LUND UNIVERSITY
School of Economics and Management

BUSM36 – DEGREE PROJECT

Spring 2011

DETERMINANTS OF INTEREST RATE EXPOSURE

A STUDY OF EUROZONE BANKS

Advisor:

Lars Oxelheim

Authors:

Markus Jarnér

Thuy Nguyen

ABSTRACT

Title	Determinants of interest rate exposure – A study of Eurozone banks
Seminar date	2011-06-01
Course	BUSM36, Degree Project Master level in Corporate and Financial Management, Business Administration Master level, 15 University Credit Points (15 ECTS)
Authors	Markus Jarnér and Thuy Nguyen
Advisor	Lars Oxelheim
Key words	Interest rate risk, Eurozone, banking industry, stock returns, balance sheet characteristics
Purpose	The purpose of this thesis is to investigate to what extent Eurozone banks are exposed to interest rates risk caused by adverse changes in short-term and long-term interest rates. Moreover, we aim towards determining what characteristics of Eurozone banks that affect their interest rate exposure.
Methodology	A quantitative approach using multiple regression analysis and panel data.
Theoretical framework	The theoretical framework provides understanding about interest rate risks, i.e. sources as well as traditional measurements of interest rate risk in banks. Furthermore, we present a general understanding about banks' characteristics, their operations and an overview of the evolution of the European banking industry. Finally, we provide a review of previous empirical studies regarding the relationship between banks' stock returns and interest rate fluctuations as the measurement of banks' interest rate risks and its determinants, based on easily accessible accounting data.
Empirical framework	A sample containing 38 listed Eurozone banks during the time period of 2002-2010.
Conclusions	Our findings show that Eurozone banks indicate a considerable degree of interest rate exposure, significantly positive with short-term interest rate movements and negative with long-term interest movements. The on-going crisis period of 2007-2010 displays a more intense interest rate risk as a consequence of an unstable and volatile interest rate environment. In addition, other than bank capital, other investigated ratios appear to be different as testing against bank interest rate sensitivity to different interest rates. The most interesting finding is regarding the impact of size to banks' interest rate sensitivity, in particular negative to short-term interest rate and positive to long-term interest rate movements.

TABLE OF CONTENTS

1. Introduction 1

1.1 Background 1

1.2 Problem discussion 2

1.3 Purpose 5

1.4 Delimitations 5

1.5 Thesis outline 5

2. Theoretical framework 7

2.1 Interest rate risk and banks 7

2.1.1 Sources of interest rate risk 7

2.1.2 Interest rate risk measurements in banks 9

2.2 Bank characteristics 10

2.2.1 The European banking industry 11

2.3 Evidence from empirical research 13

2.4. Summary of previous empirical studies 17

3. Methodology 18

3.1 Research approach 18

3.2 Data collection 19

3.2.1 Sample 20

3.2.2 Excluded observations 22

3.3 Regression model 22

3.4.1 Dependent variables 24

3.4.2 Independent and control variables 24

3.5 Summary of regression models and expectations 27
3.6 Comments on the regression models – a robustness check 28
3.7 Methodological discussion 29
3.7.1 Validity 29
3.7.2 Reliability 30
4. Empirical findings 31
4.1 Estimation of interest rate sensitivity 31
4.1.1 Descriptive statistics for the whole period 33
4.1.2 Descriptive statistics for divided period 34
4.2 Estimation of interest rate risk determinants 36
4.2.1 Short-term interest rate 37
4.2.2 Long-term interest rate 39
5. Analysis and discussion 41
5.1 Interest rate sensitivity 41
5.1.1 The variation of interest rate sensitivity across Eurozone banks 42
5.1.2 The variation of interest rate sensitivity across time 43
5.2 Determinants of banks' interest rate exposure 44
5.2.1 Determinants of banks' interest rate exposure – the similarities 44
5.2.2 Determinants of banks' interest rate exposure – the differences 46
6. Conclusions 48
6.1 Suggestions for further research 50
References 52
Appendix 1 56

1. INTRODUCTION

In this introductory chapter the background and motives of research topic chosen will be presented. This will be followed by a problem discussion that forms the purpose and research questions, which are the foundation of the thesis. The chapter ends with delimitations and a thesis outline.

1.1 Background

When the American company Lehman Brothers, one of the world's biggest banks, filed for bankruptcy in September 2008, the recent financial market crisis was a fact as the global economy went into recession. Commercial banks around the world were negatively affected and many of them were forced to be bailed out by their governments. However, in the aftermaths of the crisis, the European Union saw yet another financial crisis, when a sovereign debt crisis hit the region. Government deficits and debt levels have skyrocketed and European government debts have been downgraded, leading to a widespread concern about the future of the euro collaboration with one common currency.

In January 2002, euro banknotes and coins were put into circulation as the common currency in 12 out of 15 membership countries within the European Union. From then on, the European Central Bank's (ECB) monetary policy has played a significant role in these countries, as their monetary policies should act in accordance to ECB's policy. While the primary objective of ECB's monetary policy is to maintain price stability and keep inflation rates low, it must not favor specific nations. Instead, ECB has to act from an area-wide perspective and take actions for the monetary union as a whole. As ECB possesses monopoly power over the issuing of euro currency, they are able to set interest rates themselves, in particular EURIBOR short-term interest rates and government benchmark bond yields (ECB website). Consequently, banks are the first actors in the economy influenced by changes in ECB's interest rate policy.

Acting as financial intermediaries, banks are heavily exposed to a wide range of interest rate risks, which are closely related to business cycles. Since 2002, the market has experienced both

economic booms as well as severe recessions. To meet these fluctuations in the economy, and to keep price stability and inflation rates on steady levels, central banks worldwide have to constantly adjust their steering interest rates, i.e. the interest rates that commercial banks can borrow and lend at. When the financial crisis hit the economy in 2008, many central banks responded by lowering their interest rates to extreme levels close to zero percent, creating an abnormal interest rate risk environment (Vannerem & Iyer, 2010). Hence, as the recent turmoil spreads out and interest rates make drastic movements, it is interesting to especially look at to what extent this affects banks. Since banks are very exposed to unanticipated changes in interest rates, it would mean that it is vital for bank managers to rapidly react and to be prepared for both increases in rates as well as decreases. As an investor in a bank, it is likewise of interest to question if the return on a bank's equity is sensitive to changes in interest rates and how.

1.2 Problem discussion

The banking business used to be a relatively simple business compared to its current form today (Buehler & Santomero 2008). With rather stable interest rates, the rule of thumb is to lend at interest rates that are higher than the rates banks are able to borrow at, thus making these interest rate gaps the primary source of profitability to any bank. Examples can be seen in heavily regulated environments of interest rates prevailing before and during the 1970's, when U.S bankers used to work in accordance with the 3-6-3 rule, which meant holding deposits at 3%, lending at 6% and playing golf at 3 p.m. (Adam 2007, p. 6). The interest rate risk was not much of an issue, but suddenly things changed. The shift of monetary policy focus from stable interest rates to a more controlling policy aggregated in the 1980's and led to an increase in interest rate volatility, which was historically high relative to previous decades (Buehler & Santomero 2008). The banking industry had for the first time run into serious problems due to these volatile movements in interest rates. In response to the turmoil of the 1980s, many researchers started to investigate the asset and liability management in banks as well as the sensitivity of banks' stock returns to interest rate movements.

Within the research field of interest rate risk in the banking industry, there is a vast number of empirical studies investigating the linkage between banks' stock returns and interest rate movements. Flannery & James' (1984) study is among the first that resulted in a significantly

negative relationship between interest rate movements and banks' stock returns in the United States. Following this, other countries or regions in different time spans have been studied by Booth et al. (1985), Bae (1990), Kwan (1991) and Fraser et al. (2002) among others, and have a quite similar conclusion, i.e. all reporting a negative relationship between the bank stocks' returns and interest rate movements. However, the question regarding the determinants of banks' interest rate sensitivity is to our knowledge much less investigated (Ballester et al., 2009).

Empirical studies regarding banks' interest rate sensitivity determinants have quite recently been published, with Drakos (2001) and Fraser et al. (2002) as the pioneers. They provide evidence that bank characteristics do have effects on banks' interest rate sensitivity. Among them, banks' working capital, financial leverage, non-interest income, demand deposits and loans exhibit the most significant correlation with banks' stock returns. The following research further extends the set of determinants into a broader range, but some still present contradictive results. For example, the traditional pattern of interest rate exposure is a negative relationship between banks' stock returns and interest rate movements, e.g. in Booth et al. (1985), Bae (1990), Kwan (1991) and Fraser et al. (2002). However, more recent research somehow display a different interest rate risk in bank. In particular, Ballester et al. (2009), while studying 23 Spanish banks, found a significant positive relationship with changes in the Spanish interbank 3-month interest rate, whereas Au Yong et al. (2009) found a negative relationship while testing with the short-term interest rate, but a positive relationship with the long-term interest rate sensitivity in Asian-Pacific banks. Thus, possibly banks' interest rate exposure has changed as the result of a new interest rate environment as well as new settings. Besides, regarding the size of banks, Fraser's et al. (2002) study acknowledges no significant correlation with U.S. banks' interest rate sensitivity, while Saporoschenko (2002) report a significantly positive effect on size in Japanese banks. One possible explanation is that there are significant differences between the Japanese and the American markets that challenge the applicability of all determinants from one country to another. Thus, the universality of banks' interest rate sensitivity determinants should be questioned. Likewise, if the focus shifts to the European market, results might differ about either different determinants of banks' interest rate sensitivity or the magnitude of the effects. While the effects of interest rate movements on American banks are well documented, the effects on banks in other countries and regions are less investigated. Some of the previous efforts have

aimed at investigating interest rate exposure in some other countries, e.g. Saporoschenko (2002) about Japan, Ballester et al. (2009) about Spain or in the Asian-Pacific countries as Au Yong et al. (2009) did, but to our knowledge none of them actually investigate the Eurozone countries simultaneously.

This study aims at filling some of the gaps in previous empirical research, thus being able to contribute to the literature and research of banks' interest rate exposure. In particular, the study is different from previous research for two important reasons. First, the study aims to focus on the countries within the Eurozone as a whole, of which we believe that the results will be quite different as the regulations, integration and most importantly the role of ECB as the central bank, embrace many countries simultaneously. The integration of the Eurozone is quite dynamic, especially after the introduction of the euro in 2002, however, the process somehow is slow since many governments still want to retain their autonomy as noted by Goddard et al., (2007), and thus the results obtained can be quite diverse and different across countries. Besides, as previously mentioned, ECB can be considered as the central bank of central banks in any European Economic and Monetary Union (EMU) membership country. Thus, their adjustments of interest rates might be made in different patterns compared to the United States or in Asian countries. Secondly, the time span that we aim to study is the period between 2002 and 2010, which according to us captures most features of one dramatic economic cycle. More than that, the interest rate environment during this time has never been this turbulent before. The 10-year benchmark bond yield was at the historical low, 3.15%, in September 2005 while the EURIBOR 1-year rate was lowered to 1.21% in March 2010 (see ECB website), creating space for an abnormal interest rate risk environment (Vannerem & Iyer, 2010). Taking these two contextual differences into consideration, we hope to contribute through interesting findings about the pattern of banks' interest rate sensitivity and its determinants in the Eurozone. To keep a bank sound and safe, it is vital that the risk management process in the bank is effective, thus maintaining the interest rate risk within sensible levels. As the changes in interest rates are out of banks' control, bank characteristics may affect their interest rate exposure. By adjusting these ratios, banks will be able to control their exposure, thus help improving their position in the current turmoil that would not otherwise be easily overcome.

1.3 Purpose

The aim of this thesis is to investigate the Eurozone banks' stock sensitivity to movements in interest rates and the factors affecting this sensitivity, and to what extent the trade-off or the correlation between banks' interest rate risk exposure and stock returns are.

Two questions have been formulated to support the purpose of the thesis:

- How significant is the sensitivity of European banks' stock returns to changes in interest rates?
- What are the determinants of the cross-sectional variation of interest rate sensitivity across Eurozone banks?

1.4 Delimitations

The feature of this study is to find how movements in interest rates affect certain banks as well as the impact of banks' characteristics on its interest rate risk. Even though we acknowledge that hedging activities express a strong and direct relationship with banks' interest rate exposure, however, given the time limit this thesis will not be able to account for banks' hedging activities and its influence on banks' interest rate risk. Off-balance sheet and hedging activities are not included in the financial statements and would demand a rigorous review of each bank's annual report. Besides, due to the vast number of banks within the Eurozone, this thesis will only consider the largest ones and the banks that are included in the EURO STOXX® TMI Banks Index. Furthermore, only banks in countries that adopted the Euro currency in 2002 will be investigated to maintain the consistence of the thesis.

1.5 Thesis outline

The second chapter of the thesis presents a literature review and clarifies the relevant theoretical framework that is the basis of the purpose, with a focus on interest rate risk. Chapter 3 contains the methodological framework that supports the thesis, where the approach, data collection and a methodological discussion are presented and evaluated. The fourth chapter will describe the empirical findings generated from the study by using regression models. Finally, Chapter 5 will

give an analysis and discussion about the empirical findings, while the sixth chapter summarizes the findings and presents the conclusions.

2. THEORETICAL FRAMEWORK

This chapter provides a comprehensive summary and literature review of previous studies on the subject. First, the theories of interest rate risk and exposure will be clarified and how banks manage these risks. Furthermore, the European banking industry will briefly be revised and the chapter ends with a review of previous empirical findings within the subject.

2.1 Interest rate risk and banks

Interest rate risk refers to the risk that the relative value of an interest-bearing liability or asset will change due to a change in interest rate levels. In general, this is a major risk to bondholders because if interest rates increase, the value of the bond itself will decrease due to the growing opportunity cost of holding the bond. In the case of a bank, interest rate risk is quite principally different from the case of bondholders, who only are subject to the risk if interest rates increase. As banks play the role as market intermediaries, they differ from non-financial corporations mainly in the sense that commercial banks borrow in order to lend. Their assets and liabilities are often customer products, of which the revenue and costs are interest rate driven, hence banks will be more exposed to interest rate movements (Culp 2002, p. 248). Thus, in a more specific way, *"interest rate exposure could be defined as the risk that the amount of net interest income obtainable at unchanged interest rates may not be attained given an adverse change in market interest rates"* (Oesterreichische Nationalbank, 2008). For instance, earnings from lending activities will see a decline in value if interest rates decline while borrowing costs will be higher if interest rates increase. Apparently, interest rate movements are not only about the negative aspect, movements might as well be positive, thus, wherever risk appears, chances of gains appear as well (Bessis 2002, p. 18). The question for banks is therefore how to take advantage of interest rate changes rather than being beaten down by them.

2.1.1 Sources of interest rate risk

A bank's assets and liabilities are structurally exposed to three different types of mismatches in terms of maturity, volume and interest rate references, which make banks exposed to interest rate

risk in several ways. Sharma (2008, pp. 338-340) classifies sources of interest rate risk into five categories, including re-pricing risk, yield curve risk, basic risk, embedded option and re-investment risk. However, considering the significance of these sources and the guidance on the Basel Accord framework, the classification narrows it down to four sources – yield curve risk, re-pricing risk, basic risk and embedded option risk, which will briefly be described below.

The first interest rate source worth mentioning is re-pricing risk. As banks' assets and liabilities at some time in the future have rates reset in accordance to some market rate references like LIBOR or EURIBOR, a bank's earnings are subject to re-pricing risk (Bessis 2002, p. 18). While re-pricing risk is fundamental to the banking business per se, bank value and income will be exposed to unanticipated fluctuations as interest rates vary (Basel Committee on Banking Supervision, 2004). For instance, as banks principally finance their long-term fixed rate loans with short-term floating rate deposits, future income might experience a decline in value if interest rates increase.

Yield curve risk is the risk arising from adverse changes in the yield curve, which represents the entire range of market interest rates across all maturities (Bessis 2002, p. 151). Due to re-pricing mismatches, banks become more exposed to risks derived from the changes of the slope and the shape of the yield curve. Particularly, yield curve risk materializes when a bank's income is adversely affected by unanticipated shifts in the yield curve. Often, banks are able to hedge against yield curve risks. For example, if a bank holds a long position in 10-year maturity bonds, it could hedge by taking a short position in 5-year notes. However, there will not be any perfect hedge for banks if the interest rate environment is unstable. In this case, if the yield curve increases, the value of longer-maturity instruments might still be able to sharply decline, resulting in a loss for the bank (van Greuning & Brajovic Bratanovic 2009, p. 231).

Basic risk is another name for spread risk. As banks' assets and liabilities often are priced according to different yield curves such as LIBOR or EURIBOR, they are re-priced monthly based on index rates or at prime rates. Basic risk materializes when the spread between the yield curves shifts. When interest rates change, the spread will accordingly change and can give rise to unexpected changes in cash flows and earnings spreads between banks' assets and liabilities and

off-balance sheet positions, and might thus result in a loss for the bank (van Greuning & Brajovic Bratanovic 2009, p. 232).

Finally, option embedded risk is the risk arising from the adverse effects caused by changes in interest rates to the value of option embedded products. From a bank's perspective, options may not be stand-alone derivative instruments, but they are embedded within banks' assets, liabilities and off-balance sheet activities. Banks have various types of bonds or notes with call or put provisions, i.e. non-maturity deposits that give the depositors the right to withdraw money at any time or loans that give the borrowers the right to prepay, often without any penalties. An increasing array of such options can result in a significantly increased prepayment risk and magnify the influences of option positions on the bank's financial conditions (van Greuning & Brajovic Bratanovic, 2009, pp. 231-232; Basel Committee on Banking Supervision, 2004).

As the time between rate resets of assets and liabilities varies, and the bank's asset and liability structure often is quite complex, the measure of interest rate exposure to the unstable market rates might be quite challenging, but still very critical to a bank's success in managing these risks (Bessis 2002, p. 151).

2.1.2 Interest rate risk measurements in banks

Risk identification and quantification is the primary and most critical step in any effective risk management practice. Various techniques have been developed in order to measure interest rate risks, so that banks can select whether and how to hedge them to reduce the adverse impact on their operations. In particular, there are three widely used techniques to measure interest rate risk including maturity gap analysis, duration and value-at-risk (Sharma 2008, p. 343).

Banks have traditionally used maturity gap analysis and duration to measure their interest rate exposure since these are the simplest measures that relate the interest rate changes to interest income (Bessis 2002, p. 165). However, these approaches feature serious drawbacks in measuring the impact of basic and embedded option risk given the critical limitations of static approaches as well as the potential difficulties to obtain precise year-by-year gap measures for most banks (Ballester et. al., 2009; Sharma, 2008, p. 345). On the other hand, the value-at-risk approach measures the potential loss of banks' portfolios over a period of time, which shows its

effectiveness in measuring risk in a highly volatile environment. Such approach has apparently eliminated the limitation of the gap and duration approaches. However, value-at-risk still presents some drawbacks as it does not take into account the abnormal changes in yield curves and is mostly applicable in the area of trading risk, but not in any other type of interest rate risk (Sharma 2008, pp. 348-349). Alternatively, Fraser et al. (2002) and Ballester et al. (2009) have been using a stock index approach to examine the association between banks' interest sensitivity and particular asset and liability characteristics of individual banks. Accordingly, bank stocks' sensitivity to changes in interest rates and the factors that affect this sensitivity will be investigated (Fraser et al. 2002). As this approach widely covers all banks' characteristics over a broad time span, it presents quite a comprehensive inside-out approach to measure the interest rate risk exposure of banks.

2.2 Bank characteristics

Generally, the balance sheet structure of a bank is one of the key factors that determine the risk level faced by banking institutions (van Greuning & Brajovic Bratanovic 2009, p. 81). Unlike non-financial corporations, banks report their balance sheets based on the liquidity basis, from the most liquid to the least liquid items. The relative share of various balance sheet components, e.g. loans, trading securities, property lending or deposits, reflects different potential risks that come from the four sources of interest rate risk that was mentioned above (van Greuning & Brajovic Bratanovic 2009, p. 84). Markedly, on the liability side, the relative share of its items can be a good indicator on the stability of banks' funding sources, reflecting the sensitivities of banks' funding sources toward interest rate changes. Funding sources like non-interest bearing or low-interest deposits can be considered as the most stable and least interest rate sensitive sources of funds in comparison to others. Additionally, the composition of banks' assets in comparison to liabilities presents both the maturity gap as well as the re-pricing mismatch as the variation in liquidity positions and the interest rate terms embedded in banks' assets and liabilities (Bessis 2002, p. 136). Apparently, the impact of changes in market rates is determined by the maturity and re-pricing mismatches that a bank's portfolio carries. In particular, banks can be divided into two categories. The first comprising assets that are expected to re-price faster than their liabilities is said to be asset-sensitive, which tends to benefit from a rise in market interest rates, especially

the short-term ones, as the result of increases in net interest margins. Conversely, liability-sensitive banks, whose liability durations are shorter than their asset durations, are likely to be negatively affected by an increase in market interest rates (van Greuning & Brajovic Bratanovic 2009, p. 283).

Other special characteristics of banks' balance sheets that differentiates them from non-financial corporations are visible in their liability side. As the banking business is inherently built on the concept of low margins and high leverage, banks' balance sheets feature a low capital-to-liabilities ratio that would otherwise be unacceptably risky to non-financial corporations. Bank capital is considered as a cushion against a variety of risks that banks are exposed to in the course of their business, which is highly regulated under the supervision of the Basel Accord. In accordance to the inherent risk embedded in their assets and liabilities, banks have to meet the capital adequacy requirement in order to absorb the possible losses as well as maintaining customer confidence in their business (van Greuning & Brajovic Bratanovic 2009, p. 123).

In addition to capital as a cushion against banking risk, van Greuning & Brajovic Bratanovic (2009, p. 101) also view banks' income and earnings as creditworthy indicators of banks' capacity to carry risk. Banks' income sources have far diversified from their traditional intermediation-based business by benefitting from the interest rate spread between lending and deposit taking activities. Increasing competition pressure, which considerably depresses banks' net interest margins, is the major force leading to banks' diversification. Generated from the broad array of financial services, ranging from underwriting, distributing securities, securitizing assets to cash-related services, non-interest income has instead become an increasingly important contributor to banks' bottom line (Williams & Prather 2010). On the other hand, non-interest income proves to be a less stable source of income than traditional banking interest income. Thus, the changes in banks' sources of income imply a different risk profile from that of a traditional bank (van Greuning & Brajovic Bratanovic 2009, p. 102).

2.2.1 The European banking industry

The European banking industry has fundamentally transformed in the last 20 years due to the effects of forces like globalization, technological advancement, deregulation and European

integration. The liberalization and integration of European financial markets have significantly pressured the bank's traditional lines of business, i.e. their lending and deposit taking activities. In response to the pressure, a restructuring process has started since then. Eurozone banks have started to diversify themselves in various non-interest income activities and aggressively expanded internationally by acquiring many local banks (Goddard et al., 2007). Although key legislative changes at EU level since the late 1970's have considerably stimulated the integration within the Eurozone, significant barriers to the integration of banking markets still exist. Markedly, the wholesale banking business has seen much of the advance in integration compared to retail banking (Berger et al., 2003; Cecchini et al., 2003, p. 33; Goddard et al., 2007). Due to the low integration within the region and the bundling of financial services, banks are able to charge different prices in different markets (Barros 2005, p. 35). Further evidence can be found in Dermine (2006) in which large variations in the interest margins on savings deposits was found in six Eurozone countries. On the other hand, the weak cross-border linkages can keep the systemic risk in these countries at low levels, thus further integration results in a greater systemic risk (Goddard et al. 2007). In specific, Brasili & Vulpes (2005), by decomposing bank risk into three levels, i.e. EU-wide, country-specific and bank level, have reported an increasingly significant pattern of the EU-wide component in large banks' risk following the introduction of the euro as an accounting currency in 1999. However, according to Cappiello et al. (2006), the interest rate pass-through, an individual bank interest rates' responsiveness to the changes in market interest rates, is rather slow and heterogeneous across financial products and countries in the European banking industry. Likewise, short-term products, e.g. deposits and mortgages, are more responsive than long-term products, such as corporate loans.

Under the supervision of the European Central Bank, the European banking industry with its described characteristics considerably differs from the American or the Asian banking industry. The next part will provide a comprehensive review of empirical research about bank interest rate sensitivity and its determinants in many different settings, time periods and geographical areas, serving as a benchmark and foundation in order to develop the study of the determinants of banks' interest rate risk in the Euro area.

2.3 Evidence from empirical research

The interest rate risk exposure of commercial banks has received considerable attention over the last three decades. Most empirical studies aim at investigating two interrelated questions, i.e. how sensitive the bank stocks' returns are to interest rate movements and if the interest rate sensitivity of bank stocks is associated with particular bank characteristics (Fraser et al. 2002). As to solve these questions, the capital market approach, based on the two-model factors regression model of Stone (1974), has been adopted to estimate the sensitivity of bank stocks' returns to interest rates fluctuations. The viewpoint here is to incorporate interest rate change factors as an additional explanatory variable to market index returns in order to better explain the variability of bank stock returns (Ballester et al., 2009). However, the interest towards these two questions is quite uneven, of which most empirical studies focus more on investigating the first question regarding the relationship between the changes in interest rates, whereas much less attention is given to identify the explanatory factors of banks' interest rate exposure (Fraser et al., 2002; Ballester et al., 2009).

Most empirical studies have found that changes in interest rates are negatively related to bank stock returns, regardless of markets and time span. In particular, Lynge & Zumwalt (1980), Flannery & James (1984), Booth et al. (1985), Bae (1990), Kwan (1991), Elyasiani & Mansur (1998) and Fraser et al. (2002) investigate U.S. banks in different time periods and found a negative correlation between interest rate fluctuations and banks' stock returns. Likewise, other studies, e.g. Oertmann et al. (2000) about European financial corporations and Ballester et al. (2009) about 23 Spanish banks, also document a significantly negative impact of interest rate fluctuations on bank stocks' returns. The primary explanation given is that banks have been generally exposed to a positive duration gap of which the average duration of banks' liabilities is less than the average duration of banks' assets (Ballester et al., 2009). However, empirical studies also document the declining interest rate sensitivity across banks in the early 1990's as attributed to the increasing use of interest rate derivatives for hedging purposes (see Allen & Jagtiani, 1996; Benink & Wolff, 2000; Choi & Elyasiani, 1996).

The second question, regarding the explanatory factors that affect the interest rate sensitivity of banks' stock returns, has received less attention (Fraser et al., 2002). However, it is clear that the

empirical research addressing this can be distinguished into two fundamental groups. The first approach's embedded focus is to determine how related the interest rate sensitivity of bank stocks' returns to banks' maturity composition of their assets and liabilities, whereas the second approach centralizes on a set of bank specific characteristics regarding on- and off-balance sheet activities as explanatory factors (Ballester et al., 2009).

As the pioneers, Flannery & James (1984) proposed the maturity mismatch hypothesis while investigating the cross-sectional variation in banks' interest rate sensitivity with the maturity mismatch between banks' nominal assets and liabilities. The hypothesis predicts a significant effect of maturity composition to banks' stock returns. Their findings have been supported by other research, e.g. Yourougou 1990), Kwan (1991), and Akella & Greenbaum (1992). The relationship of stock returns and unexpected inflation as the primary forces leading to changes in interest rates is also investigated. As most banks' assets and liabilities present a major maturity mismatch, and are contracted in nominal terms, bank stocks will be more sensitive to changes in interest rates if the duration gap between the assets and liabilities is greater (Ballester et al., 2009). However, if the main measurement of interest rate sensitivity adopted is the maturity gap analysis of banks' assets and liabilities, thus a static measure as discussed above, the results might not be a good indicator for a bank's interest rate exposure in the future.

The alternative approach aims to investigate the role of bank-specific characteristic sets, including both on- and off-balance sheet activities. In particular, Drakos (2001), Fraser et al. (2002), Saporoschenko (2002), Ghazanfari et al. (2007), Au Yong et al. (2009) and Ballester et al. (2009) have tried to characterize the main determinants of interest rate exposure by running multi-regression models of many different set of bank ratios against the banks' interest rate sensitivity. The methodology utilized is to seek for a systematically related set of financial variables, e.g. size, non-interest income, equity capital, off-balance sheet activities and loans-to-total assets, that could be easily observable from banks' balance sheets and income statements over an extended period. Hence, it might overcome the limitations that are often met by the static measure, i.e. the duration gap analysis in former approaches (Ballester et al., 2009).

Drakos (2001) empirical study examines the interest rate sensitivity of ten main Greek banks listed on the Athens Stock Exchange to the changes in Greek long-term interest rates. Likewise,

the findings are quite consistent, presenting evidence for a significant sensitivity of banks' stock returns to interest rate fluctuations. While testing five financial variables, including total debt, market-to-book value, equity, working capital and leverage, the working capital variable has exhibited the most significant correlation with interest rate sensitivity. The greater the working capital, the greater the bank's interest rate exposure, given a greater potential loss derived from wealth redistribution due to unexpected increases in inflation. Otherwise, equity capital and total debt ratios are also meaningful explanatory factors to the variation of banks' interest rate sensitivity, whereas the other two ratios, market-to-book value and leverage, do not play a significant role.

Fraser et al. (2002) investigate the determinants of banks' characteristics to interest rate sensitivity in a comprehensive study of 116 American banks, ranging from the larger money center banks to smaller banks, within the period of 1991-1996. Surprisingly, bank size does not accommodate any significant correlation with banks' interest rate sensitivity. Of four other variables tested, interest rate exposure exhibits a negative correlation with the equity capital ratio, the proportion of demand deposits over total deposits and the proportion of loans to banks total assets. Furthermore, banks that generate most of their revenues by non-interest income experience greater interest rate sensitivity, perhaps because a substantial part of their non-interest income is derived from securities related activities.

Saporoschenko (2002), in contrast, while studying the interest rate sensitivity of 47 Japanese banks of various types using weekly data from 1986 to 1992, has reported that bank size has a significant and positive effect on banks' interest rate sensitivity. Moreover, banks' deposit proportion also plays an important role in justifying Japanese banks' interest rate sensitivity. The greater the volume of deposits, hence a larger deposits-to-total asset ratio, the greater the extent the banks are exposed to interest rate risks. Meanwhile, the maturity gap does not show a significant impact on banks' interest rate sensitivity.

Ghazanfari et al. (2007) investigate a sample of 272 American commercial banks to see to what extent the announcement of the Federal Reserve's, i.e. the United States central bank, interest rate changes has on the banks' stocks, testing for abnormal returns five days prior to the announcement as well as five days after the announcement. During the period tested, two distinct

events occurred, one raise of the interest rate and one drop. Abnormal returns are then explained in a multiple regression model by a set of financial proxies. The results imply that the effect of the interest rate actions taken by the Federal Reserve depends on both the magnitude of the change in the rate and the expected contra the actual change. Out of the four ratios used as proxies, only two show significance. Portfolio securities-to-total assets is found to be significantly related to average abnormal returns during a rate hike, and equity-to-total assets is found to be significantly related to cumulative abnormal returns when the rate is cut. The authors imply that by using management techniques, bank managers can structure the bank's assets and liabilities as a way of hedging against interest rate shocks.

Au Yong's et al. (2009) empirical study of 110 banks in ten Asian-Pacific countries between 2002 and 2003 has a narrower focus. In particular, they aim to explain the relationship between interest rate and exchange rate exposure with the levels of banks' derivative activities. They find a negative relationship between short-term interest rates, but not with the long-term interest rate exposure. The explanation given is that derivatives might be used to speculate long-term interest rate changes or that banks are unable to hedge effectively due to changes in long-term interest rates. Furthermore, they also find that bank size is not a significant determinant of the extent of activities using derivatives.

Ballester et al. (2009) empirically investigate the primary determinants of interest rate exposure of commercial banks in Spain by using a panel data methodology. The interest rate used is the average three-month rate of the Spanish interbank market and the authors take into account both on- and off-balance sheet activities. The analysis shows that Spanish banks show a significant degree of exposure to interest rate risk during the period of study. Furthermore, the analysis supports that interest rate exposure systematically is related to various bank characteristics observable from the banks' annual reports. Bank size and loans-to-total assets are the most important determinants of interest rate risk, thus a highly significant positive relationship is evident, indicating that larger banks adopt riskier strategies. Moreover, banks that hold a greater proportion of loans to customers are to a greater extent exposed to interest rate risks. On the contrary, the proportion of deposits-to-total assets is negatively related to the level of the examined banks' interest rate risk.

2.4. Summary of previous empirical studies

In the table below, we provide a summary of the, according to our purpose, most relevant previous research. Accordingly, the summarized studies employ the similar approach to investigate the determinants of banks' interest rate exposure, i.e. the stock index approach.

Table 2.1: Summary of previous empirical research

Authors	Time period	Region	Sample size	Interest rate sensitivity	Interest rate risk determinants	
					Negative	Positive
Drakos (2001)	1997-2000	Greece	9	Negative	•Working capital	
Fraser et al. (2002)	1991-1996	USA	116	Negative	•Non-interest income •Capital •Deposits	•Loans
Saporoschenko (2002)	1986-1992	Japan	47	Negative	•Capital •Deposits	
Ballester et al. (2009)	1994-2006	Spain	23	Positive	•Deposits	•Off-balance sheet activities •Size •Loans
Au Yong et al. (2009)	2002-2003	Asia-Pacific	110	Neg. for short-term Pos. for long-term	•Capital	•Loans •Net interest revenue

3. METHODOLOGY

This chapter will present the methodology and approach that we aim to use in order to conduct the purpose of the thesis. We will describe the research approach, data collection and sample and the variables used in the regressions. The chapter ends with a methodological discussion where we critically evaluate the reliability and validity of the thesis.

3.1 Research approach

The aim of this thesis is to empirically test bank stocks' sensitivity to interest rate changes and the relation between movements in interest rates and financial ratios observable in the financial statements of the banks chosen. A vast number of previous research has focused on interest rate risks in banks, however, as to our knowledge, none is investigating the Eurozone banking industry. The thesis is supported by a stringent literature review, regarding both theory and foregoing empirical findings. To meet the terms of the purpose stated above, a deductive approach is applied, since the study concerns relationships that might exist between bank stock returns and interest rates changes, as well as the sensitivities with bank-specific characteristics. Since the foundation of the thesis stems from existing theories, we test if these theories are consistent with the empirical data collected and then confirm or reject them, hence a deductive approach is essential as the thesis is derived from established theories. An inductive approach is the opposite of a deductive, thus beginning with collecting the empirical data and then formulating hypotheses, with the empirics as the benchmark (Bryman & Bell, 2007, pp. 11-13). To be able to compare the findings and results with previous studies, an inductive approach is hence not relevant for the purpose intended. By deducting the stated hypotheses from existing theory, we wish to make a contribution to the existing work on how banks are affected by interest rate movements, by providing discerning evidence from the European market in an interesting period of time.

A quantitative study is performed by using numerical data and statistical instruments to test the hypotheses supported by the theoretical base. The results will be processed and analyzed in order

to draw conclusions whether to support or discard the hypotheses. Hence, a quantitative study, by testing the hypotheses drawn from the theoretical base regarding how the changes in interest rate influence banks' interest rate exposure, proves to be a better fit to solve our research question and to add more value to the investigation (Bryman & Bell, 2007, p. 155). Additionally, by analyzing numerical data, a quantitative study will be able to provide more objective results, and thus more reliable than qualitative data would, of which this problem can be quite serious. This thesis is to some extent is based on the previous study by Fraser et al. (2002) about the U.S. banking industry and Ballester et al. (2009) about the Spanish banking industry.

3.2 Data collection

The data collected is considered to be secondary data and is obtained from Thomson Reuters Datastream. The data consists of daily stock prices and fiscal year-end values of certain balance sheet and income statement items. Consequently, no primary data has been collected due to the large amount of information and banks that was investigated, thus we have been required to solely rely on the information reported by the banks themselves. Data of interest rate yields have also been collected from Thomson Reuters Datastream. Two types of interest rates are used; EURIBOR 1-year and EURIBOR 10-year government benchmark bond yield. The interest rate data is on a daily basis. As for the market index return used in the regressions, MSCI Europe Index is used as a benchmark. Data of index returns have been collected on a daily basis and also obtained from Thomson Reuters Datastream. This weighted index is designed as a measurement of the equity market performance of the European developed markets and is therefore considered to be a good and accurate proxy for the market return in Europe. Furthermore, by only using information from banks within the Eurozone, all data is consequently denominated in euros and covers a time period of nine years from 2002 to 2010. Besides, other data and information used for this thesis derive from literature, published articles and working papers. Articles and working papers have all been retrieved from Lund University LibHub and SSRN Electronic Library.

3.2.1 Sample

The sample of banks investigated is taken from the sector index EURO STOXX® TMI Banks, including 53 banks within the Eurozone. STOXX® classifies companies in their sector indices by grouping companies that have similar primary sources of revenue, using the Industry Classification Benchmark, provided by Dow Jones Indexes and FTSE. This provides us with a sample of banks in the same business environment that we intend to investigate, thus guaranteeing a professional and accurate classification of firms in the appropriate business environment (STOXX® website). The choice of the sample is based on different reasons. First, the index gives a wide dimension of banks, covering all except two countries in the Eurozone from 2002. Furthermore, the index classifies the banks judged by their main sources of revenue, thereby excluding financial firms and insurance companies. Finally, all the banks in the sample are traded in euros and are widely dependent on capital markets. As such, the EURO STOXX® TMI Banks Index seems fairly representative for the Eurozone and the intended purpose for this thesis.

All banks in the sample are publicly listed companies and have easily accessible information about their financials. Historical stock prices have been collected on a daily basis from January 2002 to December 2010. This has given a total of 2,436 observations for each bank and a total of 92,568 observations for the whole sample of banks. Our notion is that this is a sample big enough for performing the purpose of the thesis. Below is the complete list of the final sample of banks used in our investigation.

Table 3.1: List of banks

Bank	Country	Total assets 2010 (€ m)
BNP Paribas	France	1,988,916
Deutsche Bank	Germany	1,897,289
Crédit Agricole	France	1,588,309
Banco Santander	Spain	1,217,501
Société Génèrale Group	France	1,127,205
Unicredit	Italy	918,201
Commerzbank	Germany	750,732

Intesa Sanpaolo	Italy	652,783
Dexia	Belgium	564,025
Banco Bilbao Vizcaya Argentaria (BBVA)	Spain	547,202
Natixis	France	454,648
KBC Group	Belgium	318,456
Erste Group Bank	Austria	205,520
Allied Irish Banks	Ireland	142,838
Banco Popolare	Italy	132,742
Banco Popular Espanol	Spain	129,199
National Bank of Greece	Greece	120,274
Banco Comercial Portugues	Portugal	99,321
Banco de Sabadell	Spain	96,176
EFG Eurobank Ergasias	Greece	86,685
Banco Espirito Santo	Portugal	83,372
Mediobanca	Italy	75,878
Alpha Bank	Greece	66,371
Banca Popolare dell'Emilia Romagna (BPER)	Italy	58,050
Piraeus Bank	Greece	57,263
Bankinter	Spain	54,058
Banco BPI	Portugal	45,233
Banca Carige	Italy	39,650
Pohjola Pankki	Finland	36,145
Banco Pastor	Spain	30,909
Credem Banca	Italy	29,849
Emporiki Bank of Greece	Greece	26,492
Banca Popolare di Sondrio	Italy	26,211
Banco de Valencia	Spain	23,550
Banco Internacional do Funchal (BANIF)	Portugal	15,638
Credito Bergamasco	Italy	15,424
Banca Etruria	Italy	10,841
General Bank of Greece	Greece	4,230

3.2.2 Excluded observations

Although selecting the sample based on an already classified group of banks, we had to exclude 15 banks as their stock data was not available as far back as 2002 or throughout the period investigated. Some banks were missing data, e.g. due to government bailouts during the last part of the period or due to mergers. As this might bias the results or lead to inconsistencies, this is the main reason for excluding these banks.

3.3 Regression model

Regression analysis refers to the statistical tool to investigate the causal effects of variables upon other variables (Saunders et al., 2009, p. 461). The analysis goes beyond the function to answer whether there exists a relationship between variables, hence it enables investigators to estimate the degree of changes of one variable according to changes in others. Likewise, a specific functional form of the relationship between variables will be formed (Eye & Schuster 1998, p. 3). Hence, we found that regression analysis is the most suitable tool for our thesis as the purpose is to investigate the determinants of bank interest rate sensitivity, focusing on the role played by a set of bank-specific characteristics. As building regression models is a rather complex task, the regression models applied by Fraser et al. (2002) would provide us with the foundation, with some modifications of the variables used. Accordingly, a two-step procedure will be adopted.

The first stage is to estimate the sensitivity of bank stocks' returns to changes in interest rates. Likewise, ordinary least squares, OLS, in the framework of the traditional two-factor model of Stone (1974) will be applied. Hence, the regression model can be expressed as the following:

$$R_{it} = \alpha_i + \beta_i R_{mt} + D_i \Delta I_t + \varepsilon_{it}$$

Here, R_{it} denotes the return of bank i's stock in period t, R_{mt} denotes the return on the market portfolio in period t, ΔI_t stands for the change in the interest rate in period t and ε_{it} is the error term for period t. Specifically, we chose to test banks' interest rate sensitivity with changes in two types of interest rates, i.e. short-term and long-term. However, the coefficients are more important and actually what we are aiming to find. β_i reflects the general market return fluctuations, which can be considered as the market risk. Furthermore, D_i describes the

sensitivity of bank i's stock return to changes in interest rates, which can be interpreted as a measure of the bank's interest rate exposure. This coefficient is also considered as an estimation of bank equities' empirical duration according to Ballester et al. (2009). Specifically, the empirical duration of equity indicates the interest rate risk borne by a bank's equity. A positive coefficient implies that a bank's equity value might increase when interest rates increase and a negative coefficient reflects the opposite. As many previous empirical research, this step will employ time-series regression analysis to determine the relationship between banks' stock returns and interest rate movements.

The second stage is to point out the relationship of the empirical duration generated in stage one, with a set of bank characteristics that reflects both on-balance sheet activities in banks. This stage is performed to try to answer the question whether banks' specific features, as taken out from banks' financial statements, are good indicators for banks' interest rate risk. As panel data has both the dimensions of time-series as well as cross-sectional analysis, it is able to overcome the limitations of both time-series and cross-sectional analysis (Brooks 2008, p. 5). Thus, panel data analysis is superior in three perspectives. The first and most significant advantage that panel data analysis will provide is that investigators can address a broader range of issues and tackle more complex issues than with the other two. As to determine banks' interest rate exposure and the relationships with a larger amount of variables of bank characteristics, panel data analysis is proved to be the most relevant. Besides, in order to examine how variables or the relationships change over time, time-series data requires an extensive data set to sufficiently conduct any meaningful hypothesis tests (Brooks, 2008, pp. 488-489). Panel data, in contrast, enables us to increase the sample size and the degrees of freedom, which is particularly relevant when studying more complicated behavioral models, as the case in hand. Finally, by using panel data estimation, investigators will be able to control individual heterogeneity, which will eliminate the impact of biases resulted from omitted variables, which could be an issue with time series and cross-sectional data analysis (Baltagi 2008, p. 5; Gujarati 2004, p. 489). Likewise, the choice of regression analysis for the investigation would thus be panel data analysis rather than time series or cross-sectional analysis.

3.4 Variables

Examining how different bank characteristics affect banks' interest rate sensitivity is an important part of this thesis. The objective when analyzing complex economical problems is to obtain a high degree of determination in the models and significant results, corresponding with the theory supporting the hypotheses. The variables used and included in our models are similar to the ones used in previous research, i.e. Fraser et al. (2002) and Ballester et al. (2009), although with some modifications.

3.4.1 Dependent variables

When studying the relationship between variables, the distribution of the dependent variable depends on, or is an effect of, one or more independent variables. In this investigation, as our purpose is divided into a two-stage procedure, there are two main dependent variables. Accordingly, the first stage of the analysis tests the sensitivity of bank stocks' returns to interest rate movements, thus using the bank stocks' daily returns as the dependent variable. The second stage tests this interest rate sensitivity coefficient, D_i, against certain bank-specific characteristics, in which we use the interest rate sensitivity, obtained from the first test, as the dependent variable.

3.4.2 Independent and control variables

Independent variables, one or several, are independent of or the cause of the distribution of the dependent variable. Numerous factors and bank-specific characteristics and ratios might explain interest rate risk and how banks are affected by it. In order to examine if there are certain factors that can explain interest rate risk, five different ratios are tested. To establish which variables to test, Fraser et al. (2002) and Ballester et al. (2009) provide us with a number of benchmarks, thus with some exceptions and modifications. The five variables, explained in detail below, are easily observable from banks' financial statements and can be used as a comparison among commercial banks. All of the independent variables have been measured at fiscal year-ends.

3.4.2.1 Financial leverage

Since a higher portion of equity capital reduces the degree of financial leverage and is a good measure of capital strength, we therefore hypothesize that banks with a higher level of equity will be less exposed to interest rate risks, i.e. it reduces the sensitivity of banks' return on equity to the return on assets. Therefore, stock returns would be less sensitive to fluctuations in income that is attributed to movements in interest rates. Furthermore, having a larger portion of equity capital on the balance sheet would be similar to reducing the interest rate risk by holding more non-interest rate sensitive liabilities and a lower need of external funding. A higher level of equity capital could also reduce the probability of default and thus prevent unforeseen sell-offs of stock to respond to negative shocks, i.e. large fluctuations in interest rates (Fraser et al., 2002). Equity is a part of a bank's Tier 1 capital and which regulators require a bank to hold as a safety cushion against adverse shocks. Therefore, higher levels of capital can be seen as a larger safety net against abnormal movements in interest rates (Culp, 2002, p. 180). Fraser et al. (2002) show that banks' interest rate sensitivity coefficients are positively and significantly related to this capital ratio of American banks, whereas Ballester et al. (2009) do not see any significant relationship between Spanish banks' proportion of equity capital and the interest rate sensitivity. The financial leverage is defined as equity to total assets.

$$Financial\ leverage = \frac{Equity}{Total\ assets}$$

3.4.2.2 Reliance on non-interest income

Banks' income can be divided into two types of income, interest income and non-interest income. Income that is not derived from interest is usually generated from underwriting fees, advising or other services offered to customers. When economic growth is reduced as a result of higher interest rates, the volume of other income, e.g. advisory services connected with IPOs or acquisitions, will decline. Consequently, the bank will earn less from fees derived from underwriting and advising. If a bank relies on these types of fees more than others do, the greater their sensitivity to interest rate movements ought to be. We therefore hypothesize that banks that

rely more on income from non-interest activities are more exposed to interest rate risk. Previous research has shown no significant relationship between this ratio and the level of banks' interest rate risk. Reliance on non-interest income is defined as non-interest income to total revenues.

$$Reliance\ on\ noninterest\ income = \frac{Noninterest\ income}{Total\ revenues}$$

3.4.2.3 Proportion of income derived from re-priced assets

Commercial loans generally have floating interest rates that are re-priced more than one time per year. We therefore make the hypothesis that banks that have a higher degree of loans will be less exposed to interest rate risk. As mentioned in the theoretical framework, the duration of a bank's loans is larger than the equivalent one of the rest of the bank's assets and liabilities. Therefore, an increase in the proportion of loans on a bank's balance sheet implies an extension of the classic duration mismatch between the assets and liabilities, hence increasing the interest rate exposure for the bank. Both Fraser et al. (2002) and Ballester et al. (2009) have found evidence that the ratio of loans to total assets is positively and significantly related to banks' interest rate sensitivity coefficients when investigating American and Spanish banks respectively.

$$Reliance\ on\ income\ from\ repriced\ assets = \frac{Loans}{Total\ assets}$$

3.4.2.4 Reliance on deposits

A bank's base of deposits in the bank's balance sheet is a stable and cheap source of funding for the bank and its business. A large part of a bank's total deposits generally consists of demand deposits and savings deposits, which show low interest rate sensitivity since these kinds of deposits mainly are for savings instead of investments. A negative relationship between this ratio and level of banks' interest rate sensitivity is therefore hypothesized. This bank characteristic has shown different results in previous studies. Fraser et al. (2002) test the ratio demand deposits-to-total deposits and gain a positive and significant relationship to the interest rate sensitivity. Ballester et al. (2009) test total deposits to total assets and see a negative and significant relation

to interest rate sensitivity, suggesting that banks with a greater proportion of deposits have less interest rate risk. In this thesis, reliance on deposits is defined as total deposits to total assets.

$$Reliance\ on\ deposits = \frac{Total\ deposits}{Total\ assets}$$

3.4.2.5 Bank size

The study from Fraser et al. (2002) confirmed that there is no relation between interest rate sensitivity and the asset size of American banks. This conclusion is to some extent consistent with Au Yong et al. (2009), who found that bank size is not a significant determinant of derivative activities. However, Ballester et al. (2009) provide the result that size is clearly significant and positively correlated, thus stating that there seems to be a direct relationship between banks' assets size and their level of interest rate sensitivity. This conclusion is consistent with the study from Saporoschensko (2002) about the Japanese banking industry. A variable of bank size will be included in the regression for testing if there are certain determinants of interest rate sensitivity. Bank size will be measured as the natural logarithm of the banks' respective total assets, obtained from the banks' balance sheets. Different banks most certainly may have different types of business and have different risk attitudes and larger banks have better access to capital markets and also benefit from greater diversification compared to smaller banks. We therefore hypothesize that larger banks are less exposed to movements in interest rates.

$$Bank\ size = \ln(Total\ assets)$$

3.5 Summary of regression models and expectations

Regarding the regression models examining the relationship between interest rate changes and bank stock returns, as well as the determinants of banks' interest rate sensitivity, our expectations are driven by the theoretical framework provided in the second chapter. For the second part of the analysis, the panel data regression, our model to investigate the determinants of interest rate risk exposure will look as the following:

$$D_j = f\left\{{}^{E}/_{TA_j}, {}^{Dep}/_{TA_j}, {}^{L}/_{TA_j}, {}^{NII}/_{TR_j}, \ln(TA_j)\right\}$$

The independent variables provided are based mainly on Fraser et al. (2002), thus our expectations will be summarized as following:

Table 3.2: Summary of regression models

Variable	Definition	Expected sign	Comment
Stage 1: OLS regression			
Bank stock return	Daily returns		
Market return	Daily returns	+	MSCI Europe Index
Short-term interest rate	Daily returns	-	EURIBOR 1-year
Long-term interest rate	Daily returns	-	EURIBOR 10-year
Stage 2: Panel data regression			
Financial leverage	Equity/Total assets	-	
Reliance in non-interest income	NII/Total revenues	+	
Income from re-priced assets	Loans/Total assets	+	
Reliance on deposits	Deposits/Total assets	-	
Bank size	Ln (Total assets)	-	

3.6 Comments on the regression models – a robustness check

A robustness check is a prerequisite to guarantee that there is no violation of assumption that might lead to inconsistent and biased results. The results drawn from the ordinary least square linear model for panel data analysis based heavily on the assumption that there are no autocorrelation, heteroscedasticity and specification errors. Hence, a set of tests is employed to check whether there are any prerequisites not met in our regression, i.e. any deviation from assumptions. If so, specific methods will be employed to improve the results.

In particular, it appears that our regressions, which aim to determine the factors that influence banks' interest rate exposure, are free from any autocorrelation problems, as the Durbin-Watson statistics are in an acceptable range. Multicollinearity is also assessed by conducting a correlation matrix and no correlation value reaches extreme levels as high as 0.8, as Brooks (2008, p. 171) defines. With regards to the result, it comes to our conclusion that the variables are not correlated

and thus, suggesting that the regression models are stable and free of near multicollinearity problem (Brooks 2008, p. 172). Moreover, the investigation whether there is any unobserved heterogeneity across the sample, that is not taken into account in the model and might affect the results, is also conducted. The heterogeneity is examined based on the F-statistic and the Chi-square statistic under Redundant Fixed Effect Test. The high value obtained from the test suggests a confirmation of the null hypothesis. Thus, it appears that there is no need to carry out fix-effected or random effected models that is to account for the bank-specific effects.

Ultimately, the assumption of homoscedasticity in the model should be fulfilled in order for the regression model to yield the best estimations. If the assumption is violated, the presence of heteroscedasticity will affect the result. The ordinary least square will no longer be BLUE, i.e. Best Linear Unbiased Estimator, the ordinary least square might not be able to obtain an efficient estimator. As the consequence, the significant tests might be too low or too high (Brooks, 2008, p. 135). Thus, we conduct a Brown-Forsythe test to examine the violation of homoscedasticity in the model. As the p-value associated to the test reflects strong heteroscedasticity, the cross-section weight model is employed to eliminate the existence of heteroscedasticity and to improve the statistical properties of the model, thus guaranteeing the robustness of our models.

3.7 Methodological discussion

This part will present and discuss the appropriateness of the study, from the aspects of both validity and reliability. The degree of internal validity enlightens the relationship between the study's objective and how well and consistent the measurements employed to accommodate the study. External validity refers to the extent to which the results of a study could be generalized to other settings (Bryman & Bell 2007, p. 164). Reliability refers to the question whether the thesis will generate the same results if it was to be replicated. A brief discussion regarding these aspects will be provided as the critical view on the study.

3.7.1 Validity

The methodology employed in this thesis is similar to methods previously used in other empirical studies and thus we believe that the measurement employed is proved to be valid, as

confirmed by prior studies. In regards to the external validity, some of our study's characteristics are considered. Regarding the settings, many markets and periods are previously studied, ranging from American and Spanish banks to Japanese and Asian-Pacific banks. This implies that the results may be able to be generalized in many different markets, regardless of the size of regulations, as well as within many different periods. However, our sample is heavily based on EURO STOXX® TMI Bank Index, thus suggesting that the results may not be applicable with a more general sample.

3.7.2 Reliability

In regards to the reliability of our research, data collection procedure and methodology employed is assessed. In particular, the data collected is mostly accounting-based and market rates, e.g. stock returns and interest rates, which can easily accessed and collected on Thomson Reuters Datastream as well as from banks' annual reports, subject to no randomness or contingencies. Thus, this suggests a high reliability regarding our data collection procedure. As described above, the study is conducted with regression models, with a variety of tests to examine the robustness of the models as well as control toward any deviations from assumptions, thus ensuring that the models produce correct and consistent results. Overall, the study can be considered as highly reliable.

4. EMPIRICAL FINDINGS

This chapter presents the results from the analyses performed. First we will give an account of the descriptive statistics of the sample and the first regression model. Second, an account for the first part of the analysis will be provided, with the results from the interest rate sensitivity tests. Third, a comprehensive review of the second part of the analysis is provided, i.e. the panel data analysis, to determine if certain bank characteristics are related to the interest rate sensitivity.

4.1 Estimation of interest rate sensitivity

To estimate the interest rate sensitivity of the banks included in the sample, a regression analysis has been performed. As previously mentioned, the regressions contain daily stock return data from each bank as the dependent variable and the daily return of the MSCI Europe Index and daily movements in interest rates as the explaining variables. Two different regressions were run with two different interest rates, a 1-year interest rate and a 10-year interest rate, both provided and regulated by the European Central Bank. Accordingly, the results utilizing two different interest rates, 1-year and 10-year, will be compared to see whether there is a consistency of how banks' interest rate sensitivity is towards different interest rates with different maturities.

The pattern of changes in these two interest rates and the market index from 2002 to 2010 is provided in Figure 4.1 and 4.2 below. As can easily be observed, the two different types of interest rates fluctuate during the whole period as in every other economic cycle. However, due to the spill-over effects of the financial crisis from the United States and the sovereign debt crisis spreading out in Europe with the origin in Ireland and Greece, the period between 2007 and 2010 has seen much more volatile fluctuations in its interest rates, characterized with the steep decline right after its peak in mid-2008. This fact leads to the question whether there will be different results if the regressions are run for different time frames. Accordingly, the results will be reported in two parts, where the first part provides interest rate sensitivity of the Eurozone banks for the whole period, and the second provides results on two different periods, one from 2002 to 2006, the pre-crisis period, and one from 2007 to 2010, the on-going crisis period.

Figure 4.1: EURIBOR interest rates

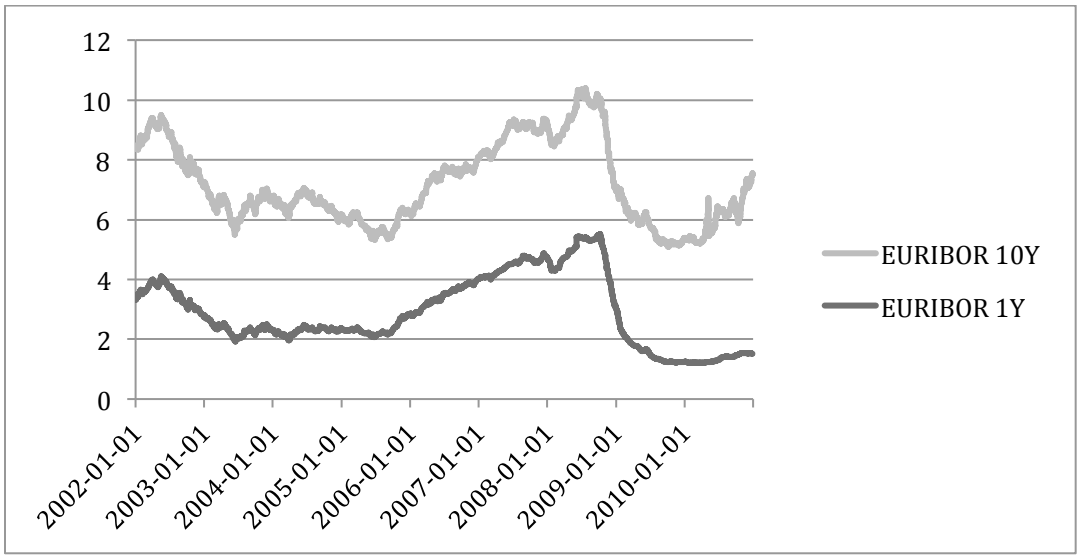
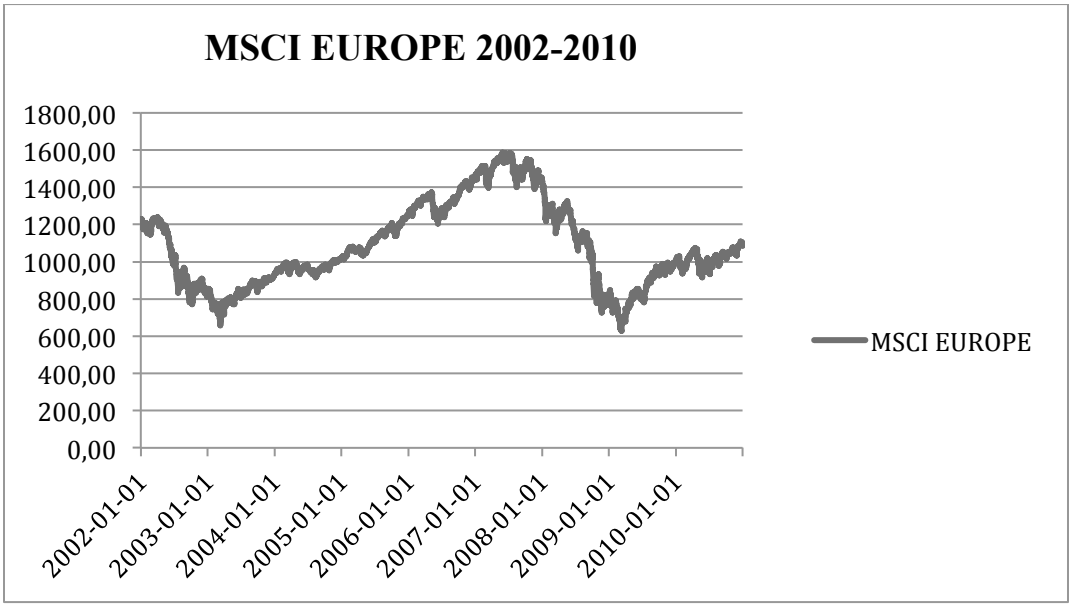


Figure 4.2: MSCI Europe Index



The total sample of European banks consists of 38 unique firms. There are 342 banks' empirical durations, i.e. 38 banks in nine years. In order to emphasize the differences between the banks

investigated, the descriptive statistics are presented below, where D is the interest rate sensitivity coefficient, β is the coefficient for the market index and R^2 is the coefficient of determination for the regression.

4.1.1 Descriptive statistics for the whole period

Tables 4.1 and 4.2 summarize the descriptive statistics for the whole period from 2002 to 2010, one for each interest rate. The major finding here is that there are significant variations of bank interest rate sensitivity across the investigated period as well as with the two interest rates. As can be seen in table 4.1, the mean value for the interest rate sensitivity of the EURIBOR 1-year coefficient is 0.15, showing a positive interest rate exposure rather than the traditional pattern of negative interest rate exposure. In fact, nearly 70% of the banks' empirical durations, i.e. 237 out of 342, are positive with the highest value of 2.7 of EFG Eurobank Ergasias in Greece, which implies that one percent increase in interest rate changes leading to 2.7 percent increase in the bank's stock return. Not surprisingly, the banks' highest empirical durations are observed in Greek and Irish banks in the period of 2008-2010. The complete result of Eurozone banks' empirical durations can be found in Appendix 1.

Table 4.1: 1-year interest rate

	Obs.	Mean	Median	St. dev.	Min	Max
D	342	0.1522	0.0656	0.3485	-0.4522	2.7405
β	342	0.8941	0.8849	0.5112	-0.0592	2.4317
R^2	342	0.3091	0.2884	0.2051	0.0011	0.7885

The empirical durations regressed on 10-year interest rates show a different pattern. Slightly over 50% of the durations, i.e. 176 out of 342, are negative, approximately the same as the traditional pattern that many previous studies have reported. The mean and median is rather low at -0.01 meaning that the average bank's stock returns are almost not responsive at all to changes in the 10-year interest rate. However, Greek and Irish banks' empirical durations show the most negative value within the period of 2008-2010, of which the General Bank of Greece has the lowest value, -1.8.

Table 4.2: 10-year interest rate

	Obs.	Mean	Median	St. dev.	Min	Max
D	342	-0.0120	-0.0134	0.3122	-1.8350	1.5703
β	342	0.8959	0.8742	0.5076	-0.0245	2.4620
R^2	342	0.3088	0.2887	0.2059	0.0007	0.7892

Overall, the evidence accounted for above presents both negative and positive relation of banks' stock returns to changes in interest rates. The market risk still plays a significant role in explaining the changes in banks' returns.

4.1.2 Descriptive statistics for divided period

The period from 2002 to 2010 includes years with high business activity as well as years with low economic activity. The years before 2007 were characterized by a strong climate on the market, whereas the years from 2007 up till today have been more turbulent. Due to this fact, the period investigated will also be presented divided into two parts, where the first one shows the more stable period of 2002-2006 and the second part shows the more volatile period of 2007-2010.

Tables 4.3 and 4.4 below give a summary of the descriptive statistics for the divided periods of the short-term interest rate. As is seen in the tables, both the mean value and the median are positive in both periods, although slightly closer to zero in the first one, showing low correlation between interest rate changes and banks' stock returns. The latter shows significant bank interest rate sensitivity, as the mean is as high as 0.28, implying a much higher interest rate risk environment to banks during the second part of the period investigated. Well over 34% of the sensitivity coefficients are negative during the first period, whereas only 26% are negative in the latter.

Table 4.3: 1-year interest rate 2002-2006

	Obs.	Mean	Median	St. dev.	Min	Max
D	190	0.0501	0.0379	0.1135	-0.2902	0.4381
β	190	0.6833	0.6898	0.4342	-0.0592	1.6048
R^2	190	0.2442	0.1897	0.2067	0.0011	0.7364

Table 4.4: 1-year interest rate 2007-2010

	Obs.	Mean	Median	St. dev.	Min	Max
D	152	0.2800	0.1751	0.4780	-0.4522	2.7405
β	152	1.1577	1.1529	0.4779	0.0677	2.4317
R^2	152	0.3902	0.3848	0.1719	0.0069	0.7885

The long-term interest rate also demonstrates more sensitivity, i.e. negative interest rate coefficients, during the second period compared to the previous period. Table 4.6 displays that the mean value, as well as the median, is negative, well below zero. About 60% percent of all observations are negative in the second period, while the same quota for the first period is 45%. This suggests that banks' stocks show more sensitivity to a volatile interest rate environment than when the market shows more stable and sound tendencies.

Table 4.5: 10-year interest rate 2002-2006

	Obs.	Mean	Median	St. dev.	Min	Max
D	190	0.0429	0.0156	0.2480	-0.4623	1.5703
β	190	0.6889	0.7047	0.4307	-0.0245	1.6329
R^2	190	0.2423	0.1852	0.2077	0.0007	0.7360

Table 4.6: 10-year interest rate 2007-2010

	Obs.	Mean	Median	St. dev.	Min	Max
D	152	-0.1027	-0.0716	0.3668	-1.8350	0.8585
β	152	1.1546	1.1562	0.4780	0.0763	2.4620
R^2	152	0.3919	0.3853	0.1709	0.0046	0.7892

To summarize the descriptive statistics, we see that many of the extreme coefficients, both positive and negative, are to be found in the second period, especially 2008 and 2009, i.e. the years characterized by an economic recession. However, this appears quite naturally, as an abnormal unstable interest rate environment makes it harder to make the perfect hedge.

4.2 Estimation of interest rate risk determinants

Five different bank characteristic ratios have been used in order to find if some specific determinants are significantly related to the banks' interest rate sensitivity, i.e. if the interest rate sensitivity can be explained by certain conditions in the financial statements. The interest rate sensitivity coefficient obtained from the first part of the analysis is here used as the dependent variable in a panel data analysis, together with the ratios chosen. Two panel data analyses have therefore been performed, i.e. one for each type of interest rate. With the intention to find any problems with multicollinearity a correlation matrix is presented in Table 4.7 below.

Table 4.7: Correlation matrix between variables used in regressions

	Size	Deposits	Equity	Loans	NII
Size	1	-0.0854	0.0249	-0.0306	0.0977
Deposits		1	-0.4136	0.4861	-0.2488
Equity			1	0.2108	0.0056
Loans				1	-0.3894
NII					1

The matrix shows no extreme levels of correlation between the variables that would indicate that multicollinearity problems exist. Likewise, including all variables in the same regression is considered to be free from the risk obtaining biased results due to multicollinearity problems. Thus, all five variables will be regressed at the same time against banks' empirical durations to test the determinants of banks interest rate risk.

Table 4.8 below summarizes the descriptive statistics for the bank characteristic ratios included in the panel data analysis. Each ratio is measured at the end of each year for each bank and over the time period of nine years. The differentials between minimum and maximum values of each characteristic ratio across investigated banks are rather large, meaning that there are large

differences between the financial statements and sources of income of the banks used in the sample.

Table 4.8: Descriptive statistics for bank characteristic ratios

	Obs.	Mean	St. dev.	Min	Max
Equity	342	22.66%	11.88%	5.06%	72.09%
Deposits	342	44.14%	15.74%	4.65%	89.92%
Size variable	342	9.88%	14.26%	-38.46%	108.12%
Loans	342	65.78%	16.90%	10.94%	92.28%
NII	342	28.64%	12.49%	3.54%	70.15%

The variation in investigated banks' characteristics, as summarized above, is of interest when investigating the determinants of banks' interest rate risk without sample biases. The next task is to test the effects of these ratios against the interest rate sensitivity of the banks. Some regression techniques are in consideration in order to improve the economic interpretation and statistical properties of the model. Likewise, the results will be described in accordance with the two interest rates, EURIBOR 1-year and 10-year.

4.2.1 Short-term interest rate

The first regression is run using the panel least square model without taking into account the firm-specific effects, from here on called the baseline model. The results provided below under Panel A reveal that among the five variables, only banks' size variable proves to be significant, particularly at the 1% level. However, it is necessary to examine the existence of unobserved heterogeneity across investigated banks. Probably, there might be some inherent features of banks that have not been taken into account or adequately captured by the five variables in the model that might have explanation power toward their sensitivity to interest rate changes. Thus, a fixed effects model has been estimated and tested against the baseline model. However, the p-value obtained from the test in accordance to the F-statistical and Chi-square is 0.6610 and 0.5345, indicating the acceptance for the null hypothesis. Thus, the bank-specific effects are inadequate in this case.

Furthermore, the Brown-Forsythe test is implemented to test against panel heteroscedasticity to improve the statistically meaning for the model. As the p-value associated in Brown-Forsythe is 0.0035, it is providing strong evidence of bank heteroscedasticity. In order to eliminate heteroscedasticity, the cross-sectional weight model is performed to improve the result and is presented in Panel B, and the significant changes in the results can easily be observed. Banks' size variables still have a strong explanatory power against banks' interest rate sensitivity, at 1% significance, although slightly different in the two cases, i.e. 0.3279 as with the baseline model and 0.3062 as with the cross-section weights model. However, after excluding panel cross-sectional heteroscedasticity in the model, two more variables, banks' equity and deposits, prove to be statistically significant in explaining banks' interest rate sensitivity. Both of them show a quite strong negative direct relationship with banks' interest rate sensitivity, i.e. -0.2581 and -0.2555 at the 5% statistical significant level.

Table 4.9: 1Y Estimation data panel results - Determinants of interest rate exposure

Panel A: Baseline model

α		Equity	Deposits	Loans	NII	Size		R^2	F	DW
0.3386		-0.2673	-0.1094	0.0338	-0.2353	-0.3279		0.0319	2.2134	1.4777
2.8966	***	-1.3187	-0.6393	0.2170	-1.4342	-2.4793	***			

Panel B: Bank-specific random effects model robust to cross-sectional heteroscedasticity

α		Equity		Deposits		Loans	NII	Size		R^2	F	DW
0.2797		-0.2581		-0.2555		0.0437	0.0273	-0.3062		0.0522	3.6997	1.6416
3.4593	***	-2.1372	**	-2.3530	**	0.4349	0.2708	-3.4210	***			

T -statistics are shown below the values of the regression coefficients

*** Indicates statistical significance at 1% level.

** Indicates statistical significance at 5% level.

* Indicates statistical significance at 10% level.

4.2.2 Long-term interest rate

As the same process with the short-term interest rate, the panel least square model is run as the baseline model and presented in Panel A in Table 4.10. Accordingly, the model presents two meaningful variables, i.e. the bank size variable and the non-interest income variable, at 10% and 5% statistically significant levels respectively. Both of them show a positive relationship with banks' interest rate sensitivity, however, the bank size here is no longer strongly significant as with the short-term interest rate. The unobserved heterogeneity across the banks is investigated. The p-value associated with the F-statistical and Chi-square is even higher at 0.8577 and 0.7759, providing evidence against the alternative hypothesis. Likewise, the bank-specific effects are inadequate.

The Brown-Forsythe test, with the long-term interest rate as a proxy, provides quite similar results. The P-value is 0.0236, a strong evidence of bank heteroscedasticity. Thus, the cross-sectional weight model is performed to eliminate this problem. As the result, banks' size variable become more influential to banks' interest rate sensitivity, from 0.2138 to 0.3239, and more significant than in the baseline model, at 1% statistical significant compared to 10% as before. The same pattern is found with banks' equity, showing a strong negative relationship with banks' interest rate sensitivity. Interestingly the effects of banks' equity proportion and size to banks' interest rate sensitivity are more or less the same with the two interest rates as the proxy, while the other variables are quite different in their influence to banks' interest rate sensitivity.

Table 4.10: 10Y Estimation data panel results - Determinants of interest rate exposure

Panel A: Baseline model

α	Equity		Deposits	Loans	NII		Size		R^2	F	DW
0.1662	-0.2915		-0.0965	0.0024	-0.3222		0.2138		0.0312	2.1650	1.7468
1.5861	-1.6048		-0.6291	0.0172	-2.1916	**	1.8040	*			

Panel B: Bank-specific random effects model robust to cross-sectional heteroscedasticity

α	Equity		Deposits	Loans	NII		Size		R^2	F	DW
0.0719	-0.2540		-0.0977	0.0495	-0.2196		0.3239		0.0549	3.9010	1.8829
0.9258	1.9390	**	-0.7797	0.4616	1.9730	**	3.4069	***			

T -statistics are shown below the values of the regression coefficients

*** Indicates statistical significance at 1% level.

** Indicates statistical significance at 5% level.

* Indicates statistical significance at 10% level.

Overall, it is interesting that all of the three possible results, positive, negative and no direct relation between banks' stock returns and interest rate movements, are found in Eurozone banks within the period of 2002-2010. Besides, of the five variables chosen, four of them do help to explain banks' interest rate sensitivity, although slightly different with short-term and long-term interest rate sensitivity.

5. ANALYSIS AND DISCUSSION

In this chapter, the empirical findings from Chapter 4 will be analyzed, evaluated and discussed. First, we discuss the results from the first part of the analysis about Eurozone banks' interest rate sensitivity. Secondly, we will analyze the findings from the panel data analysis and determine if interest rate sensitivity can be explained by certain bank characteristics and what could be the reasons for this.

5.1 Interest rate sensitivity

In the first part of the analysis, 38 banks operating in the Eurozone have been investigated in order to find if these banks' stock returns are affected by fluctuations in interest rates. One of the major findings is that there is a difference depending on which one of the two types of interest rates is used. When testing each bank over the complete time period of nine years, the long-term interest rate, i.e. the EURIBOR 10-year, shows a negatively significant relation in 31 out of 38 banks' stock returns, or 82% of the sample. The findings, that the majority of the Eurozone banks show a significant degree of interest rate risk and a negative relation between interest rate movements and banks' equity returns, are consistent with the findings in previous studies (see Bae, 1990; Kwan, 1991; Fraser et al., 2002; Booth et al., 2005). In contrast, Eurozone banks show a positive relationship between their stock returns and the 1-year interest rates. This positive relationship is also found by Ballester et al. (2009) while studying 23 Spanish banks. Interestingly, the study from Au Yong et al. (2009) shows contradictive results to our findings that instead found a negative sensitivity to the short-term interest rate in Asia-Pacific banks, while a positive relation to the long-term interest rate. Previous research found a positive relationship between banks' stock returns and interest rate movements in asset-sensitive banks, as banks will benefit from a raise in interest rates. Thus, a possible explanation for a positive coefficient in the regression run using EURIBOR 1-year is that banks' current assets are going to be re-priced faster than the liabilities. On the contrary, a negative relationship between banks' stock returns and interest rate movements is often found in liability sensitive banks. In our case, it appears that Eurozone banks consist of a majority of long term liabilities that possibly re-price

faster than their assets, thus making the banks negatively exposed to interest rate changes. Thus, the implication is whether a bank is asset or liability sensitive, they are always confronted with some kind of interest rate risk, however it enlightens that banks are able to make their stock returns less exposed to the overall changes in interest rates by adjusting their exposure to these contradicting tendencies.

Moreover, the findings reveal that European banks seem to be more exposed to movements in short-term than in long-term interest rates, which hence might imply that banks feel more prone to hedge against movements in rates with shorter duration, explaining why the banks do not show the same exposure to the short-term 1-year interest rate. Another justification for this finding is supported by Cappiello's et al. (2006) theories about the interest rate pass-through. The difference in the EMU is that banks operate under two central banks, i.e. the ECB and the governmental central bank in the specific country, which also may be an explanatory factor of the low responsiveness. However, short-term products tend to be more responsive to interest rate changes than long-term products, which implies stronger exposure of banks' interest rate risk toward short-term interest rate movements.

Further analysis will aim at providing the understanding about the diverse results across the Eurozone area and between different timeframes. The reason is that the Eurozone consists of many different countries with different cultures, operations and development levels, and the investigated period includes many dynamic changes. Thus, the first part analyses the setting of in which this investigation takes place, in particular the variation in different markets in the Eurozone, whereas the second part will focus on the time period chosen and its specific features and conditions.

5.1.1 The variation of interest rate sensitivity across Eurozone banks

As explained in the introductory chapter, the setting of the Eurozone has to our knowledge not been investigated as a whole region. What distinguishes investigating this region from testing individual countries or regions is that the Euro region consists of many different economies with different economic traditions. However, since 2002, these countries' economies have been joint together in an economic collaboration with one mutual currency. As the main governor of this

collaboration, one can find the European Central Bank, whose purpose is to regulate the region's monetary policies, being superior to the individual countries' central banks and monetary policies.

Interestingly, only two banks are found to show a positive relation to the long-term interest rate over the complete period, although not significant. These banks are the only German banks in the sample, i.e. Commerzbank and Deutsche Bank. Regarding the insignificant interest rate exposure, this might not be surprising as Germany is positioned as the strongest economy in the European Union measured in gross domestic product as well as having well-established financial markets, thus being better at hedging interest rate risk positions than other banks. As with the positive relation, German banks might be more asset-sensitive, reflecting a different risk attitude in comparison to the majority of Eurozone banks. Nearly half of the banks show a degree of exposure to the short-term interest rate, although not as significant as with the long-term rate. The three banks with the highest positive interest rate coefficients are all Greek, i.e. National Bank of Greece, Alpha Bank and Emporiki Bank of Greece, of which the last two show statistical significance (see Appendix 1). Besides, such a difference between German and Greek banks might imply a rather low level of integration in the Eurozone, leading to a quite low systematic risk in the total amount of Eurozone banks. Banks from less developed countries are therefore exposed to a more idiosyncratic interest rate risk.

5.1.2 The variation of interest rate sensitivity across time

As stated earlier, the market climate during certain years during the period investigated has been rather intense. Most interestingly, we have seen a great flourishing economy during the beginning of the period, whereas the last part has seen one of the worst financial crises in history, as well as doubt towards the euro collaboration regarding the on-going sovereign debt crisis. However, when testing the banks' interest rate sensitivity for each of the nine years during the period from 2002 to 2010, banks' interest rate exposure pattern is not stable across the time period and across the different banks, which might be due to the changing conditions in the market during the time period. Interestingly, in 2007, the year the market peaked in the time period investigated, 21 out of 38 banks, or 55%, had negative interest rate duration against the 1-

year interest rate. The same year, 21 banks show a positive interest rate duration against the 10-year interest rate.

During 2010, a year characterized by economic distress in certain countries in the European Economic and Monetary Union as well as in the whole collaboration, all 38 banks show negative interest rate coefficients to the 10-year interest rate, when testing over the complete period. The fact that economic problems in only a few countries within an economic currency collaboration spread out to all the countries in the union might be supported by this finding.

When looking at the progress of the two interest rates used (see Figure 4.1), the interest rate environment during the last three years has been quite unstable, with the rates drastically dropping from period-high levels to levels close to zero percent. However, as is seen in the figure, the long-term interest rate tends to fluctuate more during 2009 and 2010 than the short-term rate does. As mentioned, all banks show a negative relation to the long-term interest rate in 2010. Generally, abnormal interest rate environments make it harder for banks to make the perfect hedge. This is consistent with the yield curve risk mentioned in the theoretical framework by Bessis (2002, p. 151), that banks become more exposed to risk derived from changes in the slope and the shape of the yield curve.

5.2 Determinants of banks' interest rate exposure

As the research purpose is designed to determine Eurozone banks' interest rate sensitivity to changes in two, both short- and long-term, interest rates, it is quite natural to check whether there exists any different determinants with these two interest rates and why. Interestingly, the findings include both similar and different results regarding the effects and factors that determine banks' interest rate exposure. Thus, the analysis will be presented in two parts, one for the similar results, i.e. the loans and equity ratios, and the other part for the different results obtained, i.e. bank size, non-interest income and deposits.

5.2.1 Determinants of banks' interest rate exposure – the similarities

First, when comparing the results obtained from the 1-year and 10-year interest rate sensitivity, only the equity ratio is proven to have a significant impact on banks' interest rate exposure in

both cases, whereas the loans-to-total assets ratio expresses no relation with banks' interest rate sensitivity. Banks' interest rate sensitivity is highly related to the proportion of equity with a correlation of -0.2581 and -0.2540 respectively for the 1-year and 10-year interest rates. This implies that a bank with a higher level of equity will be less exposed to interest rate risks, both with long- and short-term rates. Fraser et al. (2002), Saporoschenko (2002) and Au Yong (2009), while investigating American, Japanese and Asian-Pacific banks, provide the same results, showing a significantly negative relation between banks' capital and interest rate exposure. Consequently, the explanation is that bank capital is viewed as a cushion against not only interest rate risks, but also a variety of risks that banks are exposed to in the course of their business (van Greuning & Brajovic Bratanovic 2009, p. 123). In particular, higher capital ratios represent less needs for external funding, which can be quite a serious problem for a bank when the mismatch between the assets and liabilities is high, thus making banks less exposed to the interest rate risk. Besides, as mentioned before, the financial leverage in banks is quite high, thus banks with more equity capital will be able to lower the probability of financial distress and bankruptcy, which often forces banks to sell-off of their stocks in response to negative shocks such as adverse increases in interest rates.

In contrast to Fraser et al. (2002) and Ballester et al. (2009), whose results demonstrate a significant positive relationship between the proportion of loans to banks' interest rate sensitivity, loans over total assets shows nearly no effect and no statistical significance on the European banks' interest rate sensitivity in our regression models. Both Fraser et al. (2002) and Ballester et al. (2009) consider loans over total assets as the best proxy for income derived from re-priced assets or maturity mismatches, thus being the source of re-pricing interest rate risk. However, the ratio is not significant in our case, possibly because it is an imperfect measure of bank maturity mismatch. As can be seen in our interest rate measurement discussion, the maturity mismatch is a static measure and quite dependent on year-by-year forecasts of both assets and liabilities. However, in the current uncertain environment, it is rather problematic to expect a precise forecast. In addition, banks' loans are often indicators for the re-pricing risk when it has floating interest rates, that we might not be able to measure with banks' loans in general. Fraser et al. (2002) also acknowledge that loans over total assets might not be the perfect measure for banks' maturity mismatch. Thus, it comes to our conclusion that banks' loans in

general are not a good proxy of interest rate exposure, at least with the Eurozone banks in general.

5.2.2 Determinants of banks' interest rate exposure – the differences

It comes to our surprise that the bank size variable expresses the contradict impact to banks' interest rate exposure to changes in short-term and long-term interest rates. In particular, the coefficient of banks' size is -0.3062 to the short-term interest rate and 0.3239 with the long-term interest rate exposure at 1% statistically significant level. Interestingly, the literature regarding this relationship demonstrates conflicting expectations between banks' size and interest rate exposure. The ones that support negative relationships as their line of argument is based on the better market access and greater diversification of larger banks compared to smaller banks. In contrast, the lines of argument for positive relationships between banks' size and their interest rate exposure are higher risk attitude, moral hazard as the consequence of "too big to fail", support from the government and more aggressiveness in pricing policies that often can be seen in larger banks (Ballester et al., 2009). To our knowledge, most empirical studies support a positive relationship as of Ballester et al. (2009) and Saporoschenko (2002) whereas only Zhu et al. (2007) found a negative relationship between interest rates sensitivity and bank size, although only at 10% statistically significant level. The positive relationship found with the 10-year interest rate might imply that the case when larger banks present more aggressive actions in pricing policies for long-term assets, e.g. corporate loans with long-term interest rate as they expand to many countries and are therefore forced to compete with local banks. On the contrary, negative relationships found with the EURIBOR 1-year interest rate are potentially caused by the fact that larger banks have better market access and that they are able to hedge against short-term interest rates, such as EURIBOR 1-year, which is the most common reference rate. As the result we got is highly statistically significant at 1%, both for the interest rate sensitivity to 1-year and 10-year interest rates, it is obvious that bank size has a direct impact on banks' interest rate sensitivity. However, with contradicting effects, the question here is which effect tends to be stronger, or they will offset each other that make the size a less precise proxy of banks' interest rate exposure.

The total deposits over total assets ratio coefficient is found to be negative at -0.2555, and statistically significant at 5%, however, only with the 1-year interest rate risk, but not significant at all with the long-term interest rate risk. The negative relationship found is consistent with Fraser et al. (2002), Saporoschenko (2002) and Ballester et al. (2009). In general, as classified in the Basel Accord's description of sources of interest rate, banks' deposits might be the source of option embedded risk. However, they are more often considered as the most stable sources of funding for banks. More reliance on demand deposits permits banks to be less reliant on external funding, thus they are less exposed to the re-pricing risk in accompany with bank liabilities in response to interest rate fluctuations (Fraser et al., 2002). Thus, the stronger relation between the deposits over total assets ratio to interest rate sensitivity with short-term rates might reveal that Eurozone banks' liabilities are more often re-priced against short-term interest rates than long-term ones, thus showing a stronger relationship against the short-term interest rate risk than long-term. Furthermore, the majority of deposits possibly are demand deposits, which have less sensitive costs of funding than other types of deposits, thus resulting in a significant negative relationship with banks' interest rate sensitivity.

According to our results, the non-interest income ratio, defined as the proportion of non-interest income to total revenues, in contrast to previous research, presents a more significant impact on banks' interest rate sensitivity to the long-term interest rate with the coefficient of -0.2196 at the 5% significance level, but not with the short-term one. The negative correlation is consistent with Fraser's et al. (2002) findings, in which the explanation provided is that banks tend to be less reliant on traditional intermediation activities, e.g. deposits and loans, if banks have a larger income derived from non-interest activities, hence less affected by adverse changes in interest rates, i.e. rises in interest rates. Traditional intermediation activities often involve lending long and borrowing short, hence banks' assets, e.g. loans, can be more exposed to adverse changes in long-term interest rates than short-term interest rates (Bessis, 2002, p. 151). The results indicate that by reducing the reliance on traditional intermediation activities, but instead increasing non-interest income, banks are able to reduce their sensitivity to long-term interest rate changes.

6. CONCLUSIONS

In this final chapter, conclusions regarding the findings in the investigation will be presented, covering interest rate sensitivity and the determinants of the exposure. Conclusions drawn derive from the analysis of the thesis. We also provide suggestions for further research within the subject.

The main purpose of this thesis has been two folded. First, the aim has been to decide whether the Eurozone banks' stock returns are exposed to movements in two different interest rates. Second, it has been tested whether or not this exposure can be determined by certain bank characteristics. Furthermore, two research questions were provided in order to support the purpose. The first one asked how significant the sensitivity of Eurozone banks' stock returns is to changes in interest rates, whereas the second one asked what the determinants of this sensitivity are.

Our findings related to the first part show quite a markedly difference from previous empirical research in three dimensions. Firstly, although Eurozone banks indicate a considerable degree of interest rate exposure towards their equity returns during the period from 2002 to 2010, the sensitivity against interest rate fluctuations can differ between years and banks. As we divided the investigated timeframe into two periods, one pre-crisis period of 2002-2006 and on period of 2007-2010, as the current on-going crisis, the first period display a really low exposure in Eurozone banks to interest rate risk, whereas the second period shows quite a solid relationship between interest rate changes and banks' stock returns. It is quite obvious that the banks' interest rate risk increase as the direct consequence of crisis, however, the increasing integration in the Eurozone might also have an impact on this fact, as the systematic risk between Eurozone countries increases. Surprisingly, Eurozone banks show a different pattern of interest rate exposure. In particular, with no direct relationship between 2002 and 2010, the banks show a negative relationship to the 1-year interest rate sensitivity and a positive relationship to the 10-year interest rate sensitivity during 2007-2010. Thus, differences between the 1-year and the 10-year interest rates exist, providing evidence that banks' exposure to these two interest rates is

dependent on to what extent banks chose to hedge against different maturities. In the assessment of individual banks' interest rate sensitivity, we find that there is dispersion among risk levels in different banks, showing that the magnitude of the sensitivity differs across years. This is probably evident since the integration level in the Eurozone still remains at quite low levels.

In the second part, we have examined five potential determinants to explain the interest rate sensitivity, i.e. financial leverage, reliance on non-interest income, the proportion of income derived from re-priced assets, reliance on deposits and bank size. Our findings show that in Eurozone banks' case, some determinants explain the sensitivity to the short-term interest rate, while the determinants explaining the sensitivity to the long-term interest rate are somewhat different. The only determinant that explains interest rate sensitivity for both interest rates is the capital ratio, i.e. equity over total assets, which shows statistical significance and a negative relationship in both tests, implying that banks with a larger proportion of equity capital are less exposed to interest rate fluctuations. On the contrary, the reliance on income derived from re-priced assets, i.e. the proportion of loans to total assets, does not show any significant relationship to neither the short-term nor the long-term interest rate.

While only two variables give the same result for both types of interest rates, the others differ in which one of the interest rates is used. Most surprisingly, as for bank size, this variable shows a negative correlation to the short-term interest rate, whereas a positive correlation to the long-term, both numbers statistically significant, which is different from previous empirical research. The positive relation to the long-term interest rate may imply that larger banks present more aggressive actions in pricing policies for their long-term assets, as they are present outside of their countries' borders and thereby have to compete with local actors. Moreover, the negative relation to the short-term interest rate could be an indicator that larger banks have better market access and are thus more effective at hedging against these.

The variable explaining the proportion of banks' deposits show a negative relation to both interest rates, although only significant for the short-term interest rate. Since deposits are a rather cheap way of funding for a bank, it is quite obvious that the larger proportion of deposits a bank has, the less the exposure to interest rate movements will be. On the contrary, the extent to which banks rely on non-interest income is only significantly negatively related to the long-term

interest rate. Banks relying more on non-interest activities, are thus less exposed to interest rate changes.

We conclude that Eurozone banks' equity returns experience a significant exposure towards changes in interest rates, especially in unstable and volatile interest rate environments, e.g. 2007-2010. Furthermore, the determinants of this exposure, as stated above, can be explained by easily observable items in the banks' financial statements. This evidence is therefore relevant to bank managers in the risk management process in order to hedge against such risks. Hence, the conclusions might also be valuable to investors who want to reassess bank stocks to respond to movements in interest rates.

6.1 Suggestions for further research

We provide evidence that Eurozone banks are to a great extent exposed to changes in interest rate risks, covering the period from when the euro currency was introduced as a medium of payment to today. The pattern is found to be distinctively different as regards to long-term and short-term interest rates regulated by the ECB. Thus, in order to provide further insight of how the banking business is exposed to interest rate risk, we propose that further research should employ other interest rates as the proxy to determine banks' interest rate exposure. By distinguishing and contrasting banks' interest rate exposure to different interest rates, further research would provide a more practical guidance regarding how banks' interest rate exposure responds in accordance with the terms of interest rate. Furthermore, we only examine 38 banks in the European region based on the EURO STOXX® TMI Banks Index, thus the sample is considered to be quite small compared to the European bank population. We therefore suggest that further research can broaden the sample to obtain more accurate results regarding European banks' interest rate exposure.

In regards to the determinants of the banks' interest rate sensitivity, we have only taken five determinants into consideration, as based on Fraser et al. (2002), thereby excluding other possible determinants. The determinants are all on-balance sheet items, not off-balance sheet activities, e.g. hedging or securitization. Previous research show two contradictive views on how off-balance activities affect banks' risks, in general both positive and negative relations

depending on the banks' motivation underlying to the use of off-balance sheet activities. We therefore encourage further research on the topic to clarify the influence of off-balance sheet activities on interest rate exposure of bank within the Eurozone by including off-balance sheet activities as the control variable of interest rate risk.

REFERENCES

Published sources

Adam, A., (2007). *Handbook of asset and liability management: from models to optimal return strategies*. New York: John Wiley and Sons.

Akella, S. R. & Greenbaum, S. I. (1992). Innovations in Interest Rates, Duration Transformations and Bank Stock Returns. *Journal of Money, Credit and Banking,* 24, p. 27-42

Au Yong, H.H., Faff, R. & Chalmers, K., (2009). Derivative activities and Asia-Pacific banks' interest rate and exchange rate exposures. *Journal of International Financial Markets, Institutions and Money*, 19 (1), p. 16-32

Bae, S. C., (1990). Interest Rate Changes and Common Stock Returns of Financial Institutions: Revisited. *Journal of Financial Research*, 13 (1), p. 71-79

Baltagi, B. H. (2008). *Econometric analysis of panel data*. 4th ed. Chichester: Wiley

Barros, P. P. (2005). Integration of European banking: the way forward, *Centre for Economic Policy Research*.

Basel Committee on Banking Supervision (2004). Principles for the Management and Supervision of Interest Rate Risk. *Bank for International Settlements,* July 2004

Benink, H. A. & Wolff, C. C. P. (2000). Survey Data and the Interest Rate Sensitivity of US Bank Stock Returns. *Economic Notes*, 29 (2), p. 201-213

Berger, A. N. et al. (2003). To what extent will the banking industry be globalized? A study of bank nationality and reach in 20 European nations. *Journal of Banking & Finance*, 27 (3), p. 383-415

Bessis, J. (2002). *Risk management in banking*. 2. ed. Chichester: Wiley

Booth, J. R., Officer, D. T. & Henderson, G. V. (1985). Commercial bank stocks, interest rates, and systematic risk. *Journal of Economics and Business*, 37 (4), p. 303-310

Brasili, A. & Vulpes, G. (2005). Co-movements in EU banks' fragility: a dynamic factor model approach, *EconWPA*

Brooks, C. (2008). *Introductory econometrics for finance*. 2nd ed. Cambridge: Cambridge University Press

Bryman, A. & Bell, E. (2007). *Business research methods*. 2nd ed. Oxford: Oxford University Press

Buehler, K. S. & Santomero, A. M. (2008). How Is Asset and Liability Management Changing? *RMA Journal*, 90 (6), p. 44-49

Cappiello, L., Hördahl, P., Kadareja, A & Manganelli, S. (2006). The Impact of the Euro on Financial Markets. *European Central Bank Working Paper Series*, No. 598, March

Cecchini, P., Heinemann, F. & Jopp, M. (2003). *The incomplete European market for financial services.* Heidelberg: Physica-Verlag

Culp, C. L. (2002). *The ART of risk management: alternative risk transfer, capital structure, and the convergence of insurance and capital markets*. New York: Wiley

Dermine, J. (2006). European Banking Integration: Don't Put the Cart before the Horse. *Financial Markets, Institutions & Instruments*, 15 (2), p. 57-106

Elyasiani, E. & Mansur, I. (1998). Sensitivity of the Bank Stock Returns Distribution to Changes in the Level and Volatility of Interest Rate: A GARCH-M Model. *Journal of Banking and Finance,* 22, p. 535-563

Eye, A. von & Schuster, C. (1998). *Regression Analysis for Social Sciences.* 1st ed. SanDiego: Academic Press.

Flannery, M. & James, C. (1984). The Effect of Interest Rate Changes on the Common Stock Return of Financial Insitutions. *Journal of Finance,* 20, p. 1085-1101

Fraser, D. R., Madura, J. & Weigand, R. A. (2002). Sources of Bank Interest Rate Risk. *Financial Review*, 37 (3), p. 351-367

Ghazanfari, F. P., Rogers, H. C. & Sarmas, P. (2007). The effect of the Federal Reserve interest rate policies on the returns of commercial banks stocks. *Journal of Financial Services Marketing*, 11 (4), p. 349-359

Goddard, J., Molyneux, P. Wilson, J. O. S. & Tavakoli, M. (2007). European banking: An overview. *Journal of Banking & Finance*, 31 (7), p. 1911-1935

van Greuning, H. & Brajovic Bratanovic, S. (2009). *Analyzing banking risk: a framework for assessing corporate governance and risk management*. 3rd ed. Washington D.C: World Bank Publications.

Gujarati, D. N. (2002). *Basic econometrics*. 4th ed. Boston: McGrawHill

Kwan, S. H. (1991). Re-examination of interest rate sensitivity of commercial bank stock returns using a random coefficient model. *Journal of Financial Services Research*, 5 (1), p. 61-76

Lynge, M. J. & Zumwalt, J. K. (1980). An Empirical Study of the Interest Rate Sensitivity of Commercial Bank Returns: A Multi-index Approach. *Journal of Financial and Quantitative Analysis,* 15, p. 731-742

Oertmann, P., Rendu, C. & Zimmermann, H. (2000). Interest Rate Risk of European Financial Corporations. *European Financial Management,* 6 (4), p. 459-478

Oesterreichische Nationalbank (OeNB) (2008). Guidelines on Managing Interest Rate Risk in the Banking Book. Spring 2008

Saporoschenko, A. (2002). The sensitivity of Japanese bank stock returns to economic factors: An examination of asset/liability differences and main bank status. *Global Finance Journal*, 13 (2), p. 253-270

Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research methods for business students*. 5th ed. Harlow: Financial Times Prentice Hall

Sharma, M. (2008). *Dynamics Of Indian Banking: Views and Vistas*, New Dehli: Atlantic Publishers & Dist.

Stone, B. K. (1974). Systematic Interest-Rate Risk in a Two-Index Model of Returns. *Journal of Financial and Quantitative Analysis*, 9 (05), p. 709-721

Vannerem, P. & Iyer, A. S. (2010). Assessing Interest Rate Risk Beyond Duration - Shift, Twist, Butterfly. *MSCI Barra Applied Research,* April 2010

Williams, B. & Prather, L. (2010). Bank risk and return: the impact of bank non-interest income. *International Journal of Managerial Finance*, 6 (3), p. 220-244

Yourougou, P. (1990). Interest Rate Risk and the Pricing of Depository Financial Intermediary Common Stock. *Journal of Banking and Finance,* 14, p. 803-820

Zhu, J., Hassan, M. & Li, W. (2007). Bank size and interest rate sensitivity of bank stock returns. *International Journal of Business, Accounting and Finance*, 1 (1), p. 1-25

Working papers

Allen, L. & Jagtiani, J., (1996). Risk and Market Segmentation in Financial Intermediaries' Returns. SSRN eLibrary

Ballester, L., Ferrer, R., González, C,. & Soto, G. M. (2009). Determinants of interest rate exposure of Spanish banking industry. *Instituto Valenciano de Investigaciones Económicas, S.A. (Ivie)*. 2009/1. SSRN eLibrary

Choi, J. J. & Elyasiani, E. (1996). Derivative Exposure and the Interest Rate and Exchange Rate Risks of U.S. Banks. SSRN eLibrary

Drakos, K., (2001). Interest rate risk and bank common stock returns: Evidence from the Greek banking sector. *Department of Economics: London Guildhall University*

Electronic sources

ECB: European Central Bank, URL: www.ecb.int, Retrieved 2011-03-27

STOXX, URL: www.stoxx.com, Retrieved 2011-04-01

Databases

Lund University LibHub

Thomson Reuters Datastream

SSRN Electronic Library

APPENDIX 1.

List of banks' interest rate sensitivity for complete period 2002-2010

Bank	1-y IR sensitivity		10-y IR sensitivity	
Allied Irish Banks	0.0351		-0.3396	***
Alpha Bank	0.1123	*	-0.1278	***
Banca Carige	-0.0788	**	-0.1347	***
Banca Etruria	0.0236		-0.0296	
Banca Popolare di Emilia Romagna	-0.0561	*	-0.2517	***
Banca Popolare di Sondrio	-0.0324		-0.1437	***
Banco Bilbao Vizcaya Argentaria (BBVA)	0.0337		-0.1633	***
Banco BPI	-0.0287		-0.1119	***
Banco Comercial Portugues	0.0230		-0.1250	***
Banco de Sabadell	-0.0287		-0.0985	***
Banco de Valencia	-0.0457		-0.1512	***
Banco Espirito Santo	-0.0310		-0.1430	***
Banco Internacional do Funchal (BANIF)	0.0580		-0.0684	*
Banco Pastor	-0.0170		-0.0071	
Banco Popolare	-0.0834	*	-0.0784	***
Banco Popular Espanol	-0.0980	***	-0.2031	***
Banco Santander	0.0036		-0.1648	***
Bankinter	-0.0065		-0.0938	***
BNP Paribas	0.0611		-0.0560	*
Commerzbank	0.0505		0.0573	
Credem Banca (Credito Emiliano)	0.0628		-0.0855	**
Crédit Agricole	-0.0636		-0.1634	***
Credito Bergamasco	0.0002		-0.0258	
Deutsche Bank	-0.0393		0.0133	
Dexia	0.0856		-0.0065	
EFG Eurobank Ergasias	0.0824		-0.2017	***
Emporiki Bank of Greece	0.1426	***	-0.0571	
Erste Group Bank	-0.0336		-0.1390	***
General Bank of Greece	0.0513		-0.2651	***
Intesa Sanpaolo	0.0960	**	-0.1371	***
KBC Group	0.0110		-0.2718	***
Mediobanca	0.0078		-0.0935	***
National Bank of Greece	0.0963		-0.1385	***
Natixis	-0.0966		-0.1329	***
Piraeus Bank	0.0960	*	-0.1939	***
Pohjola Pankki	-0.0177		-0.1927	***
Société Génèrale Group	0.0855	*	-0.1694	***
Unicredit	0.0156		-0.1839	***
Total	**0.0126**		**-0.1284**	