Stock Volatility In Various Financial Institutions

Case Study of Germany with GARCH Estimations

Master Thesis (One Year)

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Abstract

This study will try to determine the volatility of the stock returns of various financial institutions in Germany during the time period 1998-2007. The reasoning behind targeting Germany is that it is commonly known as one of the most stable and reliable economies in Europe, where Germany has been chosen as a representative case. The study employs a multifactor model, which incorporates interest rate (long and short being estimated separately) along with the exchange rate index EER-40. The estimation methods for determining the stock volatility are the GARCH-M and EGARCH methods. The study concludes that there is a great insignificance in the mean equation, which can be interpreted as showing one of several things: that the model is bad, that data is corrupt, or that there is an insignificant relationship between the explanatory variables and the depending variables. Although the study does often find significant GARCH-M and EGARCH coefficients, which tends to confirm (ignoring the insignificance of the mean equation) the common financial notion that the analysis of stock returns is best done under the assumption of conditional variance, meaning that the variance (volatility, risk) varies over time.

Keywords: Stock volatility, Financial Institutions, Germany, GARCH-M, EGARCH, Conditional variance

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1. Introduction

During my years in college the financial system has suffered greatly from various financial crises, including misuse of financial funds by banks and governments. In 2008 the financial system endured a crisis so serious that experts described it as the worst crisis since the great depression of 1929. The main factor behind this crisis was the misuse of subprime mortgages, which resulted in a large number of defaults when the house bubble in the US burst in 2007, which meant that banks lost a great deal of money and some of them fell, while others were saved by bailouts. More recently, (2011) EU is experiencing problems with Greece, which has gone into a debt spiral, mostly explained by governmental misuse of capital and by corruption.

It is clear that banks, along with the financial systems, have a vital role in globalized economies around the world in both good and bad times. This makes it of paramount importance that research regarding banks is conducted; this paper focuses on the subject of volatility around the banking sector in the Eurozone Stock Market. Maybe, with more research on how banks are affected by different financial variables, it will be possible to understand the banks' quantified risk more easily.

One of the most important macroeconomic variables could be considered to be the interest rate, which has been used for the determination of stock returns for decades. The key role of the interest rate has been debated and extensively investigated by economists, especially in respect to the fact that some financial institutions are more sensitive to the volatility of the interest rate than others. During the 1970s the exchange rate has emerged as a vital factor in the determination of the returns of stock, usually calculated using the relationship of the domestic currency to the US dollar. The nature and characteristics of the market are determined by the nature of the goods and services placed in the market for buying and selling. The volatility of the stock market is determined by the stock return volatility during the period in question.

The goal of my research is to approximate (estimate) the risk (volatility) of stock returns as far as exchange rates and interest rates are concerned. Both variables have been considered by many researchers, but lately the exchange rate has been the main focus of attention with the introduction of more flexible exchange rates in the 1970s. One of the first studies that highlighted the relevance of the exchange rate to stock return was by Solnik (1974) in an equilibrium asset pricing context. Solnik advised hedging, the use of short term investments in foreign bonds in order to reduce the risk to exchange rates.

Since this paper focuses on Germany for the descriptive and statistical analysis, it may be noted that the risk of the exchange rate has been considerably reduced since Germany is a member of the European Union and has introduced the Euro as its currency, which can be considered as one of the less volatile currencies. The main focus of the study is on evaluating different financial sectors such as the Banking Sector and the Financial Services Sector. More specific details on which sectors have been examined can be found below. The models that were used in this paper are mainly based on the models that were proposed by Choi et al, (1992).

The sensitivity of the interest rate of bank stock returns has been the main focus of a large amount of research. This research has been done mainly by developing and testing multi-index models. Stone (1974) first suggested incorporating the interest rate as an independent variable in an extended version of the market model. Stone (1974) also finds support for his research in the preceding paper by of Merton (1973).

It is widely considered that banks in general are more exposed to sudden variations in the interest rate due to the nature of the industry in which they operate, in which case one would expect that the stock returns of banks would be highly affected by variations in the interest rate. Many would argue that banks have different return generating processes, which could be true because the capital structure of a bank may differ enormously from that of another non-financial company. But many researchers have overlooked this important aspect, and have focused exclusively on financial institutions in these types of studies. It is conceivable that both financial institutions and non-financial companies are affected by the changes in the interest rate and in the exchange rate.

Due to the end of the more static exchange rate system in the 1970s, the role of the exchange rate in the determination of stock return has become more substantial. The world has also become more globalized and the more multinational culture has increased the exchange risk, largely due to the fact that trade across borders has increased significantly during the last decades. Therefore exchange rate should be considered as an important factor along with interest rates.

The definition of a market by economists is the place where sellers and buyers interact for the purpose of buying and selling the services and goods which they want to buy and sell. This study targets the capital market, more specifically the stock market where buyers and sellers trade in the stocks of different companies. Most would claim that the characteristics of the companies play a decisive role in the determination of the volatility of the stock. The stocks of some companies are considered more volatile due to the nature of the business which they do. Thus stocks of banks and financial institutions are more volatile than the stocks of manufacturing companies. It is also important to note that stock volatility is in fact a result of how much investors choose to buy and sell, which would make markets with more irrational investors more volatile due to sudden fluctuations in the stock returns.

In this paper it was found that the results in the mean equation were for the most part insignificant, but when it comes to the GARCH effects, the results show that there is some kind of heteroskedasticity in all of the financial sectors.

1.1 Purpose and Structure

The purpose for this paper is based around trying to understand and answer this following question:

- **Does volatility in the interest rate and exchange rates affect the volatility of stock returns in the financial institutions of Germany?**

As the author of this paper I would expect, even before conducting the research in question, that there would be some kind of relationship between the interest and exchange rates and the stock returns of financial institutions due to the nature of the business. So I would assume quite good chances of finding a significant result. Although, knowing that it is more common to find insignificant results, I am fully aware that I might find no significant relationship at all.

The reasoning behind choosing Germany as the country to examine is that it is considered one of the strongest economies in the European Union (EU), hence I expect to get more reliable results. The multifactor model of stock return is the theoretical basis of my research. This paper will study the volatility of the stock returns of German financial institutions as provoked by changes in the interest and exchange rates.

The continued structure of the paper is as follows: Chapter 2 will present the data and methods used in the paper. Chapter 3 will present an short theoretical framework to stand on, upon which next Chapter will build. In Chapter 4 the paper will review an extensive selection of previous research regarding the interest and exchange rate sensitivity of stock returns. In Chapter 5 the results are presented, along with an analysis of these results. In the final chapter, Chapter 6, I present my conclusions, and some suggestions for further research.

2. Data and Methodology

The primary objective of this section is to show how and from where data has been collected, and which type of data has been used. This section also gives a brief overview of the general and specific methods that were used in the paper. It states which model has been used, and justifies the choice of this particular model. This study uses GARCH-type models; more specifically, EGARCH and GARCH-M. These models will also be discussed.

2.1 Data Set

The data used for this study has been obtained from Deutsche Bundesbank i.e, The Central Bank of Germany. Deutsche Bundesbank maintains time-series data related to the interest rate, the market rate, bank stock returns, insurance company stock returns, mortgage banks' stock return, the yields of different securities, euro bonds, exchange rate etc and this data is updated on a daily basis, also keeping track of monthly and annual averages.. The period covered in the study is from 1998 to 2007.

All dependent and independent variables are expressed on a monthly basis. The study employs monthly returns of various financial institutions. Returns for an investment in a portfolio of short term bonds and long term bonds whose maturity is more than 10 years are also employed. For the exchange rate I have used an index of effective exchange rate which takes consumer price indices into account, an index which measures in aggregated form the competitiveness of the euro-area industrial sector. This exchange rate index is called "*Real effective exchange rate of the Euro against the currencies of the EER-40 Group, based on* *consumer price indices*", for short it´s just called the EER-40 index. EER-40 is calculated by ECB on the basis of weighted averages of the bilateral euro exchange rates against the currencies of various selected trading partners of the euro area. If there is an increase in the index rate it indicates the strengthening of the euro.[1] The weights are primarily built on the trade in manufactured goods along with the capture of third-market effects. [2]

Econometric analysis is better able to draw conclusions from the primary data since this data is often conditional and the models used in this paper are adapted to the analysis of conditional data. They are considered reliable for providing credible conclusions based on the outcomes given by such data.

The primary data is often conditional which means that it is not always possible to collect the data due to the nature of the target population. In this study it has not always been feasible to collect primary data, so the paper has to rely on secondary data, which has been taken from reliable sources. The primary data for this research is found at the Official Database of the Central Bank of Germany and from Datastream, which many would agree count as reliable sources.

The secondary descriptive data is often in the form of respectable scientific articles taken from journals or the Internet using our internal database for articles here in Lund (Libhub) and from various academic books that I have used during my years in college. Through the use of this secondary data it will be possible to collect a wide range of information about the subject in a short amount of time, thus increasing the reliability of the research. The previous section about prior research will also help me arrive at a more reliable conclusion.

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[1] For an more thorough explanation about the exchange rate index please visit this report written by Deutsche Bundesbank, March 2011, http://www.bundesbank.de/download/volkswirtschaft/devisenkursstatistik/2011/exchangeratestatistics032011.pdf

[2] The third-market in finance is often referred to the OTC-trade between exchange-rate securities.

2.2 General Method

This section discusses briefly how I conducted this paper and the order in which the paper was put together. Initially, I undertook extensive research into the literature on stock volatility and on how the interest and exchange rates affected stock volatility (with focus on the banking industry as far as possible). Most of the literature I read was found on the Internet and published by respectable journals.

After digging through previous research, I retrieved my data in order to perform the econometric analysis. The data were retrieved from Datastream and from Deutches Bundesbank website. All the data was fed into an Excel file for later insertion into Eviews.

After the results from Eviews had been dissected, I summarized the results and tried to compare it to the previous research discussed in Chapter 4, also including my own conclusions at the end.

2.3 Specific Methodology

This section discusses the methods and models available for the determination of volatility. There is a wide variety of models which can be used for determining volatility in the stock market by establishing the relation between stock returns and the factors directly influencing them. The study is empirical in nature and considers both qualitative and quantitative data for the empirical analysis of the hypothesis. It may be helpful to study prior research in the field in order to determine which research methods will be useful in this paper. The characteristics of GARCH type models are discussed in the following paragraphs.

ARCH-type models are one of the most popular types of non-linear models in empirical studies for explaining heteroskedasticity. The ARCH type of model was first proposed by Engle (1982) and considers the variance of the current disturbance term to be a function of the variances of the preceding time period´s disturbance term.

The generalized form of an ARCH type model is the GARCH type model. This model was first proposed by Bollerslev (1986), and was preferred over the ARCH model. GARCH models are overtly designed to model time varying conditional variances. There are numerous reasons that support the decision to use them. Firstly, we have the opinion of Elyasiani and

Mansur (1998) that, while ARCH incorporates a restricted number of lags in derivation of the conditional variance, GARCH models allow all lags to exert influence by including the past values of the squared disturbances. ARCH type models are considered to belong to a short memory category, while GARCH type models belong to the long memory category. GARCH models have the merit of showing how the conditional variances of the disturbance term σ_t^2 depends upon its own lags so that GARCH models are able to account for autocorrelation volatility clustering the financial and economic data.

The specification of a simple GARCH(1,1) model from Brooks (2008)[3] is as follows:

$$\sigma_t^2 = a_0 + a_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad \mathbf{(1)}$$

The a_0 term is the constant in the model and is assumed to be the long-term average. The information about volatility regarding the previous period is represented by the $a_1 u_{t-1}^2$ term, and finally the variance of the previous period is represented by the $\beta \sigma_{t-1}^2$ term. The numbers within parentheses are the number of lagged terms included in the model.

GARCH-type models have demerits too, which can be overcome by using the extended version of GARCH models. In this study, I will use the extended version of GARCH-model that has some extra terms to capture the asymmetric conditional variance between stock returns and market risks. The models that will be used in this study are the EGARCH model and the GARCH-in-mean model based on the so called z distribution to check for asymmetric effects.

2.3.1 GARCH-M

Financial models often suggest that taking additional risks is rewarded by a higher expected return. A way to operationalize this notion is to let the return of a security partly be determined by its risk. The first study to mention this type of a model by Engle, Lilien and Robins (1987) who suggested an ARCH-M specification, where the conditional variance of asset returns is included in the conditional mean equation.

[3] Note that some sections refer to the book “Introductory Econometrics for Finance” by Chris Brooks 2008 where he refers to original authors brought up in my discussion as well.

Since GARCH models are more common than ARCH, it is more common to estimate a GARCH-M model which has specifications as below, taken from Brooks (2008):

$$y_t = \mu + \delta\sigma_{t-1} + u_t \qquad \mathbf{(2)}$$

$$\sigma_t^2 = a_0 + a_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 \qquad \mathbf{(3)}$$

The residual is considered to be normally distributed: $u_t \sim N(0, \sigma_t^2)$. The equations above show the inclusion of the GARCH-effect within the mean equation and therefore the model is called GARCH-M. If the coefficient δ is positive and significant, then increased risk, which is given by the conditional variance in this case, leads to an increase in the mean return. This means that δ could be interpreted as a risk premium.

GARCH models commonly use the Maximum Likelihood method for the estimation of the model.

2.3.2 EGARCH

The EGARCH model is the exponential version of the GARCH model and was first suggested by Nelson (1991). There are various ways to express this exponential conditional variance; one possible way is given by Brooks (2008):

$$\ln(\sigma_t^2) = w + \beta\ln(\sigma_{t-1}^2) + \gamma\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + a\left[\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right] + u_t \qquad \mathbf{(4)}$$

Equation (4) consists of the conditional variance that is explained by the term $\ln(\sigma_t^2)$. This EGARCH model is represented in different explanatory sections. First there is the constant (w), which can be interpreted as the mean of the volatility and is assumed to be an intercept. The first explanatory section basically consists of the past (lagged) conditional variance ($\beta\ln(\sigma_{t-1}^2)$). The second section consists of the past residuals divided by the square root of the past conditional variance ($\gamma\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}}$). The third section is the same except that it uses section two and exclude the square root of two divided by pi ($a\left[\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right]$). In front of every section there are coefficients in order to explain the degree of explanation shown by each section has towards the dependent variable. The model also includes a residual which is later used in the next conditional variance as explained above.

The model has a couple of advantages over the ordinary GARCH model. Nelson (1992) argued that the non-negativity constraints in the linear GARCH model were too restrictive. Since the EGARCH model is the log of the conditional variance, even if the parameters are negative the conditional variance will still be positive. The EGARCH model also allows for asymmetries, since if the relationship between the risk (volatility) and return is negative then the coefficient γ will be negative.

Nelson assumed GED (Generalized Error Distribution) for the errors. GED is a very broad family of distributions but for simplicity of interpretation of the model, normally distributed errors are often preferred. Like the previous model this also uses Maximum Likelihood as the estimation method.

2.4 Specification of the used Models

Empirical studies often use a version of the improved market model, which is simply an extension of Sharpe´s single index model that assumes that the relationship between any two securities is entirely explained by the relationship to the market index.

A multi-index model that was previously used by Choi (1992) is estimated for short term and long term rates.

The econometric model is:

$$R_{it} = a + \beta_1 R_{mt} + \beta_2 R_{rt} + \beta_3 R_{et} + u_{it} \qquad \textbf{(5)}$$

The term R_{it} is the dependent variable and it stands for the stock returns from the different indexes from each financial sector examined in this paper, at time t. The other terms in the equation are represented by three independent variables. The first independent variable R_{mt} is the return of the national market index at time t. The second independent variable included in the model is the R_{rt}, which represents the return on an interest rate index at the time t (using both short and long term interest rate). The last independent variable R_{et} is the return of an foreign exchange rate index at time t. The model also includes a constant (a) and a term for the residuals (u_{it}). The Betas (β_i) are the coefficients of each independent variable.

Using the above equation, we employ the GARCH-M and EGARCH models and Ordinary Least Square Regression. Firstly, the equation given above will be obtained by using the market index, the one-year bond index and the exchange rate index. Secondly, the long term bond index will be used in place of the one year bond index. The estimations of the models are done with the program E-views v.6.

2.5 Research Limitations

Every research paper has its limitations. These can be due to time constraints, to the difficulty of the subject, or to lack of financial support. As far as this paper is concerned, there are multiple limitations to my research: much of the difficulty associated with this type of research has in fact already been identified in some of my secondary literature concerning research previously undertaken in this area. The most typical limitations have to do with the choice of the exact area of research and the extent of the time period examined. In this case I have chosen almost a decade to research since society changes, and so does economics, at least to some extent, which means that I want results that are up-to-date and that are more interesting to draw conclusions from.

The secondary data is provided by respected researchers and is therefore in general very reliable, but even it has its own limitations. First of all, there is always a risk about the accuracy and precision of past empirical work, also the further back in time the research was conducted the greater is the risk that it is outdated due to changes in society or to the use of out-dated tools in the actual performance of the research in question. It is evident that our computers and their programs today can provide better estimations than computers twenty years ago. It is therefore possible to draw the conclusion that the data used at that earlier time may have been less accurate, or at any rate less comprehensive, than ours, and if researchers get bad input they will produce bad output.

Another common problem that can occur with using secondary data is that researchers tend to use models that often give them the expected results, and they may overlook better models that give a less expected result. Such procedures can create problems with defective conclusions and findings.

To be more specific, this paper has been narrowed down to a case study of Germany and examines the stock volatility of different financial sectors with a span of ten years (1998-2007) with the help of the interest rate (long and short-term) and the exchange rate, using the index called *"Real effective exchange rate of the Euro against the currencies of the EER-40 Group, based on consumer price indices"*.

The financial sectors that were examined in this paper are the following: Commercial Banks, Credit Corporations, Landes Banks (state-owned banks in Germany), Mortgage Banks, Regional Credit Corporations, Saving Banks. There are perhaps other sectors that also could be included, but these seem to me to be the most relevant sectors, since they cover the financial sectors quite comprehensively.

3 Theoretical Framework

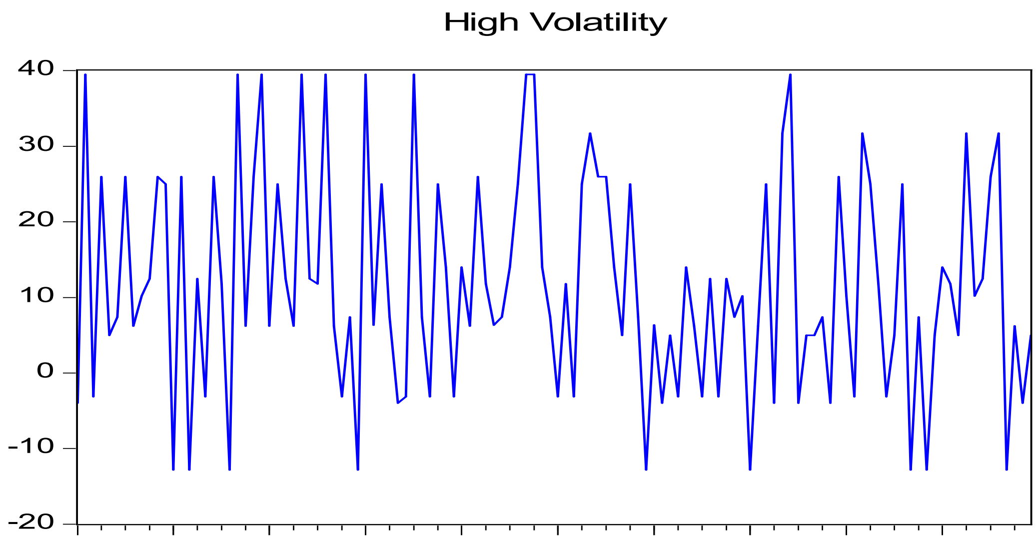
In this section the basic theoretical framework will be presented. This section, along with the previous section (methods) and the next section about previous research, will form the theoretical base on which the paper will rely. When writing a thesis about Stock Volatility it is important to define volatility for the less well-oriented reader. Since this paper treats the relationship between Stock Volatility of Banks with the Interest Rates and the Exchange rate, there will also be a brief discussion about that topic.

3.1 Defining Stock Volatility

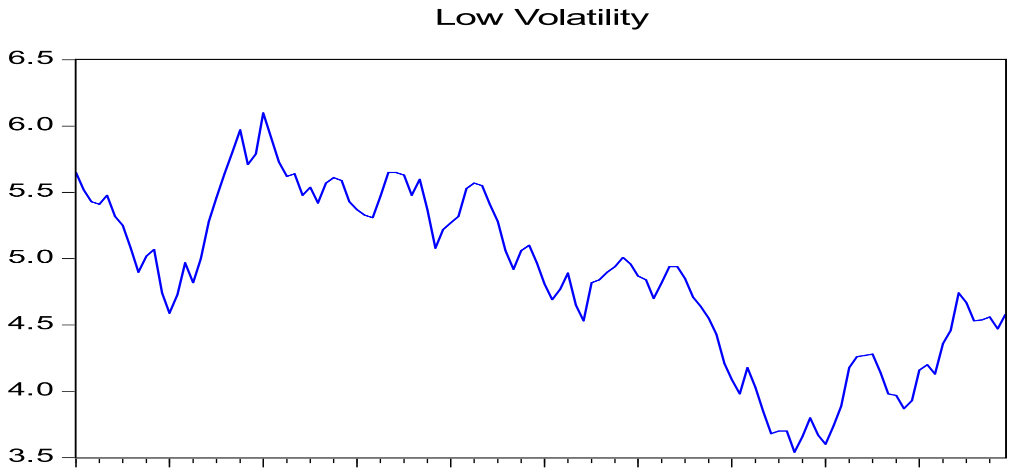
In financial economics, the term "volatility" is often used to describe the risk of various financial instruments. Volatility can be viewed as an statistical measurement which can often be derived from the variance or standard deviations between different securities or indices. If a security is highly volatile, this normally implies that the security is associated with higher risk than securities that are less volatile. In other words volatility can be viewed as a quantification of risk in order to separate highly risky instruments from less risky instruments. The price of a highly volatile security can potentially be spread out over a larger range of values. This means that the price can change more dramatically in a short period of time than the price of a less volatile security, or the chance of greater variation is higher with the more volatile security. This is one of the most important factors that investors consider when making their investments, and this is one of the reasons why this area has received a lot of research these last decades, along with the ability to calculate it more efficiently in recent years, (Brooks, 2008).

Interpreting volatility as only the variance or standard deviation could make it a quite crude measurement that acts like a stochastic measurement in ordering securities on a scale of riskiness without taking the exact number or size into account. For this purpose other measurements like Value-at-Risk (VaR), Estimated Shortfall (ES) etc exist, but most of these measurements use the variance and standard deviation in their model of risk quantification, meaning that the variance and standard deviation can be interpreted as quite good approximations, (Brooks, 2008).

One common assumption in many econometric models is that the variance is constant (homoskedastic), meaning that the risk is constant over time, although in financial economics it is known that the properties of stock returns do follow an variance that varies over time (heteroskedasticity).



Graph 1



Graph 2

The graphs above shows the difference between two time series, while graph 1 is the relative high volatile series and graph 2 is the relative low volatile series. The time series were randomly created by me in Excel and implemented in Eviews v.6 for making the graphs.

3.2 Plausible Effects of the Interest and Exchange Rates on Banking Sectors

There has been extensive research on the relationship between the interest and exchange rates on stock returns. Interest rate is the variable that has received the most studies, since it is an important macroeconomic variable which governments can alter in order to guide the economy in the desired direction.

In studies like Elyasiani, Mansur (1998) and Flannery and James (1984) it is shown that the interest rate does have a significant impact on banking sectors (discussed further in the next chapter). Intuitively it's easy to imagine that the interest rate should have an impact on banking sectors because of the nature of the business in that banks are highly dependent on the governmental repo rate and in that the business of banks largely involves lending in various forms. Some banking sectors might be more sensitive to the interest rate than others which is a question for the thesis to decide.

The sensitivity of banks as regards the exchange rate has received less research, although it could intuitively also be plausible since the world we live in is becoming more and more globalized which means that trading abroad is growing easier which, in turn, means that the exchange rate definitely becomes a risk factor, even for banks.

More consideration of this will be forthcoming in the next section.

4 Previous Research and Literature

When writing a thesis it is important that the writer acquires knowledge about the subject at hand and does so in the most beneficial way. It is also important to go through some of the previous research in the subject in order to learn what methods have commonly been used, but also to see what mistakes have been made in order to ease the writer's decisions on how to construct his own paper. It also shows if your results are in parity with the previous research. I have therefore put a lot of effort into doing this and will present the results of my efforts in this section.

The effect of exchange rates and interest rates on stock return sensitivity has been a focus of research since the 1970s. Merton (1973), Stone (1974) and Ross (1976) are some of the more respected among these. These related studies have been carried out by using different methodologies, along with different measures of interest rates, but the results mainly support the view that some individual firms and industries display more volatility in response to changes in interest rates than the market index. There have been a number of different explanations of the existence of this sensitivity to interest rates. Other studies have focused on the interest rate sensitivity of financial institutions in addition to the general arguments about sensitivity of interest rates to stock returns.

4.1 Interest Rate Effect on Stock Volatility

The experimental literature about interest rate risk sensitivity has shown varied results, although the subject has been widely studied. Different studies use models with considerable variation in specification, especially with regard to interest rate measurement. There are quite extensive studies that were conducted by Martin and Keown (1977), Lloyd and Shick (1977), Lynge and Zumwalt (1980), Flannery and James (1984a, 1984b), and Booth and Officier (1986) that show quite clear evidence that interest rates have an effect on the volatility of the stock returns of banks.

Chance and Lane (1980) are the only ones who fail to confirm these results. Scott and Peterson (1986) updated the previous research and studies and support the argument for an effect of the interest rate on stock return. Unal and Kane (1987) tested a statistical market value accounting model that included the interest rate sensitivity of unrecorded as well as recorded elements of a bank´s balance sheet. They compared some of the previous results and concluded that the return of bank stocks has a negative effect on changes in the long-term interest rate.

The stock returns of banks are more responsive to unanticipated interest rate movement than to the predicted or expected movement in the interest rate (Bae, 1990). This reveals that recent interest rate changes are a good substitute for unexpected interest rate changes.

The notion of the volatility of the interest rate is reinforced by various researchers in studies conducted by Yourougou (1990), Kwan (1991), Greenbaum and Akella (1992), and Song (1994). Yourougou (1990) assumes a two factor APT-model[4], Kwan (1991) used a random coefficient model, while Song (1994) engaged in a two factor ARCH model. Greenbaum and Akella (1992) studied the income sensitivity caused by repricing mismatch of short term assets and liabilities. In conclusion, a significant amount of research shows the same results: that the stocks of banks are more sensitive to changes in the interest rate than the ordinary market index, even when employing different methodologies.

The selection of short term and long term stock return in the two factor model is often done without any rationale, which is evident from different studies. Unal and Kane (1988) argue that there can be a difference between long and short term interest rates. The selection of market and the return of the financial instrument used in the study is also vital because the selection of the return directly and significantly affects the risk factor associated with it. For example, the return from the bond market has its own risk factor. So there is no agreement among the authors of different studies in the selection of the interest rate factor for use in the two factor model, at least not to my knowledge.

The two factor model suggested by Stone (1974) incorporates the interest rate and market returns as return generating variables. Fama and Schwert (1977), Christe (1981), and Lynge and Zumwalt (1980) conclude that the interest rate factor is the most vital factor in the determination of bank stock returns. Lloyd and Shick (1977) and Chance and Lane (1980)

[4] APT: Arbitrage Pricing Theory is general theory of pricing assets.

conclude, in contradiction to the outcomes of most of the other studies, that the interest rate is not the significant factor in the determination of the stock returns of financial institutions. This outcome may be due to the fact that financial institutions in different economies may behave differently.

Sweeney and Warga (1986) and Unal and Kane (1987) used the APT framework to conclude that the interest rate risk premium exists but is not constant over time. There are studies which reveal that the relationship between the stock return and interest rate is weak for a broader class of securities using the multi factor model (Flannery, Harjes and Hamid, 1997). Bae (1990) discussed the sensitivity to interest rates of the depository and non-depository financial institutions through three different interest rate maturity indices.

Bae (1990) concludes that the stocks of depository financial institutions are more sensitive to unexpected interest rate movement, and the degree of sensitivity is higher for longer term periods. Yourougou (1990) demonstrated the rather obvious relationship that interest rate risk is higher during a period of great volatility but lower during a period with less volatile interest rates. Choi, Kopecky and Elyaisani (1990) extended the two factor model by including a third factor in the model for the determination of stock return. They included the market return; the exchange rate and the interest rate in the determination of the stock return of financial institutions, more specifically the stocks of banks. Yourougou (1990) supports the outcome of the former study. The issue of interest rate sensitivity has remained unsettled due to the diversity in the outcome of different studies.

The study conducted by Adam, Edward and Suresh (2008) gives an explanation of the lack of agreement on the selection of interest rate factor for the determination of stock return. They mix the CAPM with the APT model to account for unpredicted fluctuations in the inflation premium, the default risk premium and the maturity risk premium. This model is better able to understand and explain interest rate sensitivity and level of risk associated with the return of bank´s stock. They conducted their study during the period 1974-1978 i.e. the period of increasing interest rate sensitivity and the volatility of the interest rate factor under the conditions of a highly regulated banking sector, also in the period spanning from 1979 – 1984, the period of high interest rates and increasing volatility under circumstances of banking deregulation, and in 1985-1990, a period of less volatility and low interest rates when banking regulations were changing shape due to various bankruptcies and considerable bank losses.

The outcome of the two factor model is compared with the outcome of three or multifactor models in order to determine the impact of the time varying risk factor on the stock returns of banks. Campbell (1987) and Shanken (1990) discussed the existence of a negative relation between the one month T-Bill yield and the stock return, while finding a positive relation between the market variance and one-month T-Bill yield. Whitelaw (1994) supports the outcome of prior research i.e, that there is positive relation between the one month T-Bill yield and market volatility. The one month interest rate factor is helpful in estimating the sign and the variance of excess return on the stock (Bren et al, 1989). Glosten et al (1993) established the GARCH-M model using the short term interest rate for the prediction of return on equity stocks. The GARCH–M model makes it possible to respond to changes in the long term and short term interest rate under different conditions of volatility.

Ozun and Chifter (2007) used the Granger Causality Test[5] on the closing values of stocks listed in the Istanbul Stock Exchange for the purpose of establishing the relation between interest rate volatility and stock returns. Their study also reveals that interest rate sensitivity is greater in the long term than it is in the short run. Konan Leon (2008) tested the relationship between movement in the interest rate and stock volatility in the economic settings of Korea. The results revealed that market return is significant and negatively associated with interest rates, while the conditional variance of the returns has a positive and insignificant relationship with interest rates.

4.2 Exchange Rate Effect on Stock Volatility

Studies related to the existence of exchange rate sensitivity are not as numerous as the ones regarding the interest rate sensitivity, and for this reason their results are less decisive. Swary, Saunders and Grammatikos (1986) found that The United States Federal Reserve Bank does not hold the best possible foreign exchange portfolios; further risks are modest and adequately covered by the bank capital. Modest exchange rate exposure is found in two studies by Jorion (1990, 1991). Kane, et.al (1990) in their research on a sample of city banks in Japan did not find exchange rate exposure. In contrast, Gentry and Bodnar (1993) and Choi and Prasad (1995) found interest rate exposure of the exchange rate, while Choi and Prasad state that the

[5] The Granger Causality Test is a statistical hypothesis test for determining whether one variable is good for forecasting another one.

risk of individual firms may cancel out if indices for the industry are tested. Elyasiani, Kopecky and Choi (1992) and Wetmore and Brick (1994) studied the effect of exchange rate risk on stock returns of banks. Both studies found some indications of exchange rate risk and both agree that exchange rate risks vary over time. Wetmore and Brick (1994) indicated that a reduction in interest rate risk may accompany an increase in the exchange rate risk.

Most of the studies have used linear regression for their estimations Choi et.al (1992). Koch and Saporoschenko (2001) estimated a GARCH(1,1) volatility model to analyze the effect of both interest and exchange rate risk, but their sole point of focus was Japanese financial firms. This is quite similar to my model, though I focus on the German financial economy.

4.3 Interest Rate/Exchange Rate Effect on Stock Volatility

Prior research papers mainly concentrated on interest rate factors and invariably assumed constant variance, Stone (1974), Lane and Chance (1980), and Bae (1990). Choi et. al (1992) made a further contribution by including the exchange rate risk as well. With the advance and development in econometrics, the use of ARCH and GARCH-type models to take time variation into consideration in the conditional variance became frequent. Song (1994), Flannery et.al (1997), Mansur and Elyasiani (1998) used the ARCH and GARCH-type models. Mansur and Elyasiani (1998) were the first to analyze the bank return by using a GARCH-M model specification which means that the mean equation is directly affected by the conditional variance and by including it in the model as a time varying risk effect on the return. A similar set of model, guidelines and framework was adopted by Brewer et. al (2006) to analyze the equity values of insurance companies.

The multivariate GARCH approach is followed by Mansur and Elyasiani (2004). These and other researchers determine the sensitivity of bank stocks return in the United States in relation to the long term and short term interest rates. Multi-country studies on interest rate risk sensitivity include Flannery and Jane (1984); & Zarruk and Madura (1995). Exchange rate risk sensitivity is investigated by Gentry and Bodnar (1993) and Choi and Prasad (1995). Few studies combine interest rate and exchange rate risk (Choi et. al, 1992; Elyasiani and Choi, 1997; Joseph, 2003; and Koch and Saporoschenko, 2001).

Merton (1973) claimed that the sensitivity of stock returns to different types of risk can be somewhat justified in terms of risk repugnance: this basically means that an agent averse to risk would demand a higher return in the presence of risk factors other than those affiliated with the market portfolio.

The most significant part of the literature supports the arguments that interest rate fluctuations significantly affect stock return volatility. Vendor et al (2008) discussed stock return volatility using a multifactor model incorporating the interest rate factor and exchange rate factor in the settings of Istanbul. His study also concludes that exchange rate volatility directly affects market volatility whereas conditional volatility is directly related to interest rate volatility. The fact is clearly proven except for in the service industry. His conclusion was that changes in the interest rate do have an increasing effect on the technological sector and a decreasing effect on the financial sector with regard to volatility.

Fama (1981) explained that stock prices can be seen as the reflector of various variables such as exchange rate, interest rate, inflation and industrial production. Sack and Rigobon (2004) conclude that there is a negative relation between short term interest rate and stock price in NASDAQ. Another discovery which they made was that short-term interest rate has a significant and positive effect on the market's interest rates. While examining the factors contributing to unconditional volatility, macroeconomic variables such as short-term interest rate, growth in the GDP, and inflation, which were considered as being among the most important variables for explaining the increasing volatility of interest rates, are also seen to be a main cause of unconditional market volatility. The interest rate sensitivity of commercial bank stock returns has been the subject matter of substantial research.

Rizwan and Khan (2007) also discussed the role of changes in macroeconomic factors due to the recent developments in stock return volatility in Pakistan. They analyzed Pakistan´s equity market by looking at the exchange rate, interest rate, industrial production, and money supply as domestic macroeconomic variables and the 6-month LIBOR and Morgan Stanley Capital International (MSCI) All Countries World Index as global variables. With the implementation of EGARCH and VAR model approaches, they explained the varying importance of the macroeconomic variables in explaining the relationship between stock returns and volatility on the Karachi Stock Exchange, but did not discuss the contribution of each variable separately.

5. Results and Analysis

This section will present summarized tables over the coefficients of each model and financial sector and its relationship to each variable investigated in this paper. To see the complete detailed results of the Eviews output, please look at the appendix. This section will also include narrative discussion about the result and attempts to analytically interpret the output in the most useful way.

The Banking Sectors that will be represented in the tables below (along with the acronyms) are as follows: Commercial Banks (CB), Credit Corporations (CC), Landes Banks (LB), Mortgage Banks (MB), Regional Credit Corporations (RCC) and Saving Banks (SB).

The GARCH-M results will be presented first and then followed by the EGARCH results, both models will be presented showing short and long term interest rates. The coefficients within the tables will be in certain colors depending on their statistical significance. Statistical significance is associated with statistical hypothesis testing and Eviews is the instrument for testing the hypothesis:

$$H_0: \beta = 0$$
$$H_1: \beta \neq 0$$

The variable is called significant if we reject the H_0 to accept the H_1 and that can be done at different significance levels, which is defined by the following color codes:

ColorCodes	Confidence level
Red	> 15%,
Orange	> 5-15% *
Green	< 5% **
Black	Inconclusive

If the color is red the result is highly insignificant, which means that we cannot reject the possibility that the coefficient is equal to 0, and could thus have no effect at all in the estimation. The color is red if the p-value is over 0.15. If the p-value lies between the intervals of 0.05-0.15 it is noted by the color orange to indicate a quite high p-value. The green color indicates that the coefficient is highly significant, which means that the model clearly reveals some kind of effect of the variable. Across the board the color codes are quite generous in that sense that 0.05 and 0.05-0.15 are the confidence levels chosen. In case a reader is unable to interpret the color codes, I have also used a system with asterisks, where "*" is the 0.05-0.15 significance level and ** is the <0.05 significance level. Insignificance is indicated, on the other hand, by no asterisk. I choose more forgiving levels to ease the assumptions in order to facilitate the analysis. Black means that Eviews had problems when it tried to estimate the model, this error occurred with the financial sector of "Saving Banks" models (with GARCH-M) and this error message would appear *"WARNING: Singular covariance - coefficients are not unique".* On the other hand Eviews could not calculate consistent statistical results; these results will be presented but ignored during the analysis.

The reason behind having color codes as the main indicator of significance, is that it is more intuitively noticeable, from a personal point of view, although elevated asterisks were later added to facilitate a presentation of the paper in monochrome.

In order to ease the understanding of what each result in the tables represents, the econometric model will be presented again but this time focusing on explaining how each coefficient was derived. The mean equations that were used in both the GARCH-M and EGARCH estimation are as follows:

$$R_{it} = a + \beta_1 R_{mt} + \beta_2 R_{rt} + \beta_3 R_{et} + u_{it} \qquad (\mathbf{6})$$

The dependent variable of R_{it} represents the return of each banking sector (CB,CC…). The independent variables, the return of the market index R_{mt}, interest rates (long and short term) R_{rt}, the return of the exchange rate index R_{et} and their beta coefficients are all represented in the tables below as MKT, STINT/LTINT and FX. The coefficient of each GARCH effect will be explained in the section relating to each model.

5.1 GARCH-M

This section presents the results of the GARCH-M estimations of the mean equations in summarized tables with each financial banking sector in with regard to both long and short term interest rates.

$$\sigma_t^2 = a_0 + a_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad \mathbf{(7)}$$
$$R_{it} = a + \beta_1 R_{mt} + \beta_2 R_{rt} + \beta_3 R_{et} + \delta \sigma_{t-1} + u_{it} \qquad \mathbf{(8)}$$

Equation (8) is the specific GARCH-M equation for this paper. The GARCH effect included in the model and its coefficient δ is presented in the table as GARCH-M. Equation (7) is the equation where equation (8) receives its GARCH and ARCH effects. The coefficients of these effects are presented by a_1 (ARCH-effect) and β (GARCH-effect) in the equation and in the table as GARCH and ARCH. For a more thorough explanation please see section 2.3.1.

Summarized table over the coefficients of the GARCH-M estimations with the short term interest:

Financial Sectors	MKT	STINT	FX	GARCH-M	GARCH	ARCH
CB	-1.070181	-0.141654	-0.081206	0.499339**	0.764152**	-0.186805**
CC	0.418281	-0.632961*	0.032488	0.836222**	-0.330677	-0.25393**
LB	-0.115543	0.188768	-0.044474	0.066276	0.81208**	-0.162913**
MB	-0.269893	-0.864949	0.192899*	-0.798701**	0.032291	-0.151563**
RCC	1.241862	-1.1685*	-0.089429	-1.163019	0.755249*	-0.082945
SB	-2.866984	1.319903	0.128566	1.51954	8.231009	0.308129

Table 1

The table above unfortunately shows immense insignificance within the first three columns, which basically involves the mean equation. This could be interpreted as meaning that the current model does not explain the movement of the financial sectors very well. On the other hand the models do show that some kind of heteroskedasticity could be found in the model and that this is explained by the GARCH and GARCH-M effects. This is in parity with most of the previous research in which the volatility of stock returns is not constant over time.

The GARCH-M effects are significant for Commercial Banks (CB), Credit Corporations (CC) and Mortgage Banks (MB), which means that their conditional variance directly affects the mean equation.

The two sectors that show some response to the short term interest rate are Credit Corporations and Regional Credit Corporations. It could be expected that both would be affected in the same manner due to the similarities between the sectors. Although the significance level with the specific and general model is not sufficient to rely on for more thorough analysis. It's also interesting to note that the GARCH-M effects differ between the both sectors.

Because of the insignificance of the mean equations the results are quite unreliable and it is hard to draw any conclusion, but let's work under the veil of ignorance and ignore the insignificance problem. Then it could be stated that the least, and only positively, effected financial sector susceptible to volatility in the short term interest rate is the state-owned Landes Banks (LB), and the most (negatively) effected sector is the Regional Credit Corporations (RCC).

Summarized table over the coefficients of the GARCH-M estimations with the long term interest:

Financial Sectors	MKT	LTINT	FX	GARCH-M	GARCH	ARCH
CB	0.070287	2.17641	0.035616	0.489919*	0.827025**	-0.21443**
CC	-0.035726	-0.881781	-0.047632	0.58427*	0.095233	-0.233484**
LB	0.278351	-2.461693**	-0.161139*	-0.386501**	0.818101**	-0.168006**
MB	0.09997	1.326321	0.068863	0.817933	0.982585**	-0.004214
RCC	0.444138	1.23763	-0.079876	6.648222**	0.957857**	-0.008048
SB	-0.458729	1.365115	0.119111	1.909141	7.679477	0.292224

Table 2

It is noticeable that the model works slightly better with the long term interest rate than the short term interest rate, since out of the 15 GARCH values (ignoring the Saving Bank sector), 11 of these are significant compared to the 10 before (in the short term interest rate) so it has a slightly better explanatory value regarding heteroskedasticity effects.

The problem that the coefficients of the mean equation are insignificant recurs, which one might expect due to the previous results. Although the Landes Banks is explained best by the model, which maybe makes sense given that the state-owned German Banks are the financial banking sector best adjusted to the domestic economic environment. This could also be coincidence, because with so many insignificant results it is rather hard to draw absolute conclusions. It could, however, be a plausible explanation.

It is also interesting to note that the model with short term interest rate differs a lot from the model with long term interest rate regarding the Landes Bank sector. The reason for this is a bit unclear to me, but a theory might be that state-owned banks may have a tendency to work in a more long term economic perspective since governments usually focus on securing long term economic growth.

5.2 EGARCH

This section, will just like the previous one, briefly present the econometric models on which the results in the tables are based on. The EGARCH model is a more advanced conditional variance model that doesn't have non-negativity constraints but instead uses a logarithm model that frees the model from these constraints. The specific econometric model used for the EGARCH estimations is:

$$\ln(\sigma_t^2) = w + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + a \left[\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + u_t \qquad (\mathbf{9})$$

The EGARCH model resembles the GARCH-M model created from the residuals from the mean equations (5). The EGARCH effect is derived from the beta coefficient in the model and it is represented in the table as EGARCH. For a more thorough explanation of the model please see section 2.3.2.

Summarized table over the coefficients of the EGARCH estimations with the short term interest:

Financial Sectors	MKT	STINT	FX	EGARCH
CB	-0.253704	1.412044	-0.38735**	0.183173
CC	0.764512*	-0.75705**	0.001374	0.854072**
LB	-0.981211	0.758808	-0.0472	0.948632**
MB	0.937608	-1.125458	0.214944*	0.582374
RCC	1.622532	-1.36854*	-0.12821	-0.259463
SB	0.321398	0.040922	-0.008911	-0.989867**

Table 3

These tables regarding the EGARCH-model do show less beneficial results than the GARCH-M model since the insignificance level of the results has slightly increased. The same tendencies appear here, though in a weaker form, that the volatility of stock returns is not constant but varies over time, at least in 3 of the 6 sectors.

Credit Corporations do show significance in the regard of short interest rate and do show some tendencies to follow the market index. Regional Credit Corporations also indicates an relationship (although weaker than the previous CC sector) to the short interest rate. As mentioned before it seems logical since both of the sectors is in the same area of expertise.

But since the majority of the results are still insignificant it is difficult to draw any general conclusions, apart from concluding that this model is insufficient to explain the return of every financial sector in regard to short term interest rate.

Summarized table over the coefficients of the EGARCH estimations with the long term interest:

Financial Sectors	MKT	LTINT	FX	EGARCH
CB	0.702463	0.970347	-0.27911	-0.864005**
CC	-0.323469	-1.219459*	-0.07686*	0.422834*
LB	0.289206	-1.144821*	-0.106	0.556983**
MB	-0.27784	-1.827219	0.076477	0.762707**
RCC	0.188195	0.356733	-0.159778	-0.366588
SB	0.257192	-0.020522	-0.013643	-0.997225**

Table 4

Table 4 is a more interesting and satisfactory table in the sense that it shows quite clearly that a heteroskedasticity effect exists using the EGARCH model with regard to long term interest rate. On another note, it is interesting to observe that, just like the previous tables, the long term effects are significant to a greater extent than the short term interest rate. Only the Regional Credit Corporations do not show any response to the EGARCH heteroskedasticity effect.

Landes-Banks show once again some dependencies on the long term interest rate without showing any relationship in the short term. This may be a result of the previously mentioned theory that state-owned banks could act in with more regard for long term prognoses, since states usually aim for long term growth. The sector also shows significant EGARCH-effect.

Table 4 is also the only table that shows a clear difference between the two different credit sectors: whilst Credit Corporations do reveal the presence of a relationship, the Regional Credit Corporations do not.

Using the EGARCH-model, but not when using the GARCH-M model, Eviews was able to compute the Saving Banks sector, although the EGARCH model still does not show the sector in a significant relationship with regard to the mean equation, even though showing significant EGARCH effects. The analysis of time series often shows that kind of effect due to the nature of the data.

5.3 Summarized Analysis

The section is to summarize the analysis with the help of some secondary sources and previous research that were discussed in previous sections. The results struggle with insignificant results which make it hard to draw any direct and consistent conclusions in the analysis. Although facing this obvious problem there are still some interesting and expected results, namely that the paper finds that there are GARCH effects in most of the estimations which proves (setting aside the insignificance in the mean equations) that the volatility (risk) involving stock returns is not constant over time (heteroskedasticity).

Scott and Peterson (1986), along with other researchers, found that the interest rate has an effect on stock return, but in economics there are seldom absolute consensuses about the effects of variables on stock return. Chance and Lane (1980) did not find that the interest rate affected the stock return, but with that being said, it is widely known that variables such as interest rate may have this effect, while variables such as the exchange rate are more indecisive. Chance and Lane (1980), along with Lloyd and Shick (1977), also concluded that this outcome may be due to the fact that financial institutions in different economies may behave differently. Elyasiani, Kopecky and Choi (1992) and Wetmore and Brick (1994) found tendencies for the exchange rate to have an effect on the stock returns of banks, though other researchers did not.

Another interesting aspect that has been mentioned before is that the long term interest rate has better results in the sense of significance than the short interest rate. The rationale behind including long and short terms in various economic analyses has been quite taken for granted and the general notion within economics is that there can be some asymmetries between the two time periods. One of the most interesting things is that the sector Landes Banks shows a great disparity between the long term interest rate and the short term interest rate, where the long term model works significantly better than the short term. The reasons for this, as previously suggested, might be that state-owned banks put the focus on long term economic policies since governments usually want long term economic growth. These results must however be handled with care since there is a lot of insignificance in the overall results which can awaken suspicions.

An additional thing that was noticeable was that both the credit sectors usually followed each other, which intuitively makes sense since the sectors have large similarities due to their areas of expertise.

The insignificance can be caused by a bad model or by a set of bad data input or simply by the fact that there is no such relationship of effect by the interest rate and exchange rate within the different sectors of the German financial market. Although it may be quite easy to imagine a certain effect of interest rates and exchange rates on companies and different financial sectors, because interest rates affect the cost of loans (investments), which can be crucial for growth, especially for capital-intensive companies. Exchange rates could also be important for companies in the sense that they could highly affect the export and import of various goods. It is plausible that there is a difference between finding statistical significance among variables and finding tendencies among variables.

6. Conclusion

The main question this paper is trying to answer is if the volatility of interest and exchange rate do actually influence the volatility of stock returns of the financial institutions in Germany. This has been done by using a quite advanced (at least according to my preferences) multivariate model in which interest rate (both long and short term separately), exchange rate and the market index are used to try to explain different financial sectors in Germany. The GARCH-M (1.1) and EGARCH (1.1) models were used as the main equations to confirm whether the stock return volatility varies over time or if the variance is constant over time. This was done within a time period of ten years, namely 1998-2007.

The results are plagued by highly insignificant results from the mean equations and this caused unreliable conclusions. On the other hand it has been shown that there is some kind of conditional variance within the models using the GARCH-M and EGARCH models in regard to stock returns. Insignificance within the mean equation can be caused by a too complex model or by a bad set of data or by a lack of relationship between the explanatory variables and the dependent variables in question.

6.1 Further Research

There has been a substantial amount of research conducted in this area before, as you can see by looking at Chapter 2, but there is always room for more research. There is some disparity between the research conducted around the interest rate and the exchange rate, with the research on the exchange rate lagging slightly behind. This is due to the nature of the banking industry which makes the interest rate more interesting to consider. I still think that more research regarding the effect of the exchange rates on stock returns (of banks in particular) could be interesting because exchange rates play an increasingly important role in the economy due to globalization.

It is also important to note that economics is like many other subjects whose object of study changes over time. The economic climate of the world changes considerably over time, and it is therefore important to conduct continuous research within multiple areas (including this one) to keep the research up to date, thus making the subject more robust and trustworthy.

Continued research could involve trying another model that has a better explanatory value than the model which I have used. It could also include a case study of another country or of another time period, since this might be a good way to either find support for or deviations from my study. It would also involve different interest and exchange rate indexes.

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Appendix: Detailed Results

This appendix shows detailed results of the Eviews estimations for the use of the interested reader. There are a total of 6 different financial sectors and every sector is estimated by GARCH-M and EGARCH. Both methods are tested with long and short term interest rate separately. In total there are 24 different Eviews outputs.

GARCH-M (Short Term Interest)

Dependent Variable: RTNCB
Method: ML – ARCH
Date: 04/26/11 Time: 12:14
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 33 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.499339	0.172429	2.895914	0.0038
C	10.37614	11.93196	0.869609	0.3845
MKT	1.070181	1.943442	0.550663	0.5819
STINT	-0.141654	1.399843	-0.101193	0.9194
FX	-0.081206	0.129783	-0.625704	0.5315
	Variance Equation			
C	78.56114	18.06344	4.349180	0.0000
RESID(-1)^2	-0.186805	0.028890	-6.465969	0.0000
GARCH(-1)	0.764152	0.080888	9.446997	0.0000

R-squared	0.010140	Mean dependent var	11.76059
Adjusted R-squared	-0.052284	S.D. dependent var	14.41300
S.E. of regression	14.78498	Akaike info criterion	8.255623
Sum squared resid	24264.11	Schwarz criterion	8.442455
Log likelihood	-483.2096	Hannan-Quinn criter.	8.331489
F-statistic	0.162435	Durbin-Watson stat	2.133351
Prob(F-statistic)	0.991893		

Dependent Variable: RTNCC
Method: ML - ARCH
Date: 04/26/11 Time: 12:20
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 30 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.836222	0.291827	2.865476	0.0042
C	8.522130	3.174804	2.684301	0.0073
MKT	0.418281	0.441063	0.948346	0.3430
STINT	-0.632961	0.349731	-1.809848	0.0703
FX	0.032488	0.030840	1.053435	0.2921
	Variance Equation			
C	22.21046	5.284744	4.202750	0.0000
RESID(-1)^2	-0.253930	0.066198	-3.835896	0.0001
GARCH(-1)	-0.330677	0.240357	-1.375773	0.1689

R-squared	0.008661	Mean dependent var	11.93319
Adjusted R-squared	-0.053855	S.D. dependent var	3.746161
S.E. of regression	3.845714	Akaike info criterion	5.487848
Sum squared resid	1641.636	Schwarz criterion	5.674680
Log likelihood	-318.5270	Hannan-Quinn criter.	5.563715
F-statistic	0.138546	Durbin-Watson stat	2.074907
Prob(F-statistic)	0.995032		

Dependent Variable: RTNLB
Method: ML - ARCH
Date: 04/26/11 Time: 12:27
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 39 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.066276	0.499064	0.132801	0.8944
C	8.062181	8.441371	0.955080	0.3395
MKT	-0.115543	1.294128	-0.089283	0.9289
STINT	0.188768	0.844402	0.223552	0.8231
FX	-0.044474	0.079800	-0.557318	0.5773
	Variance Equation			
C	15.14729	9.381418	1.614605	0.1064
RESID(-1)^2	-0.162913	0.072503	-2.246995	0.0246
GARCH(-1)	0.812080	0.189683	4.281245	0.0000

R-squared	-0.009974	Mean dependent var	4.649244
Adjusted R-squared	-0.073666	S.D. dependent var	6.611103
S.E. of regression	6.850282	Akaike info criterion	6.646314
Sum squared resid	5208.826	Schwarz criterion	6.833146
Log likelihood	-387.4557	Hannan-Quinn criter.	6.722181
Durbin-Watson stat	1.918413		

Dependent Variable: RTNMB
Method: ML - ARCH
Date: 04/26/11 Time: 11:28
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Failure to improve Likelihood after 35 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-0.798701	0.318061	-2.511156	0.0120
C	1.566973	8.312926	0.188498	0.8505
MKT	-0.269893	1.037729	-0.260081	0.7948
STINT	-0.864949	0.823992	-1.049705	0.2939
FX	0.192899	0.110025	1.753232	0.0796
	Variance Equation			
C	89.66320	35.57376	2.520487	0.0117
RESID(-1)^2	-0.151563	0.023388	-6.480493	0.0000
GARCH(-1)	0.032291	0.411631	0.078447	0.9375

R-squared	0.046887	Mean dependent var	6.514790
Adjusted R-squared	-0.013220	S.D. dependent var	9.263352
S.E. of regression	9.324380	Akaike info criterion	7.292807
Sum squared resid	9650.790	Schwarz criterion	7.479639
Log likelihood	-425.9220	Hannan-Quinn criter.	7.368674
F-statistic	0.780062	Durbin-Watson stat	2.026159
Prob(F-statistic)	0.605323		

Dependent Variable: RTNRCC
Method: ML - ARCH
Date: 04/26/11 Time: 11:40
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 37 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-1.163019	2.702820	-0.430298	0.6670

C	27.36942	19.17259	1.427528	0.1534
MKT	1.241862	1.156316	1.073981	0.2828
STINT	-1.168500	0.803512	-1.454240	0.1459
FX	-0.089429	0.096794	-0.923909	0.3555
		Variance Equation		
C	15.11879	18.44890	0.819495	0.4125
RESID(-1)^2	-0.082945	0.094594	-0.876858	0.3806
GARCH(-1)	0.755249	0.417019	1.811067	0.0701

R-squared	0.063360	Mean dependent var	6.462689
Adjusted R-squared	0.004292	S.D. dependent var	7.017964
S.E. of regression	7.002887	Akaike info criterion	6.773659
Sum squared resid	5443.487	Schwarz criterion	6.960491
Log likelihood	-395.0327	Hannan-Quinn criter.	6.849526
F-statistic	1.072667	Durbin-Watson stat	2.038345
Prob(F-statistic)	0.385787		

Dependent Variable: RTNSB
Method: ML - ARCH
Date: 04/26/11 Time: 12:02
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 10 iterations
WARNING: Singular covariance - coefficients are not unique
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	1.519540	NA	NA	NA
C	-15.07297	NA	NA	NA
MKT	-2.866984	NA	NA	NA
STINT	1.319903	NA	NA	NA
FX	0.128566	NA	NA	NA
		Variance Equation		
C	-156.0219	NA	NA	NA
RESID(-1)^2	0.308129	NA	NA	NA
GARCH(-1)	8.231009	NA	NA	NA

R-squared	#######	Mean dependent var	13.32924
Adjusted R-squared	#######	S.D. dependent var	5.120293
S.E. of regression	1.10E+53	Akaike info criterion	123.3731
Sum squared resid	1.3E+108	Schwarz criterion	123.5599
Log likelihood	-7332.699	Hannan-Quinn criter.	123.4490
Durbin-Watson stat	0.443018		

E-GARCH (Short Run Interest)

Dependent Variable: RTNCB
Method: ML - ARCH
Date: 04/05/11 Time: 14:23
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 31 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	40.32425	16.90757	2.384982	0.0171
MKT	-0.253704	2.349815	-0.107967	0.9140
STINT	1.412044	1.675177	0.842922	0.3993
FX	-0.387350	0.173419	-2.233610	0.0255
	Variance Equation			
C(5)	4.109890	6.284067	0.654017	0.5131
C(6)	0.254402	0.325283	0.782093	0.4342
C(7)	0.055850	0.172347	0.324055	0.7459
C(8)	0.183173	1.187426	0.154260	0.8774

R-squared	0.023443	Mean dependent var	11.76059
Adjusted R-squared	-0.038142	S.D. dependent var	14.41300
S.E. of regression	14.68529	Akaike info criterion	8.262815
Sum squared resid	23938.02	Schwarz criterion	8.449647
Log likelihood	-483.6375	Hannan-Quinn criter.	8.338682
F-statistic	0.380656	Durbin-Watson stat	2.173661
Prob(F-statistic)	0.911967		

Dependent Variable: RTNCC
Method: ML - ARCH
Date: 04/05/11 Time: 14:21
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 42 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	14.14033	4.641500	3.046499	0.0023
MKT	0.764512	0.437609	1.747019	0.0806
STINT	-0.757050	0.157791	-4.797810	0.0000
FX	0.001374	0.042180	0.032564	0.9740

Variance Equation				
C(5)	0.721281	0.010161	70.98611	0.0000
C(6)	-0.407304	0.011923	-34.16057	0.0000
C(7)	-0.160934	0.116074	-1.386482	0.1656
C(8)	0.854072	8.23E-05	10373.14	0.0000

R-squared	-0.030909	Mean dependent var	11.93319
Adjusted R-squared	-0.095921	S.D. dependent var	3.746161
S.E. of regression	3.921717	Akaike info criterion	5.500854
Sum squared resid	1707.165	Schwarz criterion	5.687686
Log likelihood	-319.3008	Hannan-Quinn criter.	5.576720
Durbin-Watson stat	2.248637		

Dependent Variable: RTNLB
Method: ML - ARCH
Date: 04/05/11 Time: 14:25
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 10 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	7.347192	2.821130	2.604344	0.0092
MKT	-0.981211	0.855345	-1.147152	0.2513
STINT	0.758808	0.633509	1.197786	0.2310
FX	-0.047200	0.036618	-1.289002	0.1974
Variance Equation				
C(5)	0.241377	0.001497	161.2217	0.0000
C(6)	-0.092160	0.099479	-0.926429	0.3542
C(7)	0.329543	0.141520	2.328599	0.0199
C(8)	0.948632	0.019420	48.84907	0.0000

R-squared	0.003263	Mean dependent var	4.649244
Adjusted R-squared	-0.059594	S.D. dependent var	6.611103
S.E. of regression	6.805243	Akaike info criterion	6.609070
Sum squared resid	5140.557	Schwarz criterion	6.795902
Log likelihood	-385.2397	Hannan-Quinn criter.	6.684936
F-statistic	0.051918	Durbin-Watson stat	1.924915
Prob(F-statistic)	0.999795		

Dependent Variable: RTNMB
Method: ML - ARCH
Date: 04/05/11 Time: 14:27
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 21 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	-9.635045	11.12497	-0.866074	0.3864
MKT	0.937608	1.543683	0.607384	0.5436
STINT	-1.125458	0.998451	-1.127204	0.2597
FX	0.214944	0.122112	1.760218	0.0784
		Variance Equation		
C(5)	2.021216	2.009816	1.005673	0.3146
C(6)	-0.240000	0.234387	-1.023946	0.3059
C(7)	-8.26E-05	0.106858	-0.000773	0.9994
C(8)	0.582374	0.433426	1.343651	0.1791

R-squared	0.038290	Mean dependent var	6.514790
Adjusted R-squared	-0.022358	S.D. dependent var	9.263352
S.E. of regression	9.366334	Akaike info criterion	7.360121
Sum squared resid	9737.832	Schwarz criterion	7.546953
Log likelihood	-429.9272	Hannan-Quinn criter.	7.435987
F-statistic	0.631351	Durbin-Watson stat	2.176081
Prob(F-statistic)	0.729082		

Dependent Variable: RTNRCC
Method: ML - ARCH
Date: 04/05/11 Time: 14:27
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 38 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	23.42920	8.169537	2.867874	0.0041
MKT	1.622532	1.069691	1.516823	0.1293
STINT	-1.368540	0.761068	-1.798183	0.0721
FX	-0.128210	0.086026	-1.490362	0.1361
		Variance Equation		
C(5)	4.829573	3.586931	1.346436	0.1782
C(6)	-0.039350	0.390983	-0.100644	0.9198

C(7)	-0.209876	0.173585	-1.209066	0.2266
C(8)	-0.259463	0.916654	-0.283055	0.7771

R-squared	0.052381	Mean dependent var	6.462689
Adjusted R-squared	-0.007379	S.D. dependent var	7.017964
S.E. of regression	7.043809	Akaike info criterion	6.785904
Sum squared resid	5507.293	Schwarz criterion	6.972736
Log likelihood	-395.7613	Hannan-Quinn criter.	6.861771
F-statistic	0.876523	Durbin-Watson stat	1.993765
Prob(F-statistic)	0.527532		

Dependent Variable: RTNSB
Method: ML - ARCH
Date: 04/05/11 Time: 14:28
Sample (adjusted): 1998M02 2007M12
Included observations: 119 after adjustments
Convergence achieved after 58 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	12.57378	6.884598	1.826364	0.0678
MKT	0.321398	0.709262	0.453145	0.6504
STINT	0.040922	0.483721	0.084598	0.9326
FX	-0.008911	0.069144	-0.128879	0.8975
		Variance Equation		
C(5)	6.410685	0.443055	14.46929	0.0000
C(6)	0.131158	0.243871	0.537819	0.5907
C(7)	0.031614	0.106689	0.296322	0.7670
C(8)	-0.989867	0.071941	-13.75940	0.0000

R-squared	0.000524	Mean dependent var	13.32924
Adjusted R-squared	-0.062506	S.D. dependent var	5.120293
S.E. of regression	5.277892	Akaike info criterion	6.182450
Sum squared resid	3092.032	Schwarz criterion	6.369282
Log likelihood	-359.8558	Hannan-Quinn criter.	6.258317
F-statistic	0.008316	Durbin-Watson stat	1.983913
Prob(F-statistic)	1.000000		

GARCH-M (Long Run Interest)

Dependent Variable: RTNCB
Method: ML - ARCH
Date: 04/26/11 Time: 12:17
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 17 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.489919	0.300641	1.629584	0.1032
C	-10.72089	35.03526	-0.306003	0.7596
MKT	0.070287	1.314854	0.053456	0.9574
LTINT	2.176410	2.670321	0.815037	0.4151
FX	0.035616	0.253952	0.140246	0.8885
	Variance Equation			
C	81.60651	12.15901	6.711609	0.0000
RESID(-1)^2	-0.214430	0.004673	-45.88294	0.0000
GARCH(-1)	0.827025	0.067916	12.17725	0.0000

R-squared	0.004002	Mean dependent var	11.62950
Adjusted R-squared	-0.058248	S.D. dependent var	14.42397
S.E. of regression	14.83811	Akaike info criterion	8.192167
Sum squared resid	24658.97	Schwarz criterion	8.377999
Log likelihood	-483.5300	Hannan-Quinn criter.	8.267634
F-statistic	0.064290	Durbin-Watson stat	2.158735
Prob(F-statistic)	0.999583		

Dependent Variable: RTNCC
Method: ML - ARCH
Date: 04/26/11 Time: 12:24
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 32 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.584270	0.376741	1.550852	0.1209
C	18.59685	10.01218	1.857423	0.0633
MKT	-0.035726	0.308580	-0.115775	0.9078
LTINT	-0.881781	0.778607	-1.132511	0.2574
FX	-0.047632	0.064289	-0.740910	0.4587
	Variance Equation			

C	15.61073	6.784729	2.300864	0.0214
RESID(-1)^2	-0.233484	0.084847	-2.751826	0.0059
GARCH(-1)	0.095233	0.430203	0.221368	0.8248

R-squared	0.016204	Mean dependent var	11.94075
Adjusted R-squared	-0.045283	S.D. dependent var	3.731306
S.E. of regression	3.814853	Akaike info criterion	5.529294
Sum squared resid	1629.948	Schwarz criterion	5.715127
Log likelihood	-323.7576	Hannan-Quinn criter.	5.604762
F-statistic	0.263540	Durbin-Watson stat	2.206355
Prob(F-statistic)	0.966670		

Dependent Variable: RTNLB
Method: ML - ARCH
Date: 04/26/11 Time: 11:22
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 63 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	-0.043100	0.026648	-1.617401	0.1058
C	34.41497	13.27955	2.591576	0.0096
MKT	0.363943	0.831838	0.437517	0.6617
LTINT	-2.528916	1.041482	-2.428190	0.0152
FX	-0.166823	0.097828	-1.705269	0.0881
		Variance Equation		
C	14.90784	7.351633	2.027828	0.0426
RESID(-1)^2	-0.170809	0.036456	-4.685299	0.0000
GARCH(-1)	0.820679	0.157894	5.197675	0.0000

R-squared	-0.004459	Mean dependent var	4.633833
Adjusted R-squared	-0.067238	S.D. dependent var	6.585430
S.E. of regression	6.803225	Akaike info criterion	6.597367
Sum squared resid	5183.793	Schwarz criterion	6.783200
Log likelihood	-387.8420	Hannan-Quinn criter.	6.672835
Durbin-Watson stat	1.793598		

Dependent Variable: RTNMB
Method: ML - ARCH
Date: 04/26/11 Time: 11:27
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 161 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	13.22954	16.17435	0.817933	0.4134
C	-127.2567	156.2376	-0.814507	0.4154
MKT	0.099970	1.353291	0.073872	0.9411
LTINT	1.326321	3.331976	0.398058	0.6906
FX	0.068863	0.347000	0.198454	0.8427
	Variance Equation			
C	1.199744	6.380267	0.188040	0.8508
RESID(-1)^2	0.004214	0.007666	0.549675	0.5825
GARCH(-1)	0.982585	0.074151	13.25118	0.0000

R-squared	0.077553	Mean dependent var	6.505000
Adjusted R-squared	0.019901	S.D. dependent var	9.224971
S.E. of regression	9.132719	Akaike info criterion	7.331351
Sum squared resid	9341.535	Schwarz criterion	7.517183
Log likelihood	-431.8810	Hannan-Quinn criter.	7.406818
F-statistic	1.345178	Durbin-Watson stat	2.205937
Prob(F-statistic)	0.235852		

Dependent Variable: RTNRCC
Method: ML - ARCH
Date: 04/26/11 Time: 11:43
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 17 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	6.648222	0.702701	9.460958	0.0000
C	-37.29736	5.743643	-6.493677	0.0000
MKT	0.444138	1.105089	0.401902	0.6878
LTINT	1.237630	1.398106	0.885219	0.3760
FX	-0.079876	0.084886	-0.940982	0.3467
	Variance Equation			
C	1.547380	5.162775	0.299719	0.7644
RESID(-1)^2	0.008048	0.015020	0.535853	0.5921
GARCH(-1)	0.957857	0.115440	8.297474	0.0000

R-squared	0.058824	Mean dependent var	6.456667
Adjusted R-squared	0.000001	S.D. dependent var	6.988726
S.E. of regression	6.988724	Akaike info criterion	6.794369
Sum squared resid	5470.333	Schwarz criterion	6.980202
Log likelihood	-399.6621	Hannan-Quinn criter.	6.869836
F-statistic	1.000012	Durbin-Watson stat	2.020596
Prob(F-statistic)	0.435170		

Dependent Variable: RTNSB
Method: ML - ARCH
Date: 04/05/11 Time: 14:38
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 70 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1)

	Coefficient	Std. Error	z-Statistic	Prob.
C	15.27063	13.92270	1.096815	0.2727
MKT	0.348985	0.473816	0.736541	0.4614
LTINT	-0.261113	1.070795	-0.243850	0.8073
FX	-0.019799	0.094100	-0.210404	0.8334
	Variance Equation			
C	25.82478	88.87411	0.290577	0.7714
RESID(-1)^2	0.082212	0.221183	0.371691	0.7101
GARCH(-1)	-0.082155	3.413198	-0.024070	0.9808

R-squared	0.002856	Mean dependent var	13.29450
Adjusted R-squared	-0.050090	S.D. dependent var	5.112919
S.E. of regression	5.239407	Akaike info criterion	6.203687
Sum squared resid	3102.006	Schwarz criterion	6.366290
Log likelihood	-365.2212	Hannan-Quinn criter.	6.269721
F-statistic	0.053945	Durbin-Watson stat	1.977778
Prob(F-statistic)	0.999344		

E-GARCH (Long Run Interest)

Dependent Variable: RTNCB
Method: ML - ARCH
Date: 04/05/11 Time: 14:39
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 33 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	31.10950	38.42410	0.809635	0.4181
MKT	0.702463	1.474599	0.476375	0.6338
LTINT	0.970347	3.053486	0.317783	0.7506
FX	-0.279110	0.267359	-1.043952	0.2965
	Variance Equation			
C(5)	9.680474	0.763736	12.67516	0.0000
C(6)	0.263817	0.166591	1.583623	0.1133
C(7)	0.073617	0.062965	1.169186	0.2423
C(8)	-0.864005	0.113964	-7.581394	0.0000

R-squared	0.020038	Mean dependent var	11.62950
Adjusted R-squared	-0.041210	S.D. dependent var	14.42397
S.E. of regression	14.71817	Akaike info criterion	8.244528
Sum squared resid	24261.96	Schwarz criterion	8.430360
Log likelihood	-486.6717	Hannan-Quinn criter.	8.319995
F-statistic	0.327157	Durbin-Watson stat	2.237029
Prob(F-statistic)	0.940223		

Dependent Variable: RTNCC
Method: ML - ARCH
Date: 04/05/11 Time: 14:41
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 6 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	26.19432	7.675920	3.412531	0.0006
MKT	-0.323469	0.486901	-0.664343	0.5065
LTINT	-1.219459	0.722751	-1.687247	0.0916
FX	-0.076860	0.049291	-1.559316	0.1189

Variance Equation

C(5)	1.850703	0.846128	2.187260	0.0287
C(6)	-0.357068	0.277254	-1.287872	0.1978
C(7)	-0.153042	0.195723	-0.781927	0.4343
C(8)	0.422834	0.287850	1.468939	0.1418

R-squared	-0.001836	Mean dependent var	11.94075
Adjusted R-squared	-0.064450	S.D. dependent var	3.731306
S.E. of regression	3.849671	Akaike info criterion	5.550621
Sum squared resid	1659.836	Schwarz criterion	5.736454
Log likelihood	-325.0373	Hannan-Quinn criter.	5.626089
Durbin-Watson stat	2.328296		

Dependent Variable: RTNLB
Method: ML - ARCH
Date: 04/05/11 Time: 15:06
Sample: 1998M01 2007M12
Included observations: 120
Failure to improve Likelihood after 9 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	20.11759	10.78463	1.865395	0.0621
MKT	0.289206	0.461211	0.627059	0.5306
LTINT	-1.144821	0.707634	-1.617814	0.1057
FX	-0.106000	0.075602	-1.402080	0.1609
	Variance Equation			
C(5)	2.037213	0.748947	2.720101	0.0065
C(6)	-0.512161	0.283393	-1.807245	0.0707
C(7)	0.297264	0.158789	1.872068	0.0612
C(8)	0.556983	0.176350	3.158395	0.0016

R-squared	-0.012832	Mean dependent var	4.633833
Adjusted R-squared	-0.076134	S.D. dependent var	6.585430
S.E. of regression	6.831519	Akaike info criterion	6.609226
Sum squared resid	5227.002	Schwarz criterion	6.795058
Log likelihood	-388.5535	Hannan-Quinn criter.	6.684693
Durbin-Watson stat	1.902065		

Dependent Variable: RTNMB
Method: ML - ARCH
Date: 04/05/11 Time: 15:05
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 86 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	8.698991	26.09926	0.333304	0.7389
MKT	-0.277840	0.998472	-0.278265	0.7808
LTINT	-1.827219	2.352589	-0.776684	0.4373
FX	0.076477	0.161686	0.472995	0.6362
		Variance Equation		
C(5)	1.173054	1.134736	1.033768	0.3012
C(6)	-0.162514	0.148122	-1.097163	0.2726
C(7)	0.024545	0.097429	0.251924	0.8011
C(8)	0.762707	0.249462	3.057406	0.0022

R-squared	0.027948	Mean dependent var	6.505000
Adjusted R-squared	-0.032805	S.D. dependent var	9.224971
S.E. of regression	9.375065	Akaike info criterion	7.357729
Sum squared resid	9843.887	Schwarz criterion	7.543562
Log likelihood	-433.4637	Hannan-Quinn criter.	7.433197
F-statistic	0.460021	Durbin-Watson stat	2.159194
Prob(F-statistic)	0.861455		

Dependent Variable: RTNRCC
Method: ML - ARCH
Date: 04/05/11 Time: 15:05
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 13 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	19.84922	20.41852	0.972118	0.3310
MKT	0.188195	0.688935	0.273168	0.7847
LTINT	0.356733	1.733663	0.205768	0.8370
FX	-0.159778	0.129862	-1.230370	0.2186
		Variance Equation		
C(5)	5.235281	3.287716	1.592376	0.1113
C(6)	0.013335	0.366628	0.036371	0.9710

C(7)	-0.184330	0.164218	-1.122466	0.2617
C(8)	-0.366588	0.834343	-0.439373	0.6604

R-squared	0.026791	Mean dependent var	6.456667
Adjusted R-squared	-0.034035	S.D. dependent var	6.988726
S.E. of regression	7.106662	Akaike info criterion	6.806510
Sum squared resid	5656.521	Schwarz criterion	6.992343
Log likelihood	-400.3906	Hannan-Quinn criter.	6.881978
F-statistic	0.440448	Durbin-Watson stat	1.950571
Prob(F-statistic)	0.874763		

Dependent Variable: RTNSB
Method: ML - ARCH
Date: 04/05/11 Time: 15:06
Sample: 1998M01 2007M12
Included observations: 120
Convergence achieved after 40 iterations
Presample variance: backcast (parameter = 0.7)
LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(7)
*RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
C	14.19400	12.09145	1.173888	0.2404
MKT	0.257192	0.429916	0.598238	0.5497
LTINT	-0.020522	0.935677	-0.021932	0.9825
FX	-0.013643	0.081977	-0.166419	0.8678
		Variance Equation		
C(5)	6.219389	0.487186	12.76594	0.0000
C(6)	0.070744	0.155428	0.455153	0.6490
C(7)	-0.002288	0.098912	-0.023131	0.9815
C(8)	-0.997225	0.053698	-18.57087	0.0000

R-squared	-0.000746	Mean dependent var	13.29450
Adjusted R-squared	-0.063292	S.D. dependent var	5.112919
S.E. of regression	5.272242	Akaike info criterion	6.198870
Sum squared resid	3113.212	Schwarz criterion	6.384703
Log likelihood	-363.9322	Hannan-Quinn criter.	6.274338
Durbin-Watson stat	1.971564		