocks, and hence concentrating less on other investment opportunities.

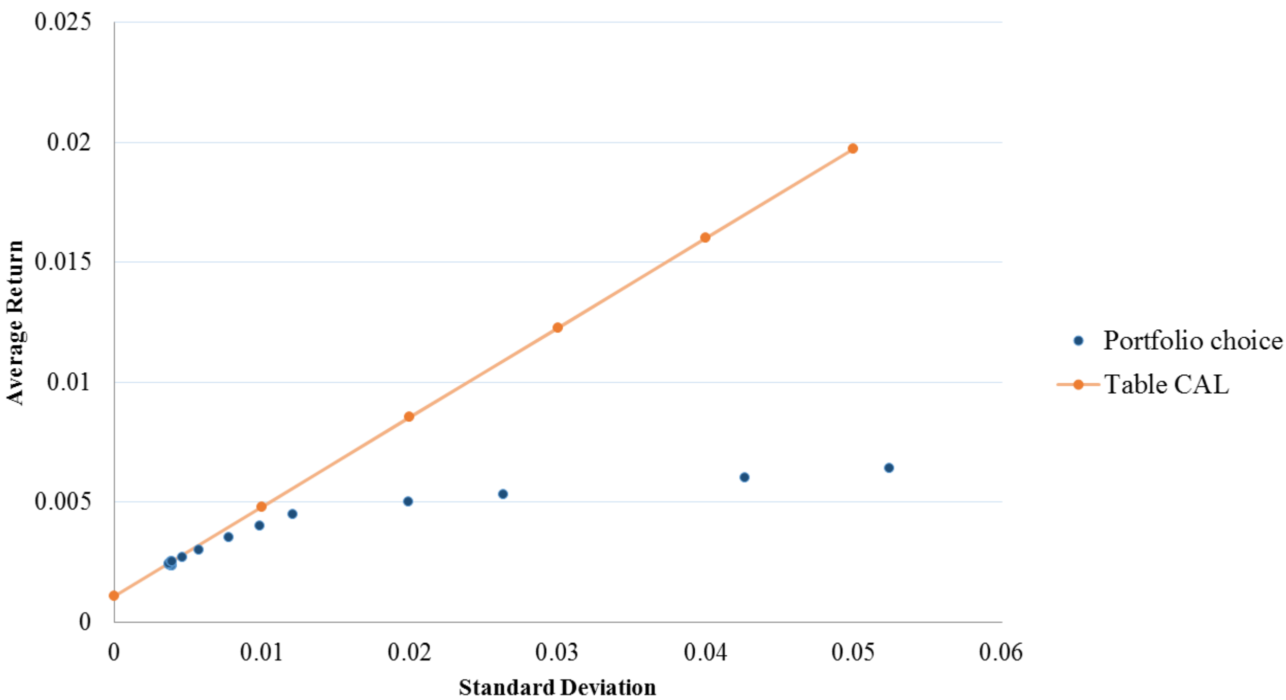
Taking a look at the fraction graph (*figure 6.*), the evidence confirm that the change in the share of each investment gives an impression of a sticky development of the change in capital allocation. Hence, once an investor loses the interest in one asset, she avoids investing in the asset for a long period of time. One example is the period from 2007 to 2008 where a fraction of capital is reallocated into the risk-free security at the expense of capital allocated in the stock market.

Considering these years in *figure 5.*, which shows the development in price indices for the different financial assets, it suggests that the prices of stocks decreased significantly during this period of time and by comparing *figure 5.* and *figure 6.,* it implies that a majority of the investors seem to be risk averse towards prior losses.

Once the stock market experienced a downfall, the share of investment in the risk-free assets increased considerably. Moreover, the same could be said for the entire time span, which leads to the fact that the shares in the risk-free asset and in the stock market are almost perfect negatively correlated. This pattern seems to strengthen the hypothesis of that private investors in Sweden find it difficult to focus on risk and return at the same time. When the stock market is performing well, there is a capital inflow to the market, indicating that the return aspect is in focus. On the other hand, when the market declines, there is a capital outflow from the market and into bank deposits, which seems to imply that the risk aspect is in focus, but only in times when the investor is implicated by losses. This finding supports the theory of prior losses and gains where investment behavior is based on the prior performance of the asset that the investor has held.

4.4 Optimal Allocation

Figure 7. Efficient Frontier of risky investments and the Capital Allocation Line



In this case, the Efficient Frontier and the optimal Sharpe Ratio provide an image of the effective allocation of the capital. After the calculations of the optimal ratios, meaningful results have been found (These results are shown in *table 3.*). In order to possess a portfolio with the highest achievable Sharpe Ratio, an investor should keep only two of the financial assets in the portfolio where only 3.5% of the capital should be in allocated in the market portfolio and thereafter as much as 96.5% in bond and money market funds. These results also speak for no investment in equity funds or in OMRX, which is also explained by their Sharpe Ratios. In comparison to the actual share of investments, the results of this thesis show that Swedish investors have not been efficient when managing their portfolios. The average weights of the assets in their portfolios have been 22.6% in equity funds, 41.1% in OMXSGI, 25.0% in bond and money market funds and 11.1% in OMRX. Investors have allocated approximately ten times more capital in the market portfolio, OMXSGI, than what is required to attain an optimal portfolio, while not allocating nearly enough in bond and money market funds. The fact that the capital has primarily been directed towards the riskiest assets as stocks and equity funds implies that investors have been risk averse and mainly focusing on return.

Only by briefly comparing these numbers with the optimal portfolio, the tables show that the allocation of private capital of Swedish investors is not to be interpreted as efficient or optimal.

Table 2. Minimum Variance Portfolio

Minimum Variance Portfolio						
OMXSGI	Equity funds	B&MM funds	OMRX	*Return*	*Volatility*	*Sharpe Ratio*
0	0.028	0.972	0	*0.002*	*0.004*	*0.36*

Table 3. Optimal Portfolio

Optimal Portfolio						
OMXSGI	Equity funds	B&MM funds	OMRX	*Return*	*Volatility*	*Sharpe Ratio*
0.035	0	0.965	0	*0.002*	*0.003*	*0.37*

Table 4. Actual Portfolio

Actual Portfolio						
OMXSGI	Equity funds	B&MM funds	OMRX	*Return*	*Volatility*	*Sharpe Ratio*
0.411	0.226	0.250	0.111	*0.004*	*0.030*	*0.12*

To reassert the previous statement, the Sharpe Ratio of the actual portfolio is significantly lower (0.12) than the optimal portfolio (0.37) that has been calculated. The reason for this is not the return of the portfolio but the volatility, which has been about ten times as high for the actual portfolio as for the optimal portfolio. Since the Sharpe Ratio is notably lower than for the optimal portfolio, it implies tat there is a lack of risk aversion when private capital holders invest in risky assets. This is in line with the hypothesis suggesting that investors in Sweden primarily focus on return rather than risk. The stock market, measured as OMXSGI, seem to perform better over time, however it cannot be considered as efficient from a reward-to-risk perspective.

Barberis and Huang (2001) report that if a stock decreases in price in the short term, an investor may still hold on to the investment in the hope of breaking the downtrend. Nevertheless, if the stock continues to decrease in value in the long term, the investor might sell it off and accept the loss.

The findings in this report can therefore underlie the results of this thesis. Swedish investors tend to be overconfident in their ability of outperforming the market and according to the outcomes; the market is not efficient but rather inefficient with a semi-strong tendency. The investor is therefore, to a certain extent, in lack of valuable information concerning the investments, which otherwise would be available to all if the market was in a strong form of efficiency. The lack of information in the market results in irrational investment behavior since Swedish portfolio holders invest 10 times more in the OMXSGI than what is required in order to obtain the optimal Sharpe Ratio. Regarding the investments in the OMRX and the equity funds, they have been inefficient and therefore should not be of interest. This is consequently in line with both Forbes and Barberis & Huang's theory of overconfident investors.

Risky investments have however given some excess return but not sufficiently to account for the risk. Further on, the optimal portfolio plots remarkable close to the Minimum Variance Portfolio *(see table 2 & 3)* suggesting that risk taking has not been worthwhile when considering the Sharpe Ratio. The largest difference between the Minimum Variance Portfolio and the optimal portfolio is that in the optimal portfolio, there is a share invested in OMXSGI instead of in equity funds. The last decade has been characterized by unstable financial markets where several booms and busts have affected the prices of stocks leading to low Sharpe Ratios where the theory of Fama (1970) has failed to predict the market. This study shows that the pricing of securities in Sweden between 070130 - 160331 have not been efficient.

5. Conclusion

Before constructing the results, the hypothesis read as: Swedish investors care less about risk and more about return when allocating their private capital. Therefore, it was presumed that investors would not hold an optimal portfolio where the return was being evaluated in relation to the risk. Further on, the financial market in Sweden was presumed not to be in a strong form of efficiency.

Firstly, all investments except for the asset equity funds, which was efficiently priced, were undervalued or highly undervalued. Hence, it can be concluded that the Swedish financial market has not been in a strong form of efficiency since prices clearly do not reflect all existing information and investors can make a profit. The market is therefore rather in a semi-strong condition where investors with fundamental knowledge in financial theories and investing skills can draw benefits. This would require rational investment behavior however, the assumption made in the CAPM of that all investors could be considered as rational, can be criticized.

The rationality of the investors can be questioned by the following fact; a major part of the private capital is still being held in bank accounts despite the historically low interest rate. In contrast, the holding of the market portfolio during the time span studied has resulted in the best monthly average return but the risk has been dominating the portfolio, making it an inefficient investment option seeing to the risk adjusted return. None of these investment options are optimal but bank deposits and the market portfolio have still been the two assets where nearly all of the capital of private investors in Sweden has been allocated in. These figures are not ideal since they result in an "all-or-nothing" situation where only the riskiest and the risk-free options are being considered.

The riskiest asset, OMXSGI and the risk-free asset, bank deposits are almost perfectly negatively correlated. This fact is explained by that the amounts invested in them respectively, are connected to the market performance. When the stock market is in an upward trend, there is a capital outflow from bank deposits and into the stock market. However, when experiencing a market downturn, capital is being reallocated into safe bank deposits. Once again, this evidence indicates that Swedish investors are highly influenced by the short term fluctuations in prices and care more about short term return than optimizing their portfolio in the long term.

The optimal Sharpe Ratio would suggest that capital should be invested mainly in the less risky asset, bonds and money market funds. However, according to the actual fractions of the savings, Swedish investors have almost operated in complete contrast to what the theory would recommend, as high ratios of capital were invested in high risk investments, instead of in bond and money market funds. Households also take on too much risk and are less risk averse when reallocating capital from the risk-free asset to risky assets.

This result can be explained by the behavioral aspects of finance. Investors find it more painful to experience losses of an asset that previously has performed badly. This finding is highly relevant seeing to the instability that has characterized both the financial and real sectors of the market, where macroeconomic shocks have been disturbing the pricing mechanism. There seems to be a higher awareness of risk when the market previously has performed badly and a stronger search for return when it has performed well, which is linked to the theory of prior gains and losses and this conclusion is further bolstered by the "all-or-nothing" situation. The classic financial models treated in this study are concluded inferior in explaining market behavior in the presence of high volatility of prices on the market that is due to market wide risk.

5.2 Limitations and Suggestions for Further Research

The shortcomings of these results are found in the aspect of time and in the form of data. The time period chosen for this paper captures several market crises leading to more volatile prices than usual. However, the evidence of the behavioral aspects is stronger when the risk is apparent, highly present and when losses are more painful. After all, this essay has come to the conclusion that a large share of the households chose to invest in directly or indirectly in stocks, the investment characterized with the highest risk, despite the risky environment.

In regards to that it was not possible to retrieve information on the composition of individual portfolios but instead aggregate data was retrieved. For that reason, the results obtained in this paper ought to be interpreted as how a "typical" Swedish investor has de facto allocated the capital. An alternative approach could be to construct a dataset of private portfolios using survey questions or attempt to use existing data. This will allow for determining the key factors affecting portfolio composition where other explanatory variables such as gender, household income and education could be studied.

In consonance with the results of this paper, the recommendation to Swedish investors is to invest less in risky assets when saving private capital in the long term and recognize the optimal Sharpe allocation more than short term return. In addition, if the investor had optimized the Sharpe Ratio, she should be less risk averse and more confident in holding on to the investment if it is predicted to perform in future.

6. References

Barberis, N. and Huang, M. (2001). Mental accounting, loss aversion, and individual stock returns, *The Journal of Finance,* 56(4) pp. 1247-1292
DOI: 10.1111/0022-1082.00367

Beckman, M. (2009). *Sparande, kapitalförvaltning och finansiella instrument.* Malmö: Liber

Berk, J. & DeMarzo, P. (2014). *Corporate Finance.* 3. ed., global ed. Harlow: Pearson, cop.

Bodie, Z., Kane, A. & Marcus, A. (2014), *Investments.*10. ed. New York: McGraw Hill higher education

Brennan, M. & Schwartz, E. (1979). A continuous time approach to the pricing of bonds. *Journal of Banking & Finance,* 3(2), pp. 133-155.
DOI:10.1016/0378-4266(79)90011-6

Campbell, J. (2006). Household Finance. *The Journal of Finance*, 61(4), pp. 1553–1604.
DOI: 10.1111/j.1540-6261.2006.00883.x

Clarke, J., Jandik T. & Mandelker,G. (2001). The Efficient Market Hypothesis. Georgia Institute of Technology: http://ww.e-m-h.org/ClJM.pdf

Fama, E. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2), pp. 383–417.
DOI: 10.1111/j.1540-6261.1970.tb00518.x

Fama, E. & French, K. (2012) Size, value, and momentum in international stock returns, *Journal of Financial Economics* 105(3) pp. 457-472
DOI: 10.1016/j.jfineco.2012.05.011

Forbes, W. (1959). *Behavioral Finance.* 1.ed., West Sussex: John Wiley and Sons

Hansson, S (2009). *Aktier, optioner och obligationer.* Lund: Studentlitteratur.

Lag (1995:1571) om insättningsgaranti. Stockholm: Ministry of finance.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets, *The review of economics and statistics* 47(1) pp. 13-37
DOI: 10.2307/1924119

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance,* 7(1), pp. 77–91.
DOI: 10.1111/j.1540-6261.1952.tb01525.x

Markowitz, H. (1959). *Portfolio Selection: Efficient Diversification of Investments*. New Haven: Yale University Press. Reprinted, New York: John Wiley and Sons, 1970.

NASDAQ OMX Nordic (2016). OMRX Total Bond Index.
https://indexes.nasdaqomx.com/Index/Overview/OMRXTBILL [2016-04-24]

Nordea (2015). För få reagerar på låga räntor. *Investeringsbloggen,* July 22
http://www.nordea.com/sv/press-och-nyheter/nyheter-och-pressmeddelanden/Investeringsbloggen/2015/2015-07-22-for-fa-reagerar-pa-laga-rantor.html
[2016-04-14]

Nordea (2015). *Börsbarometer - Börsuppgång och låga räntor skrämmer,* Pressmeddelande 2015-06-29

Ross, S. (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, 13(3), pp. 341-360.
DOI:10.1016/0022-0531(76)90046-6

Sharpe, W. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk, *The Journal of Finance* 19(3) pp.425-442
DOI: 10.1111/j.1540-6261.1964.tb02865.x

Sharpe, W. (1966). Mutual fund performance. *The Journal of Business,* 39(1), pp. 119-138
DOI: 10.1111/j.1540-6261.1964.tb02865.x

Statistics Sweden (2016). Savings barometer. http://www.scb.se/fm0105-en [2016-04-18]

Swedish national debt office (2016). Deposit insurance.
https://www.riksgalden.se/en/Deposit_insurance/About-deposit-insurance/ [2016-04-11]

7. Appendix

A.1 Beta-values

```
. reg equityfunds omxsgi

      Source |       SS           df       MS      Number of obs   =       110
-------------+----------------------------------   F(1, 108)       =   1554.95
       Model |  .180632628         1  .180632628   Prob > F        =    0.0000
    Residual |  .012545942       108  .000116166   R-squared       =    0.9351
-------------+----------------------------------   Adj R-squared   =    0.9345
       Total |   .19317857       109   .00177228   Root MSE        =    .01078

------------------------------------------------------------------------------
 equityfunds |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      omxsgi |   .7730846   .0196051    39.43   0.000     .7342239    .8119453
       _cons |  -.0004904   .0010353    -0.47   0.637    -.0025425    .0015617
------------------------------------------------------------------------------

. reg bmmfunds omxsgi

      Source |       SS           df       MS      Number of obs   =       110
-------------+----------------------------------   F(1, 108)       =      4.53
       Model |  .000067588         1  .000067588   Prob > F        =    0.0356
    Residual |  .001611687       108  .000014923   R-squared       =    0.0402
-------------+----------------------------------   Adj R-squared   =    0.0314
       Total |  .001679275       109  .000015406   Root MSE        =    .00386

------------------------------------------------------------------------------
    bmmfunds |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      omxsgi |  -.0149542   .0070268    -2.13   0.036    -.0288826   -.0010259
       _cons |   .0024457   .0003711     6.59   0.000     .0017102    .0031813
------------------------------------------------------------------------------

. reg omrx omxsgi

      Source |       SS           df       MS      Number of obs   =       110
-------------+----------------------------------   F(1, 108)       =     12.08
       Model |  .002003447         1  .002003447   Prob > F        =    0.0007
    Residual |  .017908765       108  .000165822   R-squared       =    0.1006
-------------+----------------------------------   Adj R-squared   =    0.0923
       Total |  .019912212       109  .000182681   Root MSE        =    .01288

------------------------------------------------------------------------------
        omrx |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      omxsgi |  -.0814175   .0234234    -3.48   0.001    -.1278468   -.0349883
       _cons |   .0045907   .0012369     3.71   0.000     .0021389    .0070424
------------------------------------------------------------------------------
```

A.2 Variance-Covariance matrix

	OMXSGI	***Equity funds***	***B&MM funds***	***OMRX***
OMXSGI	0.00274757	0.002124108	-4.11E+00	-0.0002237
Equity funds	0.00212411	0.001756169	-3.59E+00	-0.0001811
B&MM funds	-4.11E-01	-3.59E-01	1.53E+00	4.78E+00
OMRX	-0.0002237	-0.00018108	4.78E+00	0.00018102

A.3 The Security Market Line

	OMXSGI	**Equity Funds**	**B&MM funds**	**OMRX**
Beta	**1**	**0.77**	**-0.01**	**-0.08**
Return	**0.64**	**0.45**	**0.24**	**0.41**

A.4 The Capital Allocation Line

Exp. Return	**Std. Dev**
0.004788891	0.01000
0.008522592	0.02
0.012256293	0.03
0.015989994	0.04
0.019723695	0.05
0.00105519	0

A.5 Minimum Variance Portfolio

Minimum variance portfolio	Exp. Return	Std.dev
	0.00235	0.00390719
	0.00236	0.003850038
	0.002371	0.003798793
	0.0024	0.003725334
Global min.	**0.002408499**	**0.003721315**
	0.0025	0.003871926
	0.00252	0.003940987
	0.0027	0.004605985
	0.003	0.005773543
	0.0035	0.00780264
	0.004	0.009880056
	0.0045	0.01210843
	0.005	0.019878783
	0.0053	0.026326889
	0.006	0.042688627
	0.006402818	0.052417273