Exchange Rate Risk
From a Portfolio Investors Point of View

Master thesis within: Financial Economics
Authors: Erik Stålstedt
Head supervisor: Åke E. Andersson
Deputy supervisor: Sara Johansson
Jönköping: 2006-06-20
Master Thesis in Financial Economics

Title: Exchange Rate Risk – From a Portfolio Investor’s Point of View

Author: Erik Stålstedt

Tutors: Åke E. Andersson, Sara Johansson

Date: 2006-06-20

Subject terms: Portfolio, Risk & Return, Exchange Rates, Currency Risk, Purchasing Power Parity, Interest Rate Parity

Abstract

Due to globalization investors have increasing opportunities to invest on international markets for diversification purposes. This thesis illustrates the added risks of investing internationally due to volatile exchange rates. The purpose is to analyze how a volatile exchange rate affect the risk and return of a portfolio invested in Sweden, when the investor is located in Japan, United Kingdom or the USA.

To analyze the effect of exchange rate volatility the focus is on a portfolio consisting of Swedish stocks from the Stockholm Stock Exchange (SSE) O-list. First the risk and return to a hypothetical Swedish investor not exposed to exchange rate volatility is calculated. Then the effects the exchange rates had on the risk and return if a US investor, UK investor and a Japanese investor invested in the same portfolio is analyzed.

For the historical period 2005 the portfolio generated a return of 34.36% and a risk of 7.7%. The empirical work showed that for the international investors the risk was increased with between 1.95% – 410.52% and that the actual return decreased due to weakening currencies against the Krona.

In an attempt to predict future exchange rate movements the thesis analyses two financial relationships, PPP and IRP, to calculate equilibrium movements. Both PPP and IRP predicted a depreciation of the Dollar and Pound Sterling against the Krona over the next period, but an appreciation of the Yen against the Krona over the same period.

The analytical discussion covers the importance of a well functioning financial system, the institutional effects on exchange rates and the confidence in government policies and their ability to succeed in doing what has been promised.
Magisteruppsats Inom Finansiell Ekonomi

Titel: Exchange Rate Risk – From a Portfolio Investor's Point of View

Författare: Erik Stålstedt

Handledare: Åke E. Andersson, Sara Johansson

Datum: 2006-06-20


Sammanfattning

Tack vare globaliseringen har investerare ökade möjligheter att investera på internationella marknader i syftet att diversifiera sin portfölj. Den här uppsatsen belyser de ökade riskerna med att just investera internationellt på grund av växelkursrisken. Syftet är att analysera hur en volatil växelkurs påverkar risken och avkastningen på en portfölj investerad i Sverige av investerare lokalisera i Japan, Storbritannien och USA.

För att kunna analysera effekterna av en volatil växelkurs så ligger fokus på en portfölj bestående av svenska aktier från Stockholmsbörsens O-lista. Först så beräknas risk och avkastning till en hypotetisk Svensk investerare som inte är utsatt för växelkurssvängningar. Sedan analyseras de effekter växelkursen hade på samma portfölj för en amerikanska investerare, brittisk investerare och en japansk investerare.

För den historiska perioden 2005 så genererade portföljen en avkastning på 34,36% och en risk på 7,7%. Det empiriska arbetet visade att för de internationella investerarna så ökade risken med mellan 1,95% - 410,52% och att den faktiska avkastningen sjönk på grund av en dyrare krona.

I ett försök att förutspå framtida växelkurssvängningar så analyseras två finansiella förhållanden, PPP och IRP, för att beräkna jämviktsrörelser. Både PPP och IRP förutspädde en depreciering av Dollarn och Pundet mot Kronan över nästkommande period men en appreciering av Yenen mot Kronan över samma period.

Den analytiska diskussionen täcker vikten av ett väl fungerande finansiellt system, de institutionella effekterna på växelkursen och förtroendet i finanspolitiken och dess förmåga att hålla sina löften.
# Table of Contents

1  INTRODUCTION......................................................................................................................... 1
   1.1  BACKGROUND.......................................................................................................................... 1
   1.2  PROBLEM DEFINITION ............................................................................................................. 1
   1.3  PURPOSE.................................................................................................................................... 2
   1.4  METHOD & LIMITATIONS ......................................................................................................... 2
   1.5  OUTLINE................................................................................................................................... 2

2  THEORETICAL FRAMEWORK....................................................................................................... 3
   2.1  PORTFOLIO THEORY ............................................................................................................... 3
   2.2  THE ELEMENT OF RISK ........................................................................................................... 4
   2.3  EXCHANGE RATES ................................................................................................................... 6
   2.4  HEDGING STRATEGIES ............................................................................................................ 9
       2.4.1  Option contracts .................................................................................................................. 9
       2.4.2  Futures and Forwards ......................................................................................................... 9

3  EMPIRICAL ANALYSIS ................................................................................................................ 11
   3.1  PORTFOLIO CALCULATIONS .................................................................................................. 11
   3.2  ADDING EXCHANGE VOLATILITY ......................................................................................... 13

4  ECONOMIC FORECASTING ....................................................................................................... 15
   4.1  PORTFOLIO FORECASTING ................................................................................................... 15
   4.2  EXCHANGE RATE FORECASTING .......................................................................................... 17

5  ANALYSIS .................................................................................................................................. 20

6  CONCLUSION AND FURTHER RESEARCH ............................................................................. 28

REFERENCES ................................................................................................................................. 30
Figures

Figure 1 - The optimal portfolio given a feasible set (Sharpe, Alexander & Bailey, 1999) ........ 4
Figure 2 - Risk and Diversification (Sharpe, Alexander & Bailey, 1999) ......................... 5
Figure 3 - Supply & Demand of Foreign Currency (Copeland, 2005) ................................... 7
Figure 4 - Portfolio & Security Performance (Stockholm Stock Exchange, 2005) ............ 12
Figure 5 - Exchange Rate Volatility ........................................ 21
Figure 6 - Japanese Interest Rates .................................................................................. 21
Figure 7 - US Interest Rates ........................................................................................ 23
Figure 8 - UK Interest Rates ......................................................................................... 24

Tables

Table 1 - The APT Model and its Variables ........................................................................ 11
Table 2 - Portfolio & Security Performance ....................................................................... 12
Table 3 - Security Correlations ....................................................................................... 13
Table 4 - Currency Risk Contribution .............................................................................. 14
Table 5 - Risk & Return with respect to Exchange Rates .................................................. 14
Table 6 - Global Industry Classification System (GICS) .................................................... 15
Table 7 - Model Explanation ........................................................................................... 16
Table 8 - Calculated Expected Forward Exchange Rate (Using IRP) ................................. 18
Table 9 - Interest Rates (2006-01) .................................................................................. 18
Table 10 - Calculated Expected Forward Exchange Rates (Using PPP) ......................... 19
Table 11 - Interval of Future Exchange Rate .................................................................... 19

Appendix

Appendix A – Statistical Findings
Appendix B – Graphs & Tables

Equations

Equation 1 - The Arbitrage Pricing Model
Equation 2 - Portfolio Risk
Equation 3 - Currency Risk Contribution
Equation 4 - The APT Regression Model
Equation 5 - Interest Rate Party Condition
Equation 6 - Purchasing Power Parity Condition
1 Introduction

In 1974 Bruno Solnik published an article titled “Why not diversify internationally rather than domestically?” The idea of international investments had not yet become a natural strategy for institutional investors. For example, U.S. pension funds had never invested outside of the U.S. In Europe the picture was different. Due to the small size of most countries it was natural (and necessary) for private investors, as well as banks, to invest internationally. But still, the absence of large institutional investors was considerable (Dumas & Solnik, 2003).

Today, thirty years later, the pattern looks totally different. With a strong tendency of globalization the investment scene has changed dramatically.

1.1 Background

Due to globalization, international investment opportunities have opened up a large variety of choices for portfolio diversification, investment hedging and international corporate and private opportunities.

One effect that must be considered when investing internationally is that the investor encounters a new range of risks that one does not encounter domestically. These could be the confidence in a foreign government, the volatility of a foreign exchange rate or rules and regulations concerning the possibilities to investment in certain regions.

If an investor can master the analyses of insecurities the possibilities to diversify its portfolio increases due to the fact that international markets behave differently and a low correlation implies a reduced volatility of the global portfolio.

1.2 Problem Definition

Considering the exchange rate risk that an investor encounters when investing internationally, it is obvious that the volatility of an exchange rate affects the expected returns of an investment. Simply put, a return on an investment by 15% is directly offset by a depreciation of the home currency with 15% against the currency in the country where you have invested. On the other hand an appreciation of the home currency increases your return on the investment. Consequently, a volatile exchange rate increases the volatility of an internationally invested portfolio.

Earlier research has shown that a volatile exchange rate add somewhere between 15% – 100% on the initial risk of a portfolio investment (Sharpe, Alexander & Bailey, 1999).

How does a volatile exchange rate affect the risk and return of a portfolio invested in Sweden if the investor is located in Japan, United Kingdom or the USA?
1.3 Purpose
The purpose of this thesis is to analyse the impact of exchange rate volatility on portfolio investments in Sweden. The focus will be on three investors with three different home currencies. The three exchange rates this thesis is focusing on are SEK/USD, SEK/GBP and SEK/YEN. The scenario is an investor who from his home country invests in a Swedish portfolio and then has to convert the profits to the home currency at the prevailing spot rate at this time. From this it is possible to calculate the risk added and the effect on return from the volatility of the exchange.

1.4 Method & Limitations
To find an answer to this problem the focus must concern international portfolio theory, historical currency correlations and exchange rate forecasting. All these three aspects will be covered in the thesis. First of all the concept of portfolio theory will be covered, both from a domestic perspective as well as an international one.

In order to make any assumptions about the exchange rates and their contribution to the risk and return of the portfolio, calculations of correlations between currencies and the correlation between exchange rate volatility and portfolio performance must be made. The focus here will be on historical relationships and the possibility to make economic forecasts concerning the exchange rates.

The time frame considered in this thesis regarding all historical data is daily data between 2005-01-03 – 2005-12-30. The paper analyses a portfolio and its performance during 2005 and adds exchange rate volatility to the equation to establish the impact of exchange rate volatility. Further a discussion about economic forecasting will be presented to be able to use our newly gained knowledge on future portfolio investments.

1.5 Outline
The definition of risk in portfolio investments and exchange rate theory and facts are presented in the second chapter. In chapter three the necessary empirical work of this thesis is presented together with some statistical notations and econometric regressions. In chapter four the concept of economic forecasting is used to explain how the findings in chapter three can be used for future investment analysis. Chapter five presents the analysis of what has been found in the earlier stages of the thesis. In chapter six the work of this thesis is concluded and some further interesting and related fields of studies are suggested.
This chapter presents the theoretical foundation needed to analyse the problem of international portfolio investments, exchange rate volatility and the element of risk. The difference in risky element between domestic and international investments will be the focus of this chapter.

2 Theoretical Framework

Given the purpose of this thesis it is appropriate to start by explaining the idea behind portfolio theory, the risky elements associated with the theory and then focusing on the specific risk of volatile exchange rates which is the primary focus of this paper.

The section about portfolio theory should give the reader an idea about the selection problem and the driving forces behind diversification. This should clarify why investors seek international investment opportunities even though the investor faces more uncertainties by doing so. In the part about risk the paper covers some of the risk one encounter when investing in a security or a portfolio of securities, both domestically and internationally. Finally the concept of exchange rates is covered, first from an economic perspective and then as the risk it adds to international investing.

2.1 Portfolio Theory

The starting point of the modern portfolio theory was put forth by Harry Markowitz in 1952. One of Markowitz underlying assumptions is that the investor in time zero is faced with two conflicting objectives; to maximize the expected return and to minimize the risk.

The expected return of a portfolio is simply the weighted average of the expected returns of each individual security in the portfolio. If an investor wanted to only maximize expected return he or she would only hold one security, the one which was expected to increase the most in value. The conflicting objectives assumed by Markowitz cause the investor to diversify by buying more than one security, which could reduce the risk of the portfolio (Sharpe, Alexander & Bailey, 1999).

The whole idea of constructing a portfolio is to diversify the risk of the investment. The reason this is possible is that not all securities respond equally to changes in the market, such as interest rates, oil prices or simple supply and demand issues. They are seen as having different betas, i.e. having different market sensitivity. An important feature of securities returns, when trying to reduce risk, is their correlation. It is easy to say that if they where not at all correlated then diversification could eliminate risk. On the other hand, if all securities where perfectly correlated then diversification could not do anything to eliminate risk. The fact that most securities are correlated, but not perfectly correlated, implies that diversification could reduce a portfolios risk, but not eliminate it completely (Markowitz, 1959).

If we turn to the international arena for portfolio selection it could both lead to reduced portfolio volatility due to low correlation between global markets but also to increased opportunities to make profits if the investor is active in his or hers portfolio management. The array of securities and markets to choose from increases and could offer possibilities that the domestic market can not (Solnik, & McLeavey).

A basic assumption is that the larger the number of securities in the portfolio, the better diversified it is and the smaller is the risk that the investor has to bear. According to the theories put forth by Markowitz there is a feasible set of portfolios to choose from and every investor will choose his or her optimal portfolio from a set that offer a maximum expected
return for different level of risks and offer minimum risk for different levels of expected return. This feasible set simply represents all portfolios that can be constructed from a number of N securities.

![Figure 1 - The optimal portfolio given a feasible set (Sharpe, Alexander & Bailey, 1999)](image)

$R_p$ on the X-axis represent the percentage change in expected return to the security and $\sigma_p$ on the Y-axis represent the risk associated with any given level of expected return.

The portfolio selected is simply the one that coincides with the indifference curve that offers the highest utility given the investor’s preferences towards risk and expected return. Here an indifference curve is combinations of risk and expected returns that provide the investor with the same level of utility. The lines are upward sloping because a higher level of risk needs to be compensated for by a higher level of expected return (Sharpe, Alexander & Bailey, 1999).

The expected return to a stock is based on the expectations the public holds about the company and the stock regarding future performance, dividends and general trends on the market. If the public in general believes that a company is undervalued they will start to buy this stock, believing that it soon will reach its higher “correct” value. Since the demand for the stock increases it will start to rise until the public believes it has reached its true value and start to sell the stock. This is a type of self fulfilling prophecy that is the reason behind why the stock is volatile and does not stay at one value all the time.

### 2.2 The Element of Risk

Now the focus is on the risk side of portfolio investments. For every security there are different risks associated with the expected return. The statistical measure for the risk associated with a portfolio is the standard deviation, denoted $\sigma_p$, and is an estimate of how much the actual return will differ from the estimated return. When an investor calculate the risk associated with the portfolio he or she does not only weight the individual risks but also analyse the correlation between the individual securities. The correlation is the most important factor when trying to reduce risk with diversification. Finding two securities that have a negative correlation with one another reduces the total risk of the portfolio since they move in opposite directions. The total risk associated with a security is broken down into two parts according to Sharpe (1999), market risk and unique risk.
**Market risk**

The market risk, or systematic risk, of the portfolio is the covariance the portfolio has with the market or the exposure to the uncertain market value of the portfolio. A market risk could be said to be a risk that is common to an entire class of assets and is the risk from financial market fluctuations, economic cycles or general demand issues. This risk is hard to diversify away since the market risk, or beta, is the average beta of all single securities in the portfolio. Increasing the number of securities in the portfolio means that every single security’s beta is related to a smaller proportion of the total portfolio, and hence affects the average beta very little (Sharpe, Alexander & Bailey, 1999).

The risk associated with market fluctuations could come from several sources and affects different types of securities in different ways. Holding a portfolio diversified not only by a high number of securities but also with a large variety of types of securities will reduce the market risk.

When investing abroad the investor is exposed to market risk from the domestic market but also from market fluctuations from the country where the investment is made. Even though the investor is exposed to more risks, the different market fluctuations could have offsetting movements and actually reduce the total risk of the portfolio. As with other fluctuations and volatility a global perspective could help diversify the portfolio.

**Unique Risk**

The unique risk, or unsystematic risk, of a portfolio is on the other hand very easy to diversify away. This type of risk is the risk that is unique to every single security in the portfolio, such as very strong jumps in stock value due to unexpected good news or a deep plunge due to an industrial accident at one of the company plants. These types of events have a very little effect on a well diversified portfolio. Figure 2 displays how risk is affected from diversification. We can see that the market risk is basically unaffected from an increased number of securities in the portfolio, even though it is possible to reduce, while the unique risk is drastically reduced (Sharpe, Alexander & Bailey, 1999).

![Figure 2 - Risk and Diversification (Sharpe, Alexander & Bailey, 1999)](image)

The main reason to invest globally is the possibility to find markets with a very low correlation. When looking towards international markets one should know that an internationally invested portfolio faces all the risk a domestic portfolio does and more.
These risks are associated with the conversion of the foreign returns back into domestic money and are often denoted political risk and exchange rate risk.

When investors are talking about political risk they often mean the ability to convert foreign money to domestic money. The investor could of course experience political risk on the home market but is here referred to as an international political risk. This could be a problem when investing in insecure regions where there are risk of corrupt governments, risk for war or simply unreliable financial institutions. This type of risk also apply to currency controls, capital flow barriers, taxes, and other laws and regulations which strongly affect companies and institutional investors who are heavily invested in a country or a region (Bailey & Chung, 1995).

One can be sure that the political risk to a portfolio is larger and more apparent in emerging markets than in developed markets and should be assumed to affect the expected return and risk strongly when investing internationally. Other empirical studies have shown that the difference between emerging and developing markets with regard to political risk is statistically significant (Diamonte, Liew & Stevens, 1996).

When investing on a global market the investor has to calculate with these risks as well as with the domestic risks. Further, the investor is also facing an exchange rate risk which means the uncertainty about the rate at which the investor can convert its foreign returns into domestic money. This topic will be discussed further in the next section.

### 2.3 Exchange Rates

The exchange rate is simply a price, how much you have to pay with domestic money to receive a certain amount of foreign money. In this thesis the notation for exchange rate is $E$ and the exchange rate between, say Euro and Dollar is $E_{\text{E} / \text{D}}$, which is Euro/Dollar. This rate is referred to as a bilateral exchange rate, which is the exchange rate between two countries, for example, the euro in terms of dollars.

Which determinants does the exchange rate have? As with any other asset or commodity the price is determined by supply and demand. For any two currencies, the demand of one is the supply of the other. By importing goods from a foreign country the importer is said to demand that foreign currency and exporters are said to supply the foreign currency. According to Copeland (2005), exports and imports together with foreign investing and speculation are the strongest determinants of an exchange rate.
Other strong determinants of the exchange rate are the policies conducted by the countries government. The exchange rate is affected by the interest rate which in turn is directly affected by these policies. A stricter fiscal policy means that the government borrows less and finances its expenditure through higher taxes. A reduction of borrowing reduces the domestic real interest rate and depreciates the domestic currency. However a reduction to tighter fiscal policy also lowers inflation which leads to an appreciation of the domestic currency. The result of these conflicting effects is ambiguous (Solnik & McLeavey, 2003).

The interest rate is affected by a more expansionary monetary policy which would most certainty lead to a drop in the real interest rate and a rise in the inflation rate. Both these results lead to a depreciation of the domestic currency. A stricter monetary policy would lead to the opposite result (Solnik & McLeavey, 2003). The conclusion of this is that the government affects the demand for domestic assets, which in turn affect the demand for domestic currency. However, these changes have to be unanticipated to have an effect on the exchange rate. Such surprising changes add to the uncertainty of exchange rate volatility to the investor.

Another important topic of discussion is the institutional effects on exchange rates. Central banks are key players in exchange rate determination even though their motives are different than other market participants. Also the private banking system in any country and their actions affects the exchange rate. The effect comes from their actions and the confidence these actions leave foreign investors with. A strong central bank with clear (and successful) targets together with an uncorrupt and well-functioning financial system will make the country attractive for investors, money will flow in and the local currency will increase in power. A country on the other hand where the central bank has troubles to keep their promises and where the financial intermediaries are questionable, investor will hesitate before investing and the local currency will be more volatile.

Robert Mundell and Marcus Fleming discussed the relationship between exchange rates and economic output. The model deals with monetary and fiscal policy effects on both fixed and flexible exchange rates. Since the central bank does not intervene in a flexible system the balance is only achieved by capital flows in and out of the country. The direction of capital flows is set by the interest rates on the domestic and foreign market. So the discussion in this case is that the exchange rate is determined by private capital flows. The idea is that adjustments in the exchange rate ensure that the current account and the
capital account is zero. This is because under flexible exchange rates and without central bank interventions the balance of payments must be zero (Dornbusch, Fischer & Startz, 2004). There are no really good models for determining an exchange rate but the Mundell-Fleming model is a widely accepted idea of exchange rate determinants incorporating several important factors such as government policy, exchange rate regime, interest rates and capital flows.

The interest rates discussed in the earlier paragraph that often is referred to are the long and short interest rate. The short rate is determined by the repo rate, which is set by the central bank. This rate is set on the money market and is used in trading securities with maturities shorter than a year. If the central bank believes that the inflation is about to rise they increase the short interest rate as a preventive action.

The long interest rate is determined by market expectations and not directly by central bank interventions. The long rate reflects the markets confidence about the country in general and about its inflation rate in particular. If the demand for government securities increases, the price of these papers increase as well which is the same as the interest rate drops, and vice versa (Fondmarknaden, 2005).

Countries have different currencies and also different levels of interest rates and inflation. There is interaction between these three and they can differ noticeably between nations. The fact that they can differ among countries imply that the currencies exchange rates will not stay constant over time. There are several parity relationships in international finance (Solnik & McLeavey). These are:

1) The **Interest Rate Parity Relation** – linking spot exchange rates, forward exchange rates and interest rates.
2) The **Purchasing Power Parity** – Linking spot exchange rates and inflation
3) The **International Fisher Relation** – Linking interest rates and inflation
4) The **Uncovered Interest Rate Parity** – Linking spot exchange rates, expected exchange rates and interest rates
5) The **Foreign Exchange Expectation Relation** – Linking forward exchange rates and expected spot exchange rates.

For the purpose of finding the future value of an exchange rate when analyzing the possible future returns of a portfolio a model that gives the investor a reliable value for an expected future exchange rate is needed. The paper discusses these relationships and their use further in chapter four.

This thesis is focusing on exchange rates that the government of the home country has let to be determined by the market, i.e. floating rates. The explanation of a floating exchange rate is one whose value or “price” is determined exclusively by supply and demand, with absolutely no government intervention. However, according to Reinhart (2000) there is an outspread “fear of floating” among countries, even developed ones. This is evident because there is very low exchange rate variability among many countries relative to more committed free floaters like the USA and Japan. She claims that the low variability is a result of deliberate policy actions to stabilize the exchange rate. In this case the exchange rate would be denoted a managed or dirty float.

When it comes to international investments, a volatile exchange rate could be a considerable risk. A depreciation of the home currency could offset the entire return to the
investor when it is time to convert the profits to the home currency. If the depreciation is larger than the portfolio return the investor experiences a loss.

The return on the exchange rate is therefore an important component in the analysis of an investment in a foreign stock index. The approach to the analysis of future returns to an investment is to forecast the future home and foreign returns on the stock index and the future returns on the exchange rate (Nyberg, 2003).

2.4 Hedging Strategies

2.4.1 Option contracts

When discussing the problem with added risks with international investing one should as well acknowledge that the investor has some possibilities to defend the position through some financial strategies. A commonly used strategy is the use of options. An option is a contract giving the buyer the right to buy a specific asset at a predetermined price within a specific time frame. There are a large variety of option contracts to choose from depending on buyers preferences about the movements of the underlying asset.

A call option gives the buyer the right to buy an asset while a put option gives the buyer the right to sell a number of assets. The buyer has to buy this position but when the contract is written the buyer has a choice. If the price increases of the underlying asset the buyer simply uses his option on the lower determined price. If the price of the underlying asset drops the buyer have the opportunity to ignore the contract and buy the asset from the market instead.

For example, in the case of a very volatile exchange rate a potential investor could buy a long position in put and a call. This position is called a long straddle and would generate positive effects to the investor both if the exchange rate increases and decreases, but a loss if the price remained constant. This type of contract is hence used when the investor believes that the underlying asset will change heavily in price but is insecure about which direction (Sharpe, Alexander & Bailey).

With the large variety of option contracts, for example; long and short calls, long and short puts, American and European options, straddles and strangles, butterfly’s and exotic options, the investor can find a suitable contract for almost every situation and could in this way defend the position against large exchange rate fluctuations.

2.4.2 Futures and Forwards

Another commonly used contract is forwards or futures. Both are contracts between two parties with only some minor differences. Futures are standardized contracts traded on commercialized exchanges and boards while forwards are traded over-the-counter and the contract is specific to each individual case.

In a futures or forward contract a specific price of the asset is determined and the contracts should be executed on a specific date. The difference with options in this case is that the parties are obligated to complete the transaction at the end of the contract. In the case of the actual price dropping below the contractual price the buyer will simply have to accept the loss or could write a new contract as a reversing trade.

Since futures are standardized and forwards has to be negotiated with the other party there is not always a contract suitable for the situation. In this case the investor could turn to the
option markets and buy a combination of puts equivalent to a futures contract. This is called a synthetic futures contract.

The possibilities are numerous to the investor when trying to create a position that will generate positive returns. This thesis will not go deeper in to the hedging possibilities to the investor but will recognize that there are a number of ways to defend the position against the problem discussed in this paper.
In this chapter the relevant and necessary models, calculations and statistical data will be presented. Different models will be discussed and compared from a usefulness-to-this-problem point of view.

3 Empirical Analysis

3.1 Portfolio Calculations

To be able to calculate the expected return to a constructed portfolio where also a volatile exchange rate is incorporated as a factor a model is needed that allows us to do just that. For this purpose a multiple-factor model is a suitable approach. This model allows us to incorporate more than one explanatory variable. Two suited models for this purpose are the Capital Asset Pricing Model (CAPM) or the Arbitrage Pricing Theory (APT). Both can be extended to multi-variable models and to an international context.

The CAPM is the first widely used asset pricing model, and due to the complex reality of asset pricing this model is a strongly simplified model that captures main aspects of reality. It is based on simple assumptions like risk-averse investors and no transaction costs. The basic CAPM contains only one beta, i.e. the expected return of a security in a CAPM framework is only sensitive to movements in one variable, the market portfolio (Solnik & McLeavey, 2003).

The newer Arbitrage model assumes instead that the returns are linked to an unknown number of unknown factors. It is possible to extend the CAPM to a multiple factor model but the APT is easier to use since the original version already makes the necessary assumptions of several factors (Sharpe, Alexander & Bailey, 1999). One way to analyze this problem is to use Markowitz (1959) own method for calculating expected returns. The method is commonly used to determine an optimal portfolio given risk and return. This approach however is quite complicated and requires a substantial amount of observations and is hence a very time consuming method. For this reason this thesis is focusing on the Arbitrage Pricing Theory and its applications.

The APT can be extended and written as follows:

\[ R_p = \alpha + \beta_1 F_1 + \beta_2 F_2 + \ldots + \beta_n F_n + \epsilon_p \]  

(1.)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Denotation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>( R_p )</td>
<td>The portfolio’s expected return</td>
</tr>
<tr>
<td>Alpha</td>
<td>( \alpha )</td>
<td>The intercept term or the risk-free rate of return</td>
</tr>
<tr>
<td>Beta</td>
<td>( \beta )</td>
<td>The sensitivity of the security to factor movements</td>
</tr>
<tr>
<td>Factor</td>
<td>( F )</td>
<td>A chosen factor of determination</td>
</tr>
<tr>
<td>Market risk</td>
<td>( \varepsilon )</td>
<td>The error term or market risk to the portfolio</td>
</tr>
</tbody>
</table>

For the purpose to calculate the expected return on a portfolio invested in Sweden the thesis focus on factors relevant to the Swedish market and the securities in the portfolio.

The portfolio analyzed in this thesis is constructed from four of the top traded stocks on the OMX O-list. The stocks selected represent four different industries. The four stocks and industries selected are Carnegie (Finance), Boliden (Industrial), Eniro (Media) and
Tele 2 (Telecom). The reason for selecting stocks from this specific list of companies is that they are not listed anywhere else and a foreign investor interested in these companies would be forced to invest in Sweden and expose oneself to the exchange rate risk.

The first approach is to analyze the performance of this portfolio for the period 2005-01-03 – 2005-12-30. These days are the first and last trading days in 2005. To find the values for the portfolio the expected return and risk for each individual stock is calculated and then weighted by its related weight. Below the figures are presented together with the calculated performance of each individual stock over 2005.

Table 2 - Portfolio & Security Performance

<table>
<thead>
<tr>
<th>Stock</th>
<th>Initial value</th>
<th>End value</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie</td>
<td>86</td>
<td>117</td>
<td>36.05%</td>
</tr>
<tr>
<td>Boliden</td>
<td>28</td>
<td>65</td>
<td>132.14%</td>
</tr>
<tr>
<td>Eniro</td>
<td>69.5</td>
<td>100</td>
<td>43.89%</td>
</tr>
<tr>
<td>Tele 2</td>
<td>89.83</td>
<td>85.25</td>
<td>-5.10%</td>
</tr>
<tr>
<td><strong>Portfolio</strong></td>
<td><strong>68.3325</strong></td>
<td><strong>91.8125</strong></td>
<td><strong>34.36%</strong></td>
</tr>
</tbody>
</table>

The return to the portfolio when weighing each stock as 25% of the total stock value is calculated simply by multiplying each individual return with its weight, i.e. multiply with 0.25. Money invested in this portfolio increased with 34.36% over 2005. This return is a domestic investor’s return calculated without regard to the influence of exchange rates. The performance of the portfolio and the individual securities are depicted in figure 6 below.

![Security Performance Diagram](image)

Figure 4 - Portfolio & Security Performance (Stockholm Stock exchange, 2005)
After having calculated the return for 2005, the next step is to calculate the standard deviation, or risk, of the portfolio. When doing this one must first analyze the correlation between all four stocks in the portfolio. The calculations were done in SPSS and are presented in figure 7 as a correlation matrix.

Table 3 - Security Correlations

<table>
<thead>
<tr>
<th></th>
<th>Carnegie</th>
<th>Boliden</th>
<th>Eniro</th>
<th>Tele2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie</td>
<td>1</td>
<td>0.895</td>
<td>0.556</td>
<td>0.387</td>
</tr>
<tr>
<td>Boliden</td>
<td>0.895</td>
<td>1</td>
<td>0.672</td>
<td>0.288</td>
</tr>
<tr>
<td>Eniro</td>
<td>0.556</td>
<td>0.672</td>
<td>1</td>
<td>-0.243</td>
</tr>
<tr>
<td>Tele2</td>
<td>0.387</td>
<td>0.288</td>
<td>-0.243</td>
<td>1</td>
</tr>
</tbody>
</table>

Between the four stocks there are six correlations ranging between -0.243 to 0.895. The large spread could be explained by the fact that the stocks chosen are from different industries and is a good example of a diversification strategy. To calculate the standard deviation the following model is used.

\[
\sigma_{PF} = \sqrt{X^2 \sigma_C^2 + X^2 \sigma_B^2 + X^2 \sigma_E^2 + X^2 \sigma_F^2 + 4X_C X_B X_E X_F \sigma_C \sigma_B \sigma_E \sigma_F \rho_{CB} \rho_{CE} \rho_{CF} \rho_{BF} \rho_{BE} \rho_{EF}}
\]

\[
\sigma_{PF} = 7.7\%
\]

The model includes the individual stock weight, the variance of each stock, the stocks individual standard deviations and their correlation (Sharpe, Alexander & Bailey, 1999). We now have the return (34.36%) and risk (7.7%) of the portfolio for 2005 given that the investor was domestic and was not exposed to any exchange rate volatility.

### 3.2 Adding Exchange Volatility

In this section the same portfolio is analyzed but with the assumption that the investor is foreign and would have been exposed to exchange rate volatility. The model for calculating the contribution of currency risk is:

\[
\sigma^2_F = \sigma^2 + \sigma^2_S + 2 \rho \sigma \sigma_S
\]

Where, \(\sigma^2_S\) is the variance of the portfolio in the investor’s home currency, \(\sigma^2_F\) is the variance in SEK; \(\sigma^2_S\) is the variance in the exchange rate (number of home currency per local SEK) and \(\rho\) is the correlation between the portfolio return and the exchange rate movements. The reason for not including the cross-product, that is return (R) times the exchange rate (E), is because it is assumed relatively small to R and E and should not be regarded when calculating exchange rate risk. The contribution of currency risk is calculated as \(\sigma_F - \sigma\) (Solnik & McLeavey, 2003).

The analysis of the three foreign investors and the effect of the exchange rate to the discussed portfolio show that for the US investor the exchange rate between SEK and USD increases the risk of the portfolio from 7.7% to 8.231%. This implies a currency risk contribution of 6.88%. The UK investor experienced a portfolio risk of 7.849% which means that the exchange rate volatility added only 1.95% risk to the investment while the risk to the Japanese investor was dramatically increased to 39.31%, i.e. a currency
contribution of 410.52%. All numbers in the statistical findings are significant to a 99% level. The findings are presented in table 4.

Table 4 - Currency Risk Contribution

<table>
<thead>
<tr>
<th>Portfolio Variance in SEK</th>
<th>Exchange Rate Variance</th>
<th>Correlation</th>
<th>Risk to Foreign Investor</th>
<th>Currency Risk Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Investor</td>
<td>0.0059</td>
<td>0.000</td>
<td>0.711</td>
<td>0.08231</td>
</tr>
<tr>
<td>UK Investor</td>
<td>0.0059</td>
<td>0.000</td>
<td>0.744</td>
<td>0.07849</td>
</tr>
<tr>
<td>Japanese Investor</td>
<td>0.0059</td>
<td>0.125</td>
<td>0.521</td>
<td>0.3931</td>
</tr>
</tbody>
</table>

The change in risk due to exchange rate volatility is now determined. Interesting is of course also to see how this volatility affected the return to the Investor. The dollar depreciated against the Swedish Krona with 16.23% during 2005 which simply means that the US investor lost 47.24% of the portfolio returns when he or she converted the returns back to American dollars. The actual return to the US investor was not 34.36% but only 18.13% due to the depreciation.

The British Pound also depreciated against the Swedish Krona during 2005. The British Pound lost 7.08%, which means that the UK investor received an actual return on the portfolio of 27.28% due to the SEK/GBP exchange rate.

The Yen depreciated with 4.33% during 2005 which lead to a decreased return for the Japanese investor. The actual return to the Japanese investor was 30.03%. A comparison between the risk and return to our three investors and a Swedish investor is presented in table 5 below.

Table 5 - Risk & Return With Respect to Exchange Rates

<table>
<thead>
<tr>
<th>Return</th>
<th>Risk</th>
<th>Currency Contribution</th>
<th>Percentage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swedish Investor</td>
<td>34.36%</td>
<td>7.70%</td>
<td>0.00</td>
</tr>
<tr>
<td>US Investor</td>
<td>18.13%</td>
<td>8.23%</td>
<td>0.53</td>
</tr>
<tr>
<td>UK Investor</td>
<td>27.28%</td>
<td>7.85%</td>
<td>0.15</td>
</tr>
<tr>
<td>Japanese Investor</td>
<td>30.03%</td>
<td>39.31%</td>
<td>31.61</td>
</tr>
</tbody>
</table>
Here the very important concept of economic forecasting will be presented. The chapter discusses the way exchange rate forecasting can be used to anticipate future volatility and hence how these findings can be used in practice.

4 Economic Forecasting

With the information now gained regarding the historic effect of exchange rate volatility on the portfolio held by three investors the next approach to focus on the possibility to forecast the future. If we want to be able to use our findings as a base for future investments the concept of economic forecasting is essential.

As mentioned earlier the APT-model will come in handy when calculating the expected future return. Now one must agree on how many determining factors to include into the model and which one they should be.

4.1 Portfolio Forecasting

Considering that the stocks are only listed on the Stockholm Stock Exchange and are mainly affected by supply and demand from Swedish markets and investors, one should focus on exactly this. One of the factors should preferably be a general Swedish market index that incorporates general changes on the Swedish market which affects all companies and industries. We should also incorporate specific industry indices relevant to the companies in the portfolio. Finally we should look into the expected change in the exchange rates. Once again this is the factor that will differ between the investors and will determine if there are additional returns to investments in Swedish stock shares.

The model will contain six determining factors; one general market index, four specific industry indices and one exchange rate factor. The specific industry indices are selected with regard to the Global Industry Classification Index (GICS) composed by Morgan Stanley which is a widely used system of classification. The companies are divided into sectors, groups and industries which are more and more specific to the company the further right we move in table 6. The indices selected for this calculation are located under the sub-classification Industry.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Industry Group</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Financials</td>
<td>Diversified Financials</td>
<td>Capital Markets</td>
</tr>
<tr>
<td>Boliden Materials</td>
<td>Materials</td>
<td>Metals &amp; Mining</td>
</tr>
<tr>
<td>Eniro Consumer Discretionary</td>
<td>Media</td>
<td>Media</td>
</tr>
<tr>
<td>Tele2 Telecommunication Services</td>
<td>Telecommunication Services</td>
<td>Diversified Telecommunication Services</td>
</tr>
</tbody>
</table>

Table 6 - Global Industry Classification System (GICS)

The factor selected to represent the general movements on the Swedish market is the OMX Stockholm which is an index representing all shares on the Stockholm Stock Exchange. This will provide a good picture of the overall performance of Swedish companies. Finally the effect of changes in the exchange rates will be estimated with regard to historical
performance, correlation to the portfolio performance and exchange rate forecasting theories.

The reason for incorporating all factors into one larger model instead of calculating four regressions is to calculate an expected return for the portfolio and not for the individual security.

The model will be constructed as follows:

$$R_p = \alpha + \beta_1 F_1 + 0.25(\beta_2 F_2) + 0.25(\beta_3 F_3) + 0.25(\beta_4 F_4) + 0.25(\beta_5 F_5) + \beta_6 F_6 + \epsilon_p \quad (4.)$$

Table 7 - Model Explanation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Denotation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>$R$</td>
<td>The portfolio’s expected return</td>
</tr>
<tr>
<td>Alpha</td>
<td>$\alpha$</td>
<td>The intercept term or the risk-free rate of return</td>
</tr>
<tr>
<td>Beta</td>
<td>$\beta$</td>
<td>The sensitivity of the security to factor movements</td>
</tr>
<tr>
<td>Factor $F_1$</td>
<td></td>
<td>The General Swedish Market Index OMX Stockholm</td>
</tr>
<tr>
<td>Factor $F_2$</td>
<td></td>
<td>OMX Sthlm Capital Markets</td>
</tr>
<tr>
<td>Factor $F_3$</td>
<td></td>
<td>OMX Sthlm Metals &amp; Mining</td>
</tr>
<tr>
<td>Factor $F_4$</td>
<td></td>
<td>OMX Sthlm Media</td>
</tr>
<tr>
<td>Factor $F_5$</td>
<td></td>
<td>OMX Sthlm Diversified Telecommunication Services</td>
</tr>
<tr>
<td>Market risk</td>
<td>$\epsilon$</td>
<td>The Expected Change in Exchange Rate</td>
</tr>
</tbody>
</table>

The alpha, which represents the risk-free rate in this model, is the value of a one year Swedish T-bill. These calculations are started with a regression on the model with data for 2005, including all variables except exchange rates to find a model suited for a domestic investor. The regression showed some insignificant values for the media industry.

A problem here is that there is a fairly high correlation between the different markets (see appendix A). This causes a multicollinearity problem affecting the statistical findings by often over-fitting the model. By removing variable from the initial model one could deal with this problem. The general market factor was removed and this time all indices were significant and showed a good fit to the model. There still is correlation between the different industries as well because the capital market for instance is closely connected with all markets. With this in mind one must do a careful interpretation of the results. With this model we have now calculated all beta values to the model. These historical relationships will be used together with estimates for the development of each industry and the expected change in exchange rates.

To estimate the future performance of the stocks the approach used was to look at the performance up to today’s date and then a make relevant estimate for the future. The Carnegie stock plunged strongly between June 2001 and April 2003. Over this period the stock lost 68.05% of its original value. From April 2003 onward to today’s date the stock has strongly recovered every year with an average yearly growth of 65.73%. The Capital market industry grew with 69.90% over the last year. Historically the Carnegie has had a correlation of 0.957 with the movements on the capital market index which would imply an estimated growth of 66.89% over 2006, given that this growth rate remains over next period. Given the average growth rate of the stock this is not an impossible return.
The Boliden stock experienced a similar drop in stock value between June 2001 and October 2002, where the stock dropped 87.56%. Over the following 38 month up till today’s date the Boliden stock has grown very strongly. The stock has grown with an average of 225.64% per year, with 132.14% over the last year. Even though the stock has had a slightly diminishing return over the last year one can still assume that the strong historical performance together with the strong growth of the metal & mining industry will continue over the following period. The historical correlation of 0.965 between Boliden and the industry together with the fact that the industry performed 31.86% better than Boliden stock implies a growth of 114.57% for the Boliden stock over next period.

The situation was similar for the Eniro stock which dropped with 63.12% between June 2001 and October 2002. Since then the stock has recovered strongly with an average growth of 42.55% annually. Eniro performed stronger than index with a growth of 43.89%, which was in line with the annual average, and the growth do not seem to decrease over the next period. A good estimate for the performance for next period is that the stock will continue at the average growth rate of 42.55%.

Finally the Tele 2 stock experienced a rollercoaster ride over the last four and a half years, with an average growth of -34% over the whole period. After peaking in January 2004 the stock has dropped with 39.46% up to today’s date, with a negative return of -5.1% the last year. The market has started to turn for the telecom market which rose with 7.95% 2005. A good estimate for the industry and the stock is that this increase now continues and that the Tele 2 stock increases in value with 5% given Tele 2’s correlation with the Telecom market.

Putting these numbers into the APT-model we find that for a domestic investor these estimations imply an expected return on the portfolio of 18.59% over the following period. The next step is to investigate how the expected change in exchange rates affect these expectations for the foreign investors.

Incorporating the expected change in the exchange rate into the model gives a view of how the expected change in exchange rates affect the expected return of the portfolio. Historically the effect has been quite small, with betas between 0.028 and 0.147 for the three currencies. This would imply that the effects of exchange rates are nearly negligible when investing in an international portfolio, at least when focusing on industrialized countries. The actual effect of a change in the exchange rate becomes real when the investor wants to convert the returns into his or hers home currency. What the expected future exchange rates are and how to estimate them is presented in the next part.

4.2 Exchange rate forecasting

According to Krugman (1989) the exchange rate is determined by financial relationships, such as PPP or IRP in the long run and by asset determining factors, such as supply and demand in the short run.

In this context it seems more appropriate to look into larger financial relations when trying to determine a possible future exchange rate one year ahead. A suitable approach is to analyze the interest rate differentials between our chosen countries. The basic assumption is that there should be an exchange rate - interest rate equilibrium. Assuming that transaction costs and default risks are negligible, actors will through arbitrage opportunities in the case of disequilibrium force the relationship to hold, that is, the Interest Rate Parity Condition is:

![Interest Rate Parity Condition](image-url)
\[ F = S \left[ \frac{1 + r_{\text{FC}}}{1 + r_{\text{DC}}} \right] \] (5.)

Where \( F \) is the future exchange rate, \( S \) is the spot exchange rate between the domestic and foreign currency, and \( r_{\text{FC}} \) and \( r_{\text{DC}} \) are foreign and domestic risk free interest rates (Krueger, 1983). All exchange rates are denoted from the foreign investor’s point of view and all risk free interest rates are the rate for the equivalence of a one-year T-bill in each county purchased January 1, 2006.

A one year U.S. Treasury bill purchased in January 2006 was offered at the rate 4.45%. The Swedish one year rate at the same time was 2.28%. The difference in interest rates implied that the US-dollar was valued too high and will depreciate with 2.08% over the next period for the equilibrium to hold. The expected future exchange rate is 7.785. The same calculations were made for all currencies and exchange rates and are presented in table 8:

<table>
<thead>
<tr>
<th>IRP</th>
<th>Spot Exchange Rate</th>
<th>Interest Rate Ratio</th>
<th>Expected change in Exchange Rate</th>
<th>Forward Exchange rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA/Sweden</td>
<td>7.9506</td>
<td>0.9792</td>
<td>-2.08%</td>
<td>7.7854</td>
</tr>
<tr>
<td>United Kingdom/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>13.7575</td>
<td>0.9786</td>
<td>-2.14%</td>
<td>13.4627</td>
</tr>
<tr>
<td>Japan/Sweden (3 month)</td>
<td>0.0678</td>
<td>1.0224</td>
<td>2.24%</td>
<td>0.0693</td>
</tr>
<tr>
<td>Japan/Sweden (10 Year)</td>
<td>0.0678</td>
<td>1.0072</td>
<td>0.72%</td>
<td>0.0683</td>
</tr>
</tbody>
</table>

The reason for calculating two values for the Japanese interest rate is that Japan for a long time has conducted a zero interest rate policy and the only two interest rates available today for January 2006 are a short term interest rate for a three month government bond and a long term interest rate for a 10 year government bond. The interest rates used were:

<table>
<thead>
<tr>
<th>Table 9 - Interest Rates (2006-01)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swedish One Year Interest Rate</td>
</tr>
<tr>
<td>US One Year Interest Rate</td>
</tr>
<tr>
<td>UK One Year Interest Rate</td>
</tr>
<tr>
<td>Japanese One Year Interest Rate (3 month/10 years)</td>
</tr>
</tbody>
</table>

The theory of interest rate parity tells us that given the current interest rates the dollar will depreciate against the Krona with 2.08%, the Pound Sterling will depreciate with 2.14% against the Krona and finally the Yen will appreciate with somewhere between 0.72% and 2.24% against the Krona.

Leaving the interest rates aside the next step is to look into the relationship between exchange rates and inflation. The most commonly used relationship is the Purchasing Power Parity (PPP), which claims that the exchange rate adjusts according to inflation differentials between two countries (Solnik & McLeavey, 2003). The simple equilibrium equation used in this case is:

\[ S_1 = S_0 \left[ \frac{1 + I_{\text{FC}}}{1 + I_{\text{DC}}} \right] \] (6.)
The basic idea is much the same as in the interest rate parity condition were arbitrage conditions will force the relationship into equilibrium. With the inflation rates calculated at the end of year 2005 and the equilibrium model presented above we the calculated findings are not that different from the findings using IRP. The findings are presented in table 10:

Table 10 - Calculated Expected Forward Exchange Rates (Using PPP)

<table>
<thead>
<tr>
<th>PPP</th>
<th>Spot Exchange Rate</th>
<th>Inflation Rate Ratio</th>
<th>Expected change in Exchange Rate</th>
<th>Forward Exchange rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA/Sweden</td>
<td>7.9506</td>
<td>0.9710</td>
<td>-2.90%</td>
<td>7.7204</td>
</tr>
<tr>
<td>United Kingdom/Sweden</td>
<td>13.7575</td>
<td>0.9824</td>
<td>-1.76%</td>
<td>13.5157</td>
</tr>
<tr>
<td>Japan/Sweden</td>
<td>0.0678</td>
<td>1.0020</td>
<td>0.20%</td>
<td>0.0679</td>
</tr>
</tbody>
</table>

Also here is a depreciation of the Dollar and Pound Sterling expected while an appreciation of the Japanese Yen is expected. Given the two ways to calculate, we see that the US Dollar is expected to depreciate somewhere between 2.08% - 2.90%, the Pound Sterling somewhere between 1.76% - 2.14% and the Yen is expected to appreciate somewhere between 0.2% - 2.24%.

Table 11 - Interval of Future Exchange Rate

<table>
<thead>
<tr>
<th>PPP</th>
<th>Expected Change (PPP)</th>
<th>Expected Change (IRP)</th>
<th>Interval of Expected Future Exchange Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA/Sweden</td>
<td>-2.90%</td>
<td>-2.08%</td>
<td>[7.7204, 7.7854]</td>
</tr>
<tr>
<td>UK/Sweden</td>
<td>-1.76%</td>
<td>-2.14%</td>
<td>[13.463, 13.516]</td>
</tr>
<tr>
<td>Japan/Sweden</td>
<td>0.20%</td>
<td>2.24%</td>
<td>[0.0679, 0.0693]</td>
</tr>
</tbody>
</table>

Adding the different expected exchange rate changes into the APT-model shows that the expected return to the US investor is somewhere in the interval [20.09%, 20.21%], depending on the method of exchange rate forecasting. For the UK investor the interval for the expected return is [18.18%, 18.20%] and finally for the Japanese investor the interval for expected return is [18.23, 18.29]. As one can see the expected change in exchange rates lowers the expected return for the UK and Japanese investor while increasing the expectations for the US investor, even though the Dollar is expected to depreciate against the Krona. The reason for this could be the strong relationship the metals & Mining industry have with the Dollar.
In this chapter the analysis of the findings in the previous chapter is presented and discussed critically to determine the usefulness of the theory and findings in practice.

5 Analysis

Portfolio Risk and Return

The work of calculating the historical return to the portfolio was a fairly straightforward procedure. By weighing the individual security returns by their relative weight (25%) the portfolio constructed from Carnegie, Boliden, Eniro and Tele 2 stock resulted in a return of 34.36%.

The initial empirical work regarding the historical risk and diversification strategies showed that it was possible to reduce the combined portfolio risk to 7.7%, from the individual risks ranging between 13.97% - 18.42%. This is due to the individual stock correlations ranging between -0.243 – 0.895 showed by the correlation matrix in table 3. The method of selecting stocks, that is, choosing stocks from different industries, showed to be a very good diversification strategy. This supports the theoretical discussion by Sharpe (1999) and Solnik (2003) and section 2.2 in this paper. The result is not surprising because this is a widely used strategy and not considered just theory but practice in every risk managing firm and financial institution.

Exchange Rate Volatility

The next step in the analysis was to determine how much risk the volatility of the Dollar, Pound and Yen added to the initial risk of the portfolio. As discussed in chapter 2 earlier research had shown an increase of between 15% - 100% according to Solnik (2003) but also that an increase in risk should be compensated by an increase in expected return (Markowitz, 1952 & Sharpe, 1999).

The analysis was made over the same historic period using a method to calculate currency contribution regarding risk. The result from this test showed that the volatility in the exchange rate added 6.88% and 1.95% to the US and UK investor respectively and amazing 410.52% to the Japanese investor (see table 5). As shown in Table 5 the volatility of the exchange rates did add to the initial portfolio risk as discussed by Solnik (2003) but interestingly none of the investors was compensated for this extra exposure to risk as theory claim they should be. Theories are derived from extensive empirical work and by comparing such a small test as the one performed here could maybe not give us the same expected answers. To do this one would have to measure expected returns against all different kinds of risks and with all different types of securities over a large variety of time frames. This is not done here and the results derived in this thesis should be seen as giving a picture of the specific situation tested and not as a general effect.

By analyzing the volatility of the three exchange rates it is evident that the large risk is directly related to the high volatility of the Japanese Yen. The U.S. Dollar and the U.K. Pound did not show as much volatility over the same period and this is shown in the smaller level of risks added to the initial portfolio risk. The volatility is displayed in figure 5.

The reason for the high volatility in Japan should be found on the Japanese domestic markets and their interactions with international markets. The next step is hence to discuss
each individual country with the theories presented in chapter 2.3 and empirical findings in chapter 3 as reference.

![Exchange Rate Volatility](image)

Figure 5 - Exchange Rate Volatility

**Japan**

As figure 5 depicts the Japanese Yen has been very volatile over 2005 and has been so for a while now. The volatility of the Japanese Yen is probably originated from a very volatile financial market. Japan has over a long period has used a low or even zero interest rate policy to increase consumption in a slow domestic market. The low interest rates in turn affect capital flows. As discussed in the theoretical chapter regarding a floating exchange rates and capital flows, the low rates in Japan would imply that large amounts of capital are flowing out from Japan in search for higher rates elsewhere. The large outflow of capital affects the exchange rate which depreciates in value. The volatility on the Japanese domestic financial market is hence related to the volatility of the Japanese yen.

By looking on the interest rates for Japan over a longer period we can see that the Japanese central bank has slowly lowered the repo rate to boost the economy over the last 10 years.

![Japanese Interest Rates](image)

Figure 6 - Japanese Interest Rates
Japan has, even with a close to zero interest rate, had problem to increase productivity and consumption. Governor Hayami of the Bank of Japan said in 1999 that they where going to maintain the low interest policy “until deflationary concerns are dispelled.” This declaration was acknowledged by the financial markets as a signal that the Bank of Japan would continue the zero rates for a significant period of time. Reflecting such market expectations, interest rates for term instruments declined rapidly, and the yield curve became extremely flat (Fujiki & Shiratsuka, 2002).

The long Japanese interest rate also implies that the public expects a continuing low rate policy. The reason for this financial situation could probably be related to many different issues such as Japanese attitudes to saving and consumption, government policies or there troublesome situation as neighbors to the much cheaper and fast growing China steeling much production, development and investments. Neither of these issues will be discussed deeply in this thesis but are still recognized as important factors.

The confidence in the US Dollar and the Pound Sterling is higher and both currencies are world currencies used in many financial transactions because of its strong value and high credibility. A high credibility in a currency implies a low volatility and hence it would not affect the risk of an investment as much as a highly volatile exchange rate. This result was also shown by the currency risk contribution calculations made in chapter 3.

**USA**

The US government has not, different from the U.K. and Sweden, adopted an inflation targeting policy. The American economy is largest in the world and the strong history of economic steadiness has lead to a strong international demand for the US Dollar which in turn has held the inflation rate in check. The U.S. financial market is not at all as volatile as the Japanese due to more healthy capital flows in both directions. This is the case even though the American economy for the moment is struggling with a twin deficit, trade and budget.

By again looking at figure 5 one can clearly see that the more stable U.S. financial markets have lead to a more stable exchange rate though the value of the Dollar compared with the Swedish Krona has experienced a negative trend over 2005. But a stable negative trend is better than a large volatility from a risk point of view.

By looking at figure 6, displaying US interest rates, we see that the US long rate, again reflecting market expectations, has been much higher that the short rate over the last four years. This could be interpreted as the market expects a stronger economic growth in the future and that the general opinion is that the current economic situation and the war will come to an end and is temporary. So even though the US is experiencing some economic difficulties the dollar has the confidence of the financial markets and is not experiencing large fluctuations in value. This was shown in the currency risk contribution calculations in chapter three.
United Kingdom

From the empirical work it is evident that the U.K. exchange rate is the least volatile. By the earlier discussion this would imply that the U.K. financial markets are the most stable as well. There are some differences that notable. The UK government has a clear inflation target of $2.0\% \pm 1\%$ to be hit over a two year forecast horizon (Bank of England, 2006). The publicly announced target acts as confidence measure and the confidence investors have with the UK system is much based on how the UK Central bank has managed to keep their promise in the past.

By looking at inflation data for the UK economy it shows that the Bank of England has kept the announced target for the last seven years (National statistics, 2006). This would provide investors with a confidence and a belief that the system works and that the financial markets and institutions are reliable. The stable market has also affected the U.K. exchange rate with a very low volatility over 2005.

All this was also clearly shown by the currency risk contribution calculations in chapter three. The volatility of the Pound Sterling only added $1.95\%$ to the initial risk of the portfolio of the UK investor.

The long and short interest rates in the UK tell us that the market expects an economic slowdown from today’s level. The Bank of England has over the last ten years worked with a high repo rate not quite in parity with longer run market expectations. The importance for an investor though is the stability of the financial markets and the Bank of England has managed to provide a good financial stability attractive to investors, which also have led to a stable exchange rate. The long and short rates in the UK are presented in figure 7.
The conclusion drawn from this section is that the confidence and actual performance of the financial system of both the investor's home country and the country of interest is of great importance when looking at the risk of an investment. As discussed by Mundell-Fleming the capital flows in and out of the market affects the country's exchange rate and it was also evident in the empirical work that the volatility of the Japanese financial market caused a very volatile exchange rate.

For the Japanese investor, the problems on the domestic financial market is the worst enemy and affects the Yen in such a degree that it becomes highly volatile and adds a large amount of risk to an internationally invested portfolio. For the UK investor on the other hand the added risk of investing in Sweden is minimal because of a stable home market with clear and relatively successful government policies.

The same signs are found in the empirical findings for the US investor. Even though there are no publicly announced targets for the economy it still, due to a history of steadiness, inspires the financial markets with confidence and the low variability adds only marginal values of risk to the investment.

**Statistical findings**

In the statistical work regarding the correlation between exchange rates and portfolio returns it is evident that the investor seeks a high positive correlation, instead of the low correlation diversification approach normally pursued in portfolio investments. The discussion about correlation and risk in chapter 2.2 clearly explains that a low correlation between securities is to prefer when trying to reduce risk. But if one look closer on equation 3 it is clear that a low correlation is not always desirable in international investments.

When investments are successful the desired correlation between portfolio returns and exchange rate is absolutely positive. The investor gains if both the return of the portfolio rises and the value of the home currency rises. In this scenario the investor experiences a leverage effect in returns.

In the case of a negative return on the investment the investor wants a negative correlation between portfolio returns and exchange rates. A negative correlation in this scenario would offset the losses leaving the investor with a loss less than without the presence of exchange
rates. A positive correlation in this case would increase the losses and leave the investor much worse off than without the presence of exchange rates.

The statistical relationship between return and exchange rates showed very low betas. The analysis of the historical betas for the APT-model resulted in a relationship of 0.147 for the US investor, 0.043 for the UK investor and 0.028 for the Japanese investor. Historically, when adding exchange rate as one of many explanatory factors and over a period of one year, the exchange rate has had a very low impact on returns.

The conclusion drawn from these findings are that exchange rates have a very small impact on expected return for a portfolio but adds more to the risk of the portfolio. The basic assumption about portfolio theory, as discussed in chapter two, is that an increase in risk should be compensated by an increase in expected return. When looking at the actual risk and return for 2005 for the three investors (table 5) we see that none of the investors got compensated for their increased risk when investing in Sweden. According to Sharpe, Alexander and Bailey (1999), there is a discussion among economists about if exchange rate risk really is compensated for. According to my findings the investor is not, at least not in the actual findings for 2005.

The reason for this could be that there are actually many more factors affecting the risk and return than what is incorporated in the basic original factor models. CAPM only incorporates a “market portfolio” and when using multi-factor models, as in this thesis, a large number of explanatory factors are hard to handle. The risk of a portfolio is as discussed earlier affected by risk specific to the company; risk associated with market fluctuations, risk related to the whole industry, political risk and so on. A model that covers these aspects as well as adapts to daily changes in them is probably impossible to create and the investor will just have to accept the basic models presenting a fair picture of a possible scenario.

Further to add expected exchange rate into the model is a difficult task because there are no really good models to predict exchange rates. A suitable approach is to perform a scenario analysis with focus on the most important determinants of an exchange rate, such as capital flows, interest rates, inflation rates and exports/imports.

The model

In the process of estimating the future expected returns for the three investors it was evident that the US investor actually is expected to receive a higher return than a hypothetical Swedish investor, that is, the US investor is compensated for exposing himself to extra exchange rate risk, as the theory about risk and return explains. This was not the case for the UK investor and the Japanese investor, who is expected to receive a return just below the Swedish investor.

To estimate future returns for our three investors the APT-model was used, which allows the researcher to incorporate several determining variables as well as in this thesis, the expected change of a bilateral exchange rate. Evident is that all expected returns has a high relation with the capital markets index. This is maybe not strange since the capital market is where all other industries get funding for investments; get financial consulting or where many of the companies’ owners are located as risk capitalists. When other industries does well the capital markets do well. The other factors all had a relatively low historical relationship with portfolio returns. The statistical findings where all significant at a 99% confidence level except for three cases. The Metals & Mining industry was not significant for the Swedish, Japanese and UK investor, but highly significant for the US investor. One
explanation could be that the Metals & Mining industry is much more bound to the dollar in its every day business than to Pound and Yen.

In the empirical section the Purchasing Power Parity and the Interest rate Parity was used as estimators for the expected change in exchange rates. These two equilibriums are most suited of the five relationships discussed in chapter 2. The reason for this opinion is that the Fisher relation links interest rates and inflation and should be given when looking at both PPP and IRP. Of the other financial relationships PPP and IRP provides the most interesting results given exchange rates, inflation rates and interest rates. The result was that the two methods of calculating a forward exchange rate ended up with very similar results.

These relationships, interest rates, inflation rates and exchange rates are discussed in many different frameworks. The IS/LM framework discusses the relation between interest rates and investments and demand for money. This is discussed as an important factor with capital flows which in turn affect exchange rates. The international Fisher relationship discusses a relation between all three factors. That the empirical work ended up with similar results is maybe not strange since the general opinion is that there is a very close connection between these variables. To estimate an exchange rate is a difficult job and there are no really good models developed for it. The best approach is to perform a larger scale scenario analysis if one wants to predict the future exchange rate or in the case of an international investor simply use a hedging strategy, discussed in chapter 2, protecting the investment from a volatile exchange rate.

**End Discussion & Critique**

For the purpose of estimating an expected return on an investment the APT-model is highly suited, which also $R^2$-and F-values has shown (appendix A). The only concern is the use of PPP and IRP as estimators for the exchange rate. Sure they will provide us with an estimate, but there are some facts that need to be considered before accepting these results as true. In the case of PPP which links spot exchange rates and inflation, one must consider that all countries do not calculate inflation with the same basket of goods as base. This means that we perhaps not can assume that this relationship must hold. According to Solnik and McLeavey (2003) empirical studies of the PPP has shown that it is more suited as a long run estimator of periods of up to 20 years. For short run purposes the IRP is more appropriate. In my calculations the PPP predicted depreciation for the Dollar and Pound against the Krona and an appreciation of the Yen against the Krona.

The IRP links spot exchange rates, forward exchange rates and interest rates. There is a close connection between these two predictors since the interest rates often are used to control inflation. The findings in chapter 3 show this by also predict depreciation for the Dollar and the Pound against the Krona but an appreciation of the Yen against the Krona.

The most appropriate way to deal with this problem is to give up the attempt to find an expected future spot exchange rate and instead create an interval that most likely contains the true future exchange rate. To do this one first calculates an estimated return for all investors using the APT-model and with PPP as exchange rate estimator. Second you do the same procedure again with IRP as exchange rate estimator. The calculations gave similar results but with some deviations from each other.

By presenting an interval most likely to contain the true forward exchange rate the results would be more attractive to a potential investor. Neither of the exchange rate estimators can deal with or foresee economic shocks and large deviations from normal expectations.
When using both a short run estimator and a long run estimator we can create an interval that, to some extent, deals with this problem.

An exchange rate is not easy to estimate and is not only affected by interest rates and inflation rates. The confidence in a country’s financial system, expectations about future economic development, and the government policy used to counteract economic shocks are all equally important factors in the quest to foresee the future. An investor attempting to earn profits by investing largely abroad should perhaps accept that the exchange rate affecting his or hers investment is a factor that is hard to control and predict and should instead focus on what financial strategies that are present to protect the investment. A straddle option in the case of a very volatile exchange rate or futures and forwards to guarantee a beneficial exchange rate, are some commonly used strategies in modern investing and are today probably the best solution to the exchange rate risk problem.
In this final chapter the findings of the empirical work and analysis is concluded. Further the author presents some related areas to this thesis than could be an interesting ground for further studies within the field of financial economics.

6 Conclusion and Further Research

This thesis started out by asking how a volatile exchange rate affect the risk and return of a portfolio invested in Sweden if the investor is located in Japan, United Kingdom or the USA? The theories discussed explain that earlier empirical work shows that an investor should be compensated for exposing the investment to extra risk by a higher expected return. The empirical work on historical data showed that none of the three investors where compensated and actually experienced a lower return than a hypothetical Swedish investor.

The statistical discussion about using securities with a low correlation to reduce portfolio risk showed to be successful with a reduction from between approximately 14% - 18% for the individual stock to 7.7% for the portfolio.

Evident from the empirical work was that the Japanese currency, the Yen, added a substantial amount of risk to the portfolio. The Yen was over 2005 far more volatile than both the Dollar and the Pound and this clearly added risk to the portfolio. The analytical discussion connects this volatility with theories about government policies, financial market instability and capital flows. A volatile financial market generates a volatile exchange rate and according Mundell and Fleming the exchange rate is affected by private capital flows between domestic and foreign markets.

In the next segment of the thesis an attempt to predict future movements of the exchange rate was made together with an estimation of the future returns of the portfolio. The APT-model was used since it a very easy model to handle and lets the researcher to incorporate several explanatory factors compared with the Markowitz model also discussed in the theoretical discussion which is a far more complicated and time consuming model.

When incorporating industry related factors together with the estimations of exchange rate movements done with help of the PPP relation and the IRP relation the regression estimation was that the US investor was expected to receive a higher return than a Swedish investor. This implies that even though the US investor is exposed to the SEK/USD exchange rate volatility he or she is expected to receive a higher return. This was not the case for the UK and Japanese investor who was expected to receive a return just below the Swedish investor.

The analytical discussion about these results is the small number of cases in comparison with what is necessary to draw some general assumptions. If claiming that added risk is not compensated for based on these three cases is a bit hasty. To do this one must first empirically test all types of risk with a variety security instrument and over a range of different time frames.

The focus of the analysis is on the exchange rates, their volatility and the reasons for it. To estimate exchange rate movements the focus was on the theoretical equilibrium relationships of inflation rates, interest rates and exchange rates. An exchange rate is a complicated matter to predict and is not only affected by the simple level of inflation between two countries. It is needed a larger scenario analysis of a country and its surrounding markets to establish this. Capital flows, government policy and interest rates in
a Mundell-Fleming framework was also discussed as a determinant for exchange rate in the case of open economies.

The analytical aim has been to connect the theoretical discussion with the empirical findings from chapter 3. The empirical work showed a clear significant relation between exchange rate volatility and added portfolio risk and a specifically strong volatility in the case of Japan.

An interesting subject for further research is to go deeper into the institutional effects, and analyze the determinants of future exchange rates. The cases of Japan and the US or UK provides us with clear differences in financial systems, government policies and exchange rate volatility.

It would of course also be interesting to expand the empirical work to more countries or maybe analyze the European Union or do a comparison between developing countries and industrialized ones.

According to Solnik and McLeavey (2003) markets are much more correlated today than for 50 years ago. Globalization have made countries and markets to resemble each other and the idea of investing abroad to find uncorrelated markets and industries are maybe not as important today. A study of the mayor markets and the idea of international investing as a diversification strategy would be an interesting research topic.
References


Krugman, P. (1989), Exchange Rate Instability, the Lionel Robbins Lectures, the MIT Press, Cambridge, Massachusetts.


Internet Sources

Historical exchange rates for SEK/USD, SEK/GBP and SEK/YEN, collected 2006-04-16 from www.oanda.com

Japanese inflation rate and Interest rate data, collected 2006-04-17 from www.sourceoecd.org


Swedish inflation rate and interest rate data, collected 2006-04-17 from www.riksbank.se

UK inflation rate and interest rate data, collected 2006-04-17 from www.bankofengland.co.uk
USA inflation rate and interest rate data, collected 2006-04-17 from www.federalreserve.gov

Information about long and short interest rates, collected 2006-05-10 from www.fondmarknaden.se

United Kingdom inflation data, collected 2006-05-16 from www.statistics.uk.gov
Appendix A
Statistical Findings

Security correlations

<table>
<thead>
<tr>
<th></th>
<th>Tele 2</th>
<th>Eniro</th>
<th>Carnegie</th>
<th>Boliden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tele 2</td>
<td>1</td>
<td>-0.243</td>
<td>0.387</td>
<td>0.288</td>
</tr>
<tr>
<td>Eniro</td>
<td>-0.243</td>
<td>1</td>
<td>0.556</td>
<td>0.672</td>
</tr>
<tr>
<td>Carnegie</td>
<td>0.387</td>
<td>0.556</td>
<td>1</td>
<td>0.895</td>
</tr>
<tr>
<td>Boliden</td>
<td>0.288</td>
<td>0.672</td>
<td>0.895</td>
<td>1</td>
</tr>
</tbody>
</table>

Exchange rate correlations

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>SEK/USD</th>
<th>SEK/GBP</th>
<th>SEK/YEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio</td>
<td>1</td>
<td>0.711</td>
<td>0.744</td>
</tr>
<tr>
<td>SEK/USD</td>
<td>0.711</td>
<td>1</td>
<td>0.908</td>
</tr>
<tr>
<td>SEK/GBP</td>
<td>0.744</td>
<td>0.908</td>
<td>1</td>
</tr>
<tr>
<td>SEK/YEN</td>
<td>0.521</td>
<td>0.681</td>
<td>0.698</td>
</tr>
</tbody>
</table>

Industry correlations

<table>
<thead>
<tr>
<th>Capital</th>
<th>Metals</th>
<th>Media</th>
<th>Telecom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>1</td>
<td>0.985</td>
<td>0.869</td>
</tr>
<tr>
<td>Metals</td>
<td>0.985</td>
<td>1</td>
<td>0.902</td>
</tr>
<tr>
<td>Media</td>
<td>0.869</td>
<td>0.902</td>
<td>1</td>
</tr>
<tr>
<td>Telecom</td>
<td>0.472</td>
<td>0.437</td>
<td>0.211</td>
</tr>
</tbody>
</table>
## Exchange Rate Descriptive Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>SEK/USD</th>
<th>SEK/GBP</th>
<th>SEK/YEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.13434</td>
<td>0.07376</td>
<td>14.76174</td>
</tr>
<tr>
<td>Variance</td>
<td>0.00000</td>
<td>0.00000</td>
<td>0.12500</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.00772</td>
<td>0.00200</td>
<td>0.35314</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.12140</td>
<td>0.06980</td>
<td>13.96460</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.15030</td>
<td>0.08280</td>
<td>16.27060</td>
</tr>
</tbody>
</table>
### APT-model regression (Swedish investor)

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.768</td>
<td>0.000</td>
<td>0.984</td>
<td></td>
</tr>
<tr>
<td>Capital Market</td>
<td>0.709</td>
<td>10.449</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Metals &amp; Mining</td>
<td>0.147</td>
<td>1.915</td>
<td>0.057</td>
<td></td>
</tr>
<tr>
<td>Media</td>
<td>0.075</td>
<td>2.528</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>Telecom</td>
<td>0.127</td>
<td>8.854</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

### APT-model regression (US investor)

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-5.012</td>
<td>0.000</td>
<td>0.977</td>
<td></td>
</tr>
<tr>
<td>Capital Market</td>
<td>0.614</td>
<td>10.361</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Metals &amp; Mining</td>
<td>0.217</td>
<td>3.268</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Media</td>
<td>0.208</td>
<td>7.109</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Telecom</td>
<td>0.124</td>
<td>10.054</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>SEK/USD</td>
<td>0.147</td>
<td>9.356</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

### APT-model regression (UK investor)

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.719</td>
<td>0.473</td>
<td>0.970</td>
<td></td>
</tr>
<tr>
<td>Capital Market</td>
<td>0.738</td>
<td>10.989</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Metals &amp; Mining</td>
<td>0.108</td>
<td>1.417</td>
<td>0.158</td>
<td></td>
</tr>
<tr>
<td>Media</td>
<td>0.107</td>
<td>3.473</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Telecom</td>
<td>0.130</td>
<td>9.225</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>SEK/GBP</td>
<td>0.043</td>
<td>3.238</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

### APT-model regression (Japanese investor)

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.230</td>
<td>0.818</td>
<td>0.969</td>
<td></td>
</tr>
<tr>
<td>Capital Market</td>
<td>0.680</td>
<td>9.894</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Metals &amp; Mining</td>
<td>0.140</td>
<td>1.841</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>Media</td>
<td>0.101</td>
<td>3.171</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Telecom</td>
<td>0.135</td>
<td>9.176</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>SEK/YEN</td>
<td>0.028</td>
<td>2.159</td>
<td>0.032</td>
<td></td>
</tr>
</tbody>
</table>
Swedish Inflation

UK Inflation