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Sincerely,

Erik Machač & Renato Cucurnia

Umeå, May 30th, 2007
Abstract

Even though today’s world unwinds on the increasing way of the globalisation, investors are aware of the possibilities the international markets offer and distance is not an issue any more, they are still governed by the “home bias factor”. This phenomenon implies that investors tend to prefer investing in domestic securities rather than entering the global market. Swedish investors are not the exception and the issue of the attraction of foreign fixed income securities is highlighted even more when we have found out there is lack of academic research about the topic from the perspective of Swedish investors. To narrow down the research subject and provide a reader with an interesting approach, we decided to examine the attraction of foreign government bonds from the perspective of Swedish investors.

At the beginning of the paper we raised three research questions and defined the objective of the paper in questioning the existence of reasons to invest in foreign government bonds. Another research question was defined as identifying our local investor, who is entering the global market and last, but not least, what investing strategy do we recommend him to follow.

Along the paper we proposed to apply a decent level of informative as well as a scientific approach to provide a reader with a valuable study concerning pre-defined topic. To reach more concrete outcomes of the study we have accepted couple of assumptions which we have identified ourselves with and we have stressed them especially during the theoretical part of the paper.

After conducting the comprehensive analysis of the Swedish market for government bonds we have identified a huge gap between the demand and supply for such bonds and based on the discussion concerning the opportunities and risks connected with such investments we have defined our investor. Under given assumptions, as the most probable case of occurrence we consider a rational investor, who is offsetting the balance of interest rate sensitive assets and liabilities simultaneously looking for the best possible yield, the lowest possible risk and sound level of diversification.

During the empirical analysis, namely examination of the national yield curves we set first, however very limited investment strategy. After the incorporation of the portfolio theory, currency rate risk and the existence of instruments covering the foreign currency exposure we have come into a conclusion that our investor does not have to necessarily prefer a security from the depicted efficient frontier, but he can employ other securities as well. As a consequence, when using 100% hedging he can use whichever security on the global market.

At the conclusion, stated findings imply another investigation, since our research was based on very strong assumptions presented during the study. Thus it by far does not provide the reader with a comprehensive investment analysis, which some readers might be interested in. However, even from the beginning we claimed that we do not have such an ambitious goal.

Keywords: government bond, swedish bond market, yield curve, foreign currency risk, hedging, efficient frontier, random walk
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1 Introduction

Today’s world economy is very complex and global. It is nearly impossible to describe an economic phenomenon without describing a series of events leading to that phenomenon. Media is an important forum for global economy issues and it is via media investors get the information and the understanding of the market.

At the same time instead of using all the possibilities international markets offer, investors tend to invest in domestic assets rather than abroad. They also tend to choose information which is easily available than information which is difficult to access and not only because of their costs. The accessibility leads to a “home bias” phenomena in investor’s portfolios which implies that investors prefer to have a major part of their portfolio invested in domestic assets rather than using the benefits of international diversification, even though the most concrete result of globalization for investors is the possibility and simplicity to spread the risk and reach higher returns through global investing.1

Many studies have shown the positive effects of global investing; however most of these studies are largely dealing with investing in equity.2 And on the contrary, very few of them deal with fixed income securities.

The deregulation of the capital markets during the 80’s has made the issue of international diversification more actual. The liberalization of the capital markets increased, capital movements among countries have increased and led to more foreign investments. As a consequence, the need for global investing in such a small country like Sweden for example, has increased as well.

There is an enormous number of studies written on the stock market themes, portfolio choice, market efficiency, various financial analyses and applications of different models. However, within the list of Swedish theses ever written we (the authors of the thesis) have found that local Swedish and global bond market issue have not been covered almost at all.

Moreover, taking into consideration Sweden is one of the last western European countries that has not joined the European Monetary Union yet, the matter of attraction of investing in domestic securities compared to opportunities on the international markets is highlighted. Since the key interest rates set by the Sveriges Riksbank are currently on a lower level than the interest rates of the European central bank, Swedish investors might be motivated to invest in European bonds at least. Consequently, when investors consider the investment in the foreign assets they have to take into account the problems of currency rate risk as well as foreign yield curve exposure. Therefore the investment strategy of Swedish investors considering entering the global market will be influenced by completely different factors in comparison to individuals investing exclusively in the local market.

To narrow down the topic and get more relevant results of the research we decided to scrutinize only one particular type of the fixed income securities. Both our interest in more safe ways of investing and the issue of increased needs of governments all around the globe to cover the deficits of state budget by borrowing money on the financial markets have suggested us which direction to take during our research.

In fine, for the reasons mentioned above, as the topic of the paper we have chosen to examine the attraction of foreign government bonds from the perspective of Swedish investors; an interesting issue with no less interesting background.

1.1 Problem statement

Different investors have different interests and enter the market for different reasons. Raising the inquiry for these reasons and questioning the investment strategy of particular groups of investors will be the task about to answer in this study. How to deal with the various financial indicators when having a specific need? Our local investors will be facing the current situation on the global market for government bonds, and we will try to bring them to a close of the intricate track of investment strategy.

1.2 Research questions of the study

- Who are our “local investors“ and what are their requisites to enter the global market?
- Which national government bonds lie on the efficient frontier of local investors?
- What investment strategy, considering given assumptions and circumstances, do we recommend them to follow?

1.3 Research objective

The major objective of the thesis is to provide the reader with a sound investment analysis applied in a pre-specified situation. The general goal of the paper is to indicate the answer to the question: What is the attraction of foreign government bonds for the local investors? The answer will be provided through a model situation which sets the goal in identifying local investors who should hold foreign government bonds in their portfolios as an investment instrument and in which proportion, given certain assumptions and limitations of the study.

1.4 Demarcations and limitations of the study

Its urgent to define the limitations of our study as well as its demarcations so as to follow the path of our research objective throughout the paper. Our intension is to provide an overall point of view on investing in government bonds. This type of security was chosen due to the both interest in this particular security and an idea of setting the limits on our study, since the time constraint did not allow us to conduct the comprehensive analysis of the entire global market for the fixed income securities.
With the intention of revealing an interesting topic and come up with original approach, we have strictly defined variables and actors on the field as well as the field itself. Therefore the reader is not provided with the comprehensive analysis containing the investment strategy in the haunt for the over-return. Instead, we show him the perspective of independent university students even raising the question of the existence of such reasons; reasons to invest abroad. After the decent inspection of local market we come with the definition of the investor having specific needs and entering the foreign government bond market for very specific reasons.

Along the theoretical part we also accept few basic, however extremely significant assumptions, which express our point of view on selected theoretical concepts concerning various financial topics. First of all we assume our investors are rational, which entails they are utility “maximizers”, prefer more yield to less and are risk averse. Second of all they have adopted the long term investment strategy, so during the study we exclude all the short term investors entering the market for the purpose of speculation or arbitrage. The only risk investors face is the risk of foreign currency rate volatility, since we exclude the risk of the issuer and consequently risk premiums during the construction of the yield curves, since the government bonds of the examined countries are considered to be risk-free. As a consequence cultural risk, political risk and risk of inflation are not taken into consideration as well.

Subsequently we have adopted the efficient market hypothesis, where the future currency rates are determined by the current spot rates, so the only return investor can reach comes from the security proceeds. After the inspection of the local government bond market we have also adopted the assumption that our local investors try to offset the balance of interest rate sensitive assets and liabilities to reduce the interest rates volatility on their wealth, which entails that the main objective to enter the global market is seeking for the required duration balance having simultaneously best possible yield, lowest possible risk and sound level of diversification. All of these assumptions will be explained along the paper one after another and the logical sequence of them will be kept in order to bring the reader to a track of our analysis.

In the study we also discuss very limited range of investment solutions in the last part of the paper, where our investor faces the foreign currency risk exposure, representing the major threat for him. As a consequence we neglect any costs of hedging foreign currency risk exposure. Again, its not a purpose od the paper to deliver the investment recommendation for the business client, rather than to deal with the problems faced by pre-specified target group of investors entering the global market for government bonds.

We also do not take into consideration and inspect both macroeconomic and microeconomic factors specific for different countries, like for example central banks monetary policies, regulatory environment, inflation, GDP, balance of payments, different taxation policies etc.

Last, but not least, from our perspective the global market for government bonds is fully represented by the markets for examined fixed income securities in USA, U.K., Germany and Japan. One of the main reasons for the choice of these countries has to do with their credit ratings and liquidity, since they all represent most probable target our investor will take into consideration.
1.5 Structure and content of the work

As stated above, thesis will inspect the attraction of foreign government bonds, compared to investing in swedish government bonds examined from the perspective of the local investor.

The paper is basically divided into nine sections. First two sections provide the reader with Introduction to the thesis and Research considerations. In retiring way gives the reader information about the choice of the topic, perspective of authors and consists also of necessary formal chapters dealing with the comprehensive research methodology, the ambitions and the objective of the paper.

The third section represents the Theoretical framework of the thesis. The reader gets a sound theoretical background from the fields of statistics, portfolio theory and currency rates. All the refered theory is closely associated with the following empirical analysis, so as the reader will be clear with the steps undertaken. This part also indicates our point of view on particular variables used in the following analysis and provides the reader with decent information about the theoretical approach applied in the empirical research.

The fourth section, named „Bonds and the bond market“ meaningfully describes bonds as investment instruments, their features and characteristics, as well as an environment which our potential investor actually operates in. The bond market in Sweden is described both from the demand and the supply side.

The opportunities and risks concerning investing in foreign currency government bonds presented in section number five covers the issue of the pros and the cons of investing abroad. At the end of the section we define our assumptions used later in the empirical analysis. Thus this section simultaneously represents a mild transition to the empirical investigation part which constitutes section six.

The empirical analysis starts with the investigation of different factors mentioned in the previous part. Returns are examined through the construction of the yield curves in particular countries as well as a comparison of them. However, from the investor’s point of view he will be interested in the correlations among the securities in his portfolio as well, in regard with portfolio diversification, so a correlation analysis follows as well. Under given assumptions, risk is in our model represented by the currency rate volatilities. Their analysis as well as the analysis of hedging of investment in the foreign government bonds, since the investor should be interested in covering the created position, constitute the last part of the section.

Section seven comes up with Conclusion, as well as investment recommendation to the local investors who consider the investment in fixed income securities. It summarizes the perspective of both the researchers and bring the comprehensive point of view as well.

Last to sections of the paper cover Suggestions for further research and Truth criteria.
2 Research considerations

2.1 Choice of a topic

When connecting together the thoughts from the introduction part and approaching we are facing the development of recent years of increasing importance of internationalization and role of the global society there have been a lot of questions raised during the initial discussions between the authors of the thesis. Consequently, after couple of meetings we (authors of the thesis) found out we have very similar field of interest; the background of financial markets. Therefore during first week the topic of the paper has been narrowed down and for both the researchers interested in the actual situation in Sweden, we raised an issue of examining local market as the benchmark for the research concerning international finance and/or global financial issues. After couple of days spent in the University library we realised the importance of revealing quite a new topic and challenge of coming up with a new approach. Apparently, there is a huge amount of studies written on the stock market themes, portfolio analysis, market efficiency, various financial analyses and applications of different models. However, we have discovered that, at least within the list of swedish thesis ever written, the attraction of fixed income securities from the international perspective hasn’t been covered almost at all.

We strongly believe that Swedish investor`s point of view contribute to the informative value of the paper and will highlight the interest of students on the issue. We suggest our study might be valuable for students of finance or economics and especially due to the mentioned circumstances in Sweden.

2.2 Perspective of the study

As researchers we have been „naturally obliged“ to choose a perspective from which we are going to observe a particular issue. From our point of view this task is extremely important because the same problem can be perceived as very different from perspective of different beholders.³ Basically we can adopt either an external- or an internal perspective. The internal perspective would have been conducted in case we would like to simulate investor`s point of view and try to design our strategy based on our actual needs. However, due to the fact that paper seeks to be more comprehensive and try to provide the reader with sound introductory information, theoretical background and slightly analytical point of view as well, we have adopted external perspective throughout the study.

From the position of independent researchers we have to remark we have had limited sources of information, technical background and time to conduct a detailed analysis, which was even not an initial goal of the paper. In this regard we have modified both theory and numerical inputs according to needs of our study and created a model serving as the research approach for a study. Based on the assumptions described in the specific parts of the paper our thesis has under no circumstances the ambition of covering the whole issue from the perspective of „hired analysts“. This paper is not supposed to serve as a study material for potential investor or client, even though some hints may be used this way eventually as well. Instead we have

used the model based on an assumption of efficient markets and constructed the yield curves from the market data. As a consequence the portfolio that we have got is not taking into considerations all the possible drivers of currency rates and interest rates changes. Model serves more as an approach of university students trying to convince the reader and themselves about the power of assumptions and their impact on the research outcomes.

It also has to be noted that from the very first beginning when both authors accidently met, and during following discussions we both felt cultural differences and different backgrounds we both originate from. Even though Czech republic, Italy and Sweden (since one of the authors originates from bilingual background) are not geographically that far, cultural, social and economic environment in particular countries differ substantially. Therefore various working habits, working routine, attitude to accuracy, criticism or argumentation have became partial proofs that our work will be influenced by this fact as well, from both a positive and a negative side.

2.3 Theoretical preconceptions

Government bond, portfolio selection, currency rate risk, swap rates, yield to maturity, .. this is just a short list of terms used in the paper. Students of the Master program in Finance at Umeå School of Business and Economics should be familiar with all of them. Nonetheless when it comes to the detailed analysis and comprehend incorporation of such terms into a continual text a lot of memories and knowledges from passed courses have to be dusted off. Both authors have the same major field of study. However, many times we both came across the problems of misinterpretation, weak awareness or even totally no clue about the topics described in the literature used as the source for theoretical background. Therefore a lot of time has been spent on individual studies and discussions of terms used in treatises.

We have personally ascertained how different knowledges can two different students of the same study program dispose. Not rarely we both had not been indoctrinated through lectures to use particular theories, so we had to read it ourselves. As a matter of fact, not just a financial theory literature has been used and as a reader might be able to see research methodology literature, statistic books, financial mathematics hand-book, internet encyclopedia or other theses have been used in the theoretical background as well.

2.4 Theory of knowledge

The perceptive reader might have recognized that we have already claimed our epistemological position in the aim of the thesis when we have indicated we want to „provide the reader with the sound background concerning the potential investor’s investment strategy“ so as the paper will serve as an analytical study for various users and individuals with different perspectives.

Since all of these different potential readers have their interests, as human beings, all different from one another, a hermeneutic position trying to „grasp the subjective meaning of social action“ might seem to be appropriate.4 Hermeneutics would be relevant in some perspectives

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on the paper since the external view evolves the ability to interpret, understand and to unfold the conducted analysis.

However, **positivism** has been accepted as our epistemological position along the paper. Quantitative research methodologies are more commonly applied in the analysis of the portfolio theory and other security analyses rather than qualitative methods. In this connection the choice of the **positivistic position** is not surprising, and we strongly believe it suits much more to the multidimensionality and extension of the research topic since the positivistic position „advocates the application of the methods of the natural sciences to the study of social reality and beyond“:5 The dynamic nature of examined issue is another factor contributing to the choice of epistemological position of our study since it would be irrelevant to endeavour for analysing something stable and constant in time.

2.5 **Scientific approach**

As mentioned above, so as to be able to conduct such a demanding and challenging analyses, both the authors have to expand their knowledge and awareness about various theoretical issues, more or less connected to practical sphere. Based on this review, different theoretical concepts are going to be selected and included in the framework of the paper. Such a course of action, where conclusion being the target of the paper is drawn on the basis of logical train of thoughts is referred to as a **deductive approach**. According to Alan Bryman and Emma Bell, deductive theory occurs when “the researcher, on the basis of what is known about in a particular domain and of theoretical considerations in a relation to that domain, deduces a hypothesis that must then be subjected to empirical scrutiny.”6

On the contrary, if we had chosen an **inductive approach**, we would have started with empirical study and based on its outcome we would steer our effort to draw a general conclusion.7 Based on these discussions both authors have early realised the outcome of the thesis will not be a groundbreaking theory, which stresses even more strong the argument for the choice of the scientific approach.

2.6 **Choice of theories**

Since the paper is based on author’s prespecified assumptions, we have to be very careful with the choice of used theories and literature. In this respect constitutive literature is to be used as a back-up and source of information, however, the motivation of „not just re-writte the theory bibles in other words and apply it on the empirical basis“ forced us more to look more at various internet sources and think in context of the desired outcomes of our work. As an attainment of the thesis we want to come neither with groundbreaking theory nor comprehend analysis of all the possible factors driving investor’s portfolio selection. In the paper we have rather analysed various perspectives of different economists, students or teachers and cohered it all together so as other students or potential readers will be able to easily understand our approach. Consequently from all the theories we have decided to apply the modern portfolio theory by H. Markowitz since we consider it to be the most respected

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and relevant portfolio theory concerning our research approach and it will help to answer the set research questions in a most distinct and content way. For the same reasons we have applied the efficient market hypothesis and the random walk theory in the part dealing with foreign currency risk. However, other related theories are indicated and used along the paper as well, as e.g. the use of International Fisher effect during the derivation of formulas concerning the hedging strategy of our investors.

2.7 Choice of research method

Next task was the choice of research method, referred to as the way of assembling the information and collecting the data. Considering we have deductive research approach and are dealing with empirical data and their integration in portfolio theory, a quantitative research method was chosen, being perceived as more convenient method rather than the qualitative approach. One of the reasons for using quantitative research methods is also its embodied ability of generalization beyond the studied cases, e.g. beyond the respondents of a survey.8

Due to the characteristics and construction of the research based on quantitative study, ontological position adopted during an interpretative research is constructionism. Chosen ontological position implies that “social world is built on the outcomes of the interaction between individuals”9. Constructionist ontological position is held more often in the qualitative research, however, we accepted it since only this point of view can support our theoretical assumptions.

On the contrary objectivist position implies that „social phenomena and categories used in everyday discourse have the existence that is independent or separate from actors.”10 Since we want to come up with the investment strategy based on the market analysis, where investors themselves are the main actors, this approach would be slightly irrelevant.

2.8 Data collection

Data collection itself is conducted from the accessible databases in the Umeå University library and various online sources. The biggest repository of primary data is undoubtly the DataStream provided with the information from Thomson company. Other primary sources have been used as well, since we haven’t found all the necessary data in the DataStream database. Above all let’s mention Bloomberg, Finance.Yahoo!, the OMX Nordic Exchange database and the databases of Riksgälden and Sveriges Riksbank, applied mostly during the analysis of the local market. Secondary sources have been used as well. The secondary data used come primarily from scientific literature. We have used scientific articles and research papers reference lists to find helpful links to secondary sources. To analyse all of the collected data we have used different measurements.

All the data were analysed and applied during the construction of our graphs and tables in the statistical program Statistical Product and Service Solutions (SPSS) and MS Office Excel.

3 Theoretical framework

Bond as one of the most important fixed income security is a term the Swedish political, legal and financial society is naturally familiar with. There is also the remark in the law system documents, which more detailed and precisely defines them, specify the characteristics of different kinds of bonds, regulations connected with the issue and rules for their trading. However, it is not major objective of the paper to provide a reader with detailed information concerning such issues. Instead, in the theoretical framework of the paper we will stress the topics tightly connected to the research part so as to familiarize the reader with major concepts used later in the study.

Issuers of bonds pursue different interests and have different goals and needs. Most common is the need for financial resources due to expansions and to new business projects, or problems with liquidity and solvency. Bank loans figure as the first options for the subjects. They are not always the cheapest and most convenient way of gaining the financial sources in the particular situation, though. Issuers of bonds are not necessarily only companies seeking for capital, but also governments of countries all around the world, that need to finance the budget shortages and current problems with liquidity.

Some readers might be interested in corporate bonds as well. Characteristics of local market with the corporate bonds, liquidity and transparency of the corporate bonds market are without any doubts interesting issues. However, based on the research objective we have set, our thesis is going to deal solely with government bonds. Instruments bearing very high liquidity, highest possible rating and which were issued and traded in Sweden and other countries since time immemorial.

First of all we will ponder on the theoretical background and basic terms of statistics, which will be used throughout the paper. The indirect purpose of the thesis is to provide the reader with an information basis as well, and we want to make certain that the reader will be clear with information contained in the consecutive analysis; e.g. the relationships between individual yield curves, currency rates risk, their impact on investors portfolio composition and many others.

3.1 Statistic theory and basic relations

3.1.1 Random variables

Formally, a random variable is a measurable function from a sample space to the measurable space of possible values of the variable. Suppose that we toss a coin, we call the sides head and tail. Suppose that we have a function $\gamma$ which can assume only two values: one (1) and minus one (-1). Let's define that $\gamma$ assumes the value 1 if the coin shows heads and -1 if it shows tails. We have just assigned the value to variable, and therefore $\gamma$ will be a random variable.\footnote{http://www.stats.gla.ac.uk/steps/glossary/probability_distributions.html#randvar. (online 2007-04-17).}
3.1.2 Expected value of a random variable

“The mean of a random variable, also known as its expected value, is the weighted average of all the values that a random variable would assume in the long run. The expected value of a random variable can be thought of this way: The random variable is made to assume values according to its probability distribution, all the values are recorded and the mean is computed”12.

3.1.3 Variance and standard deviation

Standard deviation is an indicator that measures how much the value in a population differs from the mean value. The standard deviation (\( \sigma \)) is a quality at a normal distribution and is defined as the square root of the variance for a distribution:13

\[
\sigma = \sqrt{VAR(X)}
\]

The variance shows the size of dispersion of a random variable around its expected value. Mathematically the variance \( \sigma^2 \) is defined for a discrete probability distribution as:

\[
VAR(X) = \sigma^2 = \sum (x - \mu)^2 P(x)
\]

The variance and the standard deviation are examples of spread measures for a probability distribution, indicating how a measure is distributed around the expected value.14 Consequently, within the application of portfolio theory standard deviation represents the main measurement of risk.

3.1.4 Correlation

Correlation indicates the strength and direction of a linear relationship between two random variables. In general statistic usage, correlation refers to the departure of two variables from independence, although correlation does not imply causation. The mathematical formula for the correlation coefficient, \( \rho_{A,B} \), between two random variables A and B with expected values \( \mu_A \) and \( \mu_B \) and standard deviations \( \sigma_A \) and \( \sigma_B \) is given by:

\[
\rho_{A,B} = \frac{\sigma_{A,B}}{\sigma_A \sigma_B} = \frac{E((A-\mu_A)(B-\mu_B))}{\sigma_A \sigma_B}
\]

\( \sigma_{AB} = COV(A,B) \)

Where E is the expected value operator and COV means covariance.15

14 http://www.stats.gla.ac.uk/steps/glossary/probability_distributions.html#variance. (online 2007-04-17).
If the correlation is positive, the variables will on average change in the same directions. If the correlation is negative they will, on average, change in the opposite direction. The correlation between two variables always lies between minus one and plus one. If the correlation equals plus one, the variables will change exactly in the same direction and if it is minus one, they will change in the opposite direction. In case the correlation equals zero, the changes are independent of each other.\textsuperscript{16} Fore mentioned relations will be used in the following analyses.

\section*{3.1.5 Risk and Return}

Receiving the highest possible return is a natural objective of all savers and investors. To have fixed income from invested proceeds is nonetheless impossible without being exposed to any type of risk. A high return costs the price, and the price is risk. In the financial context risk is an expression for uncertainty in future returns that investors want the compensation for.

Return as the profit you get on invested capital is slightly different from the effective return which is defined as the sum of the direct yield and value changes. The direct yield can e.g. consist of interests or dividends. Principally all investments on the capital market are made with the objective to reach as high yield as possible, alternatively at as high grade as possible to minimize a loss e.g. in terms of covering an exposure position. The possibility of reaching this return is always associated with some form of risk. In general, the higher return the investor desire, the higher risk he must undergo.\textsuperscript{17}

Continuously the expression risk will be mentioned in terms of variance \((\sigma^2_X)\) and standard deviation \((\sigma_X)\). The expected value will in the future be equal to expected return.

\section*{3.2 Portfolio theory}

\subsection*{3.2.1 Modern portfolio theory}

The foundation to the modern portfolio theory was laid 1952, when Harry Markowitz published his article “Portfolio Selection”. In the article and his following studies Markowitz showed how to construct a frontier of investment portfolios so that each portfolio maximizes the expected return given its level of risk. Markowitz stated that it is possible for an investor to hold such a portfolio combination, a mean-variance portfolio. With the knowledge of the portfolios expected return and the risk (standard deviation), conclusions can be made about which portfolio should be preferred over others. The content of the article indicates that investors can through diversification, described as the distribution of their investments in many different assets, lower its total risk without any impact on the expected return.\textsuperscript{18}

\textsuperscript{17} http://www.fondbolagen.se/upload/fondspecial_risk_040617.pdf. (online 2007-04-19).
The edge of all possible portfolios is displayed in Figure 1. The portfolio frontier is divided by the point of Global minimum-variance portfolio as the portfolio with the lowest risk of all possible ones on the frontier.

The upper part of the frontier constitutes the effective part while lower part is inefficient, since portfolios placed above the minimum-variance portfolio reach the highest possible return given a specific level of risk. These portfolios have apparently bigger expected returns than the expected return of the minimum-variance portfolio. One important feature of the portfolio-frontier is that it can be identified by linear combinations of two portfolios. By investing in two portfolios lying on the frontier a third is generated and it also lies on the frontier. When the effective part of the portfolio-frontier is convex, it is stated that by investing in two effective portfolios on the frontier a third portfolio is also effective.

According to the mean-variance theorem assets are characterized only by two variables, expected return and variance. An investor can use these characteristics in the portfolio selection, assuming the investors are utility “maximizers”, prefer more to less, are risk averse, and either (1) security returns are normally distributed or (2) utility functions is quadratic. Furthermore, the approach is robust in fact, it frequently holds approximately even when assumptions (1) and (2) are violated. For instance, quadratic approximations are almost always good local approximations to non-quadratic utility functions. In the second case, when the utility function is quadratic, the expectations of higher derivatives in a Taylor-polynomial equal zero. The result is that expected utility is defined from expected return and variance. Since the normal distribution is fully characterised by its mean (the return) and its variance, the mean-variance criteria can be used in the later case.

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The frontier of efficient portfolios is a hyperbole of portfolios as shown in Figure 2. In his article, Markowitz described the procedure with the knowledge of the assets expected returns and variance, which creates a frontier of portfolio combinations. Each portfolio lying on the frontier symbolizes the portfolio with highest return given risk level (variance), alternative the lowest risk (variance) given a specific expected return.²¹

3.2.2 Delineating efficient portfolios

In previous part we have occupied ourselves with the risk and return characteristics of combinations of portfolios comprising risky assets, leading towards the construction of the efficient frontier described by Harry M. Markowitz in his research.

In the following part, let’s start with the re-examination of the attributes of combinations of two risky assets, and emphasise the geometric interpretation of asset combination. Then we make a step forward to expand the approach and we will analyse the combination of all possible risky assets, so as to delineate and construct the efficient frontier described in the previous part. In fact, when we talk about assets, we can equally well be talking about portfolios of risky assets.

The expected return on a portfolio of two assets is given by:

\[ \bar{R}_p = X_A \bar{R}_A + X_B \bar{R}_B \]

, where

- \( X_A \) is the fraction of the portfolio held in asset A
- \( X_B \) is the fraction of the portfolio held in asset B
- \( \bar{R}_p \) is the expected return on portfolio
- \( \bar{R}_A \) is the expected return on asset A
- \( \bar{R}_B \) is the expected return on asset B

In addition, since we require the investor to be fully invested, the fraction invested in A plus fraction invested in B must equal one, or:

\[ X_A + X_B = 1 \]

Substituting previous two equations together, we can express the expected return on a portfolio of two assets as:

\[ \overline{R}_p = X_A + (1 - X_A) \overline{R}_B \]

Notice that the expected return on the portfolio is a simple-weighted average of the expected returns on the individual securities, and weights add to one.

The standard deviation of the return on a portfolio is given by:

\[ \sigma_p = \left( X_A^2 \sigma_A^2 + X_B^2 \sigma_B^2 + 2X_A X_B \sigma_{AB} \right)^{1/2} \]

where

- \( \sigma_p \) is the standard deviation of the return on the portfolio
- \( \sigma_A^2 \) is the variance of the return on security A
- \( \sigma_B^2 \) is the variance of the return on security B
- \( \sigma_{AB} \) is the covariance between the returns on security A and security B

If we substitute the equation in the same way as previous one, we obtain the expression:

\[ \sigma_p = \left[ X_A^2 \sigma_A^2 + (1 - X_A)^2 \sigma_B^2 + 2X_A (1 - X_A) \sigma_{AB} \right]^{1/2} \]

Recalling that \( \sigma_{AB} = \rho_{AB} \sigma_A \sigma_B \) where \( \rho_{AB} \) is the correlation coefficient between securities A and B, then the equation above becomes:

\[ \sigma_p = \left[ X_A^2 \sigma_A^2 + (1 - X_A)^2 \sigma_B^2 + 2X_A (1 - X_A) \rho_{AB} \sigma_A \sigma_B \right]^{1/2} \]

As you might figure out, the standard deviation of the portfolio is not, in general, a simple-weighted average of the standard deviation of each security. Cross-product terms are involved and the weights do not, in general, add to one. In order to learn a little more about this relationship, we now study some specific cases involving different degrees of co-movement between securities.\(^{22}\)

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3.2.2.1 Case 1 – Perfect positive correlation

The first case in our analysis will try to outline the situation, when the correlation coefficient between two variables is equal to +1. If the correlation coefficient is +1, then the equation for the risk on the portfolio simplifies to:

\[ \sigma_p = \left[ X_c \sigma_c^2 + \left(1-X_c \right)^2 \sigma_s^2 + 2X_c \left(1-X_c \right) \sigma_c \sigma_s \right]^{1/2} \]

, while the expected return on the portfolio is:

\[ R_p = X_c \bar{R}_c + \left(1-X_c \right) \bar{R}_s \]

Thus, this case, with the correlation coefficient equal to +1, both risk and return of the portfolio are simply linear combinations of the risk and return of each security, and two variables will change exactly in the same latitude.

In the Figure 3 we show that all combinations of two securities that are perfectly correlated will lie on a straight line in risk and return space. In the case of perfectly correlated assets, the return and risk on the portfolio of the two assets are a weighted average of the return and risk on the individual assets, and therefore, there is no reduction in risk from purchasing both assets.23

3.2.2.2 Case 2 – Perfect negative correlation

The second case describes the situation when two securities are perfectly negatively correlated (i.e., they move perfectly together but in exactly opposite directions).

In this situation the standard deviation of the portfolio can be expressed, after couple of simplifications, assuming \( \rho = -1.0 \), as:

\[ \sigma_p = X_c \sigma_c - \left(1-X_c \right) \sigma_s \]

, or

\[ \sigma_p = -X_c \sigma_c + \left(1-X_c \right) \sigma_s \]

Since we took the square root to get an expression for \( \sigma_p \), either of the above equations holds only when its right hand side is positive. Since one equation is positive when the other is negative (except the case they both equal zero), there is a unique solution for the return and risk of any combinations of two securities. These equations are very similar to the ones we obtained in the previous case. Thus one would suspect that an examination on the return on the portfolio of two assets as a function of standard deviation would yield two straight lines, one for each expression for \( \sigma_p \).

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The value of $\sigma_P$ in previous equation is always smaller than the value of $\sigma_P$ for the case where correlation coefficient $\rho = +1$. Thus the risk on a portfolio is always smaller in the case when two securities are perfectly negatively correlated. Then, it should be always possible to find some combination of these two securities that has zero risk. Similarly as in the previous example, this relationship is graphically shown in Figure 3.

Here we have demonstrated the most powerful result of diversification: the ability of combinations of securities to reduce risk. In fact, it is not rare for combinations of two securities to have less risk than either of the assets in the combination.\textsuperscript{24}

3.2.2.3 Case 3 – No relationship between Returns on the Assets ($\rho = 0$)

In the case of uncorrelated returns the expression for the return on the portfolio remains the same. However, noting that the covariance term disappeared, the expression for the portfolio standard deviation becomes:

$$\sigma_P = \sqrt{X_c^2 \sigma_C^2 + (1 - X_c)^2 \sigma_S^2}^{1/2}$$

A graphical presentation of a risk and return on these portfolios is also shown in Figure 3. Anyway, there is one point on this figure that is worth special attention: the portfolio that has minimum risk.

As the reader might conclude, when the correlation coefficient equals zero, there is no relationship between the risks of both securities in the portfolio. These two variables are therefore considered to be independent.\textsuperscript{25}

3.2.2.4 Case 4 – Intermediate risk ($\rho = 0.3$)

In the most of cases, the correlation between returns of any two stocks or bonds traded on the market is always greater than 0 and considerably less than 1. To show a more typical relationship between risk and return for two stocks, or securities in general, we have chosen to illustrate more practical situation when $\rho = 0.3$

In this example, there is obviously a combination of two securities that is less risky than the least risky asset by itself, and furthermore, the combinations are still less risky than the combinations from the case of perfect positive correlation. The particular value of the correlation coefficient for which no combination of the two securities is less risky than the least risky security depends on the characteristics of the assets examined. Explicitly, for all assets there is some value of correlation coefficient such that the risk on the portfolio can not be made less than the risk of the least risky asset in the portfolio any more.\textsuperscript{26}

The previous part should provide the reader with insights into combinations of two securities or portfolios from the analysis performed to this point. First of all, we have observed that the lower (closer to -1.0) the correlation coefficient between assets, all other attributes held constant, the higher payoff from the diversification. Second, we have indicated that combinations of any two assets can never have more risk than found on the straight line connecting the two assets in the expected return standard deviation space. Finally, we have produced a simple explanation for finding the minimum variance portfolio when two assets are combined in a portfolio. Hence, in the analysis of whether Swedish investors would benefit from an international diversification in the foreign bond markets the variance of foreign bond returns and the correlation between domestic and foreign bond returns are crucial.

### 3.3 Theory of Currency rates

A major source of risk with international diversification is the currency fluctuation. A number of economic theories such as the Purchasing Power Parity (PPP), the International Fisher effect and others try to explain exchange rate movements in terms of economic fundamentals. We do not neglect them; however, in this paper we mainly look at currency rate volatility in terms of the Random walk theory and the efficient market hypothesis.
3.3.1 Random walk and the efficient market hypothesis

The efficient market hypothesis or the random walk hypothesis is the result of E.F. Fama’s research during the 60’s and 70’s. He established that the pricing on all financial assets is made from all available information and in case the market is efficient, the price on all financial assets would reflect all available information. He divided the hypothesis into three different categories to easier understand to which extent the market is efficient. Fama separated the theory into a weak, semi-strong and strong form.27

This perspective is not seeking to predict the future currency rates according to different factor models; however, it comes from the assumption of the price formation on the international currency markets.

Since the foreign currency markets are in general considered to be the most effective markets, and therefore all the relevant and accessible information are immediately implicated in the currency rates, this model has its supporters from both academic and practical environment. The entire global foreign currency market daily trading volume is about 2.9 trillion USD, which makes it the worlds’ biggest market operating 24 hours a day worldwide, which is more than ten times the size of the combined daily turnover on all the world’s equity markets more than ten times the size of the combined daily turnover on all the world’s equity markets.28 Therefore the argument about the influence of central banks on the currency rates regulation might be considered to be marginal, in a global point of view.

The trade volume with currencies due to a need of covering the trading expenses with goods and services has decreased in the recent years from 25% in year 1976 to an actual share of only 2% of value of trades with goods and services. Therefore the impact on the balance of payments deficits on the currency rates has decreased substantially as well.29

Most of the transactions are nowadays concentrated on the transfers of investment instruments and various assets, which bear the best possible yields with respect on their risk and liquidity. A large change is also the perception of the foreign currencies as a type of asset, rather than just a medium of exchange. The enormous interest in foreign currencies, the tremendous volume, the large number of participants and investors on the global financial markets leads to its efficiency. Every individual inquiry and each trade is immediately comprised into the market price and therefore we might accept the argument, that foreign currency market is the most efficient one, which has been also proved with many research papers and studies. Only new and unexpected information affects the actual currency rate. The formula for the random walk model can be therefore written in the following way:

\[ S_t = S_0 + \varepsilon_t \]

where \( S_0 \) and \( S_t \) are the spot currency rates at time \( t = 0 \) and \( t = 1 \). The term \( \varepsilon_t \) is an error term with mean zero, i.e. \( E(\varepsilon_t) = 0 \). This implies that \( E(S_t) = S_0 \). Thus, the best prediction of the future exchange rate is its current spot rate.30

3.4 Hedging

When examining the attraction of foreign government bonds from the perspective of local investors, we feel obliged to provide the reader with a background for dealing with the risks incidental with such an investment. The biggest risk represents undoubtedly currency rates and their future progress. Therefore, in the following part we provide the reader with a sound theoretical framework concerning hedging and refer to the basic strategies how to cover foreign currency exposure.

3.4.1 Introductory framework

Our potential investor might be interested in the possibility to get rid of the currency rate risk and to cover either entirely or partially the exposure towards the open position that foreign currency government bond represents. Hedging a particular currency exposure means basically establishing an offsetting currency position such that whatever is lost or gained on the original currency exposure is exactly offset by a corresponding foreign exchange gain or loss on the currency hedge.31

Currency hedging is used both by financial investors to eliminate the risks they encounter when investing overseas, as well as by non-financial actors in the global economy for whom multi-currency activities are a necessary daily reality.32

3.4.2 Possibilities of currency rate hedging

In the following section we will provide the reader with a short list of the most commonly used hedging tools in the international markets.33

First of them are **forward contracts**, which are defined as a foreign currency contracts to buy or sell a foreign currency at a fixed rate for delivery on a specified future date or period.

Foreign currency forward contracts are used as a foreign currency hedge when an investor has an obligation to either make or take a foreign currency payment in the future. If the date of the foreign currency payment and the last trading date of the foreign currency forward contract are matched up, the investor has in effect locked in the exchange rate payment amount, and has covered his position. On the contrary, foreign currency **futures contracts** have standard contract sizes, time periods, settlement procedures and are traded on international finance markets all around the world.

However, both contracts are employable just for the single transfer of the foreign currency in the future, and therefore in case of a batch of coupon payments for example, we have to apply a serie of forward contracts. Banks have therefore come up with brand-new type of contract; a **currency rate swap**. It implies a contract where the buyer and seller exchange equal initial principal amounts of two different currencies at the spot rate. The buyer and seller exchange

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fixed or floating rate interest payments over the term of the contract. At maturity, the principal amount is swapped at a predetermined exchange rate so that the parties end up with their original currencies.

Nevertheless, hedging does not have to necessarily the conversion from the local to foreign currency, called direct hedging. There are also situations, when the local currency is less convertible with certain currency pair, strongly illiquid, or they do not have bilateral quotations. In this case investors use cross hedging, which entails swap conversion of one currency to one of the core currencies and then through another swap contract to the local currency. Banks involve these operations in one single product, which, however, bears its costs.

We want to mention one more, very special way of hedging; hedging through foreign currency, which is strongly correlated with the local currency rate. It can easily happen that local currency rate is not liquid enough or is not traded, so as the swap market offers either none or very expensive ways of hedging the foreign currency exposure. Then, in currency rate swaps another currency is used than the one in which the foreign government bond is denominated in. This currency is supposed to have high correlation with particular foreign currency. Costs of such a position might be much lower and potential impact of currency rate movements should be conformable.

3.4.3 Hedging in terms of our research

At this point we have basic awareness about hedging as a strategy of covering the currency risk exposure. Now let’s divert more close to the issue from our investor’s point of view. At the beginning of the subject we come from the derived formula from interest rate parity condition, which illustrates the difference between the spot rate and its beforehand contracted forward value:

\[
\%\Delta F = \frac{F - S_0}{S_0} = \frac{r_H - r_E}{1 + r_H} = r_H - r_E
\]

From the formula we might conclude that if we buy a foreign currency, its value will be lower one year later in exactly the same range as the yields in domestic currency are higher. If we buy a foreign currency bond and entirely cover the open position through hedging, the whole interest differential entailed by holding bonds will be offset by the currency rate hedging.

A very interesting possibility for the investors is partial hedging. This approach decreases the currency rate risk and affects yield to maturity of the bond as well, since the interest rate differential between investment in domestic and foreign government bond partly disappears.

Now let’s derive a more exact approach to the issue and stress the significance of these factors to our investor. If we assign \( w \) as the ratio, or scale to which we want to hedge against a currency risk, then we get modified formulas for the expected return of portfolio and portfolio

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36 „internal rate of return“ of a bond; covered later in the thesis: Chapter 4.1.2.3.
standard deviation while hedging. Starting again from the initial formula for the expected return:

\[ r^* = W_1 \cdot r_{FI} + W_2 \cdot r_{ER} \]

However, we cannot afford to omit \( r_{ER} \) indicating the expected return from the currency rates movements, but we rather re-numerate it with the interest rate differential for that part of portfolio, which we hedge, since the currency rates changes are driven by the interest rate differential during the hedging. The formula comprising the previous discussions gives:

\[ r^* = r_{FI} + w \cdot (r_{FH} - r_{FI}) \]

, or after a simple modification:

\[ r^* = r_{FI} \cdot (1-w) + r_{FH} \cdot w \]

, where \( w \) implies the hedged part of the investment, \( r_{FI} \) return from the foreign investment denominated in foreign currency and \( (r_{FH} - r_{FI}) \) interest rate differential. The formula indicates that if there are higher interest rates abroad than in the investors’ home country, the forward rate is lower and the yield of the hedged part of the portfolio decreases by the yield differential. With increasing weight of hedging, the expected yield of the foreign currency bond decreases from the level \( r_{FI} \) (no hedging) towards \( r_{FH} \) (100% hedging). As we might suspect, the entire yield of the portfolio is a linear combination of the domestic and the foreign yield curves, where the weight is the proportion of hedging towards the foreign currency exposure.

We continue with the calculation of portfolio risk implied by its volatility. The basic formula for portfolio risk:

\[ \sigma^2 = w_1^2 \cdot \sigma_{FI}^2 + w_2^2 \cdot \sigma_{ER}^2 + w_1 \cdot w_2 \cdot R \cdot \sigma_{FI} \cdot \sigma_{ER} \]

In case of portfolio risk there is not that many changes comparing to our previous discussions. After breaking down the first and the third part of the formula, the portfolio volatility remains the same, however, only for that part of portfolio which is not hedged:

\[ \sigma = (1-w) \cdot \sigma_{ER} \]

When we have 100% hedging of the position, the risk is equal to zero and vice versa. The whole situation can be depicted in Figure 4, which in general provides the reader with the variety of investment decisions between the points A and B representing different securities. In the direction towards point A the ratio of hedging position in the entire investment in the foreign currency bond increases.37

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The derived relationships will be used in the empirical analysis later in the paper. Now we move our attention towards the examined investment instrument itself, and we will provide the reader with a background concerning government bonds and government bond market in Sweden. The conclusion from the investigation of the Swedish market for government bonds will be used in the later analysis.
4 Bonds and the bond market

4.1 Bonds

A bond is a debt security, which is constructed under the basic idea, that the issuer owes to the holder of a bond a debt and is obliged to repay the principal and interest (the coupon) at a specific future date, termed the maturity date. Other characteristics may also be attached to the issue of a bond, such as the limitations on the behaviour of the issuer, obligation of the issuer to provide the bond holder with certain type of information, sinking funds arrangements, details concerning protective covenants or a call provision of the issuing subject to repurchase the bond. In general, bonds are issued for a fixed term called maturity, which is mostly longer than one year. However, the time specification of bonds in different countries may differ.

From the previous lines the reader might understand, that a bond is simply a loan, but in the form of security. The terminology used is slightly different, though. The issuer is equivalent to the borrower, the bond holder to the lender, and coupon to the interest. As indicated before, bonds enable the issuer to finance long-term investments with external funds. However, in contrast to loan bonds are traded on a secondary market.

The range of bonds issuers is very large. Almost any subject or organization can issue bonds; however, underwriting and legal costs can be prohibitive since regulations to bonds issues are very strict. Bonds can be issued by public authorities, companies, credit institutions and supranational institutions in the primary markets, and the most common way of issuing bonds is through underwriting, which is the process where one or more securities firms or banks, form a syndicate, buy an entire issue of bonds from one issuer and re-sell them to investors on the secondary market. Government bonds are sold through auctions.

Let’s now have a look on different characteristics of bonds, which distinguish one type from another.

4.1.1 Features of bonds

- **Nominal value (also called face value or principal)** – the amount that the issuer is obligated to pay at the maturity date.

- **Issue price** – price at which investors buy a bond when it is issued for the first time. Net proceeds that issuer receives are calculated then as the issue price less the issuance fees times the nominal amount.

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39 In the USA for instance, U.S. Treasury securities issued as debt security with the maturity of ten years or more is a bond. New debt between one year and ten years is a note, and new debt with the maturity no longer than one year is called a bill.
• **Maturity date** – the date on which the issuer has to repay the nominal amount. As soon as all payments have been made, the issuer of the bond has no more obligations to the bond holders after the maturity date.

• **Coupon** – the interest rate that the issuer pays to the bond holders. Most commonly, the coupon rate is fixed during the life of the bond; however, it can also vary e.g. with the money market index, such as LIBOR[^41] or any other reference price.

• **Coupon dates** – dates on which the issuer pays the coupon to the bond holders. In Europe most bonds are annual and pay only one coupon a year. On the contrary, in the U.S. the coupon payments are semi-annual.

• **Indenture** – written agreement between the borrower (issuer) and a trust company. The trust company is appointed by the corporation to represent the bondholders. The trust company must (1) be sure the terms of indenture are obeyed, (2) manage the sinking fund, and (3) represent bondholders if the company (issuer) defaults on its payments. The bond indenture generally includes following provisions:
  
  a) The basic terms of bonds  
  b) A description of property used as security  
  c) Details of protective covenants  
  d) Sinking fund arrangements

• **Protective covenants** – part of the indenture that limits certain actions of the borrowing subject. They can be classified into two main categories; a negative covenant which prohibits the actions the issuer may take, and positive covenants, which specify the action the issuer must take or condition he must abide by.

There are some more important characteristics tightly connected to bonds, which are, however, not enlisted in the contract, but which investors are sometimes interested in even more than the previous features, as we will indicate in the following text.

### 4.1.2 Other indicators connected with bonds

#### 4.1.2.1 Duration

An important measure for bonds is the bonds duration. The duration is the weighted average maturity of a bond’s cash-flows during its maturity. It is tightly related to the derivative of the bond’s price function with regard to the interest rate. Some economists and financial mathematicians consider the duration to be this derivative, with the weighted average maturity simply being an easy method of calculating the duration for non-callable bonds.

[^41]: London interbank offer rate, which is considered to be the reference rate on the local money market.
Then the duration of a zero coupon bond with the maturity of ten years is ten years, whereas the duration of the coupon bond with the same maturity time is naturally shorter than for zero coupon bonds. The standard definition of duration is:

\[ D = \sum_{i=1}^{n} \frac{P(i)t(i)}{V} \]

where \( P(i) \) is the present value of the coupon \( i \), \( t(i) \) is the future payment date, and \( V \) is the bond price.\(^{42}\)

Duration is a very useful measure of the price sensitivity of bonds to interest rate movements. It is approximately inversely proportional to the percentage change in price for given change in the yield. As an example, let’s have a coupon bond with the maturity of 10 years and with duration of 6 years and an interest rates increase by 1%. The duration characteristics then indicate that bond will under the giver circumstances fall in value by 6%.

4.1.2.2 Macaulay duration

The Macaulay duration, named after Frederick Macaulay is the weighted average maturity of a bond where the weights are the relative discounted cash flows in each period. The formula is given by:

\[ D^* = \sum \left( \frac{PVCF * T_{CF}}{P} \right) \]

where \( PVCF \) indicates the present value of Cash flows, \( T_{CF} \) is time to cash flow and \( P \) is the price of the bond at time \( T \).\(^{43}\) Macaulay has proved the non-weighted maturity is useless in determination of the interest rate risk. Theoretically correct way uses the zero coupon bond prices as discount factors, however, the more practical form uses the bond’s yield to maturity to calculate discount factors. In case of continuously compounded yield the Macaulay duration coincides with the opposite of the partial derivative of the bond price with respect to the yield. In case of yearly compounded yield, the modified duration coincides as follows:

\[ MD = \frac{D^*}{1 + \frac{r}{n}} \]

where \( r \) is the yield to maturity of the bond, and \( n \) is the number of cash flows per year.\(^{44}\)

**Application of the duration: Portfolio immunization**

As a matter of fact, when investing in bonds not all the investors look only for an over-return or investment paid off at the maturity date. They are also interested in securing against the interest rate movements. From the previous discussion we can see that changes in the level of

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interest rates has an impact on the price of bonds and thus the value of the entire possession of the investor. To lock the price sensitivity of the bond to the interest rates changes, the duration of the entire portfolio is calculated.

As a consequence, investors do not look solely on the maturity of bond, but they also very carefully observe their modified duration, which indicates the price sensitivity of the bond to the interest rates changes and time period for which the bond (entire portfolio) is immunized against the interest rates movements. However, in the following analyses we will observe mainly the maturities of the bonds for its simplification.

### 4.1.2.3 Yield to maturity

Yield to maturity, abbreviated with YTM, represents the yield promised to the bondholder assuming that bond will be held to its maturity date, all coupons and principal payments will be made and coupon payments are re-invested at the bond’s promised yield at the same rate as invested. The concept of YTM allows the investors to calculate the fair value of different financial instruments and investment tools, since it can be interpreted as the required return to the investor from the bond during the period of its possession. The YTM for a bond can be calculated by solving:

\[
P = \sum_{t=1}^{T} \frac{C}{(1 + YTM)^t} + \frac{F}{(1 + YTM)^T},
\]

where \( P \) is the market price of a bond, \( C \) are the coupon payments, \( F \) indicates the face value of the bond, \( t \) is the year the individual coupon payment is paid and \( T \) is the maturity of the bond, in years.\(^{45}\)

The yield of a bond or in general yield of any security serves as a basis for construction of so called yield curve, which is the term investors are essentially interested in. Since we are going to use this term later in our empirical analysis as well, let’s now move our attention towards the yield curves and their construction.

### 4.1.2.4 Yield curves

„The yield curve is the relation between the relevant interest rate (or cost of borrowing) and the time to maturity of the debt for a given borrower in a given currency. For example, the current U.S. dollar interest rates paid on U.S. Treasury securities for various maturities are commonly plotted on a graph informally called „the yield curve.“ More formal mathematical descriptions of this relation are often called the term structure of interest rates.“\(^{46}\)

Yield curves are used by financial analysts, who analyze bonds and related fixed income securities to understand conditions in financial markets and to seek trading opportunities. These information are later provided to potential investors. Therefore we are interested in the topic as well. To better understand the whole concept we provide an insight into the construction of such a curve.


Construction of the full yield curve from market data

The usual representation of the yield curve is a function $P$, called the discount factor function, defined on all future times $t$, such that $P(t)$ represents the value today of receiving one unit of currency $t$ years in the future. If $P$ is defined for all future $t$ then we can easily recover the yield (i.e. the annualized interest rate) for borrowing money for that period of time via the formula:

$$ Y(t) = \left( \frac{1}{P(t)} \right)^{\frac{1}{t}} - 1 $$

The significant difficulty in defining a yield curve therefore is to determine the function $P(t)$. Yield curves are built from prices available either in the bond market or the money market. Whilst the yield curves built from the bond market use prices only from a specific class of bonds (for instance zero-coupon bonds issued by the government), yield curves built from the money market use prices of „cash“ from today’s LIBOR rates, which determine the „short end“ of the curve ($t \leq 3$ months), futures rates which determine the „mid-section“ of the curve ($3$ months $\leq t \leq 15$ months) and interest rate swap rates which determine the „long end“ ($1$ year $\leq t \leq 60$ years) of the yield curve. The construction of the yield curves through the money market instruments is therefore mostly more relevant than the the construction from the bond markets data.\(^{47,48}\)

4.1.3 Different types of government bonds

Now let's turn our attention on different types of government bonds and their short characteristics.

4.1.3.1 Real bonds

A real bond is an interest-bearing security that gives the investor a protection against the inflation in comparison to nominal bonds. The Swedish government issues real-bonds primarily to reduce the risks on the central Government debt. The debt office reduces the risks by increasing the number of different types of securities to invest in. At this point the Government offers Real-bonds with maturity up to 25 years.

The debt office issues real-bonds with an annual interest payment (coupon bonds) and real-bonds with the interest to be paid at the maturity date of the bond (zero-coupon bonds). The real-loans proportion to the central government debt is settled to 25 percent. The loans are

\(^{48}\) Options, futures and other derivatives, John C. Hull, Prentice Hall, 4th edition; section 4.7: Theories of the term structure.
established through auctions. The auctions take place every other Thursday and the conditions are announced one week in advance.49

4.1.3.2 Nominal Bonds

A nominal bond is a bond with fixed annual interest-payments in terms of coupons. The interest rate is constant during the whole lifetime of the bond until the maturity.

The debt office issues nominal bonds with maturity dates from 2 to 15 years. The loans are primarily concentrated to benchmark loans. The bonds with the most turnover are the reference loans with 2, 5, and 10 years to maturity date. The outstanding volume of the benchmark loans varies from 40 to 100 Billion Swedish Kronor.

4.1.3.3 Zero-bonds

Investing in Zero-coupon bonds means that the investors buy the nominal amount under the rate exclusively accrued to inflation. At the maturity date the investor will receive all the invested capital and a compensation for the inflation. The interest rate is thus the difference between the nominal value and the face value of the security.

The investor who wishes annual payments and compensation for the inflation can choose to invest in real, coupon bonds.50

In the following part of the paper we provide the reader with the convenient information concerning the government bond market in Sweden with respect to the topic of the thesis.

4.2 The bond market

4.2.1 Supply of government bonds in Sweden

In the following part we provide a listing with all the benchmark emissions of government bonds, according to the definition of Riksgälden. Accordingly, benchmark emissions include nominal bonds with maturities from 2 to 15 years, primarily concentrated in 10 bonds with different coupon rates than the ones on the market. These are displayed in Table 1.

More than the number of emissions, for the investors, it is much more important to match their term structure. According to the specific demand of the investors the supply of emissions does not have to be desirable. The yield of the individual emissions will be inspected in the later analysis. The most important information from the table of the current emissions is, that all the emissions are “plain vanilla” bonds, which means, that all the bonds have fixed maturity and the coupon rate which makes the comparison of them easier.

Table 1: Total amount of nominal government bonds

<table>
<thead>
<tr>
<th>Maturity date</th>
<th>ISIN No</th>
<th>Coupon rate</th>
<th>No</th>
<th>Notional amount, SEK million</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-05-05</td>
<td>SE0000412397</td>
<td>6,5</td>
<td>1040</td>
<td>59,787</td>
</tr>
<tr>
<td>2009-01-28</td>
<td>SE0000460297</td>
<td>5</td>
<td>1043</td>
<td>76,65</td>
</tr>
<tr>
<td>2009-12-01</td>
<td>SE0001173709</td>
<td>4</td>
<td>1048</td>
<td>49,99</td>
</tr>
<tr>
<td>2011-03-15</td>
<td>SE0000722852</td>
<td>5,25</td>
<td>1045</td>
<td>71,037</td>
</tr>
<tr>
<td>2012-10-08</td>
<td>SE0000909640</td>
<td>5</td>
<td>1046</td>
<td>49,697</td>
</tr>
<tr>
<td>2014-05-05</td>
<td>SE0000412389</td>
<td>6,75</td>
<td>1041</td>
<td>51,747</td>
</tr>
<tr>
<td>2015-08-12</td>
<td>SE0001250135</td>
<td>4,5</td>
<td>1049</td>
<td>36,489</td>
</tr>
<tr>
<td>2016-07-12</td>
<td>SE0001517699</td>
<td>3</td>
<td>1050</td>
<td>38,987</td>
</tr>
<tr>
<td>2017-08-12</td>
<td>SE0001811399</td>
<td>3,75</td>
<td>1051</td>
<td>44,019</td>
</tr>
<tr>
<td>2020-12-01</td>
<td>SE0001149311</td>
<td>5</td>
<td>1047</td>
<td>47,702</td>
</tr>
<tr>
<td><strong>Total amount nominal benchmark bonds</strong></td>
<td><strong>528,104</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other nominal government bonds</strong></td>
<td><strong>39,828</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total amount</strong></td>
<td><strong>567,932</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 1 shows when the government has to pay back its loans. The bonds with the highest turnover/amount to be paid are the ones with time to maturity of 2 and 4 years.

Figure 5: Composition of the debt

As can be seen in Figure 5, 55% of the national debt consists of SEK bonds and bills including currency swaps. According to the Swedish debt office the nominal government bonds emission will be decreased to 2 billion Swedish Kronor per auction. They count to have this volume during 2008. The loans in real-bonds are kept on the level of 5-10 billion Swedish Kronor per year. They are also needed to finance expiring loans. During the two coming
years, the budget surplus is calculated to be bigger than payable bond loans, which gives a negative gross-loan need. To maintain the lap time of the debt, the debt office will continue to issue relative huge amount of bonds. The emission volume will be decreased from 2.5 to 2 billion SEK from the auction the 7th of March 2007 due to the diminishing borrowing requirements. During 2008 Riksgälden representatives also expect to reduce the number of auctions to 21 from 23 to limit the bond loans without decreasing the emission volume during the auctions.51

4.2.2 Demand for government bonds

In the following part we will present the actors on the demand side of the Swedish market of government bonds. At this point we discuss the potential investors as a subjects interested in investing into government bonds.

4.2.2.1 Pension funds

First potential investors which might be interested in investing into government bonds are pension funds, which administer the savings of the public for the retirement. Similarly as e.g. with the life insurance companies the obligations are settled for the long time period, during which the clients save up their proceeds to the pension funds. This means that the duration of liabilities is very long.

The major area where pension funds might use the government bonds is the asset and liability management. This entails the task to lock the risk position of the asset and liability risk exposure on the neutral level. In other words, assets with particular maturities (modified duration) must equal the liabilities with the given modified duration. If there is a time horizon off balance, pension fund faces the risk of the interest rate movements. The more the duration of the assets equals the duration of liabilities, in terms of the duration of investment horizon, the less sensitive the off balance is.

The pension funds assets allocation is regulated by the law. However, in contrast to the insurance companies the limits of the assets are not as strict. In some cases, pension funds can invest even more than 50% of the resources in equity.52 At any rate, there is clear evidence that pension funds will be strongly interested in investing into more safe instruments such as government bonds with longer maturities, so as to reach sound level of return and balance the entire duration of their assets and liabilities.

4.2.2.2 Insurance companies

Other big clients for government bonds are insurance companies. For the purpose of this study we can divide the insurance companies into two categories, life insurance and others;

51https://www.riksgalden.se/Dokument/Riksg%C3%A4ldskontoret%20och%20statsfinanserna/Rapporter/Statsuppl%C3%A5ningsrapport%202007_1.pdf.
non life insurance companies. The major area where insurance companies might use the government bonds is similarly as in case of pension funds the asset and liability management.

Products of non life insurance companies are more or less short-term and middle-term oriented and therefore they will rather use more short-term instruments to invest in. The time horizon is determined by the end of the insurance contract and risk tract. Cash flows from these products are very unstable and they do not allow the insurance companies to use the longer term investment tools. Therefore government bonds with a maturity of five years or even longer are considered to be rather speculative instrument, not attractive for the non life insurance companies.

Unfortunately, we do not know the exact duration of the liabilities of non life insurance companies, but with some level of reliability we can assume the duration of about one year. Therefore, the investment portfolio of non life insurance companies will use more short term securities. Target of interest can be government bonds such as one year or even shorter maturity zero bonds.

For life insurance companies, whose insurance portfolios consist of life insurance contracts, the redemption is very long and companies gain the capital from the clients for a very long time period. The duration of the liabilities is decreased by the contracts which are paid off earlier. For these purposes the insurance companies use mortality tables, which are counted by the statistical offices and are available even to the public. Special departments within the insurance companies then count the probabilities of the number of contracts which will be paid off before the end of the contract. Optimally quantified duration of liabilities should equal the duration of the assets, which we can assume are on the level somewhere in between 15-20 years. The asset liability management, scale of investment opportunities and allocation of financial resources is, however, more difficult due to the restrictions given by the law and existence of technical reserves proceeds promised to the clients. That forces insurance companies to invest into the fixed income securities with the long duration, such as long term government bonds.

4.2.2.3 Banks

Banks are another type of potential investors interested in government bonds. Banks perform the function of intermediaries in the system of payments and administer current accounts and other similar products of their clients. To this group of sources employable for the long-term investments we can also add the long-term deposits. The use of such sources to the investments in the bonds does not seem to be reasonable since banks need to borrow the money for higher yield which indicates the aim of the banks to look for more lucrative long term investments, such as providing clients with bank loans or credits. Government bonds are, from this point of view even on the last position.

53 Non life insurance contracts are settled for the shorter period than one year, or, they are paid just once a year. The value of the average duration then decrease the risk tract of the insurance contract. These information are very sensitive and all the insurance companies are very reluctant to share it.

54 At this point we talk about so called capital live insurance contracts, when the client saves part of the resources as the saving product with interesting appreciation of value.

Then, are there any reasons for banks to be interested in government bonds? As a first stimulus we could have reckoned the administrative pressure they were facing, because all the banks had to fulfil the conditions of the capital asset ratio. However, even though the new Basel II concept let the old rules in relevance, it provides the banks with the brand new resolution for the complex system of risk evaluation. The question now is what can actually bring this new point of view on the capital asset ratio. Banks will not be forced to buy such investment tools as government bonds with the lower yield just because of the hunt for the capital asset ratio constant. Through the diversification, they will be able to better allocate their capital to the different variously yielding assets, rather than buying the safest bonds, which sometimes appear in their balance sheets only as the low yielding burden.

Another area where the banks might use the government bonds is the asset and liability management. For this purpose there is a special department in banks, called Asset liability committee which deals with this problem on every day basis. In the longer maturities one of the possibilities to lock such an exposure is to buy or sell government bonds, which have relatively high liquidity. Again it is clearly seen that the goal of the banks is not to invest to such bonds but just to adjust the exposure layout.

Other reason for the banks to invest in government bonds is to act as a market maker on the government bonds market. Banks have the opportunity to take part in the primary emissions and subsequently act as brokers on the market with the government bonds. Banks admit bonds prices in terms of BID-ASK quotes, and whenever another part decides to exercise the quotes, market maker has to enclose the position. Main objective is not to go long or short in these trades, but to make a profit on the turnover and fees related to such transactions. Whatever position indicates the risk exposure, and therefore the brokers, on average, are in the neutral position which equals to zero position in government bonds.

As a conclusion banks do not seem to be a main investor in the long run perspective in holding the government bonds, but unexceptionably banks create the demand for the government bonds and substantially contribute to the liquidity of the market.

### 4.2.2.4 Mutual funds and other institutional investors

Fixed-income mutual funds surely also contribute to the entire demand for government bonds, but its weight is negligible. How large is their demand for either domestic or foreign government bonds is hard to determine, but with certain level of confidence we can assume it will be not that strong.

Another category is the portfolios of institutional investors. This category is also a little more difficult to recognize and define. Nevertheless we can assume that the assets of the institutional investors would reach couple of billions Swedish Kronor, which is not significant from our point of view concerning the topic of research. We assume that the majority of the institutional investors are represented by the state funds and corporations, which have to create and maintain some specific level of reserves for future expenses, related for example to

the redevelopment of the environment or re-cultivation of a landscape. However, we strongly believe these subjects will not create strong demand for government bonds.

4.2.2.5 Hedging funds and speculators

The last group we are about to mention are hedging funds and speculators. These two groups are a little impenetrable. They put their attention on the government bonds in case they expect certain level of over-return. Due to a lower liquidity of the market than in the most developed financial markets as in the USA and consequently higher transaction costs the speculative trades with the government bonds are significantly costly. That is one of the reasons government bonds, or securities in general are not used for such a purpose so often. At this point we would like to stress that the reason why we mention the foreign speculators is that they are much bigger, in term of assets they operate with, than potential speculators from Sweden. Foreign hedge funds dispose enormous amount of money in scales of tens of billions USD. The impact of this group of investors might be considerable but in the long run is trivial, because when talking about speculators, their strategies are based on the investments in the short time period seeking for the immediate proceeds.\(^{58}\)

4.2.3 Summary

From the previous part we can conclude that supply of government bonds offers decent amount of instruments with short and mid-term maturities. However, bonds with the longest maturities on the market are about to mature in 13 years. On the other side, there is a strong demand for Swedish government bonds of all maturities. The most progressive institutions in this respect are pension funds and insurance companies, whose assets even grow consequently. Their targets are most of all bonds with mid-term and long-term maturities. Due to their goal to immunize their portfolio against interest rate changes and lack of the securities with maturities longer than 13 years on the market, these two groups of investors are the most probable ones to look abroad. Other potential subjects interested and strongly contributing to the entire demand for government bonds are banks which concentrate most of all on the mid-term government bonds. We can also conclude that from the position of market makers banks considerably improve liquidity of the market.

5 Opportunities and risks concerning international investments in foreign currency government bonds

In this section we summarize the main opportunities and risks of investing in foreign government bonds compared with domestic government bonds. These factors will constitute the basis for the empirical evidence; however, the order does not say anything about its significance.

5.1 Possible advantages

5.1.1 Higher return

An obvious reason to invest in foreign government bonds instead of domestic government bonds is if they provide higher yields. In the following chapter, we will inquire the fact that yield curves in different countries are not equal and they differ enormously. In the situation of low interest rates in Sweden, which is current by the situation, investors might be interested in investments in foreign currency bonds, which offer higher yields with the comparable level of risk associated with the investment.

5.1.2 Diversification

One of the most important issues of the modern financial economy is the term diversification, which is apparently one of the reasons local investors are looking towards foreign countries. To put all the resources into single type of security would be silly in whatever situation, and international diversification allows due to the lower correlations of yield curves movements in particular countries to decrease the risk of the portfolio without decreasing the yield of entire portfolio.

International diversification provides a way of diversifying away domestic systematic risk. For example, shocks to the Swedish economy. Depending how bonds are correlated between countries investors can minimize the exposure to risk by diversifying in foreign bonds.

5.1.3 Risk

Hand in hand with the previous reason is the investment to the government bonds with lower level of risk, from the investors’ point of view. It is obvious, since the government bonds are covered by the revenues of the government budget, the risk of the redemption (rating) is not the same for all the countries. Nobody would believe that government bonds issued in Brazil or Bolivia have the same probability of redemption as “Treasuries” issued in the USA.
For a small country like Sweden it is possible that international investments require a large risk exposure for an investor in Sweden.

5.1.4 Looking for the duration

Many investors are seeking for an alignment of the duration of assets and liabilities, and they conform their investments decisions to this goal. Life insurance companies and pension funds are therefore interested in bonds with the maturity even longer than 20 years.

Searching for bonds with specific durations or average maturity equal to the investment horizon is even more difficult, when there are just a few available bonds and the entire length of the yield curve is unequal. This is just the case of the Swedish government bonds, which are quantitatively accumulated towards the shorter maturities, mostly around 5 years.

Hence, international diversification may provide a larger set of government bonds to choose from for the local investor.

5.1.5 Liquidity

Investors are concentrating not only on the return and risk, but also on the liquidity of the government bonds. We can find countries with relatively low risk, comparable yield curves, but almost no liquidity. For an investor it may then be very complicated to exit long positions. Due to this lack of liquidity they can markedly lose on the transactions. Liquidity can be measured by the spread between BID and ASK price of the bond, quoted by the dealers. The wider a spread is the more costly trading with the bonds is.

5.2 Possible disadvantages

All the above mentioned possible reasons for the investments in the foreign currency bonds are unexceptionable; however, there are some more factors which complicates the whole situation.

5.2.1 Currency rate risk

If an investor aims to extend the duration with a foreign currency bond to decrease the gap between duration of assets and liabilities, he is also exploited to the risk of mutual currency rate changes. Moreover, it comprises the changes of foreign country yield curve, which trigger off the different reaction to the changes of the rates of return even if the values of duration on both sides of the balance sheet are equal.

If an investor seeks higher proceeds from a foreign currency bond, currency rates changes revenue and proceeds become more volatile and unstable.

59 Banks, insurance companies and pension funds.
Whatever the goal of the investor is, as a conclusion we can say that the currency rate risk exposure makes yields in SEK more volatile and thus adds more risk to the entire position.

5.2.2 Other possible disadvantages

Not only currency rate risk complicates the investment in foreign government bonds. The following part will indicate some other possible issues.

5.2.2.1 Additional costs

A local investor should also be aware of the fact that he has to contract and pay a foreign county intermediary, who will provide the investor with the custody and administration of acquired securities.

To take the decision to invest in abroad as such also demands much more information, regarding the analyses to cover the new market, or territory. New analysts cannot just concentrate on the market for the fixed income securities in abroad, but they will also have to cover and analyse the influence of the local and global market indicators and the development of the currency rates, which, of course, requires additional costs related with the investments.

5.2.2.2 Trading with the foreign currency

Other costs are related with the conversion of the local currency to the domestic currency, in which the proceeds are desired during both the buying and selling of the security after the maturity date. The bigger amount we trade, the lower the prize difference between the BID and ASK price of particular instrument. Obviously it may also be costly to convert coupon payments into the local currency due to their smaller volume.

Another general rule concerns the fact, that the smallest difference between the BID and ASK price of the currencies are among the most traded currency pairs, namely USD, EUR and JPY. Conversions of the local currencies into these three are a little more expensive, and of course, conversions between two local currencies are most costly, because dealers have to trade the local currencies according to the cross currency rates rules through the global currencies, which represent additional inconsiderable costs. All of these factors have to be taken into consideration by investors during their decision making when planning the investments in the foreign currency assets.

5.2.2.3 Taxation issues

Investor also has to take into consideration the tax system in the particular foreign country. For example very common is the occurrence of the deduction tax even before the coupon payment. There also exist conventions among the countries protecting the investors from the double-taxation, not in all the bilateral countries relationships concerning financial markets, though.
6 Empirical investigation

After previous two sections dealing with the description of Swedish government bond market and Opportunities and risks concerning international investments in foreign currency government bonds, it is time to define our potential local investor who might be interested in investing into foreign government bonds and so as to answer the first research question of the paper.

From this moment we will consider our local investor to be a rational investor, who is offsetting the balance of interest rate sensitive assets and liabilities to reduce the interest rates volatility on his wealth. That means the main reason is seeking for the required duration balance having simultaneously best possible yield, lowest possible risk and sound level of diversification. This assumption is made based on the analysis of domestic market for government bonds and listing the pros and the cons linked to investments in foreign government bonds, as the most probable event of occurrence. However, we are not pointing out on any specific group of investors. Instead, we have defined our investor more precisely and at this stage we can gradually move towards another section of our thesis; the empirical investigation.

In order to investigate the attractiveness of foreign government bonds we start by analysing whether the expected returns in foreign countries are higher than yields in Sweden. So as to do this we have constructed the national yield curves in the examined countries. At the end of the first part of the section we will have comprehensive view of the expected returns.

6.1 National yield curves

Based on the theoretical background of the topic we will begin to analyse the expected returns of investing in foreign government bonds. This will be accompanied by comparing the yield curves in the different countries included in the study. However, we still have to keep in mind the ever-present influence of the currency rate changes. At this point, we will concentrate just on the yields, and consequently unfold the attraction of particular government bonds.

There are several kinds of yield curves. From the theoretical point of view the most proper and right way to design a yield curve would be the application of the yield curve on zero bonds, instruments providing no coupon to the investor. Their duration equals maturity and yield to maturity is not distorted by the previous coupon payments, which should have, separately, different yield to maturity. However, the government bonds are mostly issued as the coupon bonds, which duration is lower than maturity and yield to maturity is therefore changed as well. The difference from the zero-coupon bond curve is inconsiderable; therefore we use the yield curves constructed on the base of standard coupon bonds.

Another inconsistency among the yield curves is induced by diverse risk premiums included with different government bonds. However, rating of the countries as bond issuers, included in the research, given by the most recognized rating agencies is the same. The only exception is the Japanese bonds bearing slightly lower rating. From our perspective, this tiny inconsistence will be omitted in the following analysis. Thus we assume investors consider the probability of failure to make payment among inspected countries to be the same.
Nevertheless, we are fully aware that comparability analysis of differently risky issuers in different countries is not that easy due to different local yield curves and risk-free interest rates. If for example USA with rating AAA (the least risk) issue bonds in Japanese yen (JPY), they might have provided investors with even lower interest rates, due to the lower country risk than Japanese bonds and comparison would be apparent at first sight.

6.1.1 Sweden

What are the current yields that the Swedish government bonds offer to interested investors? Table 2 comprises all the upcoming emissions and their most important parameters.

<table>
<thead>
<tr>
<th>Name</th>
<th>ISIN</th>
<th>Coupon(%)</th>
<th>Maturity Date</th>
<th>Price</th>
<th>YTM (%)</th>
<th>Time to maturity (months)</th>
<th>Rating (S&amp;P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGKB 1037</td>
<td>SE0000304149</td>
<td>8.0</td>
<td>15.8.2007</td>
<td>101.07</td>
<td>3.428</td>
<td>3</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1040</td>
<td>SE0000412397</td>
<td>6.5</td>
<td>5.5.2008</td>
<td>102.56</td>
<td>3.782</td>
<td>11</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1043</td>
<td>SE0000460297</td>
<td>5.0</td>
<td>28.1.2009</td>
<td>101.61</td>
<td>3.973</td>
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<td>AAA</td>
</tr>
<tr>
<td>RGKB 1034</td>
<td>SE0000197535</td>
<td>9.0</td>
<td>20.4.2009</td>
<td>109.12</td>
<td>3.992</td>
<td>23</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1048</td>
<td>SE0001173709</td>
<td>4.0</td>
<td>1.12.2009</td>
<td>99.89</td>
<td>4.090</td>
<td>30</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1045</td>
<td>SE0000722852</td>
<td>5.25</td>
<td>15.3.2011</td>
<td>103.85</td>
<td>4.133</td>
<td>46</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1046</td>
<td>SE0000909640</td>
<td>5.5</td>
<td>8.10.2012</td>
<td>106.32</td>
<td>4.158</td>
<td>64</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1041</td>
<td>SE0000412389</td>
<td>6.75</td>
<td>5.5.2014</td>
<td>115.43</td>
<td>4.147</td>
<td>83</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1049</td>
<td>SE0001250135</td>
<td>4.5</td>
<td>12.8.2015</td>
<td>102.52</td>
<td>4.127</td>
<td>98</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1050</td>
<td>SE0001517699</td>
<td>3.0</td>
<td>12.7.2016</td>
<td>92.09</td>
<td>4.117</td>
<td>109</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1051</td>
<td>SE0001811399</td>
<td>3.75</td>
<td>12.8.2017</td>
<td>97.59</td>
<td>4.107</td>
<td>122</td>
<td>AAA</td>
</tr>
<tr>
<td>RGKB 1047</td>
<td>SE0001149311</td>
<td>5.0</td>
<td>1.12.2020</td>
<td>110.17</td>
<td>4.078</td>
<td>162</td>
<td>AAA</td>
</tr>
</tbody>
</table>

Source: OMX Group, Thomson Group and own calculations

The table describes the conditions on the market on the date, 11th of May, 2007. From the quoted prices, or more precisely yields of bonds, we have constructed the actual yield curve shown in Figure 6.

Figure 6: Swedish government bonds yield curve to the date 5/11/2007 (MID quotations)

Source: OMX Group and own calculations
The Swedish national yield curve is increasing. If we accept “The preferred Habitat Hypothesis” as the most accepted theory describing the slope of the yield curves, then future short-term interest rates will gradually grow or will stay unchanged. The growth of the yield curve is then interpreted by certain risk premium for lower liquidity and subsequent increase in the short-time interest rates. The current risk-free borrowing rate set by the Sveriges Riksbank equals 2.5% and the interest rate for the REPO operations equals 3.25%.

### 6.1.2 Germany

The German government bonds are frequently haunted by the investors and they even have its specific name. They are called “bunds”. Due to the huge number of issues of “bunds” only a few of them are displayed on the Table 3. Their yields can be compared with the risk-free yield rate again, which are, however, not set by Deutsche Bundesbank, the German central bank, but by the European Central Bank (ECB). ECB sets the interest rates for the whole Euro Zone, of which Germany is, of course, part of. The actual REPO rate set by the European Central Bank is 3.75%.

Yield rates of all the countries within the European Monetary Union are based on this rate. The actual differences in the government bonds yields are then given only by the risk addition of the country. Therefore the yields of government bonds in Italy are slightly higher than e.g. German bunds, which bear the rating of AAA from Standard&Poor.

<table>
<thead>
<tr>
<th>Notes/Bonds</th>
<th>Coupon (%)</th>
<th>Maturity date</th>
<th>Price</th>
<th>YTM/ (%)</th>
<th>Time to maturity (months)</th>
<th>Rating (S&amp;P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>3.750</td>
<td>13.3.2009</td>
<td>99.26</td>
<td>4.17</td>
<td>21</td>
<td>AAA</td>
</tr>
<tr>
<td>3-year</td>
<td>3.250</td>
<td>4.9.2010</td>
<td>97.51</td>
<td>4.18</td>
<td>39</td>
<td>AAA</td>
</tr>
<tr>
<td>4-year</td>
<td>3.500</td>
<td>4.8.2011</td>
<td>97.58</td>
<td>4.19</td>
<td>50</td>
<td>AAA</td>
</tr>
<tr>
<td>5-year</td>
<td>4.000</td>
<td>13.4.2012</td>
<td>99.19</td>
<td>4.18</td>
<td>58</td>
<td>AAA</td>
</tr>
<tr>
<td>6-year</td>
<td>4.500</td>
<td>1.4.2013</td>
<td>101.47</td>
<td>4.2</td>
<td>70</td>
<td>AAA</td>
</tr>
<tr>
<td>7-year</td>
<td>4.250</td>
<td>1.4.2014</td>
<td>100.23</td>
<td>4.21</td>
<td>82</td>
<td>AAA</td>
</tr>
<tr>
<td>8-year</td>
<td>3.750</td>
<td>1.4.2015</td>
<td>97.02</td>
<td>4.21</td>
<td>94</td>
<td>AAA</td>
</tr>
<tr>
<td>9-year</td>
<td>3.500</td>
<td>1.4.2016</td>
<td>95</td>
<td>4.2</td>
<td>106</td>
<td>AAA</td>
</tr>
<tr>
<td>10-year</td>
<td>3.750</td>
<td>1.4.2017</td>
<td>96.36</td>
<td>4.21</td>
<td>118</td>
<td>AAA</td>
</tr>
<tr>
<td>20-year</td>
<td>6.500</td>
<td>7.4.2027</td>
<td>127.68</td>
<td>4.4</td>
<td>238</td>
<td>AAA</td>
</tr>
<tr>
<td>30-year</td>
<td>4.250</td>
<td>7.4.2039</td>
<td>97.96</td>
<td>4.37</td>
<td>382</td>
<td>AAA</td>
</tr>
</tbody>
</table>

Source: Bloomberg and own calculations

As the reader can find out from various financial data sources of information, the German bunds carry excellent liquidity. Price spread between both the yield to maturity and market prices get around 5-10 basic points, which is, expressed with the bonds yield to maturity, trivial severance.

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Due to the huge number of “bunds” and their spread along the whole course of the curve up to 30 years, we can construct the yield curve easily for the long-term bonds as well. The yield curve shown in Figure 7 is itself rising. There is a slight decline in the 20 years period. In such a long period, however, the yield curve is not affected by the central bank’s policy any more, but more with the investors’ expectations about the development of the economy.

6.1.3 USA

Similarly as for the German government bonds, the American government bonds have their specific qualification as well. They are known to investors as “Treasury bills (T-bills)/ T-notes/ T-bonds”, according to their maturity, or inflation-indexed bonds, “TIPS”.

Table 4 indicates just a specific selection, due to the huge number of Treasuries issues on the financial markets. The risk-free interest rate is regularly assembled by the board of governors set by the central bankers from the particular federal states of the USA.63 Currently the risk-free rate set by FED referred-to as Federal reserves rate equals 5,25%. Treasuries are considered to be the least risky government bonds in the world, which is verified by all the major rating agencies, evaluating them with the highest possible rating AAA (S&P) and Aaa (Moody’s), which practically indicates zero default risk.

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63 More detailed information on official website of FED; http://www.federalreserve.gov/general.htm.
Table 4: The list of U.S. Treasuries (selection, to the date 5/11/2007)

<table>
<thead>
<tr>
<th>Type</th>
<th>Issue</th>
<th>Coupon(%)</th>
<th>Maturity date</th>
<th>Price</th>
<th>YTM(%)</th>
<th>Time to maturity (months)</th>
<th>Ratings S&amp;P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treas</td>
<td>T-NOTE 4.000 31-Aug-2007</td>
<td>4.000</td>
<td>31.8.2007</td>
<td>100.23</td>
<td>3.190</td>
<td>3</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-NOTE 4.250 30-Nov-2007</td>
<td>4.250</td>
<td>30.11.2007</td>
<td>100.11</td>
<td>4.050</td>
<td>6</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-NOTE 4.875 15-May-2009</td>
<td>4.875</td>
<td>15.5.2009</td>
<td>100.88</td>
<td>4.411</td>
<td>24</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-NOTE 3.875 15-Jul-2010</td>
<td>3.875</td>
<td>15.7.2010</td>
<td>98.54</td>
<td>4.371</td>
<td>38</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-NOTE (OLD 5YR) 4.500 31-Mar-2012</td>
<td>4.500</td>
<td>31.3.2012</td>
<td>100.29</td>
<td>4.432</td>
<td>58</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-NOTE 3.875 15-Feb-2013</td>
<td>3.875</td>
<td>15.2.2013</td>
<td>97.20</td>
<td>4.430</td>
<td>69</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-NOTE 4.000 15-Feb-2014</td>
<td>4.000</td>
<td>15.2.2014</td>
<td>97.14</td>
<td>4.495</td>
<td>81</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND 8.500 15-Feb-2020</td>
<td>8.500</td>
<td>15.2.2020</td>
<td>135.56</td>
<td>4.749</td>
<td>153</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND 7.875 15-Feb-2021</td>
<td>7.875</td>
<td>15.2.2021</td>
<td>130.73</td>
<td>4.796</td>
<td>165</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND 7.250 15-Aug-2022</td>
<td>7.250</td>
<td>15.8.2022</td>
<td>125.91</td>
<td>4.829</td>
<td>183</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND 7.625 15-Feb-2025</td>
<td>7.625</td>
<td>15.2.2025</td>
<td>132.70</td>
<td>4.855</td>
<td>213</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND 6.000 15-Feb-2026</td>
<td>6.000</td>
<td>15.2.2026</td>
<td>113.99</td>
<td>4.854</td>
<td>225</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND (OLD 30YR) 4.500 15-Feb-2036</td>
<td>4.500</td>
<td>15.2.2036</td>
<td>95.31</td>
<td>4.802</td>
<td>345</td>
<td>AAA</td>
</tr>
<tr>
<td>Treas</td>
<td>T-BOND (30YR) 4.750 15-Feb-2037</td>
<td>4.750</td>
<td>15.2.2037</td>
<td>99.35</td>
<td>4.790</td>
<td>357</td>
<td>AAA</td>
</tr>
</tbody>
</table>

Source: finance.Yahoo! and own calculation

In comparison with other markets, American Treasuries bear brilliant liquidity. As an indicator we want to mention, that observed BID–ASK spread of 1-6 basic points is ascribed especially to market characteristics, its development and trading volume of securities.64

Figure 8: U.S Treasuries Yield Curve to the date 5/11/2007 (MID quotations)

Source: finance.Yahoo! and own calculations

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The yield curve is in Figure 8. However, investment expectations imply the increase of interest rates in the longer-time period in 5 year time horizon, and for bonds with maturities longer than five years the yield curve regresses back close to the current level, up to the YTM of 4.83% for bonds with maturity of 30 years.

6.1.4 Japan

Another case for our comparison is the market for government bonds in Japan. A very specific feature of Japanese financial market is the level of interest rates. Bank of Japan, local central bank, had to implement very expansive monetary policy to battle against deflation during the recent period. Therefore, it has been 11 years of decline since the basic Discount rate and basic Loan rate have been increased. Lastly, for the second time after September 2001, when the risk-free rate reached the level of 0.1%, on February 21st, 2007 to the level of 0.75%.65

Table 5: The list of Japanese government bonds (selection, to the date 5/11/2007)

<table>
<thead>
<tr>
<th>Notes/Notes</th>
<th>Coupon (%)</th>
<th>Maturity date (months)</th>
<th>Price</th>
<th>YTM(%)</th>
<th>Time to maturity (months)</th>
<th>Rating (S&amp;P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Year</td>
<td>0.900</td>
<td>15.5.2009</td>
<td>100.04</td>
<td>0.89</td>
<td>24</td>
<td>AA</td>
</tr>
<tr>
<td>3-Year</td>
<td>1.700</td>
<td>22.3.2010</td>
<td>101.97</td>
<td>0.99</td>
<td>34</td>
<td>AA</td>
</tr>
<tr>
<td>4-Year</td>
<td>1.100</td>
<td>21.3.2011</td>
<td>99.89</td>
<td>1.13</td>
<td>46</td>
<td>AA</td>
</tr>
<tr>
<td>5-Year</td>
<td>1.200</td>
<td>20.3.2012</td>
<td>99.75</td>
<td>1.26</td>
<td>58</td>
<td>AA</td>
</tr>
<tr>
<td>6-Year</td>
<td>0.800</td>
<td>20.3.2013</td>
<td>96.93</td>
<td>1.38</td>
<td>70</td>
<td>AA</td>
</tr>
<tr>
<td>7-Year</td>
<td>1.900</td>
<td>20.6.2014</td>
<td>103.04</td>
<td>1.44</td>
<td>85</td>
<td>AA</td>
</tr>
<tr>
<td>8-Year</td>
<td>1.300</td>
<td>20.3.2015</td>
<td>98.33</td>
<td>1.54</td>
<td>94</td>
<td>AA</td>
</tr>
<tr>
<td>9-Year</td>
<td>1.600</td>
<td>20.3.2016</td>
<td>100.02</td>
<td>1.6</td>
<td>106</td>
<td>AA</td>
</tr>
<tr>
<td>10-Year</td>
<td>1.700</td>
<td>20.3.2017</td>
<td>100.21</td>
<td>1.68</td>
<td>118</td>
<td>AA</td>
</tr>
<tr>
<td>15-Year</td>
<td>2.000</td>
<td>21.3.2022</td>
<td>100.71</td>
<td>1.94</td>
<td>178</td>
<td>AA</td>
</tr>
<tr>
<td>20-Year</td>
<td>2.100</td>
<td>20.3.2027</td>
<td>99.8</td>
<td>2.12</td>
<td>238</td>
<td>AA</td>
</tr>
<tr>
<td>30-Year</td>
<td>2.400</td>
<td>20.3.2037</td>
<td>101.14</td>
<td>2.33</td>
<td>358</td>
<td>AA</td>
</tr>
</tbody>
</table>

Source: Bloomberg and own calculations

In Table 5 there is again a selection of all the government bonds outstanding. However, rating, and therefore riskiness of these securities is a little higher than in case of Bunds and Treasuries. In the second half of April, 2007, Japan’s sovereign debt rating was raised to AA by Standard&Poor’s (S&P) from AA- in the first upgrade since 1975 which cited government efforts to cut spending and polarize the monetary policy.66

Liquidity measured by the price-spread is a little worse than on the main global markets, and this BID-ASK spread rises with the maturity.

Empirical investigation

Figure 9: Japanese government bonds yield curve to the date 5/11/2007 (MID quotations)

Source: Bloomberg and own calculations

In Figure 9 the Japanese yield curve is displayed. The yield curve is similarly as the previous constructed yield curves growing. Its progression signifies the expectations of the investors on interest rates increases in the future and therefore a diminishing of the deflation threat.

6.1.5 United Kingdom

The last government bond yields to compare with the Swedish ones are the yields in the U.K. The situation here is slightly different. Since the actual basic borrowing rate set by the Bank of England has been recently increased to 5.5%, the short-term interest rates move around this level. However, the investor’s expectations on long-term rates have completely opposite direction.

Table 6: The list of U.K. government bonds (selection, to the date 5/11/2007)

<table>
<thead>
<tr>
<th>Notes/ Bonds</th>
<th>Coupon (%)</th>
<th>Maturity date</th>
<th>Price</th>
<th>YTM(%)</th>
<th>Time to maturity (months)</th>
<th>Rating (S&amp;P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Year</td>
<td>4.000</td>
<td>3.7.2009</td>
<td>97.3</td>
<td>5.58</td>
<td>25</td>
<td>AAA</td>
</tr>
<tr>
<td>3-Year</td>
<td>4.750</td>
<td>6.7.2010</td>
<td>97.89</td>
<td>5.5</td>
<td>37</td>
<td>AAA</td>
</tr>
<tr>
<td>4-Year</td>
<td>4.250</td>
<td>3.7.2011</td>
<td>95.96</td>
<td>5.43</td>
<td>49</td>
<td>AAA</td>
</tr>
<tr>
<td>5-Year</td>
<td>5.000</td>
<td>3.7.2012</td>
<td>98.54</td>
<td>5.35</td>
<td>61</td>
<td>AAA</td>
</tr>
<tr>
<td>7-Year</td>
<td>8.000</td>
<td>27.9.2013</td>
<td>114.51</td>
<td>5.29</td>
<td>76</td>
<td>AAA</td>
</tr>
<tr>
<td>8-Year</td>
<td>5.000</td>
<td>9.7.2014</td>
<td>98.65</td>
<td>5.22</td>
<td>85</td>
<td>AAA</td>
</tr>
<tr>
<td>10-Year</td>
<td>4.000</td>
<td>9.7.2016</td>
<td>91.89</td>
<td>5.1</td>
<td>109</td>
<td>AAA</td>
</tr>
<tr>
<td>15-Year</td>
<td>4.750</td>
<td>3.7.2020</td>
<td>97.72</td>
<td>4.99</td>
<td>157</td>
<td>AAA</td>
</tr>
<tr>
<td>20-Year</td>
<td>5.000</td>
<td>3.7.2025</td>
<td>101.72</td>
<td>4.85</td>
<td>217</td>
<td>AAA</td>
</tr>
<tr>
<td>30-Year</td>
<td>4.250</td>
<td>3.7.2036</td>
<td>95.04</td>
<td>4.56</td>
<td>349</td>
<td>AAA</td>
</tr>
</tbody>
</table>

Source: Bloomberg and own calculations

In Table 6 we have cited only a sample from the entire supply, again. In Figure 10 the yield curve is shown and downward slope can be seen which implies that the investors’ expectations and general opinion is that the current interest rates are too high and in the long
run they expect them to fall. Another fact is that the interest rates in the U.K. will later approximate much more the interest rates level in the EMU, influenced by the monetary policy of the European central bank.

**Figure 10: U.K. government bonds yield curve to the date 5/11/2007 (MID quotations)**

![Yield Curve Diagram]

*Source: Bloomberg and own calculations*

### 6.1.6 Comparison of the yield curves

Particular yield curves provide intriguing information about yields and expectations of local markets. In order to figure out where are the highest expected returns we will compare the curves at one diagram and add some comments on it later on. At this point we want to stress that we still disregard currency rate effects, so that expected returns are examined just with the yield curves analysis. However, the currency rate risk component will be inspected later in the paper as well.

For some readers, returns from examined government bonds are incomparable most of all due to different risk premiums in the countries. However, the only country in the list with slightly lower rating is Japan and condition of local public finance and financial sector qualities are definitely at least reconcilable to the other ones. Therefore, we will ignore risk premiums in the following analysis and we will match the yield curves directly without any modifications. The liquidity factor will be left out during the comparison of constructed yield curves as well, since the differences on particular markets are not that huge. Nevertheless, from perspective of the investor we will not omit the fact in sequent comments.
In Figure 11 we can see the different national yield curves of government bonds. Whilst yields of bonds with shortest maturity are strongly influenced by the local central banks policies and actual adjusting of basic interest rates, long-period yields are more strongly affected by investor’s expectations. Due to the fact that long-run expectations cannot vary significantly, long-period yields tend to converge.

How would the decision process of investor look like? He is looking for the bond with maturity (modified duration) equal to his investment horizon with maximum return. If our investor is in the quest for a bond with the highest yields within the time horizon up to 13 years, he would always invest in government bonds in the U.K., then U.S. and Germany. Then follow Swedish bonds and the last position occupy the government bonds of Japan with extremely low yields. In the longer investment horizon, namely for maturities longer than 18 years, American treasuries outperform bonds from U.K., third place goes still to German Bunds and since the Swedish government gave up to issue bonds with longer maturity than 13 years, the fourth position is occupied by Japanese bonds.

An integral part of the investment decision is liquidity. From previous discussions we know that bonds from less developed countries bear worse liquidity, and therefore most of the proceeds can disappear. In case of sale the loss accumulates and the investment turns out to be in “red figures.” This can be a reason why to prefer U.S. Treasuries even in the short run, since they bear excellent liquidity implied in the low bid-ask spread.

In the next part we will inquire the movements among the yield curves, scrutinized through the correlation analysis.
6.1.7 Correlation of the yield curves progress

The problem is that even though investor buys a bond with the same modified duration as his liabilities (and thus he immunizes movements of the value of his assets), the progress of the foreign yield curve is not the same as the home yield curve progress. Therefore, even in case of desired level of modified duration of investor’s assets and liabilities, his equity, meant in terms of wealth, might rebound differently due to the foreign yield curves expositions.

This problem is better displayed in the analysis of the correlations among particular yield curves. Since there is no evidence about the historical data of yields to maturity, which were used to construct particular national yield curves, we have decided to use swap interest rates, the reference rates indicating the current situation on the money market. Tables 7-9 show mutual correlations among 2-years, 5-years and 10-years swap interest rates figured from financial data regarding examined countries.67

To make sure the reader is familiar with a concept of swap interest rates we should explain the term as well. Swap interest rate is the rate at which the swap will occur for one of the parties entering into the swap agreement. These rates are quoted by the market and will be almost identical to the rate used for the swaps, minus any premiums added.68

**Tables 7, 8: Swap interest rates correlations**

<table>
<thead>
<tr>
<th>Period</th>
<th>SEK Swap 2Y</th>
<th>SEK Swap 5Y</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Pearson Correlation</td>
<td>Pearson Correlation</td>
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<tr>
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<tr>
<td>JPY Swap 2Y</td>
<td>Pearson Correlation</td>
<td>.325(**)</td>
</tr>
<tr>
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<tr>
<td>USD Swap 2Y</td>
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<td>GBP Swap 2Y</td>
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</tr>
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<td></td>
<td>N</td>
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</tr>
<tr>
<td>SEK Swap 5Y</td>
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</tr>
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<td>Sig. (2-tailed)</td>
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<td>JPY Swap 5Y</td>
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<td>Sig. (2-tailed)</td>
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</tr>
<tr>
<td>USD Swap 5Y</td>
<td>Pearson Correlation</td>
<td>.912(**)</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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</tr>
<tr>
<td></td>
<td>N</td>
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</tr>
<tr>
<td>EUR Swap 5Y</td>
<td>Pearson Correlation</td>
<td>.810(**)</td>
</tr>
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<td>Sig. (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>2608</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)**

67 Swap interest rates are used due to their characteristics and relevance, as the most convenient indicator for construction of the yield curve in the period longer than 1 year (check out the section 4.1.2.4. dealing with the yield curves and their construction).

Source: Correlations are calculated from the Thomson daily data during the period 5/16/1997 – 5/15/2007. Figure in the bracket indicates significance level on that the hypothesis about zero correlation can be rejected.

Tables 9: Swap interest rates correlations

<table>
<thead>
<tr>
<th></th>
<th>SEK Swap 10Y</th>
</tr>
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<tbody>
<tr>
<td>SEK Swap 10Y</td>
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<td></td>
<td>Sig. (2-tailed)</td>
</tr>
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<td></td>
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<td>N</td>
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<tr>
<td>JPY Swap 10Y</td>
<td>Pearson Correlation .401(**)</td>
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<td>Pearson Correlation .956(**)</td>
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<td>N</td>
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<tr>
<td>GBP Swap 10Y</td>
<td>Pearson Correlation .865(**)</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) .000</td>
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<tr>
<td></td>
<td>N</td>
</tr>
</tbody>
</table>

Table 10: Correlation among Swedish swap rates

<table>
<thead>
<tr>
<th></th>
<th>SEK Swap 2Y</th>
<th>SEK Swap 5Y</th>
<th>SEK Swap 10Y</th>
</tr>
</thead>
<tbody>
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<td>.914(**)</td>
</tr>
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<td></td>
<td>Sig. (2-tailed) .000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>2608</td>
<td>2608</td>
</tr>
<tr>
<td>SEK Swap 5Y</td>
<td>Pearson Correlation .970(**)</td>
<td>1</td>
<td>.981(**)</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) .000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>2608</td>
<td>2608</td>
</tr>
<tr>
<td>SEK Swap 10Y</td>
<td>Pearson Correlation .914(**)</td>
<td>.981(**)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) .000</td>
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<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>2608</td>
<td>2608</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)**

Source: Correlations are calculated from the Thomson daily data during the period 5/16/1997 – 5/15/2007. Figure in the bracket indicates significance level on that the hypothesis about zero correlation can be rejected.

Tables digestedly endorse the fact that individual yield curves denominated in different currencies are not hundred-percent correlated. Therefore the value of assets and liabilities may draw apart in a case that part of the investors resources are invested on foreign yield curve.
Calculated correlations signify very strong correlation of Swedish swap interest rates especially with British and German swap interest rates. Much lower correlations are visible in case of other countries, which is given mainly by different development of financial markets in recent years. We can also see that the 10 years correlations are much stronger than 2 years. From the attached figures we came to a very interesting conclusion. After the analysis based on detailed inspection of provided data we claim that yield curves in the long run move more strongly together and therefore the risk of divergent progress of the bonds value substantially decreases. This indicates that longer period interest rates are really less influenced by the actual monetary policies of central banks, which may differ. If we have a look on the long run volatilities of particular swap rates, we would find out that volatility of short term interest rates are higher than long term rates, again. That confirms the fact the longer yield curves are influenced strongly by the investors expectations which do not change every day and are more subject to long period trends. Short term rates are on the contrary exposed much more to short external shocks having effect on the economy and analyses of central banks and financial institutions.

However, we will not deal with the volatility of the yields any more, since the topic of the study is the research of investor’s behaviour who seeks for highest possible yield in given moment and who aims to immunize against future fluctuations of interest rates.

Other interesting information is very strong correlations between Swedish swap interest rates with different maturities among themselves. This is displayed in Table 10. The outcome more or less confirms the conclusion from the previous part. Hence there is strong track about the influence of monetary policy of central bank and stronger relationship between the swap curves in longer run.

On the other side, our investor is also motivated by another factor. It is the diversification of his portfolio. From this perspective he might be interested in yield curves bearing the lowest correlation and satisfactory level of return at the same time. Thus, since the Japanese yields are really extremely low, he might shift his concern on the yield curves of USA and U.K. However, in the longer run he can consider Japanese bonds as well.

At this point conclusion from the executed analysis can be made. Due to relatively strong correlation between yield curves increasing with time to maturity, the risk of different progress of yield curves decreases. Consequently the probability of distinct development of investor’s assets value decreases as well even if he invests in foreign yield curve. This risk is still present, though. However the risk can be viewed from the opposite side as our investor is looking abroad due to his increasing utility from the international diversification.

As the reader might have anticipated relationships among the yield curves cannot be appraised without the knowledge of the investor’s actual needs and preferences. However, there is still something missing. Investor shouldn’t forget the currency rate risk. In case of e.g. foreign currency investments in shares the issue is not that epochal. Currency rates and share prices movements are not significantly correlated and then the entire risk of investment grows slightly (both the risks are additive).  

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69 Stock prices and currency rates: Are they related? Evidence from South Asian countries, Naeem Muhammad, Abdul Rasheed, Section “Previous empirical studies”, p.4.
Unfortunately during investments in bonds investors seek for guaranteed yield for a certain period. However, if we add to the foreign bond “performance” of the currency rate, the yield becomes very unstable for each period and total yield can be very different from the promised one. In the following chapter we will have a closer look how to approach this kind of risk, if its worth to undergo it and what are the possibilities of its elimination. At this stage, let’s move to the second part of the empirical analysis taking into consideration the currency rate risk.

6.2 Incorporation of the currency rate risk

What can cause the movements of the currency rates during the possession of a bond? Change in the currency rate can bring about considerable changes to the contracted proceeds in both a positive and a negative way. Let’s outline a practical example, using imaginary numbers and conditions. An investor can buy a ten year coupon bond with 4,75% yield to maturity in the U.S comparing to the 4% yield to maturity ten year Swedish government bond with comparable characteristics. However, in case of the dollar depreciation against the Swedish Kronor of more than 0,75% annually on average the final yield from the American bond will be lower. Naturally this risk might have effect also on the other subject of contract and then increase requested contracted yield.

6.2.1 Foreign currency bond as the portfolio of two assets

When an investor makes the decision about the investment in a foreign currency bond, he is taking on the currency rate risk as well. Primary reason for investing in fixed income securities is assuring contracted yield for the certain period. We will not take into consideration speculative reasons for buying the bonds, where speculators, in case of foreign currency bonds, are seeking to estimate the movements of the foreign yield curve and currency rate.

Traditional long period investor is looking for the instrument, which secures his liabilities. We will treat this approach in following parts. However, the most common motivation is to go long in instruments with the same modified duration as the liabilities of the investor. Reasons to go “long” in foreign currency bonds will be mentioned later in the paper.

Foreign currency bond can be divided from the local investors’ point of view into two “assets” with different features. The first “asset” is a bond with the yield given by the foreign yield curve, which represents first risk exposure for our investor. The second “asset” is the net investment in foreign currency. What are the features of the portfolio set from these two “assets”? In the previous chapter we have already concentrated on the relationships among examined yield curves. Now let’s cover the issue of foreign currency as the second component of foreign government bonds.

6.2.1.1 Risk-return profile of the foreign currency

From the discussions in the theoretical part and previous paragraphs dealing with yield curves analysis we can follow that the estimation of the future currency rates and their yields is one
Empirical investigation of the most complicated tasks in the capital markets. As the most logically feasible theory for our research purposes was chosen the random walk - efficient market approach, described more detailed in section 3.3.1. When the individual is using this approach he might know immediately what expected yield the foreign currency as an asset can bring. It’s a zero yield, since the expected currency rate is supposed to equal the current spot rate. On the other hand the risk of the foreign currency as the asset does not equal zero. Of course, the currency rates have their volatility, which causes insecurity about the real future rates. Table 11 represents the volatility of the Swedish Krona with particular currencies related to the topic of the paper.

<table>
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<tr>
<th>Currency</th>
<th>Actual spot rate</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Volatility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUR/SEK</td>
<td>9,1865</td>
<td>8,95</td>
<td>9,60</td>
<td>9,1970</td>
<td>10,711</td>
</tr>
<tr>
<td>GBP/SEK</td>
<td>13,4125</td>
<td>12,73</td>
<td>14,22</td>
<td>13,4642</td>
<td>26,936</td>
</tr>
<tr>
<td>JPY100/SEK</td>
<td>5,61</td>
<td>5,61</td>
<td>7,33</td>
<td>6,6471</td>
<td>18,398</td>
</tr>
<tr>
<td>USD/SEK</td>
<td>6,7525</td>
<td>6,62</td>
<td>8,69</td>
<td>7,5140</td>
<td>30,399</td>
</tr>
</tbody>
</table>

Source: Volatilities are calculated from Riksbank official websites; weekly data from the period 1/1/2003 – 5/16/2007. Volatilities of particular currency rates are annualised.

The volatility of the currency rates determines the latitude of foreign currency risk exposure. From the interval estimations we concluded there is a 99% probability that the movements of annual foreign currency rates should belong to the interval ±1% of standard deviation. From the figures of the annualised volatility we can see, that the standard deviation during the period can easily reach the value of 10% and more, which could more than sufficiently delete the proceeds from the fixed income security.

Arguments mentioned above will then strongly devaluate the asset, because investment in the asset with potentially zero yield and simultaneously bearing high volatility, representing the risk of the asset, would be very irrational.

Table 11 provides a very interesting insight to the issue. The lowest volatility embodies the currency rate of Swedish Krona with its biggest business partners; namely Germany (or European Union countries which already introduced Euro). Maybe a little suprisingly, the highest volatility, and therefore highest risk bear investments in assets denominated in the USD. The value for annualised volatility vaulted over the boundary of 30%.

### 6.2.1.2 Foreign currency as the asset in the portfolio

One reason for the investment in a foreign currency as an asset exists, though. It is the diversification of a portfolio. The majority of the research confirmed very low correlations between the currency rates evolvement and yields of the assets. In spite of zero potential yield of the foreign currency and certain level of risk, it should be included in the investor’s portfolios. Reasons are clearly visible in Figure 12.
As long as the investor possesses the asset A with particular yield and risk, he can improve some features of it with adding a new asset and so as to actually create a portfolio with better characteristics than the initial asset. A little bizarre, but fortunately true is it also in case of adding the asset with zero yield and higher risk (point B). The only condition is, however, very low correlation with the yields of asset A. In this case then increasing the proportion of asset B up to the certain point C, leads to decrease in the yield of the portfolio, but also decrease in the level of risk. Then it has arisen a new efficient frontier extending the investors’ opportunity.

Main reason for the investors to put their money into the foreign currencies serving as the accessory asset is then its ability of diversification.

6.2.1.3 Foreign currency bond as the two-asset portfolio

The previous parts of the thesis has been trying to analyse as well as outline the basic factors, determining the decision making of local investors to invest into foreign currency government bonds.

First of all we have analysed basic reasons investors face when looking abroad. During the analysis we still had been considering a rational investor, who is offsetting the balance of interest rate sensitive assets and liabilities to reduce the interest rates volatility on his wealth. That means the main reason is seeking for the required duration balance having simultaneously best possible yield, lowest possible risk and sound level of diversification.

When investors put their proceeds into local bonds, thus to the local yield curve, the risk approximates zero, since the assets and liabilities are exposed to the same factors. However, shortages on the supply site force investors to go internationally, due to the lack of investment opportunities in fixed income securities on the local market. With purchasing the foreign government bond investors go long in the foreign country yield curve, however, the risk does not grow that strongly, because in case investor is buying the bond with the same duration, the changes in the yield curve might not affect the value of foreign currency bond. From the above mentioned discoveries we figured the long term yield curves are very often positively correlated. This fact, again, decrease the risk of different development of the foreign bonds’ value from the local yield curves.
In case of foreign currency bonds, though, there is one more factor, and it is currency rate volatility. However, as the most accurate approach we have accepted the random walk model for the currency rates movements, where the future currency rate is driven by the current spot rate.

**Expected return**

What is the expected return and the risk of foreign currency bond? We will use the classic formula used for the two-asset portfolio.

\[ r' = W_1 \times r_{FI} + W_2 \times r_{ER} \]

, where \( w_1 \) and \( w_2 \) are weights of the assets in the portfolio. Here, in both cases, however, these weights equal 100%, therefore we can leave them out from the formula. \( r_{FI} \) and \( r_{ER} \) are the expected returns of the bond and expected gain from the currency rate development. According to our assumption, \( r_{ER} = 0 \), and therefore we can derive the relationship for the bond yield including the foreign currency rate as:

\[ r' = r_{FI} + r_{ER} = r_{FI} \]

**Risk of the foreign currency bond**

Similarly, we can analyse the expected risk of the investment. We will start with the formula for the two-asset portfolio, again, which follows as:

\[ \sigma^2 = W_1^2 \times \sigma_{FI}^2 + W_2^2 \times \sigma_{ER}^2 + W_1^* W_2^* R \times \sigma_{FI}^* \sigma_{ER}^* \]

, where \( \sigma_{FI} \) and \( \sigma_{ER} \) are risk and standard deviation of the bond yields and development of the currency rates and \( R \) is the correlation between the yields of both the assets. We can omit the weights again, for the same reason as in case of the expected returns:

\[ \sigma^2 = \sigma_{FI}^2 + \sigma_{ER}^2 + R \times \sigma_{FI}^* \sigma_{ER}^* \]

From the point of view of long-period investor, who is trying to balance his duration exposure, is the volatility of the bond yield irrelevant, and should not have any either positive or negative impact on his wealth. This allows us to presume \( \sigma_{FI} \) equals zero. Due to this fact we can presume to vanish the third part of the formula and we get the final formula for the risk:

\[ \sigma^2 = \sigma_{ER}^2 \]

And so,

\[ \sigma = \sigma_{ER} \]
If the expected return of the bond denominated either in the foreign or local currency, is its expected return depicted on the yield curve, and the risk is the volatility of the underlying currency. We can display this in Figure 13 as well.\textsuperscript{72}

**Figure 13: Portfolio of domestic and foreign currency bonds**

In the diagram, point A represents the local government bond, which we buy with the certain level of yield. The risk of the issuer as well as the liquidity risk is ignored. The currency rate risk equals zero, of course, since we also have our liabilities denominated in the local currency. Points B represent the foreign currency bonds bearing their expected return, however, comprising the currency rate risk represented by its volatility. In this case, all of them have the same currency rate risk. From the figure it is obviously visible, that rational investor should invest into bonds with highest yield and simultaneously bearing the lowest risk. That means all the bonds with its local yield under the yield of the domestic yield curve are dominated by the domestic bond. According to the previous analyses, investors should seek out for the fixed income securities with yields above the local yields (yield curve). Whole range of foreign currency bonds with yields underperforming domestic assets carry lower proceeds and moreover bear the currency rate risk implied by its volatility. Figure 14 indicates the real data mentioned above. Namely, yields of the bonds with maturity ten years and incident volatilities of currency rates.

**Figure 14: Actual risk and returns of government bonds (time to maturity 10 years)**

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\textsuperscript{72} Analýza portfolia cenných papírů, David Havlíček, (2007). p.12
When we neglect liquidity and credit premiums, for the bonds with maturity of ten years investors should always prefer bonds with highest return and lowest implied volatility. From the Figure 14 we can conclude that the end spot would be Swedish and British bonds. If investor does not accept any level of risk he will prefer domestic government bonds. On the other side the highest returns offer British government bonds. Between those two lie German “bunds” which are not dominated by either of previous cases, since they bear higher yield than Swedish and lower volatility than British government bonds.

As implied in the previous section covering the comparison of yield curves without considering the currency rate risk, and as we can see from Figure 11, for investments into bonds with longer maturities (in our case longer than 13, or more precisely 18 years), the situation looks differently. Due to the fact that Swedish government bonds do not reach maturities higher than 13 years and that U.S. Treasuries outperform (in respect of yields) bonds from U.K., the efficient frontier of the local investor has a completely different form. As an example we took the government bonds with a modified duration (time to maturity) of 25 years. The situation is depicted in Figure 15.

Figure 15: Actual risk and returns of government bonds (time to maturity 25 years)

A very strong argument against incorporation of foreign currency government bonds for the reasons of portfolio diversification can be uttered here. As a matter of fact the only consequence of this “diversification” is adding currency rate risk. Such a strategy (strategy of adding foreign currency bonds into investor’s portfolio) can be satisfactory for the investors looking for the over-return in abroad. Half-satisfied can be investors setting better the entire duration of portfolio, since duration exposure built from foreign currency bonds comprises the exposure to foreign yield curve which does not have to move in the same way as the local yield curve.
The entire strategy holds for the long-term investors investing in fixed income securities for different reasons (most commonly to cover their liabilities, as they promise certain level of return to their clients).

A completely other strategy would employ to short-term investors and especially speculators. They would look for the curves declining faster than domestic yield curve and currencies with potential to appreciate. However, our thesis is not concerned with these kinds of investments, so we will not inspect such strategies.

Nevertheless, we are still not at the end because investors very often seek to reduce the risk through hedging. Influence of hedging on an investment strategy of the investor is approached in the following part.

6.3 **Hedging – covering the currency rate risk**

6.3.1 **Efficient frontier in the course of hedging**

For our potential investor, there is still the possibility to get rid of the currency rate risk and to cover either entirely or partially the exposure towards the open position foreign currency government bond represents. As mentioned in the theoretical part in section 3.4.3, hedging a particular currency exposure means establishing an offsetting currency position such that whatever is lost or gained on the original currency exposure is exactly offset by a corresponding foreign exchange gain or loss on the currency hedge. In our study we do not take into consideration the hedging costs, which are incorporated in the real world. However, for the purpose of the study we will neglect them.

In the previous parts of the paper we have already indicated the alternative of hedging against the negative currency rate movements. In case of portfolio risk there is not that many changes comparing to our previous discussions. As told before, after implementation of hedging strategy the portfolio volatility remains the same, however, only for that part of portfolio which is not hedged.

\[
\sigma = (1-w) * \sigma_{ER}
\]

When we have 100% hedging of the position, the risk is equal to zero and vice versa. To refresh our awareness about the issue lets refer one more time to theoretical part in section 3.4.3., where we have indicated, that the whole situation can be depicted on the graph, which in general provides the investor with the variety of investment decisions from between the points A and B. In the direction towards point A the ratio of hedging position in the entire investment in the foreign currency bond increases.

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The option of hedging has of course the impact on our investor as well. Under given assumptions his efficient frontier now entails the line between the Swedish and the British government bonds. From the investment opportunities dropped out the German “bunds”, since there exists a combination of British government bonds with certain level of currency hedging bearing same level of risk and higher return. In the extreme case we can also consider to open the entirely opposite position, without the foreign government bond. Such a combination would contain the combination of Swedish government bonds and open position in the forward contracts in the British pound, which would modify the aggregate position related to both the risk and return in the theoretically same scope. 

Figure 17 shows that with the existence of a hedging possibility the efficient frontier is now represented by the line between the Swedish and the British government bonds. Then it is up to the investor to which extend he is willing to accept the risk associated with the foreign

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currency denominated asset investment and how many percent of such a position he wants to hedge. This depends on his risk aversion and expected return.

An interesting fact is that all the potential positions among examined government bonds cross each other in the point representing the domestic bond. The interest rate differential on the foreign currency government bond is during the 100% hedging fully neutralized by the interest rate differential imputed in the hedging tool of the currency rate. The previous sentence states that fully hedged foreign government bonds are always comparable with domestic bonds. This feature can be used by our investor during diversification of his portfolio or during governing the portfolio duration.

However, this option of choice or hedging itself bears its costs, which we haven’t stressed yet, represented by costs of hedging. Intermediaries on financial markets provide hedging services for inconsiderable charges connected with such operations, and thus our investor might be aware of the hedging costs as well. In our study we do not take into consideration the hedging costs, though, so the previous discussion is not an issue. Last, but not least, the discussion above still presumes the same risk premiums in particular countries.

We want to mention one more, very special way of hedging; hedging through foreign currency, which is strongly correlated with the local currency rate. In the real world it can easily happen that local currency rate is not liquid enough or is not traded, so as the swap market offers either none or very expensive ways of hedging the foreign currency exposure. Then, in currency rate swaps is used another currency than the one which is foreign government bond denominated in. This currency is supposed to have high correlation with particular foreign currency. Costs of such a position might be much lower and potential impact of currency rate movements should be conformable. As a matter of interest we attach the table of correlations between the Swedish Krona and a selected basket of foreign currencies, which is shown in Table 12.

<table>
<thead>
<tr>
<th></th>
<th>EUR/SEK</th>
<th>GBP/SEK</th>
<th>JPY100/SEK</th>
<th>USD/SEK</th>
</tr>
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<tr>
<td>EUR/SEK</td>
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<td></td>
</tr>
<tr>
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<td>,358(**)</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<td></td>
</tr>
<tr>
<td>N</td>
<td>227</td>
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</tr>
<tr>
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<tr>
<td>Correlation</td>
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** Correlation is significant at the 0.01 level (2-tailed).

Source: Correlations are calculated from Riksbank official websites; weekly data from the period 1/1/2003 – 5/16/2007.
The highest correlation of the currency rates movements is among the currencies of the geographically closest countries; Germany and Great Britain. It reaches the level of 0.706, which can be interpreted that 70% of movements of SEK/EUR currency rate is identical with the movements towards SEK/GBP. As a consequence, if it would be too expensive to hedge in British pound, we can hedge our open position through Euro, which is closest to the currency rate movements of SEK/GBP.

6.4 Evaluation

From the above presented findings it is obvious that the currency rate risk issue has to be covered. Each investor should deal with it, evaluate it and integrate it into his analysis. In the first part of the chapter we have been dealing with the entire currency rate risk embodied into foreign government bonds. The resulting points on the efficient frontier were bonds bearing highest return given certain level of risk (caused by the currency component). From the real data (May 2007) the optimum investment for bonds with maturities around ten years are apart from Swedish ones government bonds from Germany and United Kingdom. The domestic bonds will always be the part of efficient frontier since they comprise zero risk. As a consequence they are never dominated by the foreign government bonds always bearing a certain level of foreign currency risk. However, the situation differs for bonds with maturity longer than 18 years. Due to the fact that Swedish government bonds do not reach maturities higher than 13 years and that U.S. Treasuries outperform bonds from the U.K. in the long run, the efficient frontier of the local investor has a completely different form. As an example we have examined government bonds with a modified duration (time to maturity) of 25 years. In this case the investor’s efficient frontier would consist of government bonds from Germany, U.K. and USA, depending on the investor’s attitude to risk.

With the previous paragraph we have actually answered the second research question, which asked: “Which national government bonds lie on the efficient frontier of local investors?”

The last section of the paper raised an issue of hedging the foreign currency risk imputed by foreign government bonds. For the investor looking for the fixed income securities this type of risk is substantial with regard to level of over-return foreign government bonds can bring or to other reasons he enters the international market. Thus the investor often decides to hedge his position in a decent scale.

In case of incorporation of the hedging strategy the domestic bond is part of the efficient frontier represented by a straight line, again. However, just in case that such a domestic bond with requested maturity exists. This straight line connects the foreign currency bond bearing the relatively highest return on the unit of risk (i.e. the straight line is as much steep as possible). In the current situation it was the line between the points representing the Swedish and the British government bonds.

At the origin, i.e. at the point with zero risk and hence when investing into domestic instrument we have many more possibilities, though. At this point of an efficient frontier we can use, instead of Swedish bond whichever 100% hedged foreign government bond.
Moreover, it does not have to be necessarily a security from our efficient frontier, but other securities as well. As a consequence, when using 100% hedging we can use whichever security on the market. The cost of such an approach is the price of hedging which we have neglected, and the advantage is the option of diversification and searched duration within the global supply of government bonds.

This point in Figure 17 is haunted by the investors not necessarily looking for the over-return. These investors want to diversify issuers of bonds in their portfolios without any currency rate risk and search for particular durations (e.g. extremely long). Then it totally pays off to fully hedge the foreign currency exposure. In this case he can use all the national government bonds, since the interest rate (yield) differential is fully offset by currency hedging and the consequent yield is the same as for the domestic bond (of course, we still assume no risk premiums).

At the end we can conclude that investment in domestic bonds in case they exist is advantageous for certain groups of investors since the point they are represented by lies on the efficient frontier, and thus the whole strategy of incorporation of foreign assets depends just on investor’s attitude towards the risk.
7 Conclusion

Our Master thesis set the goal to inspect the attraction of foreign government bonds compared to Swedish government bonds from the perspective of the local investors.

In the first part we have provided the reader with the introduction and research consideration and moved to another part containing a sound theoretical background for our following empirical analysis. We tried to indicate first our point of view on different variables, give the reader basic, however sufficient background concerning statistics, portfolio theory and approach on currency rate theories which were later applied in the empirical investigation. We slightly moved to a following part describing bonds as an investment tool, bearing different features the investor might be interested in, and we have inspected the Swedish market for the government bonds from both the sides of the demand and supply. We may say that there is undoubtedly huge evidence about the discrepancy in the demand and supply for the foreign government bonds on the Swedish market, which forces investors to look abroad. Especially local pension funds and insurance companies, which are forced to manage their portfolio duration due to the interest rate risk exposure seem to be the strongest actors on the demand side for foreign government bonds with longer maturities (durations). From the ascertained facts we have also defined our investor and his behaviour for the following empirical analysis.

With the inspection of the Swedish market for government bonds we have partially answered the question of foreign government bonds attraction, since there is a strong evidence about the reasons for local investors to look for the government bonds abroad. Another reasons were raised in the section of discussing the pros and the cons of such a strategy (strategy of investing abroad), and we gradually moved to the empirical investigation part, where we examined stated reasons.

At first we analysed expected returns. We have constructed the yield curves through the inspection of yield to maturities on particular government bonds markets and compared them all together. At the end we came into conclusion that from the perspective of returns as the most lucrative bonds in the middle-run seem to be government bonds issued in the U.K., however, in the longer run (more than 18 years) the British government bonds are outperformed by U.S. Treasuries. In the following analysis we have examined the yield curves correlations to see how the diversification issue should be handled. After the analysis based on detailed inspection of provided data we claim that yield curves in the long run move more strongly together and therefore the risk of divergent progress of the bonds value substantially decreases, however the opportunity for efficient diversification decreases as well.

Nevertheless we continued in the analysis and we have incorporated the currency rate risk to our analysis, which has been conducted under the general assumption that the investor has adopted long term investment strategy, arising from the assumptions accepted before. We have applied the concept of the portfolio theory and we have desintegrated foreign government bond on two assets. Then it was necessary to figure out the expected return of the bond and its volatility. As the most right concept for the currency rate estimation we have accepted the concept of the random walk which does not expect any yield from the movements of the currency rates (actual spot rate is the best basis for the future rates expectations). For all the government bonds we have calculated its expected returns and implied volatility and compared them on the suitable scheme.
From the above presented findings it is obvious that the currency rate risk issue has to be covered. Each investor should deal with it, evaluate it and integrate it into his analysis. The last section of the paper raised the issue of hedging the foreign currency risk imputed in foreign government bonds.

After the incorporation the hedging strategy domestic bond is part of the efficient frontier represented by a straight line, however, just in case that such a domestic bond with requested maturity exists. This straight line connects foreign currency bonds bearing relatively highest return on the unit of risk (i.e. the straight line is as steep as possible). In the current situation it was the line between points representing Swedish and British government bonds. In the longer run it would be the line from the origin towards German bunds. Under given circumstances these options dominate all the others.

An interesting thing is that the efficient frontier includes whichever 100% hedged foreign government bond. Moreover, it does not have to be necessarily a security from the efficient frontier from previous part, but other securities as well. As a consequence, when using 100% hedging we can use whichever security on the market. The cost of such an approach is the price of hedging, and the advantage is the option of diversification and searched duration within the global supply of government bonds.

In fine we can conclude that investment in foreign government bonds makes sense for group of investors as we have defined them before the empirical investigation. Since the points foreign government bonds are represented by lie on the efficient frontier, the whole strategy of incorporation the foreign government bonds is advantageous and depends just on investor’s attitude towards the risk and return. Therefore the answer on the third research question set as: “What investment strategy, considering given assumptions and circumstances, do we recommend the local investors to follow?” is: Enter the long position in foreign government bonds based on the current needs to cover interest rate risk exposure and apply reasonable hedging strategy using instruments offered by the financial markets. As a base for this conclusion we submitted the study helping the investors to orientate in intricate world of global financial market.
8 Suggestions for further research

We strongly believe we have fulfilled the aimed purpose of the study and answered all the research questions we have set. This paper can be employed as the sound base for consecutive research conducted either by university students, independent researchers or general public. The issue of the attraction of global market for government bonds is still undetected, and the approach of the perspective of local investors encourage researchers to try to reveal the topic more into the deep.

Presented paper by far did not intend to provide a reader with comprehensive investment analysis, which some readers might be interested in. However, stated findings imply another investigation, since our research was based on very strong assumptions presented during the study. First of all more detailed analysis of the local market for government bonds might reveal another reasons why should local investors consider international government bond markets. Consequently, the assumption of zero risk premiums on the examined markets has influenced the entire construction of the yield curves. Therefore the incorporation of the risk premiums would be interesting to question. And since we have not taken into consideration speculative investors, the study is limited from this perspective as well. However, we do not deny their presence on the global market and therefore following analysis might comprise their impact on the government bond markets and consequently the investor’s behaviour as well.
9 Truth criteria

The last chapter of our study comprises a scientific relevance measured by the research quality of the paper. Therefore a discussion on the various factors having an impact on these measurements take place in following paragraphs.

9.1 Reliability

The data we have found, which were considered to be relevant and which have been used along the study come from the huge databases of most reputable providers of financial information in the world. Among all we want to mention one more time Datastream provided by Thomson company, Bloomberg, finance.Yahoo!, the OMX Nordic Exchange Group database and various websites of Swedish authorities, or, to be more precise their databases. In order to be provided with sufficient information we had to write countless numbers of emails to get the data we have eventually applied.

During the research we have carried out the formulas entirely mentioned in the theoretical framework. Later, they have been employed through the software Umeå University disposes. Most frequently we have applied SPSS and Microsoft Excel which we strongly believe are reliable enough to conduct the empirical analysis of examined data.

9.2 Replication

Since we have provided all the descriptions of a research process during elaboration of the thesis, replication criteria is fulfilled without any doubts. Along the paper we have described our research approach, research methodologies, provide the reader with the description of applied theory, adopted assumptions, data collection and formulas employed within the empirical investigation as well as the course of the empirical analysis itself. Therefore we believe our study can be replicated by other researchers at any circumstances.

Our research approach, employed especially during the empirical analysis straightly provoke to another studies. It is also necessary to mention that all the data we have used are free to general public and therefore there is no constraint concerning the conduction of similar, or related research.

9.3 Validity

Validity of the study is stated as the absence of systematical errors in the measurement and comprises two major variants; internal and external validity. Internal validity relates mainly the issue of causality, determines if the research covers the intended objective and among others raises the question: *Can we be sure that magnitude of consequences and perceived social consensus really do cause variation in moral awareness?*\(^\text{75}\) We believe that the data analysis we have applied and which was backed with a sound theoretical framework

presented in incident section go hand in hand with the demands of the criteria. Consequently, providing the definitions and assumptions we have used along the paper, the link between intended objective and conducted research is apparent.

External validity concerns the question of whether the results of a study can be generalised beyond specific research context, or, in other words it determines how well the measurements reflect the actual reality. It is one of the main reasons why researchers applying quantitative methodology hunger to generate representative samples. From this perspective we cannot say that we feel that strong in this perspective, since our approach is limited to certain level of conditions, which are not necessarily reflecting the true situation on the market. However, given assumptions haven’t destructed practical employment of our model situation. It just covers pre-specified range of the reality, which comprises many more factors driving the process we have examined.

---

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## Appendix: Swap interest rates correlations

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**Correlation is significant at the 0.01 level (2-tailed)**

Source: Correlations are calculated from the Thomson daily data during the period 5/16/1997 – 5/15/2007. Figure in the bracket indicates significance level on that the hypothesis about zero correlation can be rejected.