Financial Intermediation and Interest Rate Risk

Maxim Zagonov

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Declaration

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Maxim Zagonov

Abstract

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by

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This thesis analyses the link between interest rate risk faced by financial intermediaries in the G-10 countries, their balance sheet composition and national bank regulation. The regulatory authorities both in the US and in Europe increasingly emphasise the issue of bank interest rate exposure. The importance of this topic is also reasserted by recent developments in the monetary environment. The thesis offers three major contributions to the area.

First, it empirically investigates the interest rate risk exposure of financial intermediaries across a large international data sample over the 1997 to 2009 time period. The results verify the importance of interest rate exposure for the majority of analysed institutions, with statistical inferences being robust to the choice of interest rate proxy, time period, and the adopted econometric methodology.

Second, this research examines the underlying determinants of bank interest rate risk. Both company and market specific information is considered in the analysis. The findings suggest that national regulatory and supervisory characteristics, and notably international diversity among these provisions, are as important as firm-level accounting variables in explaining the interest rate exposures of individual banks.

Finally, this work empirically addresses the impact of securitization on bank interest rate risk. In particular, the research questions whether securitization is conducive to the optimal hedging of bank interest rate risk, or is merely a funding source enabling these companies to pursue more profitable but riskier projects. The reported results imply that banks resorting to asset securitization do not, on average, achieve an unambiguous reduction in their exposure to the term structure developments.

To my family

for their enormous support

throughout this last decade . . .

Chapter 1

Introduction

1.1 Background

This thesis employs an international sample of financial intermediaries and empirically addresses their exposure to interest rate movements. All G-10 countries and other important regions of Asia (Hong Kong) and Pacific Rim (Australia) are considered in this analysis. The thesis also examines the link between interest rate exposure faced by financial intermediaries, their balance sheet composition and national bank regulation.

Recent decades have witnessed a profound transformation in the financial environment, with trends towards establishing more open and integrated financial markets. This development enhanced the functioning of financial systems worldwide and facilitated remarkable advances in terms of efficient capital allocation, access to external finance, product quality, and risk sharing.

Against this background, financial market integration has also exacerbated the cross-border propagation of shocks and financial instability, as witnessed during the global financial crisis of 2007-2010.

What started as a relatively isolated US subprime episode was then propagated to the rest of the financial sector worldwide, affecting all major asset classes. In response, a plethora of research contributions addressed the fundamental causes of the crisis in depth. These works have uncovered numerous deficiencies in risk management practices adopted by financial intermediaries, inefficacies in the existing financial regulation, and our limited knowledge of the market mechanism by which the financial contagion is proliferated, among others. For instance, Skreta and Veldkamp (2009) addressed the role of rating agencies, condemning their inability to properly rate the securitised products which are generally regarded as the key culprit in the crisis. Agencies' incentives, and conflict of interest are also emphasised by Bolton, Freixas, and Shapiro (2008).

The flawed design of the top managers' compensation structure has also been acknowledged for contributing to the crisis (Erkens, Hung, and Matos, 2009). In a similar vein, the regulatory architecture which allowed, and in some instances abetted, such short-termist behaviour has also been criticised (e.g., Acharya and Richardson, 2009).

Much has been learnt about the underlying causes of the recent financial events from these contributions. However, the majority of these works do not address the risks facing the financial system in the aftermath of the crisis.

In particular, it appears practitioners and academics alike paid little attention to interest rate risk in recent years. As a result, the oversight and management of interest rate risk has fallen in priority at many financial firms. This development is alarming for at least three reasons.

First, interest rate exposure represents one of the most significant risks faced by financial institutions due to their asset intermediation activities. These activities involve transforming short-term savings to long-term investments and typically result in duration mismatches between interest rate sensitive assets and liabilities. Such duration mismatches expose financial institutions to interest rate fluctuation[1]. In this respect, the interest rate risk was acknowledged as the most important source of banks' market risk by the 2007 industry survey conducted by the International Financial Risk Institute and Institute of Chief Risk Officers.

Second, the importance of interest rate risk was reasserted by recent developments in the monetary environment. As a consequence of a prolonged period of historically low nominal interest rates around the world, the concern exists at present that credit institutions have relaxed their asset-liability management practices and are less protected than ever against rising interest rates. Furthermore, due to the crisis-induced liquidity constraints, many institutions were forced to shorten the maturity of their liabilities and are accordingly exposed to greater refinancing risk.

Finally, inadequate management of interest rate risk was responsible for many infamous crises in the history of banking. The most representative example is the US "Savings and Loan" crises of the late 1970s and early 1980s which was triggered by the major shifts in monetary policy[2] (Kane, 1989). In this episode, thrifts have invested a considerable amount of their assets to the fixed-rate mortgage products and were confronted with rising funding costs due to the late

[1] The mechanism of this phenomenon is explained in the following section.

[2] The major shifts are due to the Federal Open Market Committee's policy change in 1979 and phasing out of Regulation Q initiated by the Depository Institutions Deregulation and Monetary Control Act in 1980. Barth (1991) and Curry and Shibut (2000) provide a detailed discussion on the S&L crisis.

1970s phenomenal increase in interest rates. As a result, almost 1,000 Savings and Loans institutions failed. The interest rate risk was also partly responsible for the banking crises in Sweden during 1991-1994, and the failure of individual institutions in other developed countries.

As the aforementioned concerns become increasingly noticeable, regulatory authorities both in the US and in Europe draw attention to the importance of the role interest rate risk management plays for banking stability. In particular, this issue has been flagged in the Winter 2009/2010 issue of the FDIC's Supervisory Insights publication and the Office of Thrift Supervision issue of an interagency advisory on interest rate risk management on January 6, 2010. Both publications stress the importance of accurately measuring and managing interest rate risk and conclude that banks have accepted greater levels of interest rate risk in recent years.

These communications point to the significant challenges financial institutions will face in preserving their profitability amidst rising interest rates and ongoing pressure on net interest margins and capital. A large number of intermediaries have increased the proportion of fixed rate loans in their portfolios. Many loans are also priced at variable rates with floors, implying that these rates cannot be increased unless the market rates exceed the prevailing floor level. On the liability side, credit institutions face an increasingly competitive market for deposits and therefore higher funding costs. In addition, the majority of companies become progressively reliant on the short-term, highly interest rate sensitive, certificate of deposits.

The evidence of increased interest rate risk, combined with greater regulatory attention, poses a fundamental question of how well the financial corporations are prepared for changes in the interest rate environment and what are the most effective means of hedging interest rate risk. This thesis addresses these and many other related questions.

In particular, the objective of this thesis is to identify the financial companies' exposures to interest rate fluctuations, assess the determinants of these risks, and examine the applicability of these determinants in countries with different regulatory regimes and level of market discipline. Among others, the thesis addresses empirically the following questions:

Whether, and to which degree, are financial institutions exposed to interest rate risk? Which interest rate factors are the most significant and how does this vary across time and markets (e.g., the G-10 countries)? How do the above questions fit to different types of financial intermediaries? What are the sources driving banks' interest rate exposures and to which extend? Is it possible to effectively manage bank interest rate exposure via securitization? If so, did financial institutions successfully utilise this channel in the run-up to the recent financial crisis? From an econometric perspective, which model should be used to describe adequately the institutions' interest rate sensitivity? From a policy perspective, how is interest rate exposure affected by regulation and policy? Which regulatory frameworks are most conducive to minimising interest rate exposure and why?

1.2 Financial institutions and interest rate risk

Financial institutions encounter various types of interest rate risk. These risks largely emanate from their asset transformation function which incurs intermediating transactions between lenders and borrowers. In doing so, financial intermediaries engage in direct contractual agreements with both parties. They borrow from economic agents with excess funds and lend to agents with liquidity constrains. These contracts are priced on the basis of interest rates and they make up ultimately the composition of financial firms' portfolios. In the same vein, the firm market value is largely tied to the net present value of these contracts.

In fulfilling this important intermediation function, financial institutions often mismatch maturity and liquidity characteristics of assets and liabilities and expose themselves to interest rate risk. By nature, most assets (mainly loans) are relatively illiquid and long-term, while most liabilities (mainly deposits) are liquid, have shorter maturities than loans, and can be withdrawn on demand. Accordingly, a financial intermediary with longer term assets relative to liabilities is subject to refinancing risk in a raising interest rate environment. A raise in interest rates reduces the firm's net interest income by increasing the cost of funds relative to the yield on assets. This risk is commonly referred to as the interest rate margin risk.

In addition to adverse effects on earnings, a financial intermediary also faces market value risk when interest rates change. This happens because the underlying market value of assets and liabilities (which theoretically equals the discounted present value of future and current cash flows from these assets and liabilities) will be inversely affected by rising interest rates. Accordingly, with rising interest rates, companies retaining positive maturity mismatches between interest rate sensitive assets and liabilities see the market value of their assets decreasing more than their liabilities. This reduces the market value of the firm's equity and increases the risk of insolvency.

In a bid to hedge against interest rate exposure, some institutions choose to match the maturity (or duration) of their interest sensitive assets and liabilities.

In this respect, Samuelson (1945) and Hicks (1946) first highlight the relevance of duration to planning the balance sheet maturity structure in their "Duration Theorem". The theorem implies that if the weighted duration of the asset stream is greater (less) than the weighted duration of the liability stream the increase (decrease) in interest rates will adversely affect the individual's net worth. Later, Redington (1952) formalises the practical applications of the Samuelson-Hicks Duration Theorem by introducing the "immunisation rule". This rule suggests hedging interest rate risk by perfectly matching durations of asset and liability streams[3]. Grove (1974) further generalises by developing the model of the balance sheet maturity structure based on the duration theorem. Grove demonstrates analytically that the sensitivity of a firm's net worth to interest rate developments depends on the duration mismatch between the firm's assets and liabilities. Further, the author presents conditions under which immunisation would be optimal for investors.

The duration matching strategy, however, does not provide a complete protection against other types of interest rate risk [Saunders and Cornett, 2006]. These include basis risk, yield curve risk, and risks from optionality embedded in some assets and liabilities.

The basis risk arises when the relationship between the rates earned on assets and the rates paid on liabilities change (i.e., assets and liabilities are priced on different bases). Even if assets and liabilities are priced on the same basis, financial institutions are still affected by changes in the shape of the interest rate term structure (i.e., yield curve risk). Thus, an institution which finances its short- and long-term assets with medium-term liabilities is exposed to changes in the yield curve curvature. Another important source of interest rate risk is due to options embedded in some assets, liabilities, and off-balance sheet positions (e.g., loan prepayment or funds withdrawal provisions). Such options, when exercised, introduce an unexpected change in the value of assets and cash flows for the financial intermediary [Feid, 1993; Lee and Stock, 2000].

To summarise the discussion so far, the interest rate risk can be formalised as the risk that fluctuations in market interest rates impact adversely an intermediary's financial condition. Such adverse impacts come from different, often complementary and/or offsetting sources, giving rise to different approaches for assessing and managing interest rate exposure.

In general, interest rate risk management aims at curtailing the risks arising from the duration mismatches discussed above. These risks are commonly

[3] The immunisation process is discussed in depth by Bierwag, 1977; Rosenblum, 1981; and Bierwag, Kaufman and Toevs, 1983.

measured following two approaches.

The first approach, commonly called the "Earning Perspective", relies on analysing the immediate, short-term, impact of changes in interest rates on banks' accrual or reported earnings. This method generally accounts for the effect of rate changes on both banks' net interest income and non-interest revenues over the short run.

The second approach, the "Economic Value Perspective", essentially measures the effect of interest rate changes on the economic value of an institution's assets, liabilities, and off-balance sheet positions. In effect, it captures the risk to an institution's net worth (i.e., its economic value) which results from the existing duration mismatches and other positions sensitive to interest rates. Since the economic value is viewed as the present value of future cash flows, the "Economic Value Perspective" considers the longer-term impact of interest rate changes. For this reason, it is commonly regarded as a more accurate approach to assessing banks' interest rate exposure.

The "Economic Value Perspective" is based on the duration gap analysis and relates to the work of Redington (1952) discussed above. This involves the comparison of estimates of the duration of financial intermediaries' asset and liabilities. The observation of the duration mismatch implies that the market value of assets and liabilities changes differently when rates change, and thus is indicative of how the market value of equity will change. Accordingly, the duration gap analysis represents a comprehensive method of analysing interest rate risk and is popular among practitioners. A detailed discussion of the theoretical benefits and practical applications of the duration gap analysis is presented in Toevs (1983), Kaufman (1984) and Bierwag and Kaufman (1985).

Despite its popularity, the duration gap analysis has been widely criticized. Researchers emphasise that, in practice, several important assets and liabilities have theoretically ambiguous durations which impedes the accurate estimation of duration gaps. In addition, the increased interconnectedness of financial institutions and their involvement in off-balance sheet activities may create exposures not captured accurately by a standard duration gap model. Furthermore, the gap approach does not take into account the default or credit risk of assets. Neither does it account for the negative association between interest rate and credit risk widely recognised by researchers [Drehmann, Sorensen and Stringa, 2010]. Following an interest rate increase, creditors may witness deterioration in the loan portfolio credit quality, owed to the adverse selection problem and risk shifting. Finally, as discussed above, the duration matching strategy does not offer a complete protection against all known types of interest rate risk which would affect a bank's economic value.

From an academic perspective, the use of the gap measure is also complicated by the lack of consistent information on duration gaps for the majority of financial institutions and markets.

Accordingly, instead of using the duration gap measure, prior academic works in the area analyse the effect of interest rate changes on the capitalised value of a financial institution's future cash flows. In particular, the researchers rely on market efficiency and employ equity market data to capture the interest rate sensitivity of financial firms' equity prices. The majority of contributions use the two-index asset pricing model introduced by Stone (1974). This model augments the standard market model with an interest rate factor which captures the influence of unexpected developments in the yield curve on asset prices. The coefficient estimate on the interest rate factor, i.e. the interest rate beta, is therefore treated as a measure of interest rate exposure. According to this framework, the observation of a significant relationship between the stock price and interest rate (i.e. significant interest rate beta) suggests that firm's asset-liability composition and/or dividend policy transmit interest rate fluctuations to the market as signals of changes in earnings prospects. This results in new equilibrium prices.

Since the inception of Stone's model, companies' exposure to interest rate risk has become a popular research topic. The researchers have applied widely Stone's model to study the interest rate sensitivity of both financial and non-financial corporations. Overall, the majority of empirical works have confirmed the instrumental benefits of including an interest rate factor to the single-factor model [Fama and Schwert, 1977; Fogler, Kose and Tipton, 1981].

The works focusing on the US market conclude that most financial intermediaries are negatively affected by unanticipated interest rate changes [Martin and Keown, 1977; Chance, 1979; Gultekin and Rogalski, 1979; Lynge and Zumwalt, 1980; Chance and Lance, 1980].

However, the widely acknowledged deficiency of these works was the lack of a unified theory that explained why the effect of interest rate fluctuations on stock returns varies among companies. Flannery and James (1984a) lay theoretical foundations to address this. In particular, the authors offer a theoretical rationale to relate the stock returns interest rate sensitivity to the maturity composition of the firm's nominal assets and liabilities, and provide empirical evidence to support this hypothesis. The framework presented by Flannery and James is largely based on the Samuelson-Hicks Duration Theorem discussed above.

According to Flannery and James, the equity of credit institutions maintaining a positive duration mismatch between assets and liabilities will react negatively to interest rate increase and vice versa. Accordingly, other things being equal, an increase in the proportion of long-term assets (long-term liabilities) should raise (lower) interest rate beta in Stone's two-factor model. The estimate of each bank's interest rate beta thus reflects the market's assessment of its duration gap.

The findings of Flannery and James have instigated even more academic interest in the area. Using different methodologies, data samples and time periods many works have reconfirmed or sometimes questioned Flannery and James conclusions [e.g., Booth and Officer, 1984; Scott and Peterson, 1986; Bae, 1990; Saunders and Yourougou, 1990; Madura and Zarruk, 1995; Allen and Jagtiani, 1997; Elyasiani and Mansur, 1998; Oertmann, Rendu and Zimmermann, 2000]. Numerous academic contributions have also extended the Flannery and James framework by demonstrating that the estimated interest rate betas also convey the interest rate sensitivity of financial institutions' stocks unrelated to their balance sheet structure. In particular, the researchers embrace the relevance of banks' income structure [Fraser, Madura and Weigand, 2002], off-balance sheet activities [Hirtle, 1997; Choi and Elyasiani, 1997], and equity capital [Au Yong, Faff and Chalmers, 2009]. Other works have also acknowledged the intermediaries' efforts to hedge interest rate exposures through some of these instruments. Chapter 3 of this thesis provides a detailed overview of the literature in this area.

Based on the discussion above, the interest rate beta from Stone's model can be regarded as a by-product of a financial institution's efforts to manage interest rate risk given its balance and off-balance sheet composition. Namely, this measure accounts for the firms' decision-making, planning and control regarding their balance and off-balance sheet positions that contribute to interest rate exposure. This interpretation of interest rate risk is endorsed throughout the thesis.

1.3 Thesis outline

The first chapter of this thesis presents the general background on which the rest of this work is based on. The background on the underlying research question is outlined, and the key motivations and thesis objectives are mentioned.

The remainder of the thesis consists of three empirical chapters concentrated on the identification, measurement and the analysis of the interest rate exposure faced by financial corporations. Specifically, the second chapter presents an empirical investigation of the financial institutions interest rate risk exposure across an international data sample. The material in this chapter addresses the inadequacies of the presently popular methods to quantify the exposure of the financial intermediaries to interest rate risk. In addition, this chapter also examines the foreign exchange risk and risks borne by the real estate market activities.

The third chapter addresses the key determinants of bank interest rate risk. In particular, this work examines the link between interest rate risk faced by financial intermediaries in the G-10 countries, their balance sheet composition, national regulatory regimes and level of market discipline. Both company and market specific information is considered in the analysis.

Chapter 4 empirically examines the impact of securitization on banks' interest rate exposure. In particular, the analysis conducted in this chapter questions whether securitization is conducive to the optimal hedging of bank interest rate risk, or is merely a funding source enabling these companies to pursue more profitable but riskier projects.

Finally, Chapter 5 summarises the work presented in the thesis. This chapter provides a concise summary of the thesis main contributions and examined issues, draws together the key findings, and discusses the policy implications of these findings. In addition, the chapter outlines some perspectives for future research, discussing both short- and long-term objectives and future directions in the field.

Chapter 2

Revisiting the Interest Rate Risk of Financial Intermediaries

2.1 Introduction

One of the focal topics in modern financial theory is addressing the development and improvement of the asset pricing models. In this context, the empirical identification of systematic risk factors in capital markets has received great attention with voluminous literature available.

The systematic market risk as measured by the market beta is unanimously recognised in the asset pricing theory. There is, however, extensive evidence that the market factor per se does not fully represent the undiversifiable risk component of the security and portfolio returns. Since Samuelson (1945)[1] this argument has been consistently supported by researchers who focus their attention on the relevance of the interest rate factor in explaining the variability in returns of both financial [Flannery, 1981, 1983; Saunders and Yourougou, 1990; Elyasiani and Mansur, 1998, 2003, 2005; Elyasiani, Mansur and Pagano, 2007; Faff and Howard, 1997, 1999] and non-financial [Joehnk and Nielsen, 1976; Haugen, Stroyny and Wichern, 1978; Sweeney and Warga, 1983,1986; O'Neal, 1998] institutions.

Although stocks of any industry group are potentially affected by interest rate changes, the asset transformation function of financial institutions (hereafter "FI") exposes them to a higher degree of interest rate risk. The reasons for this are discussed in Chapter 1 and can be found in Staikouras (2003, 2006).

While the attention of the regulators and researchers has lately been on the credit and operational risks, the issue of interest rate risk has been recently re-

[1]Samuelson (1945) emphasised the sensitivity of banks' equity returns to the interest rate changes as a result of their asset-liability structure. See Chapter 1 for further details.

visited. The significance of interest rate risk has been emphasised by the Basel Committee of Banking Supervision (2004, 2008) and regulatory authorities both in the US and in Europe. The Committee has introduced the significantly revised set of "Principles for the Management and Supervision of Interest Rate Risk". Within the newly introduced principles the regulators emphasise the significance of banks having "a comprehensive risk management process in place that effectively identifies, measures, monitors and controls interest rate risk exposures" (BIS, 2004: p.2) and recognise that "excessive interest rate risk can pose a significant threat to a bank's earnings and capital base" (BIS, 2004: p.5). In a more recent consultative document titled "Range of Practices and Issues in Economic Capital Modelling" and issued in August 2008, the Committee revisited the topic stating that with regards to the interest rate risk in the banking book "close attention should be paid to measuring and managing instruments with embedded options features" (BIS, 2008: p.7) since these instruments can pose the risks that are "significantly greater than suggested by the risk measure" (BIS, 2008: p.7). Consequently, it is essential for the solvency of the financial system that banks maintain prudent levels of interest rate risk.

On the empirical front, the exposure of financial intermediaries to the various systematic risks has been a subject of considerable research since the inception of Stone's (1974) two factor model. The model simply augments the standard market model of asset returns with the interest rate factor proxied by the return on a bond index. Since its inception the model has been extensively used in both its original form and numerous modifications [Martin and Keown, 1977; Lynge and Zumwalt, 1980; Flannery and James, 1984a, 1984b; Booth and Officer, 1985; Booth, Officer, and Henderson, 1985; Scott and Peterson, 1986; Kane and Unal, 1988; Akella and Chen, 1990; Wetmore, 2003; among others].

Despite this extensive research, previous studies produce rather contrasting results regarding the effect of interest rate changes on financial institutions' equity returns. The reason for this can be attributed to the different data samples, time horizons and methodological frameworks employed in these works.

In particular, the researchers use different proxies for the interest rate factor in Stone's model. Both Lynge and Zumwalt (1980) and Booth and Officer (1985) provide evidence of significant relationship between the short-term interest rates and the FIs' stock returns. On the other hand, Bae (1990) uses the interest rate proxies of three different maturities and argues that FI stock returns are more sensitive to the changes in long-term interest rates. The latter is supported by Kane and Unal (1987), Akella and Chen (1990), Browne et al. (1999), and Elyasiani and Mansur (2003, 2004, 2007).

The treatment of interest rate changes also varies among the studies. Few works apply current interest rate changes [Lynge and Zumwalt, 1980; Chance and Lane, 1980; Sweeney and Warga, 1986; Oertmann, Rendu and Zimmermann, 2000]. Others advocate the use of unanticipated changes. These contributions rely on market efficiency recognising that asset values should already incorporate all the anticipated changes in interest rates. Researches in this group of studies employ a number of different expectation generating processes to extract the interest rate "innovations" from the unadjusted series. Flannery and James (1984a), Yourougou (1990), Akella and Chen (1990), Choi, Elyasiani and Kopecky (1992), Adjaoud and Rahman (1996), and Dinenis and Staikouras (1998) use the forecast error from the autoregressive integrated moving average (ARIMA) models as the proxy for unanticipated interest rate changes. Further, Booth and Officer (1985) suggest the implementation of a Meiselman-type error learning model, while Dinenis and Staikouras (2000) support a state space system.

Similarly, the empirical methodologies selected by researchers lack consistency among the studies. Three key approaches are commonly utilised. First, the significance of the interest rate risk factor from Stone's model is tested via ordinary least squares (OLS). This is performed by Chance and Lane (1980), Flannery (1981, 1983), Giliberto (1985), Bae (1990) and others. The second approach is to address the coefficient significance using the autoregressive conditional heteroscedasticity (ARCH) type techniques. In this group, researchers [Song, 1994; Wetmore and Brick, 1994; Flannery, Hameed and Harjes, 1997; Elyasiani and Mansur, 1998; Ryan and Worthington, 2004; and Brewer, et al., 2007] recognise the inability of OLS to account for the time varying sensitivities of the risk factor to the underlying asset returns. The third and most recent methodology employed by researchers is based on the multivariate extension of the ARCH type models. For instance, Elyasiani and Mansur (2003, 2004), Carson, Elyasiani and Mansur (2006), Elyasiani, Mansur and Pagano (2007), and Faff, Hodgson and Kremmer (2005) employed the Bollerslev's (1990) Conditional Constant Correlation (CCC) GARCH model in their works.

Furthermore, the empirical research in the area has demonstrated the relevance of foreign exchange and real estate risk factors[2] to the FIs' returns generat-

[2] The importance of foreign exchange factor is highlighted by Grammatikos, Saunders and Swary, 1986; Choi, Elyasiani and Kopecky, 1992; Wetmore and Brick, 1994, 1998; Prasad and Rajan, 1995; Chamberlain, Howe and Popper, 1997; Tai, 2000; Choi, Hiraki and Takezawa, 1998; Ryan and Worthington, 2004. The researchers emphasise that financial intermediaries are continuously exposed to exchange rate movements both directly and indirectly. Likewise, the real estate factor is considered by Mei and Saunders, 1995; Allen, Madura and Wiant, 1995; He, Myer and Webb, 1996; Lausberg, 2001; Johntson and Madura, 2002; He, 2002; and Elyasiani, Mansur and Wetmore, 2010. These researchers point that the impact of the real

ing process. Nonetheless, there is no study which addresses the joint interaction of market, interest rate, foreign exchange and real estate risk factors while modelling the financial institutions' stock returns.

Accordingly, the FIs' exposure to the various types of risk should be re-examined using a recent set of data and an extensive sample of countries. While the extant contributions are mainly concentrated on the US banking industry, with only a few studies covering other regions or industry sectors [Clare and Thomas, 1994; Adjaoud and Rahman, 1996; Priestley, 1996; Faff and Howard, 1997, 1999; Dinenis and Staikouras, 1998, 2000], the research presented in this chapter is unique in several ways.

First, in this chapter, I consider an international sample of banks and insurance companies. The scope of the research is to cover the countries members of the Basel Committee of Banking Supervision and other important regions of Asia (Hong Kong) and the Pacific Rim (Australia)[3].

Second, to address the risk exposure of FIs in each market, and for the purpose of comparison with the previous empirical works, this research employs both the conventional Stone's (1974) two-factor model and its augmented multi-factor specification. Additional factors are introduced in the augmented model to represent foreign exchange risk as well as risk borne from operations in the real estate market. For both factorisations of the model, factor significance is tested under alternative econometric specifications including ordinary least squares (OLS) and the autoregressive conditional heteroscedasticity (ARCH) type technique.

Third, the same model specifications are used across a vast sample of markets. This helps to shed light on the origins of any disparity in the previously reported results with the researchers testing different formulations of Stone's model under yet diverse econometric frameworks. Moreover, by testing the homogeneous model formulation under different econometric specifications, the suitability of these specifications for the analysis of the FIs' stock returns is tested.

Fourth, I adopt a framework that allows to capture the sensitivity of the FIs' stock returns to the changes in the entire shape of the term structure. This extends the standard research methodology of assessing the FIs' interest rate exposure by using a single interest rate factor.

Finally, in the context of the ARCH model specification, I examine the key factors influencing the volatility of the FIs' equity returns. This is done by extend-

estate market activity on the bank equity positions is not completely captured by the stock market index.

[3]Subject to the constraint that each market should be represented by at least three financial institutions (banks or insurance companies) with the required data available over the studied horizon.

ing the methodology of Elyasiani and Mansur (1998). The approach proposed in this chapter allows for the conditional volatility of returns to be modelled as a function of lagged shocks (ε_{t-i}^2 and h_{t-j}) and lagged innovations in the: (a) risk factors utilised in the mean equation; and (b) conditional volatilities of these factors.

The remainder of this chapter is organised as follows: Section 2.2 provides a brief description of the dataset employed, while Section 2.3 outlines the research design and methodology. The empirical analysis and findings are presented in Section 2.4, whereas the concluding remarks are contained in Section 2.5.

2.2 Data description

To assess the FIs' risk exposure this study utilises the augmented specification of the standard market model with the factor significance being tested under alternative econometric specifications. To this end, the financial intermediaries' share returns are regressed against a number of macroeconomic factors proxying interest rate risk, foreign exchange risk, the risk implied by the real estate market conditions, and systematic market risk. These factors are defined individually for each market and discussed below.

2.2.1 Financial institutions

The study employs a sample of 425 financial intermediaries across 13 major financial markets. The extensive market coverage is necessary to meet the main research objectives, one of which is to cover the member countries of the Basel Committee of Banking Supervision[4] and other important regions of Asia (Hong Kong) and the Pacific Rim (Australia). The resulting sample consists of 303 banks and 122 insurance companies.

The requisite data on these institutions are sourced from the Bloomberg database. The key requirement for the data collection is the availability of at least three banks (insurers) for each market each with annual balance sheet and weekly share price data being continuously available from January 1997 to December 2007. For each market, two portfolios are formed, the first one including all banks and the second all insurance companies.

Since the size of a company may indirectly determine the sensitivity of its values to interest rate movements [Akella and Chen, 1990; Faff and Howard,

[4]The member countries of the Basel Committee of Banking Supervision are Belgium, Canada, France, Germany, Italy, Japan, Luxembourg, Netherlands, Spain, Sweden, Switzerland, United Kingdom, and United States.

Table 2.1
Mean and median asset size

This table reports mean and median of the banks' asset size alongside with the number of banks in the size based portfolios for each market. All banks are grouped into size portfolios with classification based on the asset value as of year-end 2004. These portfolios are identified as Large (with asset value exceeding $50 billion); Medium (with asset value ranging from $15 to 50 billion); and Small (with asset value less than $15 billion). All data is in millions of dollars.

Panel A: Banks

Portfolio	Mean	Median	Banks	Portfolio	Mean	Median	Banks
AUSTRALIA				**JAPAN**			
All Firms	$109,057	$44,298	9	All Firms	$30,881	$23,479	64
Large	$201,245	$202,029	5	Large	$74,371	$62,912	10
Medium	$16,870	$8,791	4	Medium	$26,387	$23,966	42
BELGIUM				Small	$10,371	$11,493	12
All Firms	$545,558	$526,461	3	**SWEDEN**			
CANADA				All Firms	$211,064	$223,489	4
All Firms	$139,371	$147,414	10	**SWITZERLAND**			
Large	$228,926	$232,354	6	All Firms	$9,969	$7,301	12
Small	$5,040	$3,118	4	Small	$7,238	$6,775	10
FRANCE				**UK**			
All Firms	$295,325	$8,424	15	All Firms	$504,218	$147,343	9
Large	$699,605	$814,304	5	Large	$628,196	$545,706	7
Small	$6,554	$7,210	10				
GERMANY				**US - Money Center**			
All Firms	$309,738	$49,989	11	All Firms	$1,872,077	$460,587	8
Large	$644,269	$575,332	5	**US - Regional**			
Medium	$47,929	$48,096	3	All Firms	$16,182	$2,733	79
Small	$13,994	$12,526	3	Large	$117,595	$94,040	7
HONG KONG				Medium	$33,340	$31,470	7
All Firms	$143,105	$11,516	10	Small	$3,213	$1,875	65
ITALY				**US - Savings & Loans**			
All Firms	$94,835	$21,046	14	All Firms	$13,621	$1,902	42
Large	$364,233	$359,390	3	Large	$146,281	$106,889	3
Medium	$27,470	$21,046	8	Medium	$18,630	$16,826	3
Small	$5,076	$6,306	3	Small	$2,275	$1,192	36

1999], both insurance and banking companies are classified into three equally weighted portfolios. This classification is based on the asset value as of year-end 2004. The portfolios are identified as Large (with asset value exceeding $50 billion); Medium (with asset value ranging from $15 to 50 billion); and Small (with asset value less than $15 billion). Studying the size portfolios is consistent with Kane and Unal (1988), and Fraser, Madura and Weigand (2002) and allows direct inferences regarding the risks exposure across firms of different sizes[5].

The US banks are classified further to different groups according to the nature

[5]There are, however, a number of disadvantages in employing the portfolio approach, of these one being the presentation of smoothed returns among the portfolio constituents. In other words, this approach filters out the key dissimilarities in the return generating process of the individual institutions.

of their business (Money Centre Banks, Regional Banks, and Saving & Loans Institutions). This is in line with Song (1994), and Wetmore and Brick (1998). A similar approach is followed for Italian, German, British and US insurance companies, where categories include Life & Health, Medical, Multiline, Reinsurance, and Property & Casualty insurance companies. The basic statistics regarding the asset values of institutions in each market, industry, and size portfolios are reflected in Table 2.1: Panel A for banks and Panel B for insurance companies.

The returns on the portfolios of banks and insurance companies in each size category are calculated as weekly logarithmic first difference transformations of Wednesday stock prices for the portfolio constituents. I chose the weekly sampling interval instead of daily or monthly for two reasons. First, the findings of Trzcinka (1986) and Fama (1976) indicate that the returns calculated at a daily frequency are not well explained by the normal distribution. By using, however, monthly sampling frequency the non-normality of daily observation would be avoided just at the expense of information loss. Second, the use of weekly intervals reduces distortions due to non-trading holidays, and non-synchronous trading (Lo and MacKinlay, 1990). This is particularly important for cross-country studies. Furthermore, the calculation of returns based on the Wednesday to Wednesday stock prices helps avoid the bias introduced by the Monday or Friday market effects [French, 1980; Pettengill, Wingender, and Kohli, 2003]. The calculated returns are then used as dependent variables in the model framework. Whereas the methodological framework is described in the following section, the descriptive statistics on the portfolios' returns are reflected in Appendix 2.2: Panel A for banks and Panel B for insurance companies.

The test statistics reveal that the average weekly returns are typically positive for most size portfolios and for both banks and insurance companies. For all portfolios, the unconditional distributions of returns are not normal. The non-normality is supported by the Jarque-Bera test, which overwhelmingly rejects normality at the 1% significance level.

Furthermore, the skewness statistics deviate significantly from zero for most portfolios. The values of kurtosis figures are also high, indicating that the return series are leptokurtic or fat-tailed. The results of the Ljung-Box (1978) serial correlation test reject the null hypothesis of no autocorrelation in returns for the majority of analysed portfolios. Based on this evidence, the use of least squares techniques may result in biased and inconsistent parameter estimates. To address this problem I test the parameter significance under alternative econometric specifications with pertinent comparisons provided in the following sections.

Table 2.1 (cont'd)
Mean and median asset size

This table reports mean and median of the insurance companies' asset size alongside with the number of insurance companies in the size based portfolios for each market. All insurers are grouped into size portfolios with classification based on the asset value as of year-end 2004. These portfolios are identified as Large (with asset value exceeding $50 billion); Medium (with asset value ranging from $15 to 50 billion); and Small (with asset value less than $15 billion). All data is in millions of dollars.

Panel B: Insurance companies

Portfolio	Mean	Median	Banks	Portfolio	Mean	Median	Banks
AUSTRALIA				**SWITZERLAND**			
All Firms	$25,105	$20,854	4	All Firms	$106,835	$51,787	7
CANADA				Large	$177,166	$153,049	4
All Firms	$68,439	$86,765	5	**UK - Life & Health**			
FRANCE				All Firms	$170,157	$159,661	4
All Firms	$305,074	$210,578	5	**UK - Property & Casualty**			
GERMANY - Life & Health				All Firms	$8,582	$1,476	7
All Firms	$74,200	$18,293	3	**US - Life & Health**			
GERMANY - Multiline				All Firms	$5,873	$5,319	12
All Firms	$231,974	$70,319	6	**US - Medical**			
Large	$455,551	$158,919	3	All Firms	$8,044	$3,653	5
GERMANY - Reinsurance				**US - Multiline**			
All Firms	$118,531	$48,988	3	All Firms	$16,459	$3,865	18
				Medium	$18,361	$13,041	5
ITALY - Life & Health				Small	$2,785	$2,281	12
All Firms	$32,835	$20,841	3	**US - Property & Casualty**			
ITALY - Multiline				All Firms	$4,947	$2,024	19
All Firms	$97,398	$44,604	5	Medium	$18,844	$16,985	3
Large	$156,850	$45,409	3	Small	$2,341	$1,185	16
JAPAN				**US - Reinsurance**			
All Firms	$31,935	$28,556	6	All Firms	$29,545	$8,066	8

2.2.2 Interest rate proxy

The existing literature suggests that estimation results are affected by the choice of the interest rate proxy. Therefore, multiple interest rate proxies are used in this study. All series are obtained from the Bloomberg database.

First, short- and long-term interest rates are sampled. The inclusion of both short- and long- interest rate proxies is consistent with Flannery and James (1984a), Bae (1990), Saunders and Yourougou (1990), and Madura and Zarruk (1995). These factors are represented by the first difference[6] in the market yields of two sovereign bills with different maturities (short- and long-term respectively). The detailed descriptions of these measures are provided in Appendix 2.1.

Second, I also calculate the interest rate term spread as the difference between long-term and short-term interest rates. This factor is included since the empirical results of Fama and French (1989), Chen (1991), and Boudoukh, Richardson and Whitelaw (1997) suggest positive relationships between the size of the term spread and the risk premium. Hence, when the yield curve structure is inverted due to the expectations of lower interest rates and poor economic conditions, financial intermediaries, commonly playing the role of creditors, are expected to be negatively affected.

Finally, the variables representing the level, slope and curvature of the interest rate yield curve are also employed in this study. These measures control for the sensitivity of FIs' stock returns to the changes in the entire shape of the term structure. Following the reasoning of Diebold and Lee (2006)[7] the yield curve level, slope and curvature are calculated via the Diebold and Lee factorisation of the Nelson and Siegel (1987, 1988) model:

$$y_t(\tau) = \beta_{1,t} + \beta_{2,t}\left[\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right] + \beta_{1,t}\left[\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right] \tag{2.1}$$

where τ represents the maturity of the underlying fixed-income security and λ is a decay parameter discussed below.

The Nelson-Siegel model uses just a few parameters (compared for example to spline methods) and provides enough flexibility to capture a range of monotonic, S-type and humped shapes typically observed in the yield curve data. It fits the

[6] The use of the first difference transformation rather than the unadjusted series is determined by the findings of Bradley and Lumpkin (1992) who demonstrate the presence of the unit root (nonstationarity) in time series of both 1- and 10-year Treasury note yields via the Dickey-Fuller and Augmented Dickey-Fuller tests. Mehra (1996) also finds that 10-year Treasury note yields and a time series of the Fed Fund rates are nonstationary.

[7] Diebold and Lee (2006) demonstrate that factor $\beta_{1,t}$ from the Nelson-Siegel model governs the level of the yield curve whereas $\beta_{2,t}$ and $\beta_{3,t}$ govern its slope and curvature.

term structure using a flexible, smooth parametric function based on a Laguerre function. Notably, due to its ability to provide a good fit of the interest rate yield curves the model is advocated by Diebold and Lee (2006), and Czaja, Scholz and Wilkens (2010), and is widely used by central banks and practitioners. The central banks in nine out of thirteen countries members of the Basel Committee of Banking Supervision construct a sovereign zero-coupon yield curve using the Nelson-Siegel class of models.

To estimate the yield curve level, slope and curvature, the series of the sovereign zero-coupon yields of 12 different maturities ($\tau = 3$, 6, 12 months, as well as 2, 3,...,10 years) are collected[8] for each market analysed in the study. These series are used as the initial estimates on the left hand side.

Based on the model parameterization above, the loading on the level ($\beta_{1,t}$) parameter is 1 and is independent of time-to-maturity. Taking the limit, it is easy to see that $\lim_{\tau\to\infty} y_t(\tau) = \beta_{1,t}$ and hence the yield curve level can be seen as a long-term interest rate variable. It also worth noting that an increase in $\beta_{1,t}$ would identically affect all yields, thereby shifting the level of the yield curve. Similarly, the loading on the slope parameter $\beta_{2,t}$ is driven by the exponential function starting at 1 and decreasing monotonically to zero with increasing maturity. Therefore, the slope parameter might be seen as short-term interest rate variable. An increase in this parameter would amplify the short-rates more than the long ones. In mathematical terms, given $\lim_{\tau\to 0} y_t(\tau) = \beta_{1,t} + \beta_{2,t}$, it is easy to see that $y_t(\infty) - y_t(0) = -\beta_{2,t}$. The loading on the last parameter $\beta_{3,t}$(curvature) is also driven by the exponential function, now starting at zero (with the $\tau = 0$), increasing for the medium maturities and decaying back to zero as maturity increases. Accordingly, the yield curve curvature ($\beta_{3,t}$) can be seen as the medium term interest rate variable. Therefore it is of particular interest to this research since the medium rates are not covered by any of the interest rate proxies discussed above.

Following Diebold and Lee(2006), Fabozzi et al. (2005), and Czaja, Scholz and Wilkens (2006), to obtain the estimates of the level, slope and curvature, the identified series of zero-coupon yields are regressed on the parameter loadings and a constant using the cross-sectional ordinary least squares technique. With this model factorisation the parameters on the right hand side are calculated assuming the prefixed value of decay parameter λ. Consistent with Diebold and Lee (2006)

[8] The standard way to construct the term structure of interest rate is by using the zero-coupon bonds. The Bloomberg database derives and supplies the required series of zero-coupon yields for different maturities, derived from coupon bearing Treasury Notes and Bonds following a bootstrapping approach.

the value of this decay parameter λ is fixed at 0.0609. For comparison, the time-varying decay parameter λ is also employed. In this specification λ is chosen to maximize the goodness-of-fit statistics of the underlying model at each time t. Both specifications yield statistically identical results. To avoid introducing an additional time-varying component in the yield-curve model, I resort to the fixed λ specification.

As suggested by previous research, only unanticipated changes in interest rates affect the financial institutions values. I follow this literature and extract the interest rate "innovations" from the unadjusted series of interest rates discussed above. The unanticipated interest rate changes are estimated as the difference between the actual interest rate changes and the ones forecasted via the appropriate specification of the ARMA model[9]. This approach remains one of the most popular in the literature. The descriptive statistics for all interest rate proxies are outlined in Appendix 2.3.

The estimated "innovations" are used as an interest rate factor in the empirical framework. In particular, the sensitivity test of FIs' returns to interest rate risk is performed using interchangeably short- and long-term interest rates, interest rate term-spread, and the variable representing the curvature of domestic zero-coupon yield curve. The use of multiple interest rate proxies helps to identify the patterns in risk exposure of financial institutions across the whole term structure.

Finally, following previous empirical works [Scott and Peterson, 1986; Bae, 1990; Flannery and James, 1984] the percentage changes in the underlying interest rate proxies are also calculated. Their unexpected components are used as alternative to the interest rate proxies discussed above. By utilising both arithmetic and percentage changes the importance of the approximation technique choice is tested. Any observed dissimilarities will help to shed light on the reasons for diverse results reported in previous works. Moreover, to further examine the effects of large interest rate shocks on the value of the analysed companies, the squared changes in the underlying interest rate proxies are also calculated and used as alternatives.

[9] The appropriate order of the autoregressive and moving average parameters used in the model framework varies across variables and markets covered. Moreover, the use of only one expectation generating process is supported by the findings of Bae (1990) who using three different models to form expectations finds identical results regardless of the model employed. Further, Dinenis and Staikouras (1998) using a sample of the UK institutions report the robustness of their results to five different models used to extract the unexpected interest rate changes.

2.2.3 Additional independent variables

The information on the domestic equity market price indices and the REIT market price indices has also been collected. The historical values for each of the indices are obtained from the Bloomberg database and the returns are calculated in the same manner as for the financial institutions. Whereas the market indices are listed in Appendix 2.1, all real estate indices are presented by European Public Real Estate Association/National Association of Real Estate Investment Trust (EPRA/NAREIT) Equity REIT Index series for each country compiled by the Financial Times.

The FTSE EPRA/NAREIT Indices are well established and serve as key benchmarks for investment in eligible listed real estate companies. The use of the REIT returns as a proxy for the national real estate markets' activity is further supported by Giliberto (1990), Martin and Cook (1991) and is also in line with the work by Allen, Madura and Wiant (1995).

As regards to the foreign exchange variable, the JP Morgan trade-weighted multilateral foreign exchange index of the domestic currency against a broad-based basket of other currencies is used. The foreign exchange index is obtained for every country in the sample.

Following the literature, the unanticipated changes in the foreign exchange index are calculated in the same way as for interest rates. The estimated "innovations" in the index are used as a foreign exchange factor in the empirical framework outlined in the next section. The pertinent statistics for the analysed indices are displayed in Appendix 2.3.

2.3 Research design and methods

The risk exposure of the FIs stock returns is assessed via both Stone's two-factor model and its augmented multi-factor parameterisation. The parameters' significance is tested under alternative econometric specifications including ordinary least squares (OLS) and generalised autoregressive conditional heteroscedasticity (GARCH) with its multivariate extension (MV-GARCH). The impetus of this selection is to shed light on previous findings and to identify the origins of the disparity in previously reported results.

Furthermore, the GARCH framework is ideal for examining the key factors influencing the volatility of the FIs' equity returns.

2.3.1 Two factor model

Ordinary least squares estimation

Since Stone (1974), who extended the traditional market model by incorporating an interest rate factor, this topic has been widely revisited. Following Stone's methodology, various researchers have confirmed the significance of the interest rate factor in explaining the variability of the FIs' equity returns. Given its wide recognition and for purposes of comparison with the previously reported findings, the conventional Stone's two-factor model is used in this chapter:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it} \tag{2.2}$$

where R_{it} and $R_{M,t}$ are the returns on the underlying banking/insurance portfolio and the market portfolio respectively at time t. $R_{IR,t}$ is the interest rate factor which represents the unexpected changes (arithmetic, percentage, and squared) in the underlying interest rate proxy. Following the discussion in Section 2.2.2 I use four interest rate proxies. These are short- and long-term interest rates, interest rate term-spread, and the variable representing the curvature of domestic zero-coupon yield curve. The yield curve curvature is estimated via the Diebold and Lee factorisation of the Nelson-Siegel model in Equation 2.1.

Despite its popularity, a significant drawback of Stone's model as specified above is that both positive and negative interest rate changes are assumed to have the same impact on the underlying equity (portfolio) returns. This contradicts with the well documented evidence supporting the view that different types of FIs exhibit heterogeneous responses to an interest rate increase than to a decline in interest rates. Chen and Chan (1989) report that the returns of Savings & Loan institutions are more sensitive to a rate decrease, while the commercial banks' stock returns are strongly affected by a rate increase. Based on this evidence, I employ the enhanced version of Stone's model as follows:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR,POS} R_{IR,t} D_{IR,t} + \beta_{IR,NEG} R_{IR,t}(1 - D_{IR,t}) + \varepsilon_{it} \tag{2.3}$$

The model accounts for the asymmetric impact of the interest rate changes on the FIs' portfolio returns through a dummy variable $D_{IR,t}$. This dummy takes a value of one if $R_{IR,t} > 0$ at time t and zero otherwise. The interest rate factor $R_{IR,t}$ is the same as in Equation 2.2.

The significance of the asymmetry is addressed via the Wald[10] coefficient

[10] The Wald test computes a test statistic based on unrestricted regression. The test statistic (F-statistics) measures how close the unrestricted estimates come to satisfying the restrictions

restriction test with the null hypothesis stating the equality of coefficients $\beta_{IR,POS}$ and $\beta_{IR,NEG}$, e.g. both positive and negative interest rate changes have identical impact on the FI's portfolio returns. Whenever the null hypothesis is not rejected, the model (2.3) is reduced to the conventional linear form of Stone's model (2.2).

Generalised autoregressive conditional heteroscedasticity estimation

Models (2.2) and (2.3) are estimated via the ordinary least squares estimation procedure which does not take into account some relevant empirical properties of the time series data. One of these properties is the time variation of the risk factor sensitivity to the underlying asset returns. This property is well documented in the empirical literature[11], suggesting that if the banks' return generating process is time-dependant the use of least squares techniques may result in biased and inconsistent parameter estimates. The heteroscedastic and leptokurtic residuals of the traditional linear model might inflate the parameters' standard errors and lead to incorrect conclusions regarding the parameters' statistical significance.

To address this issue, recent empirical literature suggests using the autoregressive conditional heteroscedasticity (ARCH) type techniques. Proposed by Engle (1982) these models make it possible to simultaneously model both the mean and the variance of the series and relax the assumption of homoscedasticity. This in turn allows the economic time series to exhibit time-varying volatility, such that periods of unusually large volatility are followed by periods of relative tranquillity. This phenomenon is also known as "volatility clustering". In the research context, the univariate ARCH extension of Stone's two-factor model, capturing the time-varying sensitivity of banks' stock returns to the market and interest rate risks, was first employed by Song (1994). Song emphasises that the two betas in Stone's conventional model depend on the conditional information[12] and are potentially time-varying. Therefore, the author suggests the use of the ARCH modelling strategy as a "natural way to model this time-variation in the conditional variance and covariance" (Song, 1994: p. 324). This proposition is supported by Song's findings which demonstrate that both market and interest rate risk exhibit a significant degree of time-variation over the studied horizon.

under the null hypothesis, with inference made based on the associated p-value.

[11] Song (1994), Kane and Unal (1988), Akella and Chen (1990), Brewer and Lee (1990), Kwan (1991), and Adjaoud and Rahman (1996) suggest that the sensitivities of the FI's stock returns to interest rate risk are time-varying. Likewise, Wetmore and Brick (1994, 1998) and Tai (2000) have established the time-varying properties of the foreign exchange risk in the FIs stock returns.

[12] The rationale relies on the fact that the beta coefficient is specified as the ratio of the conditional covariance between the return on a particular asset i and a specified factor, and the conditional variance of this factor.

These findings also question the validity of the results reported in previous studies assuming constant betas in the modelling of FIs' stock returns.

Since then, the basic ARCH framework has been extended and generalized resulting in the introduction of a whole family of ARCH type models. Bollerslev (1986) extends the original Engle's ARCH model by developing the framework where the conditional variance constitutes an ARMA (Autoregressive Moving Average) process. In other words the volatility in this model is dependent not only on the persistence of the shock occurred (autoregressive component) but also on the historical volatility patterns (reflected by the moving average component). Following the success of Song's experiment, Bollerslev's ARCH model generalisation has also found its applications in modelling the sensitivity of FIs' stock returns. This is done in the context of the two-factor model by Elyasiani and Mansur (1998), Flannery, Hameed and Harjes (1997), and Brewer et al. (2007). The model used by these authors is specified as follows:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it} \tag{2.4}$$

$$h_{it} = \omega_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{i,t-i}^2 + \sum_{j=1}^{q} \gamma_i h_{i,t-1} \tag{2.5}$$

$$\varepsilon_{it} | \Omega_{t-1} \sim N(0, h_{it}) \tag{2.6}$$

where R_{it}, $R_{M,t}$, and $R_{IR,t}$ are as in (2.2). ε_{it} is the estimated error term from the mean equation of portfolio i, and h_{it} is a conditional variance of portfolio i over week t. The model in (2.4-2.6) is used as an alternative to the Stone's model in Equation 2.2.

While the simple GARCH model above provides robust coefficient estimation, it has some limitations. Specifically, the effects of the positive shocks (news) have the same impact on volatility as the negative shocks. This is not always supported by empirical evidence, and Nelson (1991) with Bekaert and Harvey (1997) argue that the asymmetry should be appropriately modelled.

Following this argument, I also employ the extended version of the GARCH model proposed by Glosten, Jagannathan and Runkle (1993) (GJR-GARCH) which allows for the asymmetric effect of news. More specifically the model modifies the specification in (2.4-2.6) through the use of a dummy variable as follows:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it} \tag{2.7}$$

$$h_{it} = \omega_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{i,t-i}^2 + \sum_{j=1}^{q} \gamma_i h_{i,t-1} + \delta_i \varepsilon_{i,t-1}^2 (I_{|\varepsilon_{i,t-1}<0|}) \tag{2.8}$$

$$\varepsilon_{it}|\Omega_{t-1} \sim N(0, h_{it}) \tag{2.9}$$

where the term $(I_{|\varepsilon_{i,t-1}<0|})$ is an indicator function assuming the value of zero when $\varepsilon_{i,t-1} > 0$, and 1 otherwise. Accordingly, in the GJR-GARCH(p,q) model the impact of positive news on conditional variance h_{it} is α_i, while negative news have an impact of $\alpha_i + \delta_i$. Therefore, when $\delta_i > 0$ one would expect the negative news to have a greater impact on volatility and vice versa. The parameters ω_0, α_i, and γ_i are assumed to be positive. The covariance stationarity condition is satisfied by assuming $\alpha_i + \gamma_i + \delta_i/2 < 1$. In the case when the δ_i coefficient is insignificant the model is reduced to the simple GARCH (p,q) model in (2.4-2.6).

Multivariate GARCH estimation

There is a growing interest in the literature towards identification of the key factors influencing the financial corporation returns' riskiness (volatility). Accordingly, in this study I utilise an augmented specification of the model in (2.4-2.6), with the estimation being carried out in the multivariate framework. A similar augmented specification has been previously employed by Elyasiani and Mansur (1998, 2004), Ryan and Worthington (2004), and Faff, Hodgson and Kremmer (2005)[13]. Specifically, this model allowed researchers to augment the conditional volatility equation of banking returns with a conditional volatility of the interest rate factor.

All aforesaid authors (except Tai, 2000) used the conditional constant correlation (CCC) GARCH model of Bollerslev (1990) in their research. This model specification imposes the assumption of constant correlation and allows for the variance and covariance to be separately modelled. Each of the N variances can be modelled with a univariate GARCH model. This results in a variance-covariance matrix based on these univariate processes and the correlation matrix.

Whilst, however, the multivariate CCC-GARCH model is computationally simple it is not without limitations. As argued by Cappiello, Engle, and Sheppard (2003) the assumption of the conditional correlation stability over time seems to

[13]Further examples of papers using the MV-GARCH techniques in the research context include Carson, Elyasiani and Mansur (2006), Elyasiani, Mansur and Pagano (2007), Elyasiani, Mansur and Wetmore (2010), and Tai (2000).

be unrealistic and is repeatedly violated in the empirical studies. In this chapter, the assumption of the constant conditional correlations is relaxed by employing the BEKK (Bollerslev, Engle, Kroner, and Kraft) parameterisation of the MV-GARCH model which allows for the time variation of the conditional correlation. Proposed by Engle and Kroner (1995) the BEKK parameterisation ensures the final output (variance-covariance matrix) to be positive definite by construction. The first-order case of the BEKK model can be written as:

$$H_t = CC' + A(r_{t-1}r'_{t-1})A' + BH_{t-1}B' \tag{2.10}$$

where A, B and C are $N \times N$ parameter matrices, with C being a lower triangular matrix.

Whilst being superior to the CCC-GARCH case this model also has some limitations. For instance, the model estimation involves rather heavy computations due to the several matrix inversions with $N(N+1)/2 + 2N^2$ parameters to be estimated. For instance, there are 11 parameters in the conditional variance-covariance structure of the bivariate first order BEKK model. To ease this limitation the study employs a special case of the BEKK parameterisation, namely the diagonal-BEKK model parameterisation proposed by Bollerslev, Engle and Wooldridge (1988). The resulting empirical representation of the model that governs the joint process takes the following form:

$$\begin{aligned}
R_{it} &= \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it} && (2.11)\\
R_{IR,t} &= \beta_0 + \varepsilon_{IR,t} && (2.12)\\
R_{M,t} &= \beta_0 + \varepsilon_{M,t} && (2.13)\\
h_{it} &= \omega_{i,0} + \alpha_i \varepsilon^2_{i,t-i} + \gamma_i h_{i,t-1} + \xi h_{IR,t} && (2.14)\\
h_{IR,t} &= \omega_{IR,0} + \alpha_{IR} \varepsilon^2_{IR,t-i} + \gamma_{IR} h_{IR,t-1} && (2.15)\\
h_{M,t} &= \omega_{M,0} + \alpha_M \varepsilon^2_{M,t-i} + \gamma_M h_{M,t-1} && (2.16)\\
h_{i/IR,t} &= \rho_{i/IR,t}\sqrt{h_{it}h_{IR,t}} && (2.17)\\
h_{i/M,t} &= \rho_{i/M,t}\sqrt{h_{it}h_{M,t}} && (2.18)\\
h_{IR/M,t} &= \rho_{IR/M,t}\sqrt{h_{IR,t}h_{M,t}} && (2.19)\\
& \varepsilon_t|\Omega_{t-1} \sim N(0, H_{it}) && (2.20)
\end{aligned}$$

where R_{it}, $R_{M,t}$, and $R_{IR,t}$ are as are as discussed above. The conditional time-varying variance-covariance matrix of the banking (insurance) portfolios' returns and the underlying macroeconomic factors is represented by H_{it}, with Ω_{t-1} being the information set available at time $t-1$. Given the BEKK parameterisation imposed above, the conditional variance-covariance matrix is:

$$H_t = CC' + A(\varepsilon_{t-1}\varepsilon'_{t-1})A' + BH_{t-1}B' \qquad (2.21)$$

where matrix C is $N \times N$ lower triangular matrix of coefficients, while A and B are $N \times N$ diagonal matrices. Under the assumption of conditional normality, the parameters of the model are estimated by maximising the log-likelihood function.

2.3.2 Multi - factor model

Ordinary least squares estimation

To account for further sources of risk faced by FIs, a number of additional risk factors are introduced in Stone's model, with the factors' statistical significance being established by examining the FIs' stock returns across the markets covered by the research. Following existing empirical findings and based on the discussion in Sections 2.2, these measures include the foreign exchange and real estate factors. The resultant multi-factor model takes the following form:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \beta_{FX} R_{FX,t} + \beta_{PROP} R_{PROP,t} + \varepsilon_{it} \qquad (2.22)$$

where R_{FX} represents the unanticipated changes in the trade-weighted multilateral foreign exchange index of the domestic currency against a broad-based basket of other currencies at time t. R_M and R_{PROP} are the returns on the domestic equity market price index and the REIT market price index respectively. Model (2.22) is estimated separately for all banking and insurance portfolios, assuming the interest rate factor R_{IR} proxied by the unexpected changes in either short- or long- term interest rates.

Moreover, most studies that employ the augmented specification of the market model orthogonalise[14] one or more factors. This helps to avoid the problem of multicollinearity between variables which might result in estimation of unstable regression coefficients. On the other hand Giliberto (1985) argues that following the orthogonalisation procedure may introduce bias due to model misspecification, and hence some studies chose to avoid the factor orthogonalisation [Chen and Chan, 1989; Wetmore and Brick, 1994, 1998]. To ascertain whether orthogonalisation is required I consider the individual correlations between factors. In the case that extreme values are detected the factors are orthogonalised. In all other cases this study employs unorthogonalised factors.

[14] See for instance Chance and Lane (1980), Flannery and James (1984), Bae (1990), Madura and Zarruk (1995), and Fraser, Madura and Weigand (2002).

In addition, to examine the joint interaction of the interest rate yield curve level, slope and curvature factors in modelling the financial corporations' stock returns, I also employ an alternative specification of the multi-factor model in (2.22). In this specification the FIs' returns are modelled as a function of the market returns and three other interest rate factors representing the unanticipated changes in the yield curve level, slope and curvature[15]:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{Lev} R_{Lev,t} + \beta_{Slo} R_{Slo,t} + \beta_{Cur} R_{Cur,t} + \varepsilon_{it} \tag{2.23}$$

with R_{Lev}, R_{Slo}, and R_{Cur} represent the unanticipated changes in the yield curve level, slope and curvature factors respectively. Due to the high correlations observed between these factors, the orthogonalisation procedure is followed. This also helps to assess an exclusive impact of changes in each factor on the FIs' stock returns. I follow the approach adopted by Czaja, Scholz and Wilkens (2006) in recognising the level factor as major driver of the yield curve changes. The slope and curvature are ranked second and third respectively. Accordingly, I orthogonalise the slope factor with respect to the level factor, while also orthogonalising the curvature factor with respect to both yield curve level and slope. The orthogonalised series are then used in Equation 2.23.

Generalised autoregressive conditional heteroscedasticity estimation

As already emphasised, models (2.22) and (2.23), estimated via the OLS procedure, do not take into account the time variation of the risk factors' sensitivity to the underlying asset returns. Accordingly, to account for these data properties, the GJR-GARCH multi-factor model is deployed:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \beta_{FX} R_{FX,t} + \beta_{PROP} R_{PROP,t} + \varepsilon_{it} \tag{2.24}$$

$$h_{it} = \omega_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{i,t-i}^2 + \sum_{j=1}^{q} \gamma_i h_{i,t-1} + \delta_i \varepsilon_{i,t-1}^2 (I_{|\varepsilon_{i,t-1}<0|}) \tag{2.25}$$

$$\varepsilon_{it}|\Omega_{t-1} \sim N(0, h_{it}) \tag{2.26}$$

where the term $(I_{|\varepsilon_{i,t-1}<0|})$ is an indicator function assuming the value of zero when $\varepsilon_{i,t-1} > 0$, and 1 otherwise. Similar to (2.22) this model is estimated separately for all banking and insurance portfolios in the sample, with the interest rate factor being interchangeably proxied by the unexpected changes in either short- or long-term interest rates. In the case when the δ_i coefficient is insignificant the model

[15] The yield curve level, slope, and curvature are estimated via the Diebold and Lee factorisation of the Nelson-Siegel model in Equation 2.1.

is reduced to simple GARCH (p, q):

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \beta_{FX} R_{FX,t} + \beta_{PROP} R_{PROP,t} + \varepsilon_{it} \quad (2.27)$$

$$h_{it} = \omega_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{i,t-i}^2 + \sum_{j=1}^{q} \gamma_i h_{i,t-1} \quad (2.28)$$

$$\varepsilon_{it} | \Omega_{t-1} \sim N(0, h_{it}) \quad (2.29)$$

A similar approach is applied to the estimation of the multi-factor model in (2.23). In the research context, a similar multi-factor GARCH parameterisation found its application in the works by Ryan and Worthington (2004) and Elyasiani and Mansur (2005).

Augmented GARCH estimation

Comprehensively to investigate the key factors influencing the volatility of the FIs' portfolio returns, I resort to the method proposed by Flannery, Hameed and Harjes (1997), and Elyasiani and Mansur (1998). Both papers suggest augmenting the conditional volatility equation in (2.24-2.26) by an additional factor representing the interest rate volatility.

However, in this chapter, I extend this methodology by augmenting the conditional volatility equation of FIs' portfolio returns with multiple factors. In particular, the conditional volatility equation is interchangeably augmented by the one-period lagged values of: (a) contemporaneous factors $R_f = R_{IR}; R_{FX}; R_{PROP}$ utilised in the mean equation; and (b) conditional volatilities (h_f) of these factors.

Assuming a simple GARCH $(1, 1)$ process, the resulting augmented specification takes the following form:

$$R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \beta_{FX} R_{FX,t} + \beta_{PROP} R_{PROP,t} + \varepsilon_{it} \quad (2.30)$$

$$h_{it} = \omega_0 + \alpha_i \varepsilon_{i,t-1}^2 + \gamma_i h_{i,t-1} + \varphi X_{f,t-1} \quad (2.31)$$

$$\varepsilon_{it} | \Omega_{t-1} \sim N(0, h_{it}) \quad (2.32)$$

where the exogenous variable X_f is specified as:

$$(a) \quad X_{ft} = R_{ft} = R_{IS,t}; R_{IL,t}; R_{FX,t}; R_{PROP,t} \quad (2.33)$$

$$(b) \quad X_{ft} = h_{ft} \quad (2.34)$$

$$R_{ft} = \beta + \varepsilon_t \quad (2.35)$$

$$h_{ft} = \omega_0 + \sum_{i=1}^{p} \alpha_f \varepsilon_{f,t-i}^2 + \sum_{j=1}^{q} \gamma_f h_{f,t-1} \quad (2.36)$$

In the model specification (a) above, variable R_f denotes either the unanticipated changes in short- or long-term interest rate proxies; the unanticipated changes in the trade-weighted multilateral foreign exchange index of the domestic currency against a broad-based basket of other currencies R_{FX}; or the returns on the domestic REIT market price index R_{PROP}. Variable h_f, in parameterisation (b) denotes the conditional volatility of the factors described in specification (a).

The resultant model (2.30-2.37) is subsequently estimated for all banking and insurance portfolios in the sample assuming the interest rate factor R_{IR} in the mean equation proxied by the unexpected changes in either short- or long-term interest rates.

2.4 Empirical results

This selection of models and variables outlined in Sections 2.2 and 2.3 defines the structure of this section. The discussion initially tests the two-factor model via the OLS estimation technique for both banking and insurance companies, and proceeds thereon with its estimation via the GARCH and MV-GARCH type models. The chapter continues by examining the multi-factor model. Each of the two sub-sections concludes by providing a brief comparison of the results reported for both banking and insurance institutions. This demonstrates an inter-industry comparison in the financial services industry and emphasises possible dissimilarities.

For the convenience of the reader, each section is accompanied by a "highlight" table indicating the magnitude and coefficient significance for the interest rate factor in each model under scrutiny[16].

2.4.1 Two-factor model

Ordinary least squares estimation

The first model estimated in this study is Stone's two-factor model represented by Equation 2.2. The model is designed to account for the sensitivity of FIs' stock returns to interest rate movements. In addition, the model in Equation 2.3 which accounts for the asymmetric impact of the interest rate changes on the FIs' stock returns is also estimated and analysed within this section. The simultaneous analysis of both models provides additional flexibility to my approach. It offers a

[16] To form the complete view of the models' estimation results the reader can request the fully detailed tables from the author.

separate treatment of the effects from positive and negative interest rate shocks on the FIs equity returns, and hence facilitates potential empirical inferences.

The empirical results for the two-factor model are presented in Table 2.2: Panels A and B, while Table 2.3: Panels A-B present the results for the generalised version of the two-factor model accounting for the asymmetry effect.

A. Banking institutions

For the banking sector, the market factor is always positive and highly significant with the results being robust across all markets and "size" portfolios. The highest coefficient of 1.289 is reported for large British banks, followed by Belgian banks and the US Money Centre institutions with an estimated market beta of 1.252 and 1.187 respectively. The lowest market risk coefficient with a value of 0.065 is observed for the portfolio of small French banks, followed by the small German banks with a market beta of 0.077.

The estimation results in Table 2.2 reveal the significance of at least one interest rate factor[17] in explaining the return variations in the majority of the banking portfolios. The noticeable exception is the US Money Centre portfolio. This group of banks shows no sensitivity to either of the interest rate proxies used, perhaps demonstrating their ability to comprehensively hedge the interest rate risk exposure over the studied horizon. These findings for the US Money Centre banks support the ones previously reported by Madura and Zarruk (1995), but contrast with the conclusions of Allen, Madura and Wiant (1995). Employing a similar methodological framework, Madura and Zarruk find no sensitivity of the US Money Centre banks to the adverse movements in either short- or long-term interest rates over the period between January 1988 and April 1993. Contrary to these findings, the paper by the second group of authors, employing a time horizon overlapping the one used by Madura and Zarruk (from 1979 to 1992), concludes that returns of the US Money Centre banks exhibit a high degree of sensitivity to the unanticipated changes in the long-term rates. This disparity between the findings in both papers, and those reported in my study, could be explained by the adoption of different time horizons and portfolio constituents. For instance, Madura and Zarruk (1995) employ only money centre banks with significant foreign exchange operations.

[17] The estimation of the two-factor model for Swedish banks produces no significant coefficients for the interest rate factor. However, the results from the model's asymmetric extension suggest that there is an asymmetry in the response of the Swedish banks' stock returns to the positive and negative long-term interest rate changes.

Table 2.2
Two-factor model: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected arithmetic (column $\triangle$); percentage (column $\%\triangle$); and squared (column $\triangle^2$) changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
AUSTRALIA												
All Firms	-0.025***	-0.138***	-0.041**	-0.022***	-0.124***	-0.043**	-0.012**	0.000	-0.036*	0.000	0.000	0.000
Large	-0.012	-0.070	0.010	-0.027***	-0.156***	-0.042*	-0.022**	0.000	-0.014	-0.002	0.000	0.000
Medium	-0.045**	-0.243**	-0.118**	-0.014	-0.080	-0.035	0.004	0.000	-0.067	0.003	0.000	-0.001
BELGIUM												
All Firms	0.018*	0.061*	0.062	0.019***	0.084***	0.120***	0.001	0.003	-0.045	-0.004**	0.000	0.001
CANADA												
All Firms	-0.021**	-0.065*	-0.016	-0.008	-0.052	-0.034	-0.009	-0.001***	-0.029*	-0.002*	0.000	0.001
Large	-0.027**	-0.092**	-0.028	-0.020**	-0.129**	0.030	-0.009	-0.001***	-0.027	-0.001	0.000	0.000
Small	-0.008	0.000	0.012	0.020	0.128	-0.183	-0.010	0.000*	-0.035	-0.004	0.000	0.001
FRANCE												
All Firms	0.008	0.026	-0.065	-0.001	-0.002	0.067*	0.000	0.001	-0.014	0.002	0.000*	-0.004**
Large	0.042**	0.135**	-0.118	-0.002	0.001	0.164**	0.001	-0.002	-0.038	0.004	0.000	-0.011***
Small	-0.002	-0.009	-0.034	-0.001	-0.001	0.030	-0.003	-0.002	-0.017	0.000	0.000**	-0.001
GERMANY												
All Firms	0.022	0.065	-0.033	0.007	0.035	-0.109*	-0.011	0.001	0.004	0.005*	0.065	-0.033
Large	0.013	0.008	-0.069	0.001	0.019	-0.061	-0.026*	0.001	0.005	0.013	0.008	-0.069
Medium	0.028	0.103	-0.035	0.028	0.115	-0.216*	-0.003	0.001	-0.001	0.028	0.103	-0.035
Small	0.030**	0.121**	0.028	-0.005	-0.017	-0.082	0.006	0.000	0.008	0.030**	0.121**	0.028
HONG KONG												
All Firms	-0.022***	-0.005*	-0.003	-0.036***	-0.137***	-0.047***	-0.007**	-0.001	-0.015***	0.001	0.000	0.000
Large	-0.020***	-0.005**	-0.004	-0.034***	-0.133***	-0.045**	-0.006*	-0.001	-0.016***	0.001	0.000	0.000
ITALY												
All Firms	-0.010***	-0.019	0.007	0.004	-0.012	-0.093**	-0.007**	-0.004**	0.002	0.004***	0.000	0.000
Large	-0.011*	-0.016	0.012*	0.018	0.081	-0.031	0.000	-0.001	-0.003	0.004*	0.000	0.001
Medium	-0.008**	-0.019	0.006	0.005	-0.001	-0.077*	-0.007**	-0.006***	0.006	0.004***	0.000	0.000
Small	-0.013**	-0.023	0.004	-0.015	-0.135**	-0.197***	-0.013**	-0.004	-0.001	0.006**	0.000	0.000

Table 2.2 (cont'd)
Two-factor model: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected arithmetic (column $\triangle$); percentage (column $\%\triangle$); and squared (column $\triangle^2$) changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
JAPAN												
All Firms	-0.004	-0.002	-0.150*	0.003	0.000	0.013	-0.004	-0.008	-0.016	0.000	0.008	-0.007
Large	-0.002	-0.001	-0.130	0.009	0.009	0.041	-0.007	-0.013	-0.014	-0.001	0.005	-0.005
Medium	-0.003	-0.002*	-0.143	0.001	-0.006	0.003	-0.004	-0.007	-0.016	0.000	0.008	-0.007
Small	-0.008	-0.001	-0.188**	0.008	0.012	0.024	-0.003	-0.008	-0.015	0.003	0.013	-0.010
SPAIN												
All Firms	0.010	0.024	-0.210***	-0.009	-0.028	-0.061	-0.010	-0.011**	-0.031	0.000	0.000	-0.006
Large	0.004	-0.007	-0.278***	0.006	0.043	0.020	-0.011	-0.008	-0.050	0.001	0.000	0.001
Medium	-0.002	-0.011	-0.275***	-0.012	-0.056	-0.111**	-0.018**	-0.014**	-0.013	0.001	0.000	-0.011**
Small	0.024	0.077	-0.104	-0.018*	-0.063	-0.085	-0.002	-0.010	-0.029	-0.002	0.000	-0.008
SWEDEN												
All Firms	0.003	0.028	0.033	0.009	0.044	-0.058	-0.007	-0.010	-0.042	-0.006*	0.000	0.001
SWITZERLAND												
All Firms	0.024***	0.022***	-0.022	0.005	0.008	-0.094***	-0.011**	0.000	-0.017	0.002	0.000	-0.011***
Small	0.023***	0.020**	-0.023	0.008	0.017	-0.065*	-0.010**	0.000	-0.016	0.002	0.000	-0.009**
UK												
All Firms	-0.018*	-0.106*	-0.105**	-0.010	-0.051	-0.019	-0.004	-0.001	0.001	0.001	0.001	-0.005***
Large	-0.014	-0.085	-0.101**	-0.003	-0.022	-0.002	-0.002	0.000	0.003	0.001	0.001*	-0.005**
US - Money Center												
All Firms	-0.003	0.001	0.002	-0.013	-0.062	-0.001	-0.001	0.001	0.000	-0.001	0.000	-0.004
US - Regional												
All Firms	-0.003	-0.006	0.006	0.001	0.008	0.004	-0.002	0.000	0.000	0.001	0.000	-0.002
Large	-0.012	-0.023	-0.003	-0.010	-0.044	0.016	-0.004	0.001	0.006	0.002	0.000	-0.001
Medium	0.007	0.016	0.012	-0.004	-0.020	0.081	0.003	-0.001	-0.002	0.000	0.000	0.003
Small	-0.004	-0.007	0.006	0.003	0.017	-0.006	-0.003	0.000	0.000	0.001	0.000	-0.003
US - Savings & Loans												
All Firms	-0.011**	-0.038**	0.014*	-0.002	-0.014	-0.007	-0.013***	0.000	0.000	-0.001	0.000	0.002
Large	-0.036***	-0.116***	0.037**	-0.006	-0.020	0.050	-0.030***	-0.002	-0.024	-0.003	0.001	0.006
Medium	-0.021	-0.083*	0.045**	-0.006	-0.026	0.050	-0.030***	-0.001	-0.015	-0.006	0.000	0.000
Small	-0.008	-0.028	0.010	-0.002	-0.012	-0.016	-0.010**	0.000	0.004	-0.001	0.000**	0.001

Another explanation for conflicting findings in the previous works relies on the possible time-variation in the interest rate risk sensitivity of analysed institutions. This hypothesis is supported by Wetmore and Brick (1998). The authors employ a similar methodology, with the FIs' stock returns modelled in the context of a multi-factor model. They separate the whole period under investigation (January 1986 to June 1995) into five time horizons to reflect the pertinent regulatory changes. Among other categories of bank institutions, the authors analyse the returns of the US Money Centre banks for sensitivity to the movements in the domestic long-term rate for each of the five horizons. The results suggest the significance of the interest rate factor over only one period from January 1986 to October 1987. This period is covered by Allen, Madura and Wiant (1995) but not by Madura and Zarruk (1995). For the four remaining horizons, overlapping the time period considered by Madura and Zarruk, no interest rate sensitivity is observed.

This evidence supports the view of the time-varying interest rate sensitivity of the analysed institutions. Hence, the results reported in my study could be biased to the considered time-horizon. Therefore, appropriately to account for the possible time-variation in risk sensitivity, I also implement the GARCH modelling techniques in latter sections.

I analyse next the model with the interest rate factor proxied by the yield curve curvature. The empirical results imply the sensitivity of the Belgian, Canadian, German, Italian, and Swedish banks to the unanticipated movements in the yield curve curvature with no evident asymmetric response reported for any of these markets. As Table 2.3 suggests, Belgian, Canadian and Swedish corporations report losses following a medium-term increase. On the contrary, the institutions in Germany and Italy profit from the rising medium rates. This may be because these firms hold more medium-term interest rate sensitive liabilities than assets.

Further, the statistical inferences regarding the interest rate factor significance are biased to the choice of interest rate proxy and approximation technique adopted to calculate these proxies (e.g. the use of arithmetic or percentage changes). For instance, Italian Banks demonstrate the sensitivity to the interest rate factor proxied by the unanticipated percentage changes in the long-rates, but show no sensitivity to the factor proxied by the arithmetic changes in the long-rates. Similarly, small Spanish banks exhibit significant sensitivity to the arithmetic rate changes in the long-term rates, while no such evidence is recorded with percentage changes. This observation enriches the evidence to support the

Table 2.3
Two-factor model with asymmetry: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR,POS} R_{IR,t} D_{IR,t} + \beta_{IR,NEG} R_{IR,t}(1 - D_{IR,t}) + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and the ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. variable $D_{IR,t}$ is the dummy variable which takes a value of one if $R_{IR,t} > 0$ at time t and zero otherwise. The test statistics ($F-$statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficients $\beta_{IR,POS}$ and $\beta_{IR,NEG}$ is reported in column WALD. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
AUSTRALIA												
All Firms	-0.044***	-0.003	4.366**	-0.036***	-0.007	4.130**	-0.022**	0.000	2.225	-0.001	0.001	0.122
Large	-0.008	-0.017	0.192	-0.041***	-0.013	3.676*	-0.025***	-0.019**	0.132	-0.003	-0.001	0.143
Medium	-0.097***	0.012	5.232**	-0.026	-0.001	0.482	-0.018	0.029	1.679	0.003	0.002	0.011
BELGIUM												
All Firms	0.041**	-0.004	2.945*	0.034***	-0.001	3.009*	-0.012	0.017	2.541	-0.001	-0.007**	1.561
CANADA												
All Firms	-0.023	-0.019	0.020	-0.022	0.006	0.988	-0.019	0.000	0.952	0.000	-0.004*	1.014
Large	-0.035**	-0.017	0.470	-0.020	-0.020	0.000	-0.015	-0.003	0.266	0.000	-0.002	0.355
Small	0.007	-0.025	0.431	-0.027	0.066**	2.803*	-0.031	0.007	0.923	-0.001	-0.007*	0.826
FRANCE												
All Firms	-0.004	0.019	1.467	0.010	-0.015	2.380	0.000	-0.001	0.012	-0.004	0.007***	7.710***
Large	0.028	0.053*	0.308	0.025	-0.034	2.647	0.006	-0.004	0.106	-0.007	0.016***	6.550**
Small	-0.010	0.005	0.564	0.004	-0.006	0.359	-0.006	0.001	0.253	-0.002	0.003	1.592
GERMANY												
All Firms	0.002	0.039	0.908	-0.023	0.041**	4.901**	-0.004	-0.020	0.447	-0.005	0.065	-0.033
Large	-0.004	0.028	0.239	-0.022	0.028	0.969	-0.014	-0.041	0.411	0.013	0.008	-0.069
Medium	-0.024	0.074	1.806	-0.021	0.084**	3.633*	-0.002	-0.005	0.002	0.028	0.103	-0.035
Small	0.039*	0.021	0.278	-0.027*	0.021	3.246*	0.012	-0.001	0.320	0.030**	0.121**	0.028
HONG KONG												
All Firms	-0.028***	-0.013**	4.053**	-0.048***	-0.021	2.019	-0.022***	0.008	11.427***	-0.003	0.005*	3.129*
Large	-0.026***	-0.012**	3.820**	-0.045***	-0.021*	1.640	-0.021***	0.010*	12.443***	-0.002	0.004	2.315
ITALY												
All Firms	-0.006	-0.013**	0.575	-0.015	0.023*	2.985*	-0.002	-0.011**	1.190	0.005**	0.004	0.222
Large	-0.008	-0.014	0.151	0.008	0.030	0.322	0.004	-0.005	0.332	0.009**	-0.001	2.589
Medium	-0.006	-0.010*	0.127	-0.007	0.018	1.226	0.000	-0.014**	2.605	0.004*	0.004*	0.000
Small	-0.004	-0.021**	1.271	-0.059***	0.031	5.928**	-0.014	-0.011	0.040	0.004	0.007*	0.139

Table 2.3 (cont'd)
Two-factor model with asymmetry: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR,POS} R_{IR,t} D_{IR,t} + \beta_{IR,NEG} R_{IR,t}(1 - D_{IR,t}) + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and the ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. variable $D_{IR,t}$ is the dummy variable which takes a value of one if $R_{IR,t} > 0$ at time t and zero otherwise. The test statistics ($F-$statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficients $\beta_{IR,POS}$ and $\beta_{IR,NEG}$ is reported in column WALD. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
JAPAN												
All Firms	-0.063**	0.073**	8.839***	0.010	-0.009	0.422	-0.007	0.002	0.104	-0.005	0.005	1.013
Large	-0.059**	0.072**	7.805***	0.020	-0.010	1.004	-0.008	-0.005	0.014	-0.004	0.002	0.263
Medium	-0.060**	0.071**	7.501***	0.006	-0.009	0.242	-0.009	0.005	0.224	-0.006	0.005	1.017
Small	-0.077**	0.082**	10.449***	0.017	-0.007	0.575	-0.002	-0.005	0.010	-0.004	0.009	1.354
SPAIN												
All Firms	-0.023	0.038**	4.826**	-0.018	0.001	0.871	-0.018*	0.000	0.946	-0.006	0.007*	4.121**
Large	-0.030	0.033*	4.252**	0.010	0.001	0.144	-0.023*	0.003	1.379	0.001	0.002	0.021
Medium	-0.050**	0.040*	6.560**	-0.031**	0.010	2.593	-0.028**	-0.007	0.774	-0.009*	0.012**	6.845***
Small	0.006	0.040	0.579	-0.029	-0.006	0.462	-0.007	0.005	0.125	-0.009	0.006	2.270
SWEDEN												
All Firms	0.007	-0.001	0.033	-0.033*	0.063***	7.344***	-0.017	0.008	0.691	-0.003	-0.011	0.610
SWITZERLAND												
All Firms	0.018**	0.031***	0.847	-0.013	0.025**	4.455**	-0.016**	-0.005	0.765	-0.004	0.010***	6.516**
Small	0.016*	0.029***	0.877	-0.004	0.021*	1.897	-0.014*	-0.005	0.525	-0.003	0.008**	4.504**
UK												
All Firms	-0.035**	0.000	1.886	-0.015	-0.004	0.163	-0.007	-0.001	0.079	-0.005	0.008**	4.982**
Large	-0.030*	0.004	1.690	-0.005	-0.001	0.032	-0.003	-0.001	0.004	-0.003	0.007*	2.943*
US - Money Center												
All Firms	-0.003	-0.004	0.006	-0.018	-0.007	0.183	0.003	-0.004	0.604	-0.004	0.003	0.880
US - Regional												
All Firms	-0.006	-0.002	0.096	0.004	-0.002	0.124	0.000	-0.005	0.186	-0.001	0.002	0.422
Large	-0.029*	-0.003	1.414	-0.008	-0.011	0.012	-0.002	-0.008	0.108	0.001	0.002	0.042
Medium	0.006	0.008	0.005	0.020	-0.030*	3.372*	0.002	0.005	0.023	0.004	-0.004	1.135
Small	-0.005	-0.003	0.023	0.004	0.002	0.006	0.000	-0.006	0.222	-0.001	0.003	0.807
US - Savings & Loans												
All Firms	-0.015	-0.010	0.099	-0.003	-0.002	0.001	-0.009	-0.018**	0.599	0.001	-0.003	0.661
Large	-0.040*	-0.034**	0.034	-0.006	-0.005	0.000	-0.031**	-0.028*	0.009	0.000	-0.006	0.339
Medium	-0.014	-0.025	0.081	0.013	-0.026	0.780	-0.036**	-0.023	0.174	0.000	-0.012	0.786
Small	-0.013	-0.006	0.219	-0.004	0.000	0.062	-0.005	-0.017**	1.146	0.001	-0.002	0.396

view that the choice of approximation methodology adopted to calculate the interest rate factors has evident repercussions on the consistency of the estimation results.

The empirical results based on the asymmetric two-factor model (Table 2.3) indicate that positive and negative interest rate changes have different impact on the underlying portfolio returns. In particular, small Canadian, medium German, Italian and Swiss banks benefit from a decline in the long-term rate, but display no response to the positive rate changes. A similar observation is noted for the Swedish banks. This, in turn, violates a common assumption that both positive and negative interest rate changes have the same impact on the underlying portfolio returns. Therefore, this asymmetry should be appropriately modelled in future studies.

B. Insurance companies

We now turn to analysing the interest rate risk exposure of the insurance companies. The results presented in Panel B of Table 2.2 indicate that the market beta is always positive and significant for all portfolios and markets examined. The highest value of 1.444 is reported for the portfolio of large Swiss insurance companies, followed by the UK Life & Health institutions with a market beta of 1.269. This observation for the UK is consistent with the findings presented for the banking portfolios where the market beta of British banks is also among the highest reported.

The results also reveal that, similar to banks, the majority of insurance portfolios are significantly related to at least one interest rate proxy. As for banks, the statistical inferences are biased to the choice of interest rate proxy and an approximation methodology to calculate this proxy. Noticeable exceptions are the Australian institutions, where the selected group of insurance companies shows no sensitivity to the interest rate factor regardless of the choice of approximation methodology or maturity of interest rate measures. Similarly, Italian Life & Health insurers are only found to be sensitive to the percentage changes in the yield curve curvature factor with no sensitivity reported to the remaining interest rate proxies.

The results from the asymmetric two-factor model are presented in Table 2.3: Panel B. Large Canadian, small Swiss and German Reinsurance companies benefit predominantly from negative changes in the short-rates with no reaction registered following positive rate changes. The same is true for the Japanese companies. These insurers, however, are also negatively affected by increases in

Table 2.2 (cont'd)
Two-factor model: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of insurance companies over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected arithmetic (column $\triangle$); percentage (column $\%\triangle$); and squared (column $\triangle^2$) changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
AUSTRALIA												
All Firms	-0.017	-0.080	-0.017	-0.009	-0.053	0.063	-0.002	0.000	-0.030	-0.001	0.000	-0.001
CANADA												
All Firms	0.019	0.078	-0.020	-0.010	-0.068	-0.010	0.016	0.000	-0.022	-0.002	0.000	-0.001
Large	0.012	0.050	-0.075*	-0.002	-0.022	-0.059	0.004	0.000	0.002	-0.002	0.000	-0.001
FRANCE												
All Firms	0.025*	0.084*	-0.066	0.018	0.086	-0.037	-0.013	-0.016	-0.105**	0.007**	0.000	-0.014***
Large	0.017	0.066	-0.035	0.018	0.083	-0.043	-0.007	-0.010	-0.091**	0.007*	0.000	-0.016***
GERMANY - Life & Health												
All Firms	0.027	0.098	-0.030	0.015	0.080	-0.064	-0.009	0.002	-0.101*	0.003	0.001	0.000
GERMANY - Multiline												
All Firms	0.002	0.022	-0.028	0.004	0.016	-0.073	-0.025**	0.001	-0.038	0.006**	0.000	-0.005
Large	-0.010	-0.011	0.094	-0.001	-0.008	-0.055	-0.015	0.002	-0.069	0.005	0.000	-0.012**
GERMANY - Reinsurance												
All Firms	0.035*	0.122*	-0.198**	0.009	0.053	0.247***	-0.012	0.000	-0.093	0.004	0.000	0.005
ITALY - Life & Health												
All Firms	-0.001	0.010	0.000	0.014	0.056	-0.031	-0.005	-0.003	-0.003	0.003	0.001**	0.000
ITALY - Multiline												
All Firms	-0.001	0.002	0.000	-0.017*	-0.096*	-0.116**	-0.007	-0.008**	-0.006	0.002	0.001**	-0.001
Large	0.000	0.003	0.000	-0.021**	-0.107**	-0.126**	-0.008	-0.013**	-0.008	0.000	0.001**	0.001
JAPAN												
All Firms	-0.002	-0.004**	-0.364**	-0.001	-0.009	-0.035	-0.007	-0.018	-0.051	-0.003	0.003	-0.017
Large	0.015	-0.003	-0.326*	0.003	-0.006	-0.034	-0.007	-0.014	-0.081	0.000	0.005	-0.016
Medium	-0.020	-0.004**	-0.402**	-0.005	-0.012	-0.035	-0.007	-0.021	-0.020	-0.006	0.001	-0.017

Table 2.2 (cont'd)
Two-factor model: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of insurance companies over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected arithmetic (column $\triangle$); percentage (column $\%\triangle$); and squared (column $\triangle^2$) changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$	$\triangle$	$\%\triangle$	$\triangle^2$
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
SPAIN												
All Firms	-0.036	-0.076	0.021	-0.008	0.001	0.092	0.000	-0.001	-0.157*	0.005	0.000	-0.014
SWITZERLAND												
All Firms	0.031***	0.063***	-0.041	0.031***	0.080***	-0.042	-0.010	0.000	-0.074**	0.002	0.000	-0.008
Large	0.019	0.061***	-0.003	0.048***	0.127***	-0.199**	-0.016	0.000	-0.063	-0.001	0.000	-0.009
Small	0.047***	0.066***	-0.091**	0.007	0.018	0.169**	-0.001	0.000	-0.090**	0.005	0.000	-0.007
UK - Life & Health												
All Firms	0.023	0.152*	0.016	-0.002	-0.002	0.166**	-0.004	-0.001	-0.154**	0.004	0.000	0.005
UK - Property & Casualty												
All Firms	0.001	0.016	0.021	0.003	0.018	-0.087	-0.035**	-0.003**	-0.165**	0.008***	0.001*	0.001
US - Life & Health												
All Firms	0.008	0.042	-0.017	-0.004	-0.017	0.026	-0.010	-0.001	-0.012	0.002	0.000	-0.004
US - Medical												
All Firms	0.006	0.054	-0.055**	-0.021	-0.110	0.087	-0.012	-0.005	-0.015	0.001	0.000	-0.006
US - Property & Casualty												
All Firms	-0.011	-0.051**	0.018*	-0.014**	-0.067*	-0.047	-0.006	0.000	-0.006	0.001	0.000	0.000
Medium	-0.003	0.015	-0.001	-0.010	-0.043	0.065	-0.003	-0.003	-0.015	0.003	0.000	-0.005
Small	-0.013*	-0.063**	0.022*	-0.015**	-0.072*	-0.069	-0.006	0.000	-0.004	0.001	0.000	0.001
US - Multiline												
All Firms	0.002	0.014	-0.010	-0.004	-0.014	0.043	-0.006	-0.001	-0.008	0.002	0.000	-0.004
Medium	0.007	0.040	-0.041***	-0.010	-0.040	0.099	-0.005	-0.003	-0.010	0.002	0.000	-0.005
Small	0.001	0.005	0.000	-0.003	-0.006	0.021	-0.005	0.000	-0.006	0.002	0.000	-0.003
US - Reinsurance												
All Firms	0.023**	0.054	-0.061***	-0.013	-0.068	0.034	0.002	-0.002	0.005	-0.001	0.000	-0.002

Table 2.3 (cont'd)
Two-factor model with asymmetry: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR,POS} R_{IR,t} D_{IR,t} + \beta_{IR,NEG} R_{IR,t}(1 - D_{IR,t}) + \varepsilon_{it}$ estimated employing the sample of insurance companies over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and the ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. variable $D_{IR,t}$ is the dummy variable which takes a value of one if $R_{IR,t} > 0$ at time t and zero otherwise. The test statistics ($F-$statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficients $\beta_{IR,POS}$ and $\beta_{IR,NEG}$ is reported in column WALD. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
AUSTRALIA												
All Firms	-0.013	-0.020	0.034	0.010	-0.029	1.611	0.010	-0.029	1.611	-0.009	0.007	3.189*
CANADA												
All Firms	0.006	0.035	0.694	-0.020	0.000	0.258	-0.005	0.034*	1.853	-0.002	-0.003	0.035
Large	-0.014	0.044*	2.736*	-0.021	0.018	0.875	-0.002	0.009	0.143	-0.001	-0.003	0.137
FRANCE												
All Firms	0.003	0.047**	1.388	0.003	0.035	0.646	-0.056**	0.033	10.607***	-0.006	0.020***	7.130***
Large	0.002	0.031	0.620	0.002	0.036	0.747	-0.044**	0.033	8.111***	-0.009	0.022***	9.848***
GERMANY - Life & Health												
All Firms	0.009	0.042	0.522	-0.003	0.036	1.257	-0.043**	0.030	6.025**	0.003	0.004	0.023
GERMANY - Multiline												
All Firms	-0.007	0.010	0.176	-0.005	0.015	0.386	-0.042**	-0.006	1.779	0.005	0.006	0.006
Large	0.015	-0.033	0.679	0.003	-0.006	0.039	-0.037	0.010	1.574	-0.002	0.012*	1.518
GERMANY - Reinsurance												
All Firms	-0.014	0.080***	3.948**	0.049**	-0.038*	5.929**	-0.038*	0.019	3.434*	0.010	-0.002	1.874
ITALY - Life & Health												
All Firms	-0.003	0.000	0.029	-0.004	0.033	0.868	-0.001	-0.009	0.199	0.006	0.001	0.586
ITALY - Multiline												
All Firms	-0.001	-0.001	0.001	-0.052***	0.019	5.740**	-0.014	-0.001	1.282	-0.002	0.006*	2.161
Large	0.002	-0.002	0.085	-0.060***	0.019	6.125**	-0.014	-0.002	0.953	-0.001	0.002	0.420
JAPAN												
All Firms	-0.088*	0.129**	7.161***	-0.018	0.028	0.982	-0.023	0.020	0.929	-0.016	0.008	2.136
Large	-0.064	0.137*	4.599**	-0.024	0.050	1.941	-0.033	0.035	1.751	-0.013	0.012	1.655
Medium	-0.112**	0.122*	6.768***	-0.012	0.006	0.118	-0.014	0.004	0.133	-0.019	0.005	1.698

Table 2.3 (cont'd)
Two-factor model with asymmetry: OLS estimation

This table presents the OLS regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR,POS} R_{IR,t} D_{IR,t} + \beta_{IR,NEG} R_{IR,t}(1 - D_{IR,t}) + \varepsilon_{it}$ estimated employing the sample of insurance companies over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and the ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. variable $D_{IR,t}$ is the dummy variable which takes a value of one if $R_{IR,t} > 0$ at time t and zero otherwise. The test statistics ($F-$statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficients $\beta_{IR,POS}$ and $\beta_{IR,NEG}$ is reported in column WALD. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD	$\beta_{IR,POS}$	$\beta_{IR,NEG}$	WALD
	Short-term IR			Long-term IR			IR Term Spread			IR Curvature		
SPAIN												
All Firms	-0.063	-0.014	0.733	-0.009	-0.007	0.003	-0.037	0.044	4.056**	-0.004	0.014*	2.013
SWITZERLAND												
All Firms	0.011	0.052***	2.336	0.012	0.051**	1.345	-0.036**	0.019	5.165**	-0.005	0.009	1.949
Large	0.013	0.026	0.150	-0.005	0.105***	6.119**	-0.036	0.006	1.804	-0.008	0.007	1.262
Small	0.010	0.086***	6.268**	0.034	-0.021	1.956	-0.034*	0.035*	6.337**	-0.002	0.011	1.200
UK - Life & Health												
All Firms	0.031	0.014	0.191	0.033	-0.037	3.463*	0.033	-0.037	3.463*	0.010**	-0.002	2.057
UK - Property & Casualty												
All Firms	-0.004	0.006	0.072	-0.033	0.040*	4.429**	-0.081**	0.013	11.271***	0.005	0.012**	0.949
US - Life & Health												
All Firms	0.004	0.010	0.074	-0.002	-0.007	0.055	-0.023**	0.009	3.503*	0.000	0.004	0.422
US - Medical												
All Firms	-0.015	0.017	0.478	0.005	-0.049	0.932	-0.028	0.011	1.008	-0.002	0.004	0.133
US - Property & Casualty												
All Firms	-0.021	-0.006	0.589	-0.024*	-0.003	0.781	-0.008	-0.003	0.097	0.004	-0.001	0.650
Medium	-0.017	0.004	0.539	-0.004	-0.017	0.131	-0.023	0.025	3.664*	0.003	0.004	0.015
Small	-0.021	-0.008	0.440	-0.027**	-0.001	1.206	-0.005	-0.008	0.032	0.004	-0.002	0.892
US - Multiline												
All Firms	0.002	0.002	0.000	0.000	-0.009	0.190	-0.013	0.003	0.985	-0.001	0.005	0.870
Medium	-0.011	0.017	1.058	-0.003	-0.018	0.202	-0.021	0.018	2.790*	0.002	0.002	0.000
Small	0.008	-0.003	0.430	0.002	-0.008	0.181	-0.008	-0.002	0.159	-0.002	0.006	1.339
US - Reinsurance												
All Firms	0.013	0.028**	0.299	-0.013	-0.013	0.000	-0.003	0.008	0.258	-0.002	0.001	0.099

the short-term rates. A similar observation was also reported for the Japanese banks, thereby suggesting that the asymmetry for the Japanese FIs should be appropriately modelled in future studies.

As regards to the developments in the long-term interest rates, Swiss institutions enhance the return figure following the rate decline. There is no pronounced reaction following the rate increase. A similar asymmetric effect is reported for the UK Property & Casualty companies where the decline in long-term rates by one percent benefits the return figure by 0.04 percent. Contrary to both Swiss and UK insurers, the Italian companies are only responsive to the rate increase. Following the one percent increase in the long-term rates, these companies lose approximately 0.05 percent in returns. The evidence of an asymmetric response also extends to the portfolio of German reinsurers. These institutions appear to be gaining from the rate increase, while they are negatively affected by the decline in long rate. These findings contradict the ones reported by Oertmann, Rendu and Zimmermann (2000) perhaps due to the different time horizons and sample of insurance companies adopted in my research.

Having analysed the interest rate exposure of the large sample of financial institutions, there seem to be two common findings for both banking and insurance companies. First, both banks and insurers are found to be significantly affected by unanticipated movements in the term structure of the interest rate. Second, for both types of companies, the statistical inferences regarding the interest rate factor significance are biased to the choice of approximation technique to calculate the interest rate factor, e.g. the use of arithmetic or percentage changes.

On the other hand, there are also some dissimilarities emerging from the analysis of both groups. First, the majority of banking portfolios appear to be more sensitive to the interest rate factor proxied by the domestic short-term rates. No apparent evidence exists to confirm this for insurance companies. In particular, 18 of 42 banking portfolios are sensitive to the short-term rates with just nine being sensitive to the medium-rates and seven to the long-term rates. For insurance companies, equal numbers of portfolios are sensitive to either of the short- or long-term rates (6 of 30). Only four portfolios are sensitive to changes in the medium-term rates. Second, while for banking institutions there is no evidence of asymmetry in the returns sensitivity to the spread-term changes, such evidence is found for 11 out of 30 insurance companies.

Generalised autoregressive conditional heteroscedasticity estimation

Following the discussion in Section 2.3.1, the study utilises the two-factor GARCH model described by Equations 2.7-2.9. The main reason for the use of the GARCH type strategy is the concern that the use of a least squares technique may result in biased and incorrect conclusions regarding the parameters' statistical significance.

Model (2.4-2.6) is estimated for all banking and insurance portfolios. Table 2.4: Panel A outlines the estimation results for the portfolios of banks. The pertinent model outputs for insurance companies are listed in Table 2.4: Panel B. Each table indicates the magnitude and significance of the interest rate coefficients (column "GARCH"). For comparison, the interest rate coefficients for the two-factor model estimated via an OLS type technique (Equation 2.2) are also reported in column "OLS".

A. Banking institutions

Similar to the results from the two-factor model estimated via OLS, the majority of banks are significantly exposed to unanticipated changes in at least one interest rate proxy. However, the statistical inference regarding the interest rate factor significance is occasionally different to those concluded from OLS based model. On average, the application of the OLS modelling strategy underestimates the institutions exposure to interest rate fluctuations.

In particular, analysing a sample of British banks via GARCH, my findings suggest that the shock of 100 basis points in the short-term interest rate would, on average, result in a decline of the market value of large British banks by approximately £740 million. This amount is comparable to 20% of the total capitalisation of a smaller bank Alliance & Leicester plc in the same market over the examined horizon. On the other hand, the OLS based model failed to recognise the significance of these losses.

Given such results I conclude that statistical inferences regarding the interest rate factor significance are biased to the choice of the model econometric specification (OLS or GARCH). This observation also sheds some light to the origins of the disparity in the previously reported results discussed in Section 2.1.

B. Insurance companies

Turning to insurance companies, the results in Table 2.4: Panel B reveal significant relations between insurers' values and the interest rate factors for some

Table 2.4
Two-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	OLS	GARCH	OLS	GARCH	OLS	GARCH	OLS	GARCH
	Short-term IR		Long-term IR		IR Term Spread		IR Curvature	
AUSTRALIA								
All Firms	-0.025***	-0.018**	-0.022***	-0.023***	-0.012**	-0.018***	0.000	0.000
Large	-0.012	-0.008	-0.027***	-0.026***	-0.022**	-0.022***	-0.002	-0.001
Medium	-0.045**	-0.003	-0.014	-0.007	0.004	-0.002	0.003	0.002
BELGIUM								
All Firms	0.018*	0.019*	0.019***	0.012**	0.001	0.007	-0.004**	-0.003**
CANADA								
All Firms	-0.021**	-0.020*	-0.008	-0.015*	-0.009	-0.005	-0.002*	-0.002
Large	-0.027**	-0.025**	-0.020**	-0.016*	-0.009	-0.006	-0.001	-0.001
Small	-0.008	0.000	0.020	0.023	-0.010	-0.004	-0.004	-0.003
FRANCE								
All Firms	0.008	0.010	-0.001	-0.004	0.000	0.000	0.002	0.001
Large	0.042**	0.029**	-0.002	-0.002	0.001	0.009	0.004	0.004
Small	-0.002	-0.005	-0.001	0.002	-0.003	-0.002	0.000	0.001
GERMANY								
All Firms	0.022	0.020	0.007	0.005	-0.011	-0.003	0.005*	0.006***
Large	0.013	0.038	0.001	0.006	-0.026*	-0.007	0.013	0.003
Medium	0.028	0.003	0.028	0.008	-0.003	-0.006	0.028	0.009***
Small	0.030**	-	-0.005	-	0.006	-	0.030**	-
HONG KONG								
All Firms	-0.022***	-0.014***	-0.036***	-0.010**	-0.007**	-0.004	0.001	0.002
Large	-0.020***	-0.014***	-0.034***	-0.010**	-0.006*	-0.003	0.001	0.001
ITALY								
All Firms	-0.010***	-0.006***	0.004	-0.010**	-0.007**	-0.006*	0.004***	0.003***
Large	-0.011*	-0.001	0.018	0.003	0.000	-0.001	0.004*	0.002
Medium	-0.008**	-0.005**	0.005	0.004	-0.007**	-0.007**	0.004***	0.003***
Small	-0.013**	-0.012**	-0.015	-0.015	-0.013**	-0.011*	0.006**	0.006***

Table 2.4 (cont'd)
Two-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of bank institutions i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	OLS	GARCH	OLS	GARCH	OLS	GARCH	OLS	GARCH
	Short-term IR		Long-term IR		IR Term Spread		IR Curvature	
JAPAN								
All Firms	-0.004	-0.005	0.003	0.004	-0.004	-0.005	0.000	-0.002
Large	-0.002	0.009	0.009	0.005	-0.007	-0.010	-0.001	0.000
Medium	-0.003	-0.009	0.001	0.000	-0.004	-0.005	0.000	-0.002
Small	-0.008	-0.001	0.008	0.010	-0.003	-0.005	0.003	0.000
SPAIN								
All Firms	0.010	0.004	-0.009	-0.006	-0.010	-0.004	0.000	-0.001
Large	0.004	0.018**	0.006	0.008	-0.011	-0.004	0.001	-0.001
Medium	-0.002	-0.002	-0.012	-0.012*	-0.018**	-0.008	0.001	-0.001
Small	0.024	-	-0.018*	-	-0.002	-	-0.002	-
SWEDEN								
All Firms	0.003	0.023	0.009	-0.001	-0.007	0.000	-0.006*	-0.005
SWITZERLAND								
All Firms	0.024***	0.011**	0.005	0.005	-0.011**	-0.007*	0.002	0.002
Small	0.023***	0.012***	0.008	0.007	-0.010**	-0.005	0.002	0.002
UK								
All Firms	-0.018*	-0.022**	-0.010	-0.017**	-0.004	-0.004	0.001	0.000
Large	-0.014	-0.020**	-0.003	-0.014**	-0.002	-0.002	0.001	0.002
US - Money Center								
All Firms	-0.003	-0.001	-0.013	-0.015**	-0.001	-0.001	-0.001	-0.005**
US - Regional								
All Firms	-0.003	-0.007	0.001	-0.001	-0.002	-0.007*	0.001	-0.001
Large	-0.012	-0.002	-0.010	-0.013*	-0.004	-0.002	0.002	-0.002
Medium	0.007	-0.002	-0.004	-0.013	0.003	0.000	0.000	-0.003
Small	-0.004	-0.005	0.003	0.001	-0.003	-0.007*	0.001	0.000
US - Savings & Loans								
All Firms	-0.011**	-0.016***	-0.002	-0.005	-0.013***	-0.007*	-0.001	-0.002
Large	-0.036***	-0.023***	-0.006	-0.001	-0.030***	-0.021***	-0.003	-0.005*
Medium	-0.021	-0.032**	-0.006	-0.029**	-0.030***	-0.019	-0.006	-0.010**
Small	-0.008	-0.013***	-0.002	-0.004	-0.010**	-0.005	-0.001	0.000

Table 2.4 (cont'd)
Two-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of insurance companies i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	OLS	GARCH	OLS	GARCH	OLS	GARCH	OLS	GARCH
	Short-term IR		Long-term IR		IR Term Spread		IR Curvature	
AUSTRALIA								
All Firms	-0.017	-0.016	-0.009	-0.011	-0.002	-0.004	-0.001	-0.004
CANADA								
All Firms	0.019	0.022**	-0.010	-0.019*	0.016	-0.003	-0.002	-0.002
Large	0.012	0.020**	-0.002	-0.013	0.004	-0.006	-0.002	-0.001
FRANCE								
All Firms	0.025*	0.025**	0.018	0.004	-0.013	-0.005	0.007**	0.007***
Large	0.017	0.016	0.018	0.006	-0.007	0.000	0.007*	0.006**
GERMANY - Life & Health								
All Firms	0.027	-0.003	0.015	0.014	-0.009	0.000	0.003	0.004
GERMANY - Multiline								
All Firms	0.002	-0.001	0.004	0.000	-0.025**	-0.019***	0.006**	0.008***
Large	-0.010	-0.013	-0.001	-0.001	-0.015	-0.007	0.005	0.009***
GERMANY - Reinsurance								
All Firms	0.035*	0.033**	0.009	0.011	-0.012	-0.002	0.004	0.004
ITALY - Life & Health								
All Firms	-0.001	0.001	0.014	0.003	-0.005	-0.003	0.003	0.001
ITALY - Multiline								
All Firms	-0.001	0.001	-0.017*	-0.021***	-0.007	-0.007**	0.002	0.001
Large	0.000	0.002	-0.021**	-0.023***	-0.008	-0.011***	0.000	0.000
JAPAN								
All Firms	-0.002	-0.023	-0.001	-0.001	-0.007	-0.003	-0.003	-0.006
Large	0.015	-0.022	0.003	0.003	-0.007	-0.003	0.000	-0.003
Medium	-0.020	-0.024	-0.005	0.000	-0.007	0.001	-0.006	-0.010*

Table 2.4 (cont'd)
Two-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for model $R_{it} = \beta_0 + \beta_M R_{M,t} + \beta_{IR} R_{IR,t} + \varepsilon_{it}$ estimated employing the sample of bank institutions over 1997-2007. Variables R_{it}, and $R_{M,t}$, denote weekly logarithmic returns to the size portfolio of insurance companies i and the return to the market at time t respectively. $R_{IR,t}$ represents the unexpected changes in the domestic short- and long-term interest rates, interest rate term-spread, and the curvature of domestic zero-coupon yield curve at time t. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	OLS	GARCH	OLS	GARCH	OLS	GARCH	OLS	GARCH
	Short-term IR		Long-term IR		IR Term Spread		IR Curvature	
SPAIN								
All Firms	-0.036	-0.024	-0.008	0.000	0.000	-0.008	0.005	0.003
SWITZERLAND								
All Firms	0.031***	0.016*	0.031***	0.008	-0.010	-0.001	0.002	0.003
Large	0.019	0.001	0.048***	0.015	-0.016	-0.006	-0.001	0.002
Small	0.047***	0.040***	0.007	0.014	-0.001	0.020***	0.005	-0.002
UK - Life & Health								
All Firms	0.023	-	-0.002	-	-0.004	-	0.004	-
UK - Property & Casualty								
All Firms	0.001	-0.008	0.003	0.007	-0.035**	-0.020***	0.008***	0.009***
US - Life & Health								
All Firms	0.008	0.004	-0.004	-0.001	-0.010	-0.009*	0.002	0.003
US - Medical								
All Firms	0.006	-0.004	-0.021	-0.023	-0.012	-0.003	0.001	0.004
US - Property & Casualty								
All Firms	-0.011	-0.012**	-0.014**	-0.009	-0.006	-0.006	0.001	0.001
Medium	-0.003	-0.004	-0.010	-0.007	-0.003	-0.005	0.003	0.003
Small	-0.013*	-0.015**	-0.015**	-0.013**	-0.006	-0.005	0.001	0.000
US - Multiline								
All Firms	0.002	0.004	-0.004	-0.002	-0.006	-0.008*	0.002	0.001
Medium	0.007	-0.003	-0.010	-0.007	-0.005	-0.008	0.002	0.004*
Small	0.001	0.006	-0.003	0.000	-0.005	-0.007	0.002	0.001
US - Reinsurance								
All Firms	0.023**	0.018***	-0.013	-0.012	0.002	-0.006	-0.001	0.003

markets. Similar to banks, a detailed examination of the results uncovers several dissimilarities in the empirical outputs of the model estimated via OLS and GARCH. Just as for banks, the application of the OLS technique for insurance companies tends to understate the significance of interest rate risk for the majority of the examined portfolios. This further emphasises the importance of model choice.

As an example, OLS appears to be unsuccessful in establishing the portfolio returns' sensitivity to the unanticipated movements in the term-spread for Swiss and the US Multiline insurers. Further, OLS fails to confirm the tendency of Canadian insurers to post losses following a long-rate increase. On the contrary, it overestimates the significance of the interest rate risk exposure of Swiss institutions.

Multivariate GARCH estimation

Given the growing research interest in identifying the key factors influencing the volatility of companies' returns, I employ a multivariate extension of the previously specified two-factor GARCH model in this chapter. The model is described by Equations 2.11-2.20.

The pertinent empirical results are outlined in Table 2.5: Panels A to B for banks and insurance companies respectively. The table indicates the magnitude and significance of both, the interest rate coefficient from the mean equation (column " MV-GARCH") and the coefficient for the interest rate conditional volatility factor from the volatility equation (column "CV-IR"). For comparison, the interest rate coefficients with respective significances for the two-factor model estimated via OLS (Equation 2.2) and GARCH (Equations 2.7-2.9) are also reported in column "OLS" and "GARCH" respectively. Due to the convergence problems with carrying out the BEKK model estimation the results for some markets are incomplete.

A. Banking institutions

The estimation results reveal some significant interest rate betas and significant coefficients for the interest rate conditional volatility factor in the volatility equation. More specifically, the coefficients reported for the univariate GARCH and MV-GARCH models vary significantly. The identical results are reported only for Australian, French, Italian, Swiss, British and large US Savings & Loans banks.

Table 2.5
Two-factor model: MV-GARCH estimation

This table presents the MV-GARCH regression results for the model in equations 2.11-2.20, estimated employing the sample of bank institutions over 1997-2007. The column headings indicate the choice of the econometric methodology utilised in the model estimation; that is "OLS", "GARCH", and "MV-GARCH" indicate the use of OLS, GARCH, or MV-GARCH type estimation techniques respectively. The coefficient for the interest rate conditional volatility factor from the volatility equation appears in column "CV-IR". *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	OLS	GARCH	MV-GARCH	CV-IR	OLS	GARCH	MV-GARCH	CV-IR
	Short-term IR				Long-term IR			
AUSTRALIA								
All Firms	-0.025***	-0.018**	-0.110***	0.034***	-0.022***	-0.023***	-0.047***	0.027***
Large	-0.012	-0.008	-0.015***	-0.011***	-0.027***	-0.026***	-0.042***	0.034***
Medium	-0.045**	-0.003	-0.270***	-0.238***	-0.014	-0.007	-0.018	0.047***
BELGIUM								
All Firms	0.018*	0.019*	-0.003***	0.034***	0.019***	0.012**	0.366***	-0.02***
CANADA								
All Firms	-0.021**	-0.020*	0.029***	0.029***	-0.008	-0.015*	-0.123***	0.024***
Large	-0.027**	-0.025**	0.070***	0.022***	-0.020**	-0.016*	-0.02***	0.026***
Small	-0.008	0.000	-	-	0.020	0.023	-	-
FRANCE								
All Firms	0.008	0.010	0.048***	0.027***	-0.001	-0.004	-0.075	0.000
Large	0.042**	0.029**	0.062***	0.045***	-0.002	-0.002	-0.059***	0.025***
Small	-0.002	-0.005	0.016***	0.018***	-0.001	0.002	0.003***	0.000
GERMANY								
All Firms	0.022	0.020	-0.023***	0.017***	0.007	0.005	-0.044***	0.000
Large	0.013	0.038	-0.085	0.000	0.001	0.006	-0.054***	0.000
Medium	0.028	0.003	-	-	0.028	0.008	-	-
Small	0.030**	-	-	-	-0.005	-	-	-
HONG KONG								
All Firms	-0.022***	-0.014***	-	-	-0.036***	-0.010**	-	-
Large	-0.020***	-0.014***	0.004***	0.009***	-0.034***	-0.010**	-0.13***	0.000
ITALY								
All Firms	-0.010***	-0.006***	0.000***	-0.005***	0.004	-0.010**	-0.377	0.023***
Large	-0.011*	-0.001	0.005***	-0.007***	0.018	0.003	-0.272***	0.000
Medium	-0.008**	-0.005**	-0.004***	-0.005***	0.005	0.004	0.118***	0.000
Small	-0.013**	-0.012**	-	-	-0.015	-0.015	-	-

Table 2.5 (cont'd)
Two-factor model: MV-GARCH estimation

This table presents the MV-GARCH regression results for the model in equations 2.11-2.20, estimated employing the sample of bank institutions over 1997-2007. The column headings indicate the choice of the econometric methodology utilised in the model estimation; that is "OLS", "GARCH", and "MV-GARCH" indicate the use of OLS, GARCH, or MV-GARCH type estimation techniques respectively. The coefficient for the interest rate conditional volatility factor from the volatility equation appears in column "CV-IR". *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	OLS	GARCH	MV-GARCH	CV-IR	OLS	GARCH	MV-GARCH	CV-IR
	Short-term IR				Long-term IR			
JAPAN								
All Firms	-0.004	-0.005	0.006	0.000	0.003	0.004	0.065***	0.000
Large	-0.002	0.009	0.013***	-0.001***	0.009	0.005	0.032***	0.000
Medium	-0.003	-0.009	0.010	0.000	0.001	0.000	0.065***	0.000
Small	-0.008	-0.001	-0.024***	0.000	0.008	0.010	0.068***	0.000
SPAIN								
All Firms	0.010	0.004	-0.022	0.014***	-0.009	-0.006	0.030	-0.008***
Large	0.004	0.018**	-	-	0.006	0.008	-	-
Medium	-0.002	-0.002	-	-	-0.012	-0.012*	-	-
Small	0.024	-	-	-	-0.018*	-	-	-
SWEDEN								
All Firms	0.003	0.023	0.015***	0.039***	0.009	-0.001	0.454***	0.000
SWITZERLAND								
All Firms	0.024***	0.011**	0.025***	-0.008***	0.005	0.005	-	-
Small	0.023***	0.012***	0.022***	0.010***	0.008	0.007	-	-
UK								
All Firms	-0.018*	-0.022**	-0.009***	0.000	-0.010	-0.017**	0.049***	0.028***
Large	-0.014	-0.020**	-0.004***	0.005***	-0.003	-0.014**	0.041***	0.03***
US - Money Center								
All Firms	-0.003	-0.001	-	-	-0.013	-0.015**	-	-
US - Regional								
All Firms	-0.003	-0.007	-0.003***	0.013***	0.001	-0.001	-0.174	0.000
Large	-0.012	-0.002			-0.010	-0.013*		
Medium	0.007	-0.002	-0.024***	0.070***	-0.004	-0.013	-0.135***	0.000
Small	-0.004	-0.005	-0.036***	0.072***	0.003	0.001	-0.204**	0.000
US - Savings & Loans								
All Firms	-0.011**	-0.016***	-	-	-0.002	-0.005	-	-
Large	-0.036***	-0.023***	-0.072***	0.000	-0.006	-0.001	-	-
Medium	-0.021	-0.032**	0.066***	0.244***	-0.006	-0.029**	-	-
Small	-0.008	-0.013***	0.005***	0.006***	-0.002	-0.004	-	-

Table 2.5 (cont'd)
Two-factor model: MV-GARCH estimation

This table presents the MV-GARCH regression results for the model in equations 2.11-2.20, estimated employing the sample of insurance companies over 1997-2007. The column headings indicate the choice of the econometric methodology utilised in the model estimation; that is "OLS", "GARCH", and "MV-GARCH" indicate the use of OLS, GARCH, or MV-GARCH type estimation techniques respectively. The coefficient for the interest rate conditional volatility factor from the volatility equation appears in column "CV-IR". *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	OLS	GARCH	MV-GARCH	CV-IR	OLS	GARCH	MV-GARCH	CV-IR
	Short-term IR				Long-term IR			
AUSTRALIA								
All Firms	-0.017	-0.016	-0.066***	-0.152***	-0.009	-0.011	-0.011***	0.108***
CANADA								
All Firms	0.019	0.022**	0.043***	0.030***	-0.010	-0.019*	-	-
Large	0.012	0.020**	0.043***	0.033***	-0.002	-0.013	0.144***	0.000
FRANCE								
All Firms	0.025*	0.025**	0.005***	0.023***	0.018	0.004	-0.179***	0.000
Large	0.017	0.016	-0.003***	0.024***	0.018	0.006	-0.164***	0.020***
GERMANY - Life & Health								
All Firms	0.027	-0.003	0.039***	0.074***	0.015	0.014	0.027	0.118***
GERMANY - Multiline								
All Firms	0.002	-0.001	-0.020***	0.025***	0.004	0.000	0.002	0.099***
Large	-0.010	-0.013	-0.030***	0.055***	-0.001	-0.001	-0.050***	0.132***
GERMANY - Reinsurance								
All Firms	0.035*	0.033**	-	-	0.009	0.011	-	-
ITALY - Life & Health								
All Firms	-0.001	0.001	-0.004***	-0.006***	0.014	0.003	0.223***	0.000
ITALY - Multiline								
All Firms	-0.001	0.001	0.002***	-0.005***	-0.017*	-0.021***	0.384***	0.051***
Large	0.000	0.002	0.002***	-0.005***	-0.021**	-0.023***	-0.270***	0.015***
JAPAN								
All Firms	-0.002	-0.023	-	-	-0.001	-0.001	-	-
Large	0.015	-0.022	-0.056***	0.208***	0.003	0.003	-0.020***	0.034***
Medium	-0.020	-0.024	-	-	-0.005	0.000	-	-

Table 2.5 (cont'd)

Two-factor model: MV-GARCH estimation

This table presents the MV-GARCH regression results for the model in equations 2.11-2.20, estimated employing the sample of insurance companies over 1997-2007. The column headings indicate the choice of the econometric methodology utilised in the model estimation; that is "OLS", "GARCH", and "MV-GARCH" indicate the use of OLS, GARCH, or MV-GARCH type estimation techniques respectively. The coefficient for the interest rate conditional volatility factor from the volatility equation appears in column "CV-IR". *, **, *** indicate the coefficient significance at the 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	OLS	GARCH	MV-GARCH	CV-IR	OLS	GARCH	MV-GARCH	CV-IR
	Short-term IR				Long-term IR			
SPAIN								
All Firms	-0.036	-0.024	-0.127***	0.132***	-0.008	0.000	-	-
SWITZERLAND								
All Firms	0.031***	0.016*	0.052***	0.000	0.031***	0.008	-0.070***	0.000
Large	0.019	0.001	-	-	0.048***	0.015	-	-
Small	0.047***	0.040***	0.152**	0.000	0.007	0.014	-	-
UK - Life & Health								
All Firms	0.023	-	-	-	-0.002	-	-	-
UK - Property & Casualty								
All Firms	0.001	-0.008	-0.163	0.000	0.003	0.007	0.007	0.000
US - Life & Health								
All Firms	0.008	0.004	0.033***	0.012***	-0.004	-0.001	-	-
US - Medical								
All Firms	0.006	-0.004	-	-	-0.021	-0.023	-	-
US - Property & Casualty								
All Firms	-0.011	-0.012**	-0.011***	0.028***	-0.014**	-0.009	-	-
Medium	-0.003	-0.004	0.032***	0.038***	-0.010	-0.007	0.001***	0.000
Small	-0.013*	-0.015**	-	-	-0.015**	-0.013**	-	-
US - Multiline								
All Firms	0.002	0.004	0.000	0.018***	-0.004	-0.002	-	-
Medium	0.007	-0.003	-	-	-0.010	-0.007	-0.256	0.000
Small	0.001	0.006	-0.001***	0.015***	-0.003	0.000	-	-
US - Reinsurance								
All Firms	0.023**	0.018***	0.017***	0.064***	-0.013	-0.012	-0.007***	0.081***

With univariate GARCH, the model tends to underestimate the significance of the interest rate exposure for the portfolios of large and medium Australian, small French, large Italian and Japanese, Swedish, and US Regional banks. This further suggests that statistical inference can be biased to the choice of model specification and is in line with the findings reported in previous sections.

Analysing the volatility of portfolio returns, the significant coefficients for the interest rate conditional volatility factor take positive values for 27 out of 36 portfolios. This implies that the higher volatility of the domestic interest rates feeds into increased volatility of banking returns.

B. Insurance companies

The results for the portfolios of insurance companies are similar to those reported for banks. Therefore, the theoretical rationale applied to analyse the model outputs is identical to the one presented above.

To conclude, having analysed Stone's two-factor model under alternative econometric specifications and considering different interest rate proxies, there are some common findings for both banking and insurance companies.

First, the majority of banking and insurance portfolios are found to be significantly affected by at least one interest rate factor, with just a few exceptions reported. Second, there is strong evidence of asymmetric response in the FIs' returns to positive and negative rate changes. Finally, the statistical significance of the interest rate factor and consequent inferences made are biased to the choice of the model econometric specification, approximation methodology adopted to calculate the interest rate factor (e.g. arithmetic or percentage changes), and the choice of the interest rate proxy. For instance, in this research I used four alternative interest rate proxies, two approximation strategies to calculate the interest rate factors and three model frameworks. The reported statistical inferences appear to be biased to the choice of these items.

On the other hand, there are also some dissimilarities emerging from the analysis of both groups. First, the majority of banks appear to be more sensitive to the unanticipated changes in the short-term interest rates. There is no apparent evidence to confirm this for insurance companies. Second, while for banking institutions there is no evidence of asymmetry in the returns sensitivity to the spread-term changes, such evidence is found for 11 out of 30 insurance companies.

2.4.2 Multi-factor model

Ordinary least squares estimation

In this section we employ the multi-factor model described by Equation 2.22. In this model, the FIs' stock returns are modelled as a linear function of the short- or long-term interest rates in combination with two additional factors. These factors capture the unanticipated changes in the foreign exchange index and the returns on the domestic REIT market price index (Section 2.2.3).

The estimation results are presented in Table 2.6: Panels A and B. Columns "Short-term IR" and "Long-termIR" provide the results for the FI portfolios with the interest rate factor being proxied by the unanticipated changes in short- and long-term interest rates respectively. Column "Nelson-Siegel" reports the estimation results for the multifactor model in which the portfolio returns are modelled as a function of the interest rate yield curve level, slope and curvature factors.

A. Banking institutions

The empirical results show significant relationships between the financial corporations' stock returns and both foreign exchange and real estate factors, beyond the effect of market and interest rate risks. While the importance of the foreign exchange factor is less pronounced, the relevance of the real estate factor in explaining the banking values across the majority of markets is overwhelming. For instance, the only markets with insignificant real estate factors are Australia and Belgium. For the remaining markets positive relations between FIs' and real estate returns are reported, suggesting that a substantial amount of firms' funds is allocated in real-estate related assets. The highest coefficient is observed for the portfolio of US Savings & Loan institutions (hereafter "S&L"), which is expected given that real estate lending has historically been one of the major components of S&Ls' loan portfolio. This is consistent with findings of Allen, Madura and Wiant (1995) who studied the relationships between real estate and US banking industry over the 1979-1992 period.

The coefficient of the foreign exchange factor is significant for France, Japan, Spain, Switzerland, UK and the US Regional and Savings & Loan banks[18]. For these institutions the foreign exchange coefficients are negative, with the only

[18] For the US Savings & Loans banks the coefficient on the foreign exchange factor is significant only in the model with the long-term interest rate proxy.

Table 2.6
Multi-factor model: OLS estimation

This table presents the OLS regression results for the model in equation 2.22 (columns "Short-term IR" and "Long-term IR") and equation 2.23 (column "Nelson-Siegel") estimated employing the sample of bank institutions over 1997-2007. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	β_{IR}	β_{FX}	β_{PROP}	β_{IR}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
	Short-term IR			Long-term IR			Nelson-Siegel		
AUSTRALIA									
All Firms	-0.025***	0.000	-0.004	-0.023***	0.001	-0.004	-0.016***	-0.014*	-0.001
Large	-0.012	-0.001	0.007	-0.027***	0.000	0.012	-0.024***	0.015*	-0.003*
Medium	-0.046**	0.001	-0.006	-0.017	0.002	-0.012	-0.002	-0.062***	0.001
BELGIUM									
All Firms	0.018*	0.000	-0.020	0.018***	0.000	-0.008	0.021***	0.015***	0.000
CANADA									
All Firms	-0.023**	0.000	0.134***	-0.010	0.000	0.131***	-0.003	0.006**	-0.002
Large	-0.028***	-0.001	0.119***	-0.021**	-0.001	0.117***	-0.014**	0.004	-0.002
Small	-0.011	0.002	0.168***	0.016	0.002	0.164**	0.021*	0.009	0.000
FRANCE									
All Firms	0.007	0.000	0.102***	-0.001	0.000	0.102***	-0.002	0.004	0.003*
Large	0.041**	0.001	0.183***	0.000	0.001	0.186***	-0.006	0.012	0.008**
Small	-0.004	-0.001*	0.059***	-0.001	-0.001*	0.058***	0.000	0.001	0.001
GERMANY									
All Firms	0.019	0.001	0.104***	0.005	0.001	0.105***	-0.002	0.013	0.006**
Large	0.011	0.001	0.116***	0.000	0.001	0.117***	-0.003	0.015	0.002
Medium	0.011	0.000	0.077	0.058	-0.017	0.081	0.006	0.016	0.013**
Small	0.029**	0.000	0.009	-0.005	0.000	0.011	-0.006	0.008	0.006**
HONG KONG									
All Firms	-0.018***	-0.005	0.293***	-0.032***	-0.004	0.323***	-0.021***	-0.009***	-0.005**
Large	-0.016***	-0.004	0.279***	-0.031***	-0.003	0.305***	-0.021***	-0.007**	-0.004**
ITALY									
All Firms	-0.008**	-0.001	0.146***	0.001	-0.001	0.150***	-0.006	-0.002	0.006***
Large	-0.010	-0.001	0.103***	0.016	-0.001	0.106***	-0.005	0.001	0.006**
Medium	-0.006*	-0.001	0.141***	0.002	-0.001	0.144***	-0.002	-0.003	0.005***
Small	-0.010*	-0.001	0.204***	-0.020*	-0.002	0.210***	-0.016*	-0.003	0.007**

Table 2.6 (cont'd)
Multi-factor model: OLS estimation

This table presents the OLS regression results for the model in equation 2.22 (columns "Short-term IR" and "Long-term IR") and equation 2.23 (column "Nelson-Siegel") estimated employing the sample of bank institutions over 1997-2007. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	β_{IR}	β_{FX}	β_{PROP}	β_{IR}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
	Short-term IR			Long-term IR			Nelson-Siegel		
JAPAN									
All Firms	-0.010	-0.001*	0.105***	0.000	-0.001*	0.103***	0.009	-0.018	0.003
Large	-0.008	-0.002***	0.089***	0.007	-0.002***	0.087***	0.011	-0.017	0.004
Medium	0.011	0.000	0.077	0.058	-0.017	0.081	0.008	-0.014	0.002
Small	-0.014	-0.002**	0.090***	0.007	-0.002**	0.087***	0.010	-0.031	0.007
SPAIN									
All Firms	0.013	0.001*	0.026	-0.007	0.001	0.023	-0.009	0.018**	0.001
Large	0.002	0.000	-0.029	0.005	0.000	-0.028	0.001	0.017*	0.002
Medium	0.002	0.001*	0.057**	-0.008	0.001	0.054**	-0.011	0.012	0.003
Small	0.029	0.002*	0.045	-0.014	0.002	0.038	-0.015	0.022	0.000
SWEDEN									
All Firms	0.003	0.001	0.152***	0.011	0.001	0.153***	0.010	0.001	-0.007*
SWITZERLAND									
All Firms	0.022***	-0.003***	0.090***	0.002	-0.003***	0.089***	-0.004	0.021***	0.005**
Small	0.020***	-0.003***	0.093***	0.005	-0.003***	0.092***	0.000	0.018***	0.005**
UK									
All Firms	-0.021*	0.001	0.114***	-0.010	0.001	0.113***	-0.008	0.007	0.001
Large	-0.017	0.002*	0.100***	-0.003	0.002	0.099***	-0.003	0.006	0.002
US - Money Center									
All Firms	-0.004	0.000	0.161***	-0.011	0.000	0.155***	-0.009	-0.007	-0.002
US - Regional									
All Firms	-0.005	0.000	0.271***	0.005	-0.001	0.271***	0.000	-0.008	0.001
Large	-0.013	-0.001	0.224***	-0.006	-0.001	0.219***	-0.011*	-0.011	0.000
Medium	0.007	-0.003**	0.204***	0.000	-0.003**	0.205***	-0.003	0.006	0.000
Small	-0.006	0.000	0.283***	0.007	0.000	0.284***	0.002	-0.009	0.001
US - Savings & Loans									
All Firms	-0.010*	0.000	0.274***	0.002	-0.001	0.275***	-0.003	-0.016**	-0.002
Large	-0.034***	-0.003	0.311***	0.001	-0.004*	0.312***	-0.005	-0.053***	-0.006
Medium	-0.020	0.001	0.631***	0.004	0.001	0.633***	-0.009	-0.018	-0.008
Small	-0.007	0.000	0.241***	0.002	0.000	0.242***	-0.003	-0.013*	-0.001

Table 2.6 (cont'd)
Multi-factor model: OLS estimation

This table presents the OLS regression results for the model in equation 2.22 (columns "Short-term IR" and "Long-term IR") and equation 2.23 (column "Nelson-Siegel") estimated employing the sample of insurance companies over 1997-2007. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	β_{IR}	β_{FX}	β_{PROP}	β_{IR}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
	Short-term IR			Long-term IR			Nelson-Siegel		
AUSTRALIA									
All Firms	-0.016	0.001	-0.072	-0.010	0.001	-0.075	-0.010	-0.013	-0.001
CANADA									
All Firms	0.017	-0.004***	0.259***	-0.012	-0.003***	0.263***	-0.006	0.006	-0.001
Large	0.010	-0.003***	0.289***	-0.004	-0.003***	0.291***	-0.002	0.010**	0.002
FRANCE									
All Firms	0.025	0.002*	0.206***	0.022*	0.002**	0.208***	0.005	0.013	0.012***
Large	0.017	0.002**	0.162***	0.022*	0.003**	0.164***	0.006	0.008	0.010***
GERMANY - Life & Health									
All Firms	0.023	-0.001	0.085***	0.011	-0.001	0.085***	0.001	0.028*	0.005
GERMANY - Multiline									
All Firms	0.000	0.000	0.063**	0.003	0.000	0.062**	-0.004	-0.002	0.006**
Large	-0.010	0.001	0.052	-0.001	0.001	0.051	-0.004	-0.022	0.004
GERMANY - Reinsurance									
All Firms	0.034*	0.001	0.092***	0.007	0.001	0.093***	0.005	-0.001	0.005
ITALY - Life & Health									
All Firms	-0.001	-0.002*	0.063*	0.011	-0.002	0.062*	-0.004	-0.008	0.003
ITALY - Multiline									
All Firms	0.001	0.000	0.148***	-0.019**	0.000	0.149***	-0.019**	0.000	0.002
Large	0.002	0.000	0.134***	-0.023**	-0.001	0.134***	-0.026***	0.004	0.000
JAPAN									
All Firms	-0.010	-0.002**	0.166***	-0.005	-0.002**	0.166***	0.001	0.026	-0.002
Large	0.010	-0.004***	0.193***	0.000	-0.004***	0.193***	0.000	0.028	0.006
Medium	-0.030	-0.001	0.138***	-0.009	-0.001	0.138***	0.000	0.028	0.006

Table 2.6 (cont'd)
Multi-factor model: OLS estimation

This table presents the OLS regression results for the model in equation 2.22 (columns "Short-term IR" and "Long-term IR") and equation 2.23 (column "Nelson-Siegel") estimated employing the sample of insurance companies over 1997-2007. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	β_{IR}	β_{FX}	β_{PROP}	β_{IR}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
	Short-term IR			Long-term IR			Nelson-Siegel		
SPAIN									
All Firms	-0.034	-0.002	0.139***	-0.006	-0.002	0.142***	-0.012	-0.015	0.005
SWITZERLAND									
All Firms	0.031***	0.000	0.004	0.031***	0.000	0.008	0.014	0.023**	0.007*
Large	0.021	0.001	-0.049	0.050***	0.002	-0.046	0.029***	0.013	0.006
Small	0.046***	-0.001	0.076	0.005	-0.002	0.081	-0.007	0.037***	0.009**
UK - Life & Health									
All Firms	0.024	-0.001	0.201***	-0.003	-0.001	0.197***	-0.005	0.006	0.007**
UK - Property & Casualty									
All Firms	0.003	-0.002	0.214***	0.003	-0.002	0.214***	0.008	-0.017*	0.010***
US - Life & Health									
All Firms	0.006	0.000	0.239***	-0.002	0.001	0.240***	-0.003	0.007	0.002
US - Medical									
All Firms	0.005	-0.001	0.185**	-0.018	-0.001	0.181**	-0.014	0.009	0.000
US - Property & Casualty									
All Firms	-0.013*	-0.001	0.317***	-0.010	-0.001	0.312***	-0.011**	-0.005	0.000
Medium	-0.007	0.004*	0.195***	-0.010	0.004*	0.191***	-0.014*	-0.006	0.002
Small	-0.014**	-0.001	0.340***	-0.010	-0.001	0.334***	-0.011*	-0.004	0.000
US - Multiline									
All Firms	0.001	0.000	0.216***	-0.002	0.000	0.215***	-0.005	0.001	0.002
Medium	0.005	0.002	0.242***	-0.008	0.002	0.240***	-0.009	0.012	0.002
Small	0.000	-0.001	0.212***	0.000	-0.001	0.213***	-0.003	-0.003	0.002
US - Reinsurance									
All Firms	0.022**	0.001	0.081	-0.013	0.001	0.081	-0.005	0.023*	0.000

exception reported for the portfolio of Spanish and UK large institutions. The positive foreign exchange coefficient registered for these banks implies that these institutions have a net-long position in foreign currency, as positive values of the foreign exchange factor imply the depreciation of domestic currency. The opposite is true for the banks in France, Japan, Switzerland and the US (Regional), perhaps implying their tendency to have net-short positions in one or more foreign currencies. Further, the difference between the exchange rate sensitivities among the countries may be caused by the divergence in bank operations across markets and the regulatory conditions prevailing in different countries. For instance, the US banks have historically dominated the foreign exchange trading market (Madura and Zarruk, 1995). Hence, the values of the US banks are significantly affected by the unanticipated changes in foreign exchange.

It is worth mentioning, that regardless of the interest rate proxy, the coefficients on the REIT factor remain statistically similar. Nevertheless, some differences are reported for the coefficient of the foreign exchange factor. Specifically, while using the short-rates to proxy the interest rate factor, the portfolios in Spain and UK exhibit some sensitivity to the foreign exchange factor. This is however not the case when it comes to the model with the long-term rates.

Turning to the empirical results for the multi-factor model with the yield curve level, slope and curvature factors, the chapter refers to the column "Nelson-Siegel" of Table 2.6. Since both slope and curvature factor are orthogonalised with regards to the yield curve level, the exclusive impact of each factor on the FIs' returns can be studied.

As expected, the statistical inferences drawn from the examination of the parameter estimates on the yield curve level factor are identical to ones reported from the models with long-term interest rates. The reason for this can be found in the formulation of the Nelson-Siegel model, where the loading on the level factor is one and is independent of time-to-maturity. Therefore the yield curve level can be interpreted as the long-term factor. The slope factor, on the other hand, can be interpreted as the short-term factor. Its negative and significant values reported for the Australian, Hong Kong, and US Savings & Loans banks means that institutions in these countries record losses following the short-rate increase.

The table also reports the significant relevance of the yield curve curvature factor in explaining the variability of banking returns for 15 of 42 portfolios. The majority of significant coefficients are positive, perhaps implying that the value of the rate sensitive medium-term liabilities held by banks is well above the value of matching assets.

B. Insurance companies

Similar to banks, the insurance companies are significantly affected by the real estate market activity. The coefficient on the REIT factor is positive and significant for 24 of 30 studied portfolios. The sensitivity of the insurers' returns to the real estate values varies across the markets and the type of insurance companies. The highest coefficient of 0.340 is reported for the portfolio of US Property & Casualty insurance institutions. High REIT coefficients are also reported for the remaining US insurers. This is in line with the findings of Johnston and Madura (2002). This significance may be explained by the fact that insurers commonly invest a higher proportion of their funds in a variety of real estate assets, such as equity investment in real estate, loans on commercial and industrial properties, residential mortgages and others. An extensive discussion on this subject is available from Kopcke and Randall (1991) and Johnston and Madura (2002).

Insurance portfolios exposed to the movements in the foreign exchange market include Canadian, French, Italian (Life & Health), Japanese and the US Property & Casualty insurers. A positive coefficient sign is reported only for French and US corporations, implying the tendency of these institutions to have a net-long position in foreign currency. The remaining insurers, exposed to the foreign exchange index fluctuations, tend to maintain net-short foreign currency positions as suggested by the negative foreign exchange coefficients.

Analysing the results for insurance portfolios with the yield curve level, slope and curvature factors, the relevance of the medium-term interest rate in explaining the insurers' values is evident. The significant coefficient for the curvature factor is reported for 8 out of 30 insurance portfolios. The significant coefficients are always positive implying that the value of medium-term liabilities held by insurers in reference countries exceeds that of corresponding assets. The significant coefficients for the yield curve level and slope factors are reported for six markets. For the level factor the majority of significant coefficients bear a negative sign, while the opposite is valid for the yield curve slope factor.

Generalised autoregressive conditional heteroscedasticity estimation

In this section we estimate the multi-factor model via a GARCH type technique (eq. 2.24-2.26). The multifactor model in which the FIs' returns are modelled as a function of the interest rate yield curve level, slope and curvature factors is also estimated via GARCH in this section. Table 2.7: Panels A and B present the results for the portfolios of banking and insurance companies respectively. For comparison, the foreign exchange and the REIT coefficients in the multi-factor model estimated via OLS (Equations 2.22) are also reported in column "OLS". The market and the interest rate factors are not discussed in this section as an extensive examination of these factors is provided in the previous sections.

A. Banking institutions

The coefficient signs reported for the OLS and GARCH models are generally identical. However, the model estimated via OLS fails to recognise the significant exposure of Canadian, Italian, Swedish, and the US Savings & Loan institutions to the foreign exchange risk. Further, the OLS based model overestimates the significance of the foreign exchange factor for the portfolio of small French banks, small Japanese, and Spanish medium and small banks. For the remaining portfolios both techniques yield an identical coefficient sign for the foreign exchange factor. Nonetheless, the model based on OLS still overestimates the foreign exchange coefficients for the Swiss banking institutions.

In addition, the OLS based model persistently underestimates or overestimates the sensitivities of the banking returns to the slope and curvature factors. The most representative example is reported for the portfolios of US based Savings & Loan corporations. While the OLS based model does not recognise the exposure of these firms to the medium rates changes, the model based on GARCH reports the significance of the medium-term factor for three out of four examined portfolios.

B. Insurance companies

Turning to analysing the insurance companies, the REIT betas are generally positive and significant, with the exception of Australian and American Medical insurers. These findings are somewhat conflicting with the ones reported from the OLS based model. For instance, the OLS based model fails to confirm the significant exposure of Swiss and US Reinsurance companies to the real estate market conditions, while it also overestimates the REIT sensitivity of the US Medical insurers.

The estimation also reveals the significant association between insurers' values and the foreign exchange factor for some portfolios. These results are, however, not robust to the choice of interest rate proxy. With regard to the multi-factor model with the yield curve level, slope and curvature, the OLS based model fails to detect the sensitivity of Canadian and American Reinsurance companies to the level factor, while it also overestimates the significance of the curvature factor for the portfolios of Swiss companies. Further, the GARCH based model reports the

Table 2.7
Multi-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for the model in equations 2.24-2.26 and 2.27-2.29 estimated employing the sample of bank institutions over 1997-2007. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

	Short-term IR				Long-term IR				Nelson-Siegel		
	OLS		GARCH		OLS		GARCH		GARCH		
Portfolio	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
AUSTRALIA											
All Firms	0.000	-0.004	0.000	-0.015	0.001	-0.004	0.001*	-0.010	-0.018***	-0.005	-0.001
Large	-0.001	0.007	0.000	-0.009	0.000	0.012	0.000	-0.003	-0.024***	0.013	-0.002
Medium	0.001	-0.006	0.001	0.018	0.002	-0.012	0.001	0.021	-0.004	-0.059***	0.001
BELGIUM											
All Firms	0.000	-0.020	0.000	-0.048	0.000	-0.008	0.000	-0.037	0.013***	0.013***	0.000
CANADA											
All Firms	0.000	0.134***	-0.001	0.098***	0.000	0.131***	-0.001	0.106***	-0.008	0.005**	-0.002*
Large	-0.001	0.119***	-0.001*	0.109***	-0.001	0.117***	-0.001**	0.101***	-0.013**	0.001	-0.001
Small	0.002	0.168***	0.002**	0.160***	0.002	0.164**	0.002*	0.157***	0.017	0.008*	-0.001
FRANCE											
All Firms	0.000	0.102***	0.000	0.044**	0.000	0.102***	0.000	0.045**	-0.003	0.006	0.002
Large	0.001	0.183***	0.001	0.087***	0.001	0.186***	0.000	0.090***	-0.006	0.010	0.006**
Small	-0.001*	0.059***	0.000	0.008	-0.001*	0.058***	0.000	0.008	0.000	-0.003	0.002
GERMANY											
All Firms	0.001	0.104***	0.000	0.105***	0.001	0.105***	0.000	0.109***	-0.001	0.000	0.007***
Large	0.001	0.116***	0.000	0.084**	0.001	0.117***	0.001	0.089***	0.001	0.011	0.005
Medium	0.000	0.077	0.000	0.205***	-0.017	0.081	0.000	0.203***	0.005	-0.037**	0.009**
Small	0.000	0.009	-	-	0.000	0.011	-	-	-	-	-
HONG KONG											
All Firms	-0.005	0.293***	-0.002	0.162***	-0.004	0.323***	-0.002	0.160***	-0.011***	-0.008*	0.001
Large	-0.004	0.279***	0.000	0.130***	-0.003	0.305***	-0.001	0.131***	-0.009**	-0.007*	0.000
ITALY											
All Firms	-0.001	0.146***	-0.001*	0.089***	-0.001	0.150***	-0.001*	0.090***	-0.009**	-0.001	0.004***
Large	-0.001	0.103***	-0.001	0.051*	-0.001	0.106***	-0.001	0.052*	-0.005	0.005	0.005**
Medium	-0.001	0.141***	-0.001**	0.103***	-0.001	0.144***	-0.001**	0.105***	0.001	-0.001	0.005***
Small	-0.001	0.204***	-0.001	0.157***	-0.002	0.210***	-0.001	0.161***	-0.011	-0.008	0.007***

Table 2.7 (cont'd)
Multi-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for the model in equations 2.24-2.26 and 2.27-2.29 estimated employing the sample of bank institutions over 1997-2007. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

	Short-term IR				Long-term IR				Nelson-Siegel		
	OLS		GARCH		OLS		GARCH		GARCH		
Portfolio	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
JAPAN											
All Firms	-0.001*	0.105***	-0.001*	0.087***	-0.001*	0.103***	-0.001*	0.084***	0.008	-0.012	-0.001
Large	-0.002***	0.089***	-0.002***	0.076***	-0.002***	0.087***	-0.002***	0.073***	0.006	-0.009	0.004
Medium	0.000	0.077	-0.001	0.094***	-0.017	0.081	-0.001	0.091***	0.006	-0.008	-0.002
Small	-0.002**	0.090***	-0.001*	0.076***	-0.002**	0.087***	-0.001*	0.071***	0.010	-0.029	0.003
SPAIN											
All Firms	0.001*	0.026	0.001**	0.031***	0.001	0.023	0.001*	0.030***	-0.005	0.015**	0.000
Large	0.000	-0.029	0.000	-0.008	0.000	-0.028	0.000	-0.006	0.007	0.022***	0.000
Medium	0.001*	0.057**	0.001	0.062***	0.001	0.054**	0.001	0.058***	-0.011*	0.012	0.001
Small	0.002*	0.045	-	-	0.002	0.038	-	-	-	-	-
SWEDEN											
All Firms	0.001	0.152***	0.003**	0.095***	0.001	0.153***	0.003**	0.096***	0.004	0.006	-0.005
SWITZERLAND											
All Firms	-0.003***	0.090***	-0.002***	0.065***	-0.003***	0.089***	-0.002***	0.058**	-0.002	0.009**	0.004**
Small	-0.003***	0.093***	-0.002***	0.070***	-0.003***	0.092***	-0.002***	0.062**	0.001	0.009**	0.004**
UK											
All Firms	0.001	0.114***	0.001	0.058**	0.001	0.113***	0.001	0.047*	-0.012**	0.002	0.000
Large	0.002*	0.100***	0.002*	0.056**	0.002	0.099***	0.001	0.049**	-0.010*	-0.001	0.001
US - Money Center											
All Firms	0.000	0.161***	0.000	0.102***	0.000	0.155***	0.000	0.090***	-0.008*	-0.002	-0.005***
US - Regional											
All Firms	0.000	0.271***	-0.001	0.239***	-0.001	0.271***	-0.001	0.240***	-0.001	-0.015**	-0.001
Large	-0.001	0.224***	-0.001	0.167***	-0.001	0.219***	-0.001	0.162***	-0.009*	0.001	-0.003
Medium	-0.003**	0.204***	-0.003***	0.153***	-0.003**	0.205***	-0.003***	0.151***	-0.009	-0.006	-0.004
Small	0.000	0.283***	-0.001	0.254***	0.000	0.284***	-0.001	0.248***	0.001	-0.015**	-0.001
US - Savings & Loans											
All Firms	0.000	0.274***	-0.001	0.216***	-0.001	0.275***	-0.001	0.220***	-0.005	-0.025***	-0.004**
Large	-0.003	0.311***	-0.002*	0.243***	-0.004*	0.312***	-0.002*	0.245***	0.001	-0.032***	-0.007**
Medium	0.001	0.631***	0.003	0.649***	0.001	0.633***	0.003	0.642***	-0.024***	-0.040**	-0.012***
Small	0.000	0.241***	-0.001	0.187***	0.000	0.242***	-0.001	0.191***	-0.004	-0.021***	-0.002

Table 2.7 (cont'd)
Multi-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for the model in equations 2.24-2.26 and 2.27-2.29 estimated employing the sample of insurance companies over 1997-2007. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

	Short-term IR				Long-term IR				Nelson-Siegel		
	OLS		GARCH		OLS		GARCH		GARCH		
Portfolio	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
AUSTRALIA											
All Firms	-0.016	0.001	0.000	-0.030	0.001	-0.075	0.000	-0.030	-0.010	-0.017	-0.005**
CANADA											
All Firms	0.017	-0.004***	-0.003***	0.211***	-0.003***	0.263***	-0.003***	0.214***	-0.015**	0.007**	-0.002
Large	0.010	-0.003***	-0.003***	0.200***	-0.003***	0.291***	-0.002***	0.202***	-0.010	0.008**	0.001
FRANCE											
All Firms	0.025	0.002*	0.001	0.131***	0.002**	0.208***	0.001	0.140***	-0.001	0.016	0.012***
Large	0.017	0.002**	0.001	0.103***	0.003**	0.164***	0.001	0.111***	-0.002	0.013	0.009***
GERMANY - Life & Health											
All Firms	0.023	-0.001	-0.001	0.087***	-0.001	0.085***	-0.001	0.086***	-0.001	-0.001	0.004
GERMANY - Multiline											
All Firms	0.000	0.000	-0.001	0.040**	0.000	0.062**	-0.001	0.042**	-0.007	-0.018	0.007***
Large	-0.010	0.001	0.001	0.001	0.001	0.051	0.001	0.000	-0.011	-0.045***	0.007***
GERMANY - Reinsurance											
All Firms	0.034*	0.001	0.000	0.057***	0.001	0.093***	0.000	0.058***	0.008	0.000	0.004
ITALY - Life & Health											
All Firms	-0.001	-0.002*	-0.002***	0.059*	-0.002	0.062*	-0.002***	0.058*	-0.003	-0.006	-0.001
ITALY - Multiline											
All Firms	0.001	0.000	-0.001	0.146***	0.000	0.149***	-0.001	0.140***	-0.017**	0.001	0.001
Large	0.002	0.000	0.000	0.127***	-0.001	0.134***	-0.001	0.118***	-0.022***	0.005	0.000
JAPAN											
All Firms	-0.010	-0.002**	-0.002	0.144***	-0.002**	0.166***	-0.002	0.146***	0.005	0.037	-0.003
Large	0.010	-0.004***	-0.002**	0.179***	-0.004***	0.193***	-0.002**	0.179***	0.011	0.024	0.006
Medium	-0.030	-0.001	0.000	0.083**	-0.001	0.138***	0.000	0.085**	0.011	0.024	0.006

Table 2.7 (cont'd)
Multi-factor model: GARCH estimation

This table presents the GARCH/GJR-GARCH regression results for the model in equations 2.24-2.26 and 2.27-2.29 estimated employing the sample of insurance companies over 1997-2007. The column headings indicate the choice of the econometric methodology utilised to estimate the model; that is "OLS" and "GARCH" indicate the use of OLS or GARCH type estimation techniques respectively. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

	Short-term IR				Long-term IR				Nelson-Siegel		
	OLS		GARCH		OLS		GARCH		GARCH		
Portfolio	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{FX}	β_{PROP}	β_{Lev}	β_{Slo}	β_{Cur}
SPAIN											
All Firms	-0.034	-0.002	-0.002	0.137***	-0.002	0.142***	-0.002	0.138***	-0.006	-0.004	0.004
SWITZERLAND											
All Firms	0.031***	0.000	-0.002*	0.074*	0.000	0.008	-0.002*	0.072	-0.001	0.010	0.004
Large	0.021	0.001	-0.002*	-0.018	0.002	-0.046	-0.002**	-0.013	0.004	-0.006	0.002
Small	0.046***	-0.001	-0.002	0.121**	-0.002	0.081	-0.002	0.103*	0.002	0.036***	0.006
UK - Life & Health											
All Firms	0.024	-0.001	-	-	-0.001	0.197***	-	-	-	-	-
UK - Property & Casualty											
All Firms	0.003	-0.002	-0.001	0.133***	-0.002	0.214***	-0.001	0.135***	-0.001	-0.015**	0.009***
US - Life & Health											
All Firms	0.006	0.000	0.002**	0.184***	0.001	0.240***	0.002**	0.186***	-0.003	0.002	0.003
US - Medical											
All Firms	0.005	-0.001	0.004	-0.003	-0.001	0.181**	0.005*	-0.017	-0.029***	-0.014	0.006
US - Property & Casualty											
All Firms	-0.013*	-0.001	0.000	0.261***	-0.001	0.312***	0.000	0.259***	-0.008	-0.012	0.000
Medium	-0.007	0.004*	0.005***	0.113**	0.004*	0.191***	0.004***	0.104**	-0.010	-0.019*	0.001
Small	-0.014**	-0.001	-0.001	0.295***	-0.001	0.334***	-0.002	0.275***	-0.010**	-0.010	-0.001
US - Multiline											
All Firms	0.001	0.000	0.000	0.145***	0.000	0.215***	0.000	0.146***	-0.002	0.000	0.001
Medium	0.005	0.002	0.002*	0.139***	0.002	0.240***	0.002	0.136***	-0.007	-0.004	0.004
Small	0.000	-0.001	-0.001	0.163***	-0.001	0.213***	-0.001	0.167***	-0.001	0.002	0.002
US - Reinsurance											
All Firms	0.022**	0.001	-0.001	0.134***	0.001	0.081	0.000	0.114***	-0.013*	0.006	0.002

sensitivity of the German Multiline and US Property & Casualty insurers to the slope factor, while OLS appears to refute this observation. The opposite is true for the portfolios of German Life & Health and American Reinsurance firms.

This observation of inconsistent results between the two models (OLS and GARCH) further emphasises the importance of model choice while modelling the assets returns and risk exposure.

Augmented GARCH estimation

To examine the key determinants of the FIs' return volatility, the study employs the system of Equations 2.30-2.36. The model estimation is organised as a two step process.

First, once the heteroscedastic residuals in the final version of the multi-factor model (2.30) are registered via the Engle Lagrange Multiplier (LM) test, the GARCH type modelling strategy is adopted to model the conditional volatility of returns. The two competing models utilised in the study are GARCH and GJR-GARCH. Depending on the significance of factor δ_i(GJR-GARCH) one of the competing factorisations is employed. The appropriate order of the GARCH process is specified by evaluating relevant statistical measures (such as Engle LM test and Ljung-Box statistics of squared standardised residuals).

In the second step, based on the model specified in step one, the conditional volatility equation is augmented interchangeably by the one-period lagged values of: (a) contemporaneous factors $R_f = R_{IR}; R_{FX}; R_{PROP}$ utilised in the mean equation (column "Risk factors"); and (b) conditional volatilities (h_f) of these factors (column "CV Risk factors").

The model is evaluated with the interest rate factor being proxied by either the short- or long-term interest rates. In the interest of brevity, this section analyses the estimation results only for banking companies, and for the model with the interest rate factor being proxied by the short-term interest rates. The pertinent results are outlined in Table 2.8. The table reports only the values for the φ coefficient in (2.30-2.36).

A. Lagged risk factors (R_f)

We first discuss the results for the model with the conditional volatility equation being augmented by the lagged factors $R_f = R_{IR}$; R_{FX}; R_{PROP}. Representing, by design, the unanticipated changes in the underlying macroeconomic variables, these factors are expected to significantly affect both the first and second moments of the financial institutions' stock returns.

Table 2.8
Augmented GARCH Multi-Factor Model

This table presents the augmented GARCH/GJR-GARCH regression results for the model in equations 2.30-2.36 estimated for the sample of bank institutions over 1997-2007. The volatility equation is interchangeably augmented by the one-period lagged values of: (a) contemporaneous risk factors $R_f = R_{IR}; R_{FX}; R_{PROP}$ utilised in the mean equation (column "Risk factors"); and (b) conditional volatilities (h_f) of these factors (column "CV Risk factors"). The column headings indicate the choice of the pertinent augment in the volatility equation. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	R_{IS}	R_{FX}	R_{PROP}	h_{IS}	h_{FX}	h_{PROP}
	Risk factors			CV Risk factors		
AUSTRALIA						
All Firms	1.1E-04**	-7.4E-06**	2.0E-05	-	-4.1E-06	-
Large	6.0E-05	2.2E-06	1.5E-04	-	-3.7E-05***	-
Medium	7.0E-04***	-5.3E-05***	-1.0E-02***	-	4.1E-05***	-
BELGIUM						
All Firms	-9.6E-06	4.1E-06*	-6.9E-04***	-	-2.0E-06**	1.1E-02**
CANADA						
All Firms	3.4E-05	4.8E-06	-1.1E-04	1.8E-03*	1.9E-07	1.6E-03
Large	2.0E-04***	9.3E-06*	6.4E-05	5.8E-03*	-1.2E-06	6.6E-03
Small	2.0E-04	-5.4E-06	-8.6E-04	2.9E-02**	-8.6E-06	4.0E-02*
FRANCE						
All Firms	2.8E-06	-3.3E-06	-2.1E-04**	1.2E-03**	3.3E-06	-6.4E-04
Large	-3.0E-06	7.2E-06	1.2E-04	2.7E-03*	-3.1E-06	6.8E-03
Small	9.6E-06	-1.3E-06	1.3E-05	3.0E-04**	7.1E-07	4.1E-03
GERMANY						
All Firms	-4.6E-04***	3.1E-06	5.1E-04*	-	-7.1E-03***	2.4E-02*
Large	-1.3E-03*	3.3E-06	3.4E-03***	-	-2.0E-05	8.9E-03
Medium	7.3E-04***	-2.3E-05*	-2.1E-03***	-	-5.6E-05***	-2.8E-02***
Small	-	-	-	-	-	-
HONG KONG						
All Firms	-4.4E-05	-2.9E-05	-6.4E-04**	6.1E-05	-2.2E-05	2.2E-02
Large	-9.0E-06	-4.7E-05**	-4.0E-04	8.2E-05	-9.2E-05	1.1E-02
ITALY						
All Firms	-2.2E-04***	2.0E-06	-1.5E-04	8.7E-05**	-1.3E-06	-
Large	-1.0E-04*	9.9E-08	-5.3E-04**	9.3E-05	4.5E-06	-
Medium	-9.6E-06	3.1E-06	-3.5E-05	1.2E-04**	-2.2E-06	-
Small	-4.7E-04***	2.3E-05**	6.4E-04*	1.3E-04***	-9.2E-06	-
JAPAN						
All Firms	-3.8E-04	5.3E-06	-7.5E-04**	-1.1E-03	-9.0E-07	-2.9E-03
Large	-1.9E-04	1.2E-05	-3.6E-04	3.7E-04	7.8E-06	-2.2E-04
Medium	-4.5E-04**	8.4E-06	-8.5E-04**	2.1E-04	6.2E-06	8.1E-03
Small	-4.3E-04	-3.8E-05**	-7.3E-04	-3.1E-03***	-1.6E-05	-4.0E-02**
SPAIN						
All Firms	4.5E-05	1.8E-06	-1.4E-04	9.0E-05	-4.3E-05***	6.3E-04
Large	-1.2E-04	4.8E-06	1.0E-04	2.1E-03**	-5.2E-06***	5.4E-03**
Medium	-1.7E-04	1.3E-05	-5.0E-04*	1.1E-03	-7.2E-06*	5.9E-03
Small	-	-	-	-	-	-
SWEDEN						
All Firms	2.6E-04***	-2.9E-05**	-4.2E-04	-	4.0E-05	1.6E-02***
SWITZERLAND						
All Firms	-5.1E-05**	1.0E-05***	-4.0E-04***	6.0E-06	-	4.1E-03
Small	-4.6E-05	1.0E-05**	-4.9E-05	1.5E-05	-	6.9E-03

Table 2.10 (cont'd)
Augmented GARCH Multi-Factor Model

This table presents the augmented GARCH/GJR-GARCH regression results for the model in equations 2.30-2.36 estimated for the sample of bank institutions over 1997-2007. The volatility equation is interchangeably augmented by the one-period lagged values of: (a) contemporaneous risk factors $R_f = R_{IR}; R_{FX}; R_{PROP}$ utilised in the mean equation (column "Risk factors"); and (b) conditional volatilities (h_f) of these factors (column "CV Risk factors"). The column headings indicate the choice of the pertinent augment in the volatility equation. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel A: Banking portfolios

Portfolio	R_{IS}	R_{FX}	R_{PROP}	h_{IS}	h_{FX}	h_{PROP}
	Risk factors			CV Risk factors		
UK						
All Firms	-3.0E-05	5.3E-06	-1.5E-04	2.7E-03**	-8.7E-06	-2.2E-03
Large	-4.3E-05	3.7E-06	-1.4E-04	2.8E-03**	1.1E-06	-5.7E-03
US - Money Center						
All Firms	-1.2E-05	1.1E-05	-7.9E-04***	-1.6E-06	-	2.6E-03
US - Regional						
All Firms	-1.8E-05	-4.0E-07	-1.6E-04**	1.1E-04	-	-3.7E-03
Large	-2.8E-04***	3.9E-06	-8.1E-04***	8.1E-04***	-	9.6E-03
Medium	8.8E-05	4.3E-05***	-1.2E-03***	3.8E-05	-	-1.3E-02
Small	-2.8E-06	-3.7E-06	-1.4E-04*	3.5E-06	-	-1.4E-03
US - Savings & Loans						
All Firms	-3.0E-04***	9.2E-06***	-5.0E-04***	-1.0E-03***	-	-7.6E-03**
Large	-4.4E-04***	3.1E-05**	-1.7E-03***	-1.9E-03	-	4.3E-03
Medium	-1.8E-03***	2.8E-05	1.2E-02***	4.8E-04	-	3.2E-01***
Small	-2.6E-04***	6.5E-06***	-2.8E-04***	7.6E-04	-	-1.5E-02***

First, I augment the conditional volatility equation with the short-term interest rate factor. The coefficient φ, therefore, measures the effect of the unexpected changes of the domestic short-term interest rate at time $t-1$ on the FIs' returns volatility at time t. A positive and significant coefficient is observed for large banks in Canada, medium in Australia and Germany and all banks in Sweden. Negative values are reported for Italian, Japanese, Swiss, American (Regional and Savings & Loans) and for the "All firms" portfolio of German banks, suggesting that the riskiness of these institutions decreases following a positive rate shock.

The rationale behind these findings can be explained by the following reasoning. As suggested by Fama (1975), the unanticipated changes in short rates might be attributed to increased uncertainty regarding the changes in expected inflation, with its negative implications on FI values. Another common finding in the finance literature also suggests that short-term interest rate volatility commonly peaks following a short-rate increase. Combining these expectations with the observation that the interest rate shocks commonly affect banking values, the rate changes are expected to be translated into increased volatility of banking returns. Confronted by these risks, banks would try to hedge themselves against these adverse rate movements. This objective appears to be achieved within just one week (the sampling horizon in this study). As a result, the volatility figure is reduced in the period following the short-rate increase. The only banks struggling to prevent the volatility increase in the period following the unexpected short-rate change are those in Canada, Australia, Germany and Sweden. Surprisingly, the riskiness of French, Hong Kong, Spanish and British banks is not inflated by the shocks in short-rates even though the banking values in these counties exhibit significant sensitivity to the short-term rate changes.

Second, the conditional volatility equation is augmented with the long-term interest rate factor. It appears that Italian, Swiss, American (Regional and Savings & Loans), and medium banks from Australia and Germany tend to hedge better against the long-rate changes, with volatility decreasing following the shock in the long-rate. On the contrary, for the portfolios of Hong Kong and small Japanese institutions the reverse is true. Similar to the Hong Kong companies, banking portfolios for Australia and Germany are struggling to prevent the volatility increase in the period following the raise in the long-term domestic rates.

Third, interesting findings emerge with the volatility equation is augmented by the lagged foreign exchange factor. It appears that the portfolios with both first and second moments of returns distribution being affected by the exchange rate changes are those of Canadian, Swedish, Swiss, and the US (Regional and Savings & Loan) institutions. While the depreciation of domestic currency would negatively affect the return figures of Canadian, Swedish, Swiss, and American institutions, it would also increase their riskiness in the subsequent period. On the contrary, the Swedish banks have a tendency to benefit by reducing their volatilities subsequent to domestic currency depreciation.

Finally, the volatility equation is augmented by the lagged REIT factor. It appears that positive real estate returns improve the banks' return volatility figure in the subsequent period. The negative sign of the φ coefficient is reported for French, small German, Hong Kong, large Italian, Japanese, Spanish, Swiss and American (Regional, Savings & Loans) banking portfolios. The exceptions are the portfolios of large German, small Italian and medium US Saving & Loans banks for which the positive REIT returns would be translated into increased bank riskiness in the subsequent week.

B. Lagged factors' conditional volatilities (h_f)

To examine the relations between the values of FIs and risk factors R_f at volatility level, the study augments the volatility equation in (2.31) with the lagged conditional volatilities of the corresponding factors utilised in the mean

Table 2.8 (cont'd)
Augmented GARCH Multi-Factor Model

This table presents the augmented GARCH/GJR-GARCH regression results for the model in equations 2.30-2.36 estimated for the sample of insurance companies over 1997-2007. The volatility equation is interchangeably augmented by the one-period lagged values of: (a) contemporaneous risk factors $R_f = R_{IR}; R_{FX}; R_{PROP}$ utilised in the mean equation (column "Risk factors"); and (b) conditional volatilities (h_f) of these factors (column "CV Risk factors"). The column headings indicate the choice of the pertinent augment in the volatility equation. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	R_{IS}	R_{FX}	R_{PROP}	h_{IS}	h_{FX}	h_{PROP}
	Risk factors			CV Risk factors		
AUSTRALIA						
All Firms	1.6E-04	-4.1E-06	4.4E-03***	-2.2E-03***	3.1E-05	-
CANADA						
All Firms	-7.9E-05	3.3E-06	-5.3E-04*	1.1E-03***	-5.3E-06**	1.0E-02***
Large	1.4E-05	-5.6E-06	-5.3E-04*	1.3E-03**	-2.7E-06	1.0E-02
FRANCE						
All Firms	-5.0E-05	2.5E-06	-4.3E-04**	7.2E-04**	2.4E-05**	-1.2E-03
Large	-1.6E-05	2.3E-06	-3.5E-04*	7.1E-04**	3.7E-06	-4.4E-03
GERMANY - Life & Health						
All Firms	-7.3E-04***	7.6E-06	1.3E-04	-	-5.1E-06	1.9E-02
GERMANY - Multiline						
All Firms	-7.3E-04***	-2.9E-06	-3.7E-04	-	1.5E-05	2.7E-02**
Large	-7.2E-04***	-1.1E-05	8.5E-04**	-	2.1E-04**	2.5E-02
GERMANY - Reinsurance						
All Firms	-2.5E-04	3.8E-06	-2.2E-04	-	3.8E-06	4.8E-03
ITALY - Life & Health						
All Firms	9.1E-06	-6.9E-06	1.5E-04	-9.9E-04***	1.5E-05	-
ITALY - Multiline						
All Firms	-7.0E-05*	1.4E-06	-1.3E-04	9.0E-05	-6.3E-06*	-
Large	-2.6E-05	7.9E-06	-2.6E-04*	6.0E-05	-6.5E-06*	-
JAPAN						
All Firms	-1.6E-03***	4.7E-05***	-1.3E-03**	9.6E-03**	2.8E-05*	4.2E-01***
Large	-1.4E-03***	9.4E-05***	-2.7E-03***	1.7E-01***	1.4E-04***	1.9E-01**
Medium	-2.1E-03***	-3.4E-05	-1.3E-03	1.1E-02***	3.7E-05*	2.4E-02
SPAIN						
All Firms	1.9E-03***	-1.7E-06	-1.8E-03**	8.9E-02***	1.0E-04	-1.0E-01***
SWITZERLAND						
All Firms	-1.6E-04***	3.7E-05***	6.5E-04*	2.8E-04*	-	6.1E-02***
Large	-9.0E-05	4.6E-05***	-8.9E-05	-2.0E-03***	-	7.5E-02**
Small	-4.6E-04***	6.8E-05***	1.4E-03*	-2.4E-04	-	1.3E-01**
UK - Life & Health						
All Firms	-	-	-	-	-	-
UK - Property & Casualty						
All Firms	-1.4E-04	1.1E-06	-5.6E-04*	9.2E-04*	-3.4E-04***	-1.0E-02
US - Life & Health						
All Firms	-7.6E-05	1.3E-05	-4.9E-04***	-5.5E-04	-	1.5E-02**
US - Medical						
All Firms	1.2E-03***	6.3E-05***	-4.7E-04	-1.2E-03**	-	-7.6E-02***

Table 2.10 (cont'd)
Augmented GARCH Multi-Factor Model

This table presents the augmented GARCH/GJR-GARCH regression results for the model in equations 2.30-2.36 estimated for the sample of insurance companies over 1997-2007. The volatility equation is interchangeably augmented by the one-period lagged values of: (a) contemporaneous risk factors $R_f = R_{IR}; R_{FX}; R_{PROP}$ utilised in the mean equation (column "Risk factors"); and (b) conditional volatilities (h_f) of these factors (column "CV Risk factors"). The column headings indicate the choice of the pertinent augment in the volatility equation. *, **, *** indicate the coefficient significance at 10%, 5%, and 1% levels, respectively.

Panel B: Insurance portfolios

Portfolio	R_{IS}	R_{FX}	R_{PROP}	h_{IS}	h_{FX}	h_{PROP}
		Risk factors			CV Risk factors	
US - Property & Casualty						
All Firms	3.8E-06	1.4E-05***	-5.4E-04***	8.7E-04*	-	6.9E-03
Medium	-5.0E-05	1.8E-06	-8.5E-04***	1.5E-03**	-	1.5E-02**
Small	-2.9E-05	3.1E-06	-6.9E-04***	2.7E-03	-	1.6E-02**
US - Multiline						
All Firms	3.3E-05	8.4E-06	-3.5E-04***	1.1E-03*	-	6.8E-03
Medium	-9.7E-06	-3.2E-07	-9.3E-04***	1.0E-03	-	1.6E-02**
Small	2.7E-05	1.5E-05**	-5.1E-04***	2.1E-03**	-	1.8E-03
US - Reinsurance						
All Firms	4.8E-06	2.6E-05***	-1.2E-04	3.9E-04*	-	9.6E-03**

equation.

When the conditional volatilities of the long-term rates are examined the reported coefficients are significant for banks in Australia, Canada, Germany, Italy, Sweden, UK and the US. For banking portfolios in these markets (except portfolios of British and Italian Banks) the reported coefficients are negative, suggesting that increased volatility of interest rates would result in the stabilisation (volatility decrease) of the banks' returns in the subsequent period. These findings are in line with those by Elyasiani and Mansur (1998). These authors suggest that the volatility enhancement benefits from the hedging strategies employed by banks in response to increased uncertainty.

Contrary to the long-term rates, the higher volatility in the domestic short-term rates translates into the higher volatility of the banking returns in the following period (13 of 15 significant coefficients bear a positive sign). These relations are valid for Canadian, French, Italian, Spanish, British and American Regional banks. The opposite is true for small Japanese and large American Savings & Loans institutions. This may be explained by the fact that short-term interest rates are generally more volatile. Therefore, it is more difficult for banks to address the issue of the short-rates volatility increase more efficiently that for the case of long-term rates.

Analysing the volatility transmission from foreign exchange to the banking returns, the significant coefficients are reported for eight out of 42 banking portfolios. The coefficient sign is negative except for the "Medium" portfolio of Australian banks. This suggests the tendency of the banks to improve the volatility figure following an increase in the volatility of exchange rates. This is perhaps due to the fact that banks generally maintain a net-short position in foreign currency and hence benefit following a domestic currency appreciation (which is one of the possible reasons for increased volatility of the FX index).

Having established the positive relations between the REIT and FI returns, the observation of the positive φ coefficients in the conditional volatility equation for Belgian, small Canadian, large Spanish, Swedish and medium US Savings & Loans banks is not surprising. This is because banks allocate a substantial proportion of their funds in real-estate related assets and tend to share the risks common to the real estate market. On the other hand, the negative coefficient values observed for the "Medium" portfolio of German banks, small Japanese and small American Saving & Loans institutions provide rather intriguing evidence.

2.5 Concluding remarks

The exposure of financial intermediaries to various risks has been the subject of considerable empirical research since the inception of Stone's (1974) two factor model. This model has been extensively used in both its original form and numerous modifications. Despite the extensive interest in the area, the researchers have demonstrated conflicting results to date regarding the effect of interest rate changes on financial institutions' equity returns. The reasons for this are attributed to the different data samples, time horizons and methodological frameworks employed in previous works. In addition, the majority of the existing studies focus on the US market. This limits the extent to which that evidence produced can be used to cast light on the exposure of financial intermediaries to interest rate fluctuations in other markets.

Furthermore, the research to date has also demonstrated the relevance of foreign exchange and real estate risk factors to the financial intermediaries' returns generating process. Nonetheless, there is no study which addresses the joint interaction of market, interest rate, foreign exchange and real estate risk factors while modelling the financial institutions' stock returns.

Motivated by these inadequacies, this research contributes to the existing literature along several dimensions. First, this study examines the risk exposure of financial intermediaries across the widest so far selection of markets. This includes the countries members of the Basel Committee of Banking Supervision and other important regions of Asia (Hong Kong) and the Pacific Rim (Australia). Second, the joint interaction of market, interest rate, foreign exchange and real estate risk factors on the banks' and insurance companies' stock returns is studied for the first time. Third, the study adopts the same model specifications across all markets, with the factor significance being tested using alternative econometric techniques. This, in turn, provides robust and up to date empirical evidence on the studied matter and sheds light to the origins of any disparity in the previously reported results. Fourth, the analysis extends the literature by employing the framework that allows capturing the sensitivity of the FIs' stock returns to the changes in the entire shape of the term structure. Finally, this study provides an in-depth examination of the key factors influencing the volatility of the FIs' returns.

The empirical results reported in this chapter reveal a number of common findings for banking and insurance institutions. First, despite the growing quantity and popularity of innovative risk management instruments, financial institutions are found to be significantly exposed to the adverse movements in at least one interest rate proxy. This observation indicates the company managers' inability to take accurate views regarding the changes in the entire shape of the term structure and implement comprehensive hedging strategies. For example, analysing a sample of British banks, my findings suggest that a shock of 100 basis points in the short-term interest rate triggers, on average, a decline of the market value of large British banks by approximately £740 million. This amount is comparable to 20% of the total capitalisation of a smaller bank, Alliance & Leicester plc, in the same market over the reference horizon. Likewise, the empirical findings for Australia suggest that a single shock of 100 basis points in the long-term interest rate would, on average, result in a loss of approximately AUS $811million by the large Australian banks. This amount is akin to 84% of the total capitalisation of a smaller Australian bank, Bendigo & Adelaide Bank Ltd., over the examined horizon.

Second, empirical findings also show significant relationships between the financial corporations' stock returns and both foreign exchange and real estate factors. While the importance of the foreign exchange factor is less pronounced, the relevance of the real estate factor in explaining the financials' values across the majority of markets is overwhelming. The only banks with insignificant real estate factor are in Australia and Belgium. For the remaining markets positive relationships between banking and REIT returns are reported. The values of insurance companies (for 24 of 30 studied portfolios) are also positively and significantly affected by the real estate market conditions. The effect of both the foreign exchange and real estate market activity on the financial institutions' values is different across the markets. The reasons for the difference between the exchange rate sensitivities among the countries are attributed to the divergence in bank operations across markets and the regulatory conditions prevailing in different countries. For the real estate factor the differences might be explained by the market-varying dynamic of property prices due to differences in a number of specific supply and demand factors. While previous research in the area has been neglecting the importance of the real estate market, my findings can offer an essential insight for practitioners in the area of risk management, monetary authorities and financial regulators.

Third, for both banking and insurance portfolios, the statistical inferences regarding the interest rate factor significance are biased to the choice of interest rate proxy (the author used four alternative proxies), approximation technique adopted to calculate these proxies (e.g. the use of arithmetic or percentage changes) and the model econometric specification (OLS, GARCH, MV-GARCH). For instance, in example of British banks, the OLS based model (as opposed to GARCH) failed to recognise the significance of the discussed losses. Similarly, the amount of the discussed losses for large Australian banks rockets to AUS $4.7billion with the long-rate factor calculated as percentage changes. The statistical inferences regarding the significance of both foreign exchange and real estate factors are also heavily affected by the choice of econometric specification. Accordingly, the importance of the factor (model) choice for the consistency of the empirical results among the studies should be further emphasised.

Finally, examining the factors influencing the volatility of the financial institutions' stock returns, the study concludes the relevance of the lagged risk factor and the conditional volatilities of these factors. The riskiness of financial institutions changes in the period subsequent to the changes in most of these factors, with the sign and significance of the change being different across the markets examined. This suggests that institutions of different types and geographical origins may employ heterogeneous asset-liability and risk management strategies.

Appendix 2.1

Market data

Country	Definition	Ticker
Panel A: National market index		
Australia	ASX All Ordinaries Index (AOI)	AS30 INDEX
Belgium	Euronext Brussels benchmark index	BEL20 INDEX
Canada	S&P/TSX Composite Index	SPTSX INDEX
France	Euronext Paris benchmark index CAC 40	CAC INDEX
Germany	Deutsche Aktein Xchange index DAX	DAX INDEX
Hong Kong	Hang Seng Index	HSI INDEX
Italy	Milano Italia Borsa 30 Index MIB 30	MIB30 INDEX
Japan	Tokyo Stock Exchange Market Index Nikkei 225	NKY INDEX
Sweden	OMX Nordic Exchange Stockholm's tradable in	OMX30 INDEX
Switzerland	Swiss Market Index SMI	SMI INDEX
UK	Financial Times Stock Exchange All Share Index	ASX INDEX
US	Standard & Poor's 500 Market Index	SPX INDEX
Panel B: Short-term interest rate		
Australia	3-month Australia bank bill short-term rate	Reserve Bank of Australia
Belgium	3-month Government Treasury Bill yield	National Bank of Belgium
Canada	3-month LIBOR rate	British Bankers Assosiation
France	3-month Government Treasury bill yield	Bloomberg
Germany	Generic 6-month German Treasury paper yield	Bloomberg
Hong Kong	3-month Hong Kong Exchange fund bill yield	Hong Kong Monetary Authority
Italy	3-month Italian Treasury bill	Bloomberg
Japan	6-month Japan Treasury bill redemption yield	Bloomberg
Sweden	3-month Treasury bill yield	Bloomberg
Switzerland	3-month Treasury bill yield	Bloomberg
UK	3-month Treasury bill yield	Bloomberg
US	3-month Treasury bill secondary market rate	Federal Reserve Board
Panel C: Long-term interest rate		
Australia	10-year Commonwealth Treasury bond yield	Australian Reserve Bank
Belgium	30-year Government bond yield	Bloomberg
Canada	30-year Government bond yield	Bloomberg
France	Generic 30-year Government bond yield	Bloomberg
Germany	Generic 30-year Government bond yield	Bloomberg
Hong Kong	10-year Hong Kong Exchange fund note yield	Hong Kong Monetary Authority
Italy	Generic 30-year Government bond yield	Bloomberg
Japan	10-year interest-bearing government bond yield	Bank of Japan
Sweden	10-year Government Bond Yield	Bank of Sweden
Switzerland	10-year Government Bond Yield	Bloomberg
UK	Generic 30-year Government bond yield	Bloomberg
US	20-year U.S. Treasury securities market yield	Federal Reserve Board

Appendix 2.2

Descriptive statistics for financial intermediaries

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for autocorrelation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_{ALL}, R_{LARGE}, R_{MED}, R_{SMALL} denote returns on the corresponding market's portfolio of all banks, large banks, medium size and small banks, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

Panel A: Banking portfolios

	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}
	AUSTRALIA				**FRANCE**				**ITALY**			
Mean	0.0019	0.0023	0.0010	-	0.0016	0.0022	-	0.0013	0.0024	0.0035	0.0021	0.0020
St.Dv.	0.020	0.021	0.039	-	0.014	0.040	-	0.011	0.023	0.039	0.022	0.027
Skew.	-0.87***	-0.11	-3.12***	-	-0.48***	-0.03	-	-0.64***	0.00	0.41***	-0.15	0.79***
Kurt.	8.42***	3.77***	35.36***	-	5.73***	7.41***	-	8.16***	7.9***	6.78***	7.14***	8.75***
J-Bera	761.6***	15.1***	25528.9***	-	196.7***	455.4***	-	661.6***	559.8***	347.5***	401.4***	827.5***
LB(6)	12.74	9.40	14.13	-	18.09	16.74	-	61.68	31.56	15.34	25.86	14.96
	(0.047)	*(0.152)*	*(0.028)*	-	*(0.006)*	*(0.010)*	-	*(0.000)*	*(0.000)*	*(0.018)*	(0.000)	(0.021)
LB(12)	19.86	24.64	27.55	-	33.61	46.19	-	69.91	41.13	28.46	39.82	22.32
	(0.070)	*(0.017)*	*(0.006)*	-	*(0.001)*	*(0.000)*	-	*(0.000)*	*(0.000)*	*(0.005)*	(0.000)	(0.034)
	BELGIUM				**GERMANY**				**JAPAN**			
Mean	0.0016	-	-	-	0.0007	0.0006	-0.0003	0.0019	-0.0005	-0.0003	-0.0004	-0.0010
St.Dv.	0.038	-	-	-	0.024	0.040	0.037	0.017	0.025	0.024	0.026	0.024
Skew.	0.1	-	-	-	-0.42***	0.33***	-0.56***	0.78***	0.21**	0.28***	0.18*	0.29***
Kurt.	10.99***	-	-	-	6.46***	5.72***	13.1***	8.11***	4.02***	3.83***	3.92***	5.35***
J-Bera	1497.6***	-	-	-	297.2***	184***	2420.7***	667.9***	27.9***	22.8***	22.1***	133.9***
LB(6)	21.79	-	-	-	21.20	5.60	65.92	14.08	19.63	24.65	20.16	13.11
	(0.001)	-	-	-	*(0.002)*	*(0.470)*	*(0.000)*	*(0.029)*	*(0.003)*	*(0.000)*	(0.003)	(0.041)
LB(12)	38.37	-	-	-	38.78	10.95	79.33	18.40	30.18	35.68	29.82	23.43
	(0.000)	-	-	-	*(0.000)*	*(0.533)*	*(0.000)*	*(0.104)*	*(0.003)*	*(0.000)*	(0.003)	(0.024)
	CANADA				**HONG KONG**				**SPAIN**			
Mean	0.0024	0.0021	-	0.0030	0.0013	0.0015	-	-	0.0023	0.0021	0.0028	0.0022
St.Dv.	0.023	0.026	-	0.036	0.043	0.043	-	-	0.020	0.031	0.022	0.023
Skew.	-0.04	-0.15	-	0.48***	-0.16	-0.18*	-	-	0.77***	-0.11	0.23**	5.18***
Kurt.	4.92***	4.64***	-	5.99***	8.36***	8.04***	-	-	9.42***	5.72***	6.85***	55.86***
J-Bera	86.6***	65.7***	-	232.3***	656.4***	581.9***	-	-	1012***	172.8***	348.9***	67338.8***
LB(6)	4.71	11.84	-	5.42	23.63	19.88	-	-	22.86	15.47	12.19	6.95
	(0.581)	*(0.066)*	-	*(0.492)*	*(0.001)*	*(0.003)*	-	-	*(0.001)*	*(0.017)*	(0.058)	(0.326)
LB(12)	7.26	21.45	-	20.75	28.80	24.72	-	-	26.47	22.82	17.15	11.83
	(0.840)	*(0.044)*	-	*(0.054)*	*(0.004)*	*(0.016)*	-	-	*(0.009)*	*(0.029)*	(0.144)	(0.459)

Appendix 2.2 (cont'd)

Descriptive statistics for financial intermediaries

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for autocorrelation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_{ALL}, R_{LARGE}, R_{MED}, R_{SMALL} denote returns on the corresponding market's portfolio of all banks, large banks, medium size and small banks, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

Panel A: Banking portfolios

	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}
	SWEDEN				**US - Money Centre**			
Mean	0.0019	-	-	-	0.0009	-	-	-
St.Dv.	0.038	-	-	-	0.034	-	-	-
Skew.	0.09	-	-	-	-0.17*	-	-	-
Kurt.	5.98***	-	-	-	5.28***	-	-	-
J-Bera	207.2***	-	-	-	125.8***	-	-	-
LB(6)	28.08	-	-	-	7.29	-	-	-
	(0.000)	-	-	-	*(0.295)*	-	-	-
LB(12)	47.15	-	-	-	27.54	-	-	-
	(0.000)	-	-	-	*(0.006)*	-	-	-
	SWITZERLAND				**US - Savings & Loans**			
Mean	0.0019	-	-	0.0020	0.0013	0.0018	0.0012	0.0012
St. Dev.	0.014	-	-	0.015	0.017	0.034	0.041	0.016
Skewness	-0.27***	-	-	-0.21**	-1.27***	0 .00	-1.95***	-1.23***
Kurtosis	5.77***	-	-	5.66***	13.72***	6.38***	27.09***	12.14***
Jarque Bera	190.2***	-	-	173.8***	2780.8***	262.1***	13642.6***	2055.7***
LB(6)	67.91	-	-	56.890	17.86	7.27	13.00	27.08
	(0.000)	-	-	*(0.000)*	*(0.007)*	(0.296)	(0.043)	(0.000)
LB(12)	74.81	-	-	59.144	27.77	14.883	14.776	38.244
	(0.000)	-	-	*(0.000)*	*(0.006)*	(0.248)	(0.254)	(0.000)
	UK				**US - Regional**			
Mean	0.0018	0.0019	-	-	0.0011	0.0012	-0.0003	0.0012
St. Dev.	0.033	0.034	-	-	0.017	0.031	0.026	0.017
Skewness	-0.14	-0.05	-	-	-0.23**	-0.06	-0.49***	-0.15
Kurtosis	5.14***	5.14***	-	-	5.17***	5.38***	5.12***	5.20***
Jarque Bera	110.0***	108.7***	-	-	117.3***	135.4***	129.5***	117.1***
LB(6)	16.20	17.46	-	-	14.12	5.74	10.04	15.11
	(0.013)	(0.008)	-	-	*(0.028)*	(0.453)	(0.123)	(0.019)
LB(12)	32.83	36.85	-	-	23.30	18.46	18.23	21.44
	(0.001)	(0.000)	-	-	*(0.025)*	(0.102)	(0.109)	(0.044)

Appendix 2.2 (cont'd)

Descriptive statistics for financial intermediaries

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for autocorrelation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_{ALL}, R_{LARGE}, R_{MED}, R_{SMALL} denote returns on the corresponding market's portfolio of all banks, large banks, medium size and small banks, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

Panel B: Insurance portfolios

	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}
	AUSTRALIA				**GERMANY - Life & Health**				**ITALY - Life & Health**			
Mean	0.0005	-	-	-	0.0012	-	-	-	0.0014	-	-	-
St.Dv.	0.035	-	-	-	0.023	-	-	-	0.045	-	-	-
Skew.	-0.77***	-	-	-	0.68***	-	-	-	-0.06	-	-	-
Kurt.	9.49***	-	-	-	5.47***	-	-	-	6.43***	-	-	-
J-Bera	1047.6***	-	-	-	186.9***	-	-	-	274.0***	-	-	-
LB(6)	8.05	-	-	-	27.56	-	-	-	4.67	-	-	-
	(0.234)	-	-	-	*(0.000)*	-	-	-	*(0.587)*	-	-	-
LB(12)	11.90	-	-	-	30.54	-	-	-	15.05	-	-	-
	(0.454)	-	-	-	*(0.002)*	-	-	-	*(0.239)*	-	-	-
	CANADA				**GERMANY - Multiline**				**ITALY - Multiline**			
Mean	0.0022	0.0033	-	-	0.0001	0.0010	-	-	0.0017	-	0.0013	-
St.Dv.	0.029	0.029	-	-	0.026	0.038	-	-	0.029	-	0.030	-
Skew.	-0.29***	-0.09	-	-	-0.74***	-0.66***	-	-	-0.22**	-	-0.33***	-
Kurt.	6.95***	5.78***	-	-	8.68***	8.17***	-	-	5.40***	-	5.29***	-
J-Bera	375.3***	182.3***	-	-	807.5***	665.8***	-	-	138.2***	-	132.6***	-
LB(6)	11.82	1.88	-	-	14.529	10.05	-	-	3.08	-	4.06	-
	(0.066)	*(0.930)*	-	-	*(0.024)*	(0.122)	-	-	*(0.798)*	-	*(0.668)*	-
LB(12)	24.90	12.39	-	-	29.97	31.30	-	-	18.87	-	10.42	-
	(0.015)	*(0.415)*	-	-	*(0.003)*	(0.002)	-	-	*(0.092)*	-	*(0.579)*	-
	FRANCE				**GERMANY - Reinsurance**				**JAPAN**			
Mean	0.0006	0.0014	-	-	0.0014	-	-	-	0.0005	0.0012	-0.0001	-
St.Dv.	0.043	0.044	-	-	0.035	-	-	-	0.037	0.040	0.041	-
Skew.	-0.99***	-0.69***	-	-	0.44***	-	-	-	0.16	0.20*	0.06	-
Kurt.	10.6***	9.45***	-	-	12.83***	-	-	-	4.21***	5.01***	4.16***	-
J-Bera	1448.7***	1021.2***	-	-	2282.6***	-	-	-	35.8***	95.9***	31.1***	-
LB(6)	19.79	28.43	-	-	14.37	-	-	-	10.63	13.41	9.75	-
	(0.003)	*(0.000)*	-	-	*(0.026)*	-	-	-	*(0.100)*	*(0.037)*	*(0.135)*	-
LB(12)	35.67	46.68	-	-	20.65	-	-	-	15.06	17.48	16.79	-
	(0.000)	*(0.000)*	-	-	*(0.056)*	-	-	-	*(0.238)*	*(0.133)*	*(0.158)*	-

Appendix 2.2 (cont'd)
Descriptive statistics for financial intermediaries

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for autocorrelation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_{ALL}, R_{LARGE}, R_{MED}, R_{SMALL} denote returns on the corresponding market's portfolio of all banks, large banks, medium size and small banks, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

Panel B: Insurance portfolios

	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}	R_{ALL}	R_{LARGE}	R_{MED}	R_{SMALL}
	SPAIN				**UK - Property & Casualty**				**US - Multiline**			
Mean	0.0030	-	-	-	0.0005	-	-	-	0.0008	-	0.0014	0.0005
St.Dv.	0.034	-	-	-	0.028	-	-	-	0.025	-	0.035	0.024
Skew.	1.04***	-	-	-	-1.41***	-	-	-	0.04	-	0.16	-0.11
Kurt.	10.39***	-	-	-	13.77***	-	-	-	4.96***	-	6.01***	4.32***
J-Bera	1367.3***	-	-	-	2926.7***	-	-	-	90.4***	-	216.6***	42.2***
LB(6)	13.878	-	-	-	47.51	-	-	-	6.02	-	4.945	8.586
	(0.031)	-	-	-	*(0.000)*	-	-	-	*(0.421)*	-	*(0.551)*	*(0.198)*
LB(12)	17.93	-	-	-	55.38	-	-	-	19.91	-	17.69	22.68
	(0.118)	-	-	-	*(0.000)*	-	-	-	*(0.069)*	-	*(0.125)*	*(0.031)*
	SWITZERLAND				**US - Life & Health**				**US - Property & Casualty**			
Mean	0.0008	0.0007	-	0.0009	0.0009	-	-	-	0.0015	-	0.0014	0.0015
St.Dv.	0.037	0.049	-	0.030	0.028	-	-	-	0.024	-	0.035	0.024
Skew.	-1.24***	-1.38***	-	-0.32***	-0.58***	-	-	-	0.19*	-	0.48***	0.14
Kurt.	12.61***	15.31***	-	7.99***	6.26***	-	-	-	4.35***	-	5.84***	4.14***
J-Bera	2306.9***	3727.9***	-	592.6***	282.3***	-	-	-	46.7***	-	212.3***	32.7***
LB(6)	27.06	27.50	-	34.43	4.08	-	-	-	5.89	-	6.16	8.10
	(0.000)	*(0.000)*	-	*(0.000)*	*(0.665)*	-	-	-	*(0.435)*	-	*(0.405)*	*(0.231)*
LB(12)	39.68	46.09	-	36.88	13.08	-	-	-	12.03	-	18.65	13.14
	(0.000)	*(0.000)*	-	*(0.000)*	*(0.364)*	-	-	-	*(0.443)*	-	*(0.097)*	*(0.359)*
	UK - Life & Health				**US - Medical**				**US - Reinsurance**			
Mean	0.0009	-	-	-	0.0030	-	-	-	0.0003	-	-	-
St.Dv.	0.039	-	-	-	0.046	-	-	-	0.029	-	-	-
Skew.	-0.74***	-	-	-	-0.67***	-	-	-	-0.46***	-	-	-
Kurt.	7.77***	-	-	-	7.05***	-	-	-	11.25***	-	-	-
J-Bera	589.7***	-	-	-	429.5***	-	-	-	1626.6***	-	-	-
LB(6)	4.02	-	-	-	4.82	-	-	-	2.03	-	-	-
	(0.674)	-	-	-	*(0.567)*	-	-	-	*(0.917)*	-	-	-
LB(12)	14.16	-	-	-	11.12	-	-	-	8.55	-	-	-
	(0.291)	-	-	-	*(0.519)*	-	-	-	*(0.741)*	-	-	-

Appendix 2.3
Descriptive statistics for risk measures

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for auto-correlation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_M, R_{PROP} correspond to the domestic market and property indices, respectively. R_{IS}, R_{IL}, R_{SPR}, R_{LEV}, R_{SLO}, R_{CURV}, and R_{FX} denote first differences in the short- and long-term domestic interest rates; interest rate term spread; sovereign zero-coupon yield curve level, slope, and curvature; and exchange rate index, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

	R_M	R_{PROP}	R_{IS}	R_{IL}	R_{SPR}	R_{LEV}	R_{SLO}	R_{CURV}	R_{FX}
					AUSTRALIA				
Mean	0.0017	0.0013	0.0025	-0.0025	-0.0048	-0.0051	0.0070	0.0088	0.0214
St.Dv.	0.017	0.023	0.080	0.133	0.127	0.150	0.152	0.423	1.364
Skew.	-0.79***	-0.52***	1.04***	0.11	0.22**	0.04	-0.25**	-0.07	-0.55***
Kurt.	5.42***	5.04***	23.2***	3.72***	4.9***	3.61***	4.04***	7.08***	3.85***
J-Bera	195.6***	123.7***	9690.8***	13.5***	89.8***	8.9**	31.2***	392.2***	44.8***
LB(6)	6.44	12.84	19.35	2.40	3.59	4.59	10.77	13.47	3.96
	(0.375)	*(0.046)*	*(0.004)*	*(0.880)*	*(0.733)*	*(0.597)*	*(0.096)*	*(0.036)*	*(0.682)*
LB(12)	17.04	14.65	25.85	4.19	9.13	6.53	16.43	14.47	16.34
	(0.148)	*(0.261)*	*(0.011)*	*(0.980)*	*(0.692)*	*(0.887)*	*(0.172)*	*(0.272)*	*(0.176)*
					BELGIUM				
Mean	0.0014	0.0007	0.0015	-0.0027	-0.0038	-0.0057	0.0079	0.0085	0.0474
St.Dv.	0.028	0.015	0.055	0.088	0.093	0.101	0.167	0.333	0.978
Skew.	-0.16	-0.51***	-0.45***	0.47***	0.44***	0.40***	0.97***	-0.45***	0.08
Kurt.	8.81***	4.83***	12.27***	3.71***	4.16***	4.54***	40.06***	12.70***	3.51***
J-Bera	793.3***	103.2***	2036.5***	32.3***	49.4***	70.8***	32356.3***	2228.3***	6.7**
LB(6)	16.83	15.91	57.71	7.08	8.99	4.24	25.37	17.42	4.13
	(0.010)	*(0.014)*	*(0.000)*	*(0.314)*	*(0.174)*	*(0.644)*	*(0.000)*	*(0.008)*	*(0.659)*
LB(12)	27.12	24.60	85.28	13.03	12.73	12.94	38.36	24.94	7.71
	(0.007)	*(0.017)*	*(0.000)*	*(0.367)*	*(0.389)*	*(0.373)*	*(0.000)*	*(0.015)*	*(0.808)*
					CANADA				
Mean	0.0015	0.0021	0.0032	-0.0055	-0.0088	-0.0069	0.0095	0.0061	0.0652
St.Dv.	0.022	0.028	0.081	0.083	0.110	0.129	0.290	0.659	1.037
Skew.	-0.68***	-0.16	1.14***	-0.13	-0.99***	-0.32***	0.52***	0.42***	-0.49***
Kurt.	5.07***	6.07***	20.08***	4.28***	13.03***	4.27***	12.93***	11.37***	7.90***
J-Bera	144.9***	224.1***	6993.4***	40.4***	2459.4***	47.4***	2349.0***	1668.9***	587.8***
LB(6)	6.26	5.66	50.79	10.68	17.34	17.55	55.15	58.26	5.01
	(0.395)	*(0.463)*	*(0.000)*	*(0.099)*	*(0.008)*	*(0.007)*	*(0.000)*	*(0.000)*	*(0.543)*
LB(12)	11.65	11.11	75.45	22.78	31.49	25.86	63.40	64.94	9.46
	(0.474)	*(0.520)*	*(0.000)*	*(0.030)*	*(0.002)*	*(0.011)*	*(0.000)*	*(0.000)*	*(0.663)*

Appendix 2.3 (cont'd)

Descriptive statistics for risk measures

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for auto-correlation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_M, R_{PROP} correspond to the domestic market and property indices, respectively. R_{IS}, R_{IL}, R_{SPR}, R_{LEV}, R_{SLO}, R_{CURV}, and R_{FX} denote first differences in the short- and long-term domestic interest rates; interest rate term spread; sovereign zero-coupon yield curve level, slope, and curvature; and exchange rate index, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

	R_M	R_{PROP}	R_{IS}	R_{IL}	R_{SPR}	R_{LEV}	R_{SLO}	R_{CURV}	R_{FX}
					FRANCE				
Mean	0.0016	0.0027	0.0011	-0.0039	-0.0046	-0.0051	0.0058	0.0116	0.0499
St.Dv.	0.031	0.021	0.058	0.088	0.097	0.106	0.133	0.320	0.974
Skew.	-0.13	-0.34***	-0.53***	0.28***	0.49***	0.40***	-0.69***	0.04	0.04
Kurt.	6.43***	5.76***	10.75***	3.71***	4.86***	4.09***	5.83***	6.89***	3.44***
J-Bera	277.8***	189.8***	1436.3***	19.3***	103.1***	42.4***	232.5***	355.2***	4.8*
LB(6)	30.19	21.91	37.94	6.93	3.71	3.32	4.97	8.63	3.88
	(0.000)	*(0.001)*	*(0.000)*	*(0.328)*	*(0.716)*	*(0.768)*	*(0.548)*	*(0.195)*	*(0.693)*
LB(12)	46.92	33.75	70.18	14.20	13.57	12.32	13.28	19.29	7.59
	(0.000)	*(0.001)*	*(0.000)*	*(0.288)*	*(0.329)*	*(0.421)*	*(0.349)*	*(0.082)*	*(0.816)*
					GERMANY				
Mean	0.0018	0.0012	0.0033	-0.0038	-0.0066	-0.0060	0.0081	0.0095	0.0500
St.Dv.	0.034	0.034	0.052	0.086	0.095	0.101	0.118	0.318	0.974
Skew.	-0.48***	-0.07	-0.37***	0.31***	0.43***	0.42***	-0.59***	-0.22**	0.05
Kurt.	5.95***	5.6***	19.69***	3.6***	5.8***	4.11***	4.94***	5.16***	3.45***
J-Bera	225.5***	158.4***	6535.3***	17.5***	200.6***	45.7***	121.0***	114.1***	5.0*
LB(6)	16.88	8.67	126.13	2.34	7.47	2.03	10.02	8.43	3.38
	(0.010)	*(0.193)*	*(0.000)*	*(0.886)*	*(0.280)*	*(0.917)*	*(0.124)*	*(0.208)*	*(0.760)*
LB(12)	22.78	12.85	148.29	21.66	20.52	19.87	23.75	24.65	8.56
	(0.030)	*(0.380)*	*(0.000)*	*(0.042)*	*(0.058)*	*(0.070)*	*(0.022)*	*(0.017)*	*(0.740)*
					HONG KONG				
Mean	0.0014	0.0006	-0.0075	-0.0076	-0.0005	-0.0082	0.0010	0.0085	-0.0058
St.Dv.	0.035	0.046	0.383	0.172	0.349	0.220	0.432	0.784	0.383
Skew.	-0.41***	-0.04	0.68***	0.38***	-0.13	0.51***	0.35***	0.05	0.20*
Kurt.	4.52***	5.51***	20.04***	6.23***	16.90***	6.70***	17.90***	19.36***	6.56***
J-Bera	67.6***	144.1***	6663.9***	250.9***	4404.6***	335.4***	5077.6***	6112.6***	292.2***
LB(6)	7.69	14.33	36.50	29.65	39.17	12.87	30.77	50.69	19.09
	(0.261)	*(0.026)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.045)*	*(0.000)*	*(0.000)*	*(0.004)*
LB(12)	15.70	18.60	71.80	35.32	70.12	24.38	38.52	61.24	24.83
	(0.205)	*(0.099)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.018)*	*(0.000)*	*(0.000)*	*(0.016)*

Appendix 2.3 (cont'd)

Descriptive statistics for risk measures

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for autocorrelation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_M, R_{PROP} correspond to the domestic market and property indices, respectively. R_{IS}, R_{IL}, R_{SPR}, R_{LEV}, R_{SLO}, R_{CURV}, and R_{FX} denote first differences in the short- and long-term domestic interest rates; interest rate term spread; sovereign zero-coupon yield curve level, slope, and curvature; and exchange rate index, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

	R_M	R_{PROP}	R_{IS}	R_{IL}	R_{SPR}	R_{LEV}	R_{SLO}	R_{CURV}	R_{FX}
					ITALY				
Mean	0.0016	0.0032	-0.0049	-0.0056	-0.0040	-0.0066	0.0027	0.0063	0.0503
St.Dv.	0.030	0.035	0.238	0.092	0.238	0.120	0.224	0.564	0.979
Skew.	-0.39***	-0.16	-0.83***	0.00	-0.32***	-0.52***	-0.53***	-0.11	0.09
Kurt.	5.06***	9.02***	27.7***	4.69***	18.87***	8.12***	16.76***	16.32***	3.57***
J-Bera	112.4***	846.8***	14269.7***	66.5***	5872.2***	637.4***	4443.5***	4140.7***	8.5**
LB(6)	16.26	18.96	134.63	5.25	126.80	9.08	104.41	78.47	4.80
	(0.012)	*(0.004)*	(0.000)	*(0.512)*	(0.000)	*(0.169)*	*(0.000)*	*(0.000)*	*(0.569)*
LB(12)	21.62	30.68	178.07	34.74	167.21	14.90	132.09	111.53	9.70
	(0.042)	*(0.002)*	(0.000)	*(0.001)*	(0.000)	*(0.247)*	*(0.000)*	*(0.000)*	*(0.642)*
					JAPAN				
Mean	-0.0004	0.0011	0.0004	-0.0019	-0.0021	-0.0042	0.0043	0.0070	0.0099
St.Dv.	0.030	0.052	0.043	0.084	0.089	0.123	0.123	0.230	1.180
Skew.	-0.07	0.26**	0.33***	1.76***	1.34***	1.02***	-1.03***	-0.15	0.94***
Kurt.	3.72***	5.00***	43.00***	14.44***	10.20***	8.73***	7.95***	5.75***	6.52***
J-Bera	12.3***	97.8***	36542.4***	3272.7***	1349.2***	846.7***	657.6***	175.4***	362.8***
LB(6)	1.67	20.62	59.09	4.94	15.15	8.92	10.21	11.20	5.02
	(0.948)	*(0.002)*	*(0.000)*	*(0.552)*	(0.019)	*(0.178)*	*(0.116)*	*(0.082)*	*(0.541)*
LB(12)	6.45	26.75	61.41	22.62	38.44	30.73	24.52	23.76	9.10
	(0.892)	*(0.008)*	*(0.000)*	*(0.031)*	*(0.000)*	*(0.002)*	*(0.017)*	*(0.022)*	*(0.695)*
					SPAIN				
Mean	0.0024	0.0032	-0.0035	-0.0046	-0.0009	-0.0057	0.0013	0.0119	0.0505
St.Dv.	0.027	0.033	0.058	0.094	0.093	0.107	0.129	0.288	0.974
Skew.	-0.48***	0.49***	-0.74***	0.31***	0.35***	0.24**	-0.36***	0.08	0.07
Kurt.	4.38***	6.38***	12.49***	4.49***	4.89***	4.27***	4.50***	4.94***	3.59***
J-Bera	65.4***	287.6***	2139.9***	60.5***	94.6***	42.7***	64.2***	88.3***	8.5**
LB(6)	8.16	3.63	86.78	6.50	8.12	7.14	9.36	1.99	4.64
	(0.227)	*(0.727)*	(0.000)	*(0.369)*	(0.230)	*(0.308)*	*(0.154)*	*(0.921)*	*(0.591)*
LB(12)	10.42	16.78	155.08	21.06	20.08	30.78	27.17	11.83	12.24
	(0.579)	*(0.158)*	(0.000)	*(0.050)*	*(0.066)*	*(0.002)*	*(0.007)*	*(0.459)*	*(0.427)*

Appendix 2.3 (cont'd)

Descriptive statistics for risk measures

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for autocorrelation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_M, R_{PROP} correspond to the domestic market and property indices, respectively. R_{IS}, R_{IL}, R_{SPR}, R_{LEV}, R_{SLO}, R_{CURV}, and R_{FX} denote first differences in the short- and long-term domestic interest rates; interest rate term spread; sovereign zero-coupon yield curve level, slope, and curvature; and exchange rate index, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

	R_M	R_{PROP}	R_{IS}	R_{IL}	R_{SPR}	R_{LEV}	R_{SLO}	R_{CURV}	R_{FX}
					SWEDEN				
Mean	0.0015	0.0022	0.0004	-0.0043	-0.0045	-0.0071	0.0071	0.0091	0.0034
St.Dv.	0.034	0.028	0.069	0.106	0.118	0.123	0.140	0.336	0.809
Skew.	-0.44***	-0.51***	-0.56***	0.65***	0.98***	0.03	-0.32***	0.63***	0.15
Kurt.	5.52***	4.41***	18.74***	5.03***	7.46***	4.00***	5.44***	6.13***	4.39***
J-Bera	165.9***	70.9***	5799.2***	135.2***	551.2***	23.4***	148.1***	265.3***	47.1***
LB(6)	35.15	7.77	12.63	2.49	1.76	2.07	9.64	8.78	8.17
	(0.000)	*(0.255)*	(0.049)	*(0.870)*	(0.940)	*(0.913)*	*(0.141)*	*(0.186)*	*(0.226)*
LB(12)	54.10	8.88	22.14	9.36	13.13	8.58	23.66	14.61	14.52
	(0.000)	*(0.713)*	(0.036)	*(0.672)*	*(0.360)*	*(0.738)*	*(0.023)*	*(0.264)*	*(0.269)*
					SWITZERLAND				
Mean	0.0015	0.0016	0.0022	-0.0013	-0.0035	-0.0027	0.0061	0.0022	0.0122
St.Dv.	0.027	0.015	0.084	0.086	0.106	0.105	0.133	0.265	0.712
Skew.	-0.28***	0.05	0.59***	0.30***	0.06	0.19*	-0.47***	-0.11	0.37***
Kurt.	7.00***	6.02***	16.16***	4.42***	8.63***	4.59***	6.22***	4.80***	4.02***
J-Bera	390.5***	217.3***	4168.9***	56.4***	758.2***	63.5***	269.0***	79.0***	37.6***
LB(6)	17.84	8.47	28.05	9.08	4.69	11.36	3.39	9.32	2.57
	(0.007)	*(0.206)*	*(0.000)*	*(0.169)*	(0.584)	*(0.078)*	*(0.759)*	*(0.156)*	*(0.861)*
LB(12)	27.02	16.28	30.44	15.01	13.58	20.33	9.44	14.53	8.10
	(0.008)	*(0.179)*	(0.002)	*(0.241)*	*(0.328)*	*(0.061)*	*(0.665)*	*(0.268)*	*(0.777)*

Appendix 2.3 (cont'd)
Descriptive statistics for risk measures

The statistics are based on 570 weekly observations over 1997-2007. LB(q) denotes the Ljung-Box statistic for auto-correlation up to order q distributed as χ^2 with q degrees of freedom. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. R_M, R_{PROP} correspond to the domestic market and property indices, respectively. R_{IS}, R_{IL}, R_{SPR}, R_{LEV}, R_{SLO}, R_{CURV}, and R_{FX} denote first differences in the short- and long-term domestic interest rates; interest rate term spread; sovereign zero-coupon yield curve level, slope, and curvature; and exchange rate index, respectively. Heteroskedastic consistent p-values based on White's robust standard error are in parenthesis.

	R_M	R_{PROP}	R_{IS}	R_{IL}	R_{SPR}	R_{LEV}	R_{SLO}	R_{CURV}	R_{FX}
					UK				
Mean	0.0009	0.0014	-0.0014	-0.0059	-0.0045	-0.0059	0.0047	-0.0011	0.0261
St.Dv.	0.022	0.026	0.072	0.093	0.112	0.126	0.152	0.418	0.787
Skew.	-0.15	-0.27***	0.27***	-0.06	0.16	-0.05	-0.47***	0.58***	-0.45***
Kurt.	6.47***	4.20***	12.08***	4.58***	4.76***	5.84***	7.59***	5.86***	4.40***
J-Bera	285.8***	40.5***	1953.4***	59.3***	75.3***	190.6***	518.2***	224.8***	65.8***
LB(6)	16.76	5.06	43.60	6.15	6.36	5.81	8.52	5.47	7.89
	(0.010)	*(0.536)*	(0.000)	*(0.406)*	(0.384)	*(0.445)*	*(0.202)*	*(0.485)*	*(0.247)*
LB(12)	27.12	13.58	71.04	15.63	22.92	17.28	12.61	15.38	19.77
	(0.007)	*(0.329)*	(0.000)	*(0.209)*	*(0.028)*	*(0.139)*	*(0.398)*	*(0.221)*	*(0.072)*
					US				
Mean	0.0012	0.0008	-0.0040	-0.0042	-0.0005	-0.0039	0.0012	0.0022	0.0032
St.Dv.	0.023	0.024	0.216	0.106	0.226	0.143	0.121	0.330	0.579
Skew.	-0.22**	-0.33***	-0.29***	0.23**	-0.89***	0.26**	-1.07***	0.19*	0.09
Kurt.	5.21***	7.01***	147.30***	3.32***	106.06***	4.14***	9.13***	5.06***	3.40***
J-Bera	120.0***	389.9***	491055.3***	7.6**	250543.2***	36.0***	965.8***	100.4***	4.5
LB(6)	8.79	7.32	73.41	7.83	56.47	14.12	17.57	16.39	5.49
	(0.185)	*(0.292)*	(0.000)	*(0.251)*	(0.000)	*(0.028)*	*(0.007)*	*(0.012)*	*(0.482)*
LB(12)	33.37	22.67	74.51	17.33	58.37	24.86	25.39	18.96	8.84
	(0.001)	*(0.031)*	(0.000)	*(0.138)*	(0.000)	*(0.015)*	*(0.013)*	*(0.090)*	*(0.717)*

Chapter 3

Bank Regulation and Interest Rate Risk: An International Perspective

3.1 Introduction

The recent financial crisis has highlighted how risk-taking by financial intermediaries can bring the economic and financial system to its knees. Understanding what determines the amount of risk assumed by financial intermediaries is therefore of paramount importance.

It is true that most banks are highly leveraged institutions. As a result, their dominant stockholders face only limited liability and are inclined to collude with managers and gain at the expense of minority shareholders and depositors by pursuing risky projects. In such settings, the burden of overseeing bank risk-taking falls on the shoulders of depositors, who are commonly banks' major debtholders. Against this background, depositors' monitoring incentives are limited in the presence of a deposit insurance scheme. It is, therefore, commonly argued that provision of deposit protection intensifies bank risk-taking incentives. The available literature on moral hazard supports this view [Merton, 1977; Keeley, 1990; and Demirgüç-Kunt and Huizinga, 1998].

This bias has long been recognised by regulators worldwide, taking various remedies not only to ease the problem of moral hazard but also to minimise the likelihood of systemic crises in credit and financial markets.

Nonetheless, the policymakers' response varied across countries, cultivating international heterogeneity in regulations that affect the banking sector. In a bid to address bank runs, some markets have adopted various forms of explicit deposit protection schemes, among other measures. Others have chosen not to follow suit, challenging the effectiveness of such provisions in curtailing moral hazard. Even within the first group of countries the design of adopted schemes has varied significantly. The governments attempted to make the best use of market discipline by either extending only partial deposit coverage[1] ((e.g. so-called "co-insurance" is required in Germany and United Kingdom), or introducing insurance premiums tied to bank risks (Belgium, Canada, France, Italy, Sweden, and later Hong Kong). In order further to discipline financial institutions, regulators have limited the scope of activities allowed to bankers, e.g. restricting to some extent banks' engagement in securities, insurance, and real estate operations[2]. This has led to even bigger differences in the regulatory and supervisory standards across countries.

Often, the aforementioned regulatory actions have been undertaken as stabilising ex-post, upon the breakout of financial troubles[3], rather than crises preventative ex-ante measures. As noted by Diamond and Dybvig (1983) and later reconfirmed by Demirgüç-Kunt, Kane and Laeven (2008), the likelihood of adopting deposit insurance, or altering the design of an existing scheme, is maximised during systemic banking crises. These authors therefore raise concerns regarding the suitability of such provisions' design features to the country's public and private contracting environment. This is particularly important given serious time constraints and immense external pressure from supranational agencies at the time of adoption. Moreover, insurance design features are often influenced by schemes tailor-made to suit the needs of other countries, and therefore may not lead to the best outcome. The latter argument is also emphasised by Demirgüç-Kunt and Kane (2002). The authors conclude that country-specific political, legal and economic conditions need to be carefully considered amidst the design of a county's financial safety net.

The outlined concerns have historically motivated interest among academics and practitioners in modelling the direct influence of regulatory and supervisory policies on bank risk taking. An extensive body of literature has also analysed

[1] The deposit coverage is commonly limited in several ways, by assuming (a) explicit levels of deposit coverage; (b) "co-insurance" requirements; (c) protection provision to only home currency denominated deposits; (d) no guarantees to interbank deposits. For more details, see Demirgüç-Kunt, Karacaovali, and Laeven (2005).

[2] The impact of activity restrictions on risk-taking is not necessarily unambiguous. Relaxing restrictions on banks may result in more risk-taking as banks may undertake a wider range of activities. However, less stringent banking regulations may also result in lower risk as banks diversify more.

[3] The over-generous blanket insurance guarantees have been previously introduced in the midst of financial crises in Sweden (1992), Japan (1996), Thailand (1997), Korea (1997), Malaysia (1998), Indonesia (1998).

the effects of cross-country regulatory differences. In particular, national bank regulations and supervisory provisions have been acknowledged as vital external determinants of individual banks' credit risk [Barth et al., 2001, 2004; Godlewski, 2006; González, 2005; Agoraki, Delis and Pasiouras, 2008] as well as banks' systemic risk in general [Demirgüç-Kunt and Detragiache, 2002; Barth et al., 2008; Demirgüç-Kunt, Detragiache, and Tressel, 2008].

Despite the considerable interest in the area, none of the existing papers has explicitly related cross-market variations in banks interest rate risk exposure[4] to differences in international bank regulations. Even though several empirical works have identified certain company-specific determinants of interest rate risk [Flannery and James, 1984b; Fraser, Madura and Weigand, 2002; Johnson and Madura, 2002; Au Yong, Faff and Chalmers, 2009], the role of country level regulations has yet to be examined.

This is surprising for at least two reasons. First, interest rate risk, a by-product of the maturity transformation role provided by banks, remains a crucial determinant of bank solvency. Its significance has been recently articulated by the Basle Committee of Banking Supervision[5] and re-emphasised in the 2007 industry survey conducted by the International Financial Risk Institute and Institute of Chief Risk Officers (IFRI-CRO, 2007). This report declares interest rate risk as being the most important source of banks' market risk and, after credit risk, the second most significant source of risk for institutions' capital adequacy. Accordingly, as its relevance becomes increasingly noticeable, practitioners and regulators alike more than ever recognise the need for identifying standardised determinants of interest rate risk and assessing their applicability under diverse regulatory conditions.

Second, banks manage their interest rate exposure by altering the composition of nominal assets and liabilities on the balance sheet or using off-balance sheet instruments. However, the composition of both balance and off-balance sheet portfolios is commonly influenced by regulatory provisions. This influence is either direct, through regulatory incentives, or indirect, through banks exploring opportunities for regulatory arbitrage. As a result, bank interest rate exposures should be influenced by country specific regulatory provisions. Accordingly, the present study seeks to fill this major gap in the literature, analysing an international sample of banks during the period 1997-2008.

The role of interest rate risk in banking stability becomes particularly important in light of the regulatory actions undertaken by authorities in response

[4] See for instance Madura and Zarruk (1995), Oertmann, Rendu and Zimmermann (2000).
[5] See Chapter 1 and 2 for more details.

to the recent financial crisis. While aiming to contain the crisis from spreading and to enhance the flow of credit in the economy, the aggressive policy of reducing interest rates could adversely impact banking performance in the long run[6]. For instance, in a low interest rate environment, depositors would favour rather short-term investment horizons due to the expectations of higher rates in the near future. On the asset side, debtors might favour fixed-rate longer-term financing lines to lock-in the lower chargeable rates. Accordingly, should rates increase in the future[7], financial institutions may once again discover themselves in an unfavourable predicament and find it difficult to finance long-term (potentially fixed-rate) assets with short-term, possibly expensive, deposits.

Even if banks' assets are favourably placed to yield adjustable rates, their credit quality is likely to deteriorate as rates rise[8]. In this respect, the practice of bilaterally irresponsible lending and borrowing over the preceding decades resulted in the expansion of the household debt to unsustainably high levels. This potentially imposes further deterioration in the asset quality as the economic recession progresses. Moreover, as the property bubble has burst, many households find themselves in negative equity. This situation provokes a rise in the level of defaults. For example, as estimated in recent research by Hellebrandt, Kawar, Waldron (2009) of the Bank of England, approximately 7-11% of households in the UK were in negative equity in the Spring of 2009. A similar statistic is reported for the US by First American Home CoreLogic which tracks data on 90 percent of mortgage loans nationwide. As of June 2009, nearly15.2 million mortgages (32.2 percent of all mortgaged properties) in the US were in negative equity position.

Besides, net interest margins have declined over the last decade forcing banks to exploit alternative non-interest income sources (Beck and Demirgüç-Kunt, 2009). However, the depressed economic environment associated with the recent crisis has put immense pressure on these types of revenue, best characterised as being cyclical and highly correlated with GDP growth (Stiroh, 2004b). As a result, bankers have been compelled to rely on the traditional intermediary

[6] Notably, in many countries such aggressive monetary policy actions have been undertaken as only a part of a comprehensive stabilisation programme. The government in the US and many European countries have undertaken extraordinary measures of extending blanket guarantees, ensuring liquidity and credit provision, and establishing structured bail-out programmes.

[7] The Bank of Israel was the first central bank to raise the benchmark interest rate by a quarter of a percentage point on 24 August, 2009. This move was shortly followed by Norway's central Bank, the Reserve Bank of Australia, and the European Central Bank, with latter raising the benchmark rate by a quarter percentage point (from 1% to 1.25%) in April 2011.

[8] Large interest rate increases may hinder the ability of borrowers to repay variable rate loans. Drehmann, Sorensen and Stringa (2006) discuss in detail the link between interest rate and credit risks.

sources of income and hence pay closer attention to interest rate risk.

Furthermore, in the midst of the crisis, financial institutions are forced to compete for depositors' cash sending saving account rates to levels above the base rate, and often exceeding the mortgage rates offered to customers. Considering for example the United Kingdom, according to the author's calculations[9], in August 2009 the average spread between interest rates charged on a 5-year fixed-rate mortgage product and paid on a 5-year savings bond was in a region of -0.20 percent, based on three relevant products. The spreads for a similar 3- and 2-year products were 0.9 and -0.36 respectively. Similarly, the average spread between the interest charged on the base-rate tracker mortgage and the interest offered on the instant access account was estimated to be -0.07 percent, based on offers from five financial institutions. Even after taking into account the fixed-term incentives commonly attached to the high yielding instant access accounts, such statistics raise concerns regarding the banking sector stability at least in the short run.

Motivated by the arguments above, this research attempts to identify and examine the underlying sources of bank interest rate risk, and to assess the direct influence of bank regulation on bank risk taking. Specifically my work contributes to the literature in three ways.

First, my research provides a robust analysis of the factors affecting financial intermediaries' susceptibility to interest rate risk. Both company and market specific information is considered in the analysis. The former comprises conventional financial ratios readily observable from corporation accounts. The latter accommodates country-specific macroeconomic characteristics and factors representing qualitative knowledge of country bank regulations and institutional development. As mentioned above, the majority of the empirical papers in this area have largely discounted the regulatory characteristics in analysing risk taking behaviour of individual banks. Despite this oversight an understanding of such relations is of relevance as: (a) the heterogeneity in cross-country regulatory characteristics and market discipline may affect bank risk management practices, and alter the relation between accounting and capital market measures of risk; and (b) given that country-specific regulatory provisions drive banks' risk taking, the likelihood of moral hazard under a particular regulatory framework can be assessed and recommendations provided.

Second, this study employs an extensive selection of countries unlike previous works which focused on the US market. To assess the underlying determinants

[9] The calculations are based on the publically available market data reported by Moneysupermarket Financial Group at http://www.moneysupermarket.com

of interest rate risk, this study covers the G-10 countries as well as other important regions of Asia (Hong Kong) and the Pacific Rim (Australia). Focusing on these extra markets is crucial since: (a) the current global financial crisis has emphasised the need for a set of standardised risk measures applicable across countries; (b) firms' risks might be determined by market specific factors due to the heterogeneous legal structure and regulatory constraints prevailing across the countries; and finally (c) it allows to assess the extent to which the findings for the US firms hold in another major market.

Furthermore, since the analysed period spans 1997-2007, this study also tests the validity of any reported relationships in a time period that encompasses unambiguously bullish and bearish trends, the pivot of which is commonly set at March 2000.

I use a multi-factor GARCH framework to measure banks' interest rate risk. This is primarily motivated by the observation of significant ARCH and GARCH effects suggesting the presence of time-varying distributions of banks' stock returns[10]. To address the statistical relevance of the proposed risk determinants, this study utilises a panel data methodology, with controls for time, country, and institutional heterogeneity.

This chapter is structured as follows: Section 3.2 introduces a set of testable hypotheses along with a brief survey of existing literature. The dataset and research methodology employed are outlined in Section 3.3. The empirical results are discussed in Section 3.4, with Section 3.5 presenting the conclusions reached.

3.2 Literature review and hypotheses formulation

This section presents a brief survey of empirical studies, guiding us to identify risk determinants and relevant research hypotheses. Seven testable hypotheses are formulated to address the research key objectives. An in-depth description of selected variables, as well as a discussion regarding their suitability and nature of expected relationships is presented in Section 3.3.1. A more rigorous statistical discussion is deferred until Section 3.3.2.

The rise of media attention to interest rate risk can be traced back to the 1980s. That decade is best defined as a period of high and volatile interest rates which caused a significant number of financial intermediaries severe distress to the point of insolvency in large numbers. The most representative example of such

[10] The use of GARCH framework is supported by Elyasiani and Mansur (1998, 2003, 2005), Flannery, Hameed and Harjes (1997), Ryan and Worthington (2004), Brewer, et al. (2007), among others.

systemic banking failure due to inappropriate asset-liability management is the US Savings & Loan crises. Since then, the study of interest rate risk is an ongoing research avenue for academics, practitioners and regulators. Researchers are particularly interested in the topic since the matter has wide-ranging repercussions on the implementation of monetary policy, portfolio selection, risk management and pricing of a wide range of financial instruments. This interest has led to the development of a substantial literature that studies the interest rate sensitivity of financial companies.

In contrast, there is a shortage of studies examining the underlying determinants of bank interest rate risk, and the reasons why their risk sensitivities vary across time, institutions and markets.

The work done to date addressing this issue generally falls within two categories. The first group of studies takes its origins from the "nominal contracting hypothesis"[11] introduced by Kessel (1956) and French, Ruback, and Schwert (1983). The "nominal contracting hypothesis" is based on the Samuelson-Hicks Duration Theorem discussed in Chapter 1. Works in this category embrace the relevance of asset-liability maturity and duration mismatches to the interest sensitivity of bank stock returns, thus giving rise to the so-called "maturity mismatch hypothesis".

Analysing the behaviour of 67 US based commercial banks over 1976-1981, Flannery and James (1984b) utilise the measure of the maturity mismatch between banks' assets and liabilities maturing or being repriced within one year. The resulting measure is reported to be highly significant in explaining the interest rate sensitivity in the cross-section of analysed banks. These results are corroborated by Kwan (1991) employing the Flannery and James model in a random coefficient approach. Analogously, Drakos (2002) provides further evidence in support of the nominal contracting hypothesis. The author reports that Greek banks that maintain higher levels of working capital, defined as the difference between banks' current assets and liabilities, have higher interest rate risk. These findings are refuted by Saporoschenko (2002), who concludes that the maturity gap is unable to explain the interest rate exposures of Japanese banks.

Despite its popularity, this approach is not without problems for two reasons. First, there may be difficulties associated with constructing consistent gap measures for the majority of banks owing to lack of data. Some assets and lia-

[11] The hypothesis states that equity returns of companies primarily holding nominal assets and liabilities will unavoidably be affected through the wealth redistributive effect from creditors to debtors caused by unanticipated inflation and changes in expected inflation. Inflationary shocks would therefore benefit institutions with higher levels of nominal liabilities than assets.

bilities also have theoretically ambiguous maturities and the accurate maturity gaps cannot be estimated. Second, the maturity mismatch hypothesis assumes no relationships between interest rate and credit risks, leading to a severe underestimation of the analysed exposure [Jarrow and Deventer, 1998; Drehmann, Sorensen, and Stringa, 2006]. Besides, recent trends towards banks' increased usage of alternative products to manage and adjust their risk exposures relaxed the correlation between banks' assets and corresponding liabilities (DeYoung and Yom, 2008). This suggests the banks' tendency to favour less restrictive forms of asset-liability management and undermines the relevance of the "maturity mismatch hypothesis".

The second group of studies relates the interest rate risk exposures to firm-specific financial characteristics. This chapter belongs to this group, with my work extending the scope of internal explanatory variables previously considered. Furthermore, I also evaluate how these firm level measures interact with key financial sector regulations in shaping bank exposure to interest rate risk. With this in mind, theoretical predictions are built upon the following bank- and country-specific characteristics.

3.2.1 Bank income structure

Fraser, Madura and Weigand (2002) argue that higher interest rates adversely impact economic growth and translate to lower revenues realised from banks' non-interest activities (e.g. investment banking operations such as IPOs and acquisitions). Their empirical results support this view. The authors show that banks generating a higher proportion of income through alternative non-interest revenue sources exhibit higher exposure to interest rate risk.

This evidence is consistent with other US studies affirming no major improvement in financial performance associated with increases in non-interest income [DeYoung and Rice, 2004a; Stiroh, 2004a,b; Stiroh and Rumble, 2006]. DeYoung and Roland (2001) highlight that a shift from traditional lending activities towards fee-generating income, in fact, amplifies the volatility of bank earnings.

Contrary to these results, analysing a sample of banking institutions in 15 EU countries over 1994-1998, Smith et al. (2003) find that increased reliance on non-interest sources of revenue has stabilised profits for the majority of examined firms. Likewise Smith et al. (2003) and Chiorazzo, Milani and Salvini (2008) report that income diversification substantially improves the risk-adjusted performance of Italian banks over 1993-2003, with smaller institutions benefiting the most. The authors also suggest that the level of non-interest income is far more important that its source.

Interestingly, Fraser, Madura and Weigand only relate interest rate risk to banks' levels of non-interest income. They fail to address the effect of rate shocks on firms' traditional, interest generating income. Since, however, interest rate risk commonly arises as a result of the mismanagement of banks interest sensitive assets and liabilities, I stress the inappropriateness of such selective treatment.

In particular, I emphasise that in the presence of an efficient interest rate pass-through mechanism, monetary policy shocks can affects the revenues streaming from traditional intermediation activities due to potential deterioration in the quality of credit portfolio and reduced interest margins. Accordingly, banks relying more on traditional interest revenues should also bear higher level of interest rate risk.

Based on these conflicting arguments, and disagreement between the above works analysing US and European based institutions, I infer that it is the degree of revenue diversification, rather than levels of a particular income source that determines the extent of risk exposure. The activities that generate non-interest income are imperfectly correlated with those generating interest revenues. Therefore, with rising interest rates, the diversification of revenue sources should help stabilising operating income and give rise to a more stable stream of profits. Accordingly, the first testable hypothesis is as follows:

Hypothesis$_1$: *Banks maintaining a higher degree of revenue diversification face lower interest rate risk*

3.2.2 Bank equity capital

Another important driver of bank riskiness, frequently mentioned in the empirical literature, is the level of bank equity capital. The equity capital ensures bank liquidity and solvency in adverse market conditions. It also serves to reduce owners' incentives for excessive risk taking. If a financial institution had excessively high debt levels (high leverage), managers and equity holders would have only a weak incentive to monitor risk taking exploiting the risk-shifting benefits of deposit protection.

On the other hand, as argued by Demsetz and Lehn (1985) managers with private benefits of control will most likely behave in a risk-averse rather than value maximising way. Sullivan and Spong (2007) also demonstrate the appropriateness of modelling bank risk aversion as a function increasing with the proportion of shareholders' and managers' wealth at risk. Anderson and Fraser (2000) empirically support this view for the US bank holding companies in the early 1990s, reporting a negative relationship between managerial holdings and bank risk taking[12].

Fraser, Madura and Weigand (2002) and Au Yong, Faff and Chalmers (2009) demonstrate that banks with stronger capital positions assume less interest rate risk. Evidence reported by Kwan and Eisenbeis (1997) suggests that only small banks benefit in a meaningful way from maintaining higher capital levels. Johnson and Madura (2002) analyse the exposure of the US insurance companies to both interest rate and real estate risks, and fail to relate the uncovered risk exposures to the companies' level of capital. In a similar vein, findings of Ballester, et al. (2009) imply the statistical irrelevance of capital ratios to explaining the risk exposures of Spanish banks.

Based on the discussed evidence, I formulate the next testable hypothesis with three key arguments in mind.

First, despite the conflicting results I argue that the level of equity capital remains one of the most important factors in explaining banks' interest rate risk for at least two reasons: (a) given the possibility of increased credit risk following the interest rate shock, the higher levels of capital readily available to absorb losses on the loan book can help managers to prevent bank runs and sudden sell-offs; and (b) to the extent that equity capital itself is not-interest rate sensitive, firms with higher capital levels are less sensitive to interest rate shocks.

Second, I acknowledge the empirical studies reporting that the relationship between bank capital and risk is not necessarily linear, but rather U shaped [Calem and Rob, 1999; Haq and Heaney, 2008]. In these works, the authors suggest that both undercapitalised and well capitalised banks are generally riskier than those with intermediate levels of capital. These arguments are based on the view that banks with insufficient capital pursue moral hazard risk taking. Well capitalised institutions, on the other hand, utilise excessive capital buffers in their exploration of profitable, yet frequently riskier prospects.

Finally, I hypothesise that risk-capital relationships are more pronounced in countries with debtholders not explicitly protected by deposit insurance, and thus higher standards of market discipline and risk monitoring. In these markets, managers are forced to maintain equity capital at levels corresponding to the expected risk exposures. This allows banks to easily observe unanticipated interest rate shocks, yielding lower interest rate exposures[13]. Contrary, insured depositors

[12] Despite this evidence, studies analysing banks' response to the introduction of risk based capital standards provide no evidence to suggest a shift towards reduced risk-taking [Berger and Udell, 1994; Hancock and Wilcox, 1994].

[13] Based on the analysed dataset, the median values for ratios of equity capital in markets with and without explicit deposit insurance are 0.055 and 0.079 respectively. The t-statistics

have only weak risk monitoring incentives, and the link between risk and capital weakens. On the basis of the discussion so far, the following augments the set of testable hypotheses:

Hypothesis$_2$: *The relationship between bank capital and interest rate risk is non-linear.*

Hypothesis$_3$: *The relationship between bank capital and interest rate risk depends on the national provision of deposit insurance..*

3.2.3 Bank balance sheet composition

Empirical studies have also related interest rate risk to the quality and structure of banking loans and deposits. Fraser, Madura and Weigand (2002) recognise that banks with higher loan-to-asset ratios and the ones financing a larger proportion of their assets with demand deposits have less interest rate risk. Nonetheless, the former contradicts the findings of Ballester et al. (2009). The authors argue that since the maturity of loans generally exceeds the one of corresponding liabilities, the higher proportion of such assets would imply a greater asset-liability maturity mismatch in the banking book. This will translate into higher interest rate risk.

In line with Fraser, Madura and Weigand (2002) I predict a negative relationship between the level of low cost liabilities and banks' interest rate risk. This is because customer deposits represent a relatively cheap and stable source of funding.

With regards to the loans-to-assets ratio I recognise that the majority of bank loans are floating rates and frequently repriced. Therefore, in the long run, the interest rate margins are preserved yielding lower exposure to interest rate risk. The specialised commercial banks will enjoy a greater reduction in their risk exposure due to their strict asset-liability management practices and well established interest rate transmission mechanism.

On the other hand, in the short run, following the interest rate increase, such relationships may revert depending on other factors such as bank exposure to credit risk. For instance, any interest rate shocks passed on to customers will alter the credit quality of loan portfolios in the short run. This will offset the benefits introduced by the efficient repricing mechanisms. Accordingly, a bank with greater initial exposure to credit risk is expected to have higher interest rate

representing the relevant one-tailed t-test with the null hypothesis stating the equality of two measures is 12.103 with a heteroskedastic consistent p-value based on White's robust standard error being (0.000). This leads to rejection of the null hypothesis.

exposures. Such a proposition is also empirically supported by Jarrow and Turnbull (2000) and Drehmann, Sorensen, and Stringa (2006) reporting that credit and interest rate risks are correlated and this interrelation should be appropriately accounted for. Provided these arguments I formulate the following hypotheses:

Hypothesis$_4$: *Banks with a higher proportion of repriced assets and low cost liabilities assume lower interest rate risk.*
Hypothesis$_5$: *The relationships in Hypothesis 4 depend on the banks' credit risk exposure and specialisation.*

Furthermore, banks' uninsured liabilities (e.g. interbank deposits which are not commonly covered by the protection scheme and subordinated debt) are widely recognised as robust measures of market disciplinary effect (e.g. Morgan and Stiroh, 2001). Therefore, insured and uninsured deposits merit a separate treatment under Hypothesis 4.

3.2.4 Off-balance sheet composition

The evidence presented in the literature is mixed with respect to a bank's off-balance sheet activities. Hirtle (1997) and Choi and Elyasiani (1997) associate the use of derivatives with greater interest rate exposure. Chaudhry and Reichert (1999) on the other hand dispute these results. The authors suggest that higher rate risk is only due to the interest rate options, while interest rate swaps are mainly used for hedging. This evidence is later extended to foreign exchange derivatives (Chaudhry et al., 2000), and further reconfirmed by Reichert and Shyu (2003) who analyse an international sample of banks. Brewer, Jackson and Moser (1996) affirm a negative association between risks and derivative usage of Savings & Loan corporations.

More recently, a study of Asia-Pacific banks by Au Yong, Faff and Chalmers (2009) reports a positive association between the level of banks derivative activities and their exposure to the shocks in the long-term interest rates. The association is negative for the short-rate exposure. The former is supported by Haq and Heaney (2009). The latter, however, contradicts Ballester et al. (2009) who relate the level of banks' off-balance sheet activities to greater interest rate exposure once short-term rates are considered. To draw on firms' off-balance sheet composition, the last two studies [Haq and Heaney, 2009; Ballester et al., 2009] utilise the BankScope database which provides no specific classification of banks' derivative activities. Further, this database is predominated by information on contingent liabilities.

In this respect, banks' contingent liabilities, and in particular banks' loan commitments, deserve meticulous attention in the question of interest rate risk. For instance, in a volatile interest rate environment beneficiaries would seek to exercise their lawful rights on the terms favourable to them but not to banks. Hence, bank risks are likely to peak due to: (a) reduced interest rate margins as per increasing funding costs (e.g. because of basis, or yield curve risks); and (b) the decline in the borrowers' creditworthiness during these periods.

From a theoretical viewpoint, the presence of loan commitments is likely to augment the institution's credit risk due to the presence of adverse selection and moral hazard problems. Using the information deficiency, the borrower is free to favour riskier projects yielding higher potential returns (moral hazard). On the other hand, it is possible that a riskier borrower will get a loan that would not be granted in the spot market (adverse selection). These theoretical relationships are validated by Angbazo (1997) reporting a positive association between bank letters of credit and interest rate risk.

On the contrary, Avery and Berger (1991) argue that the projects financed via loan commitments or in the spot market can be very different. The lenders commonly adopt the rationing or sorting processes aiming to link commitment contracts with safer borrowers. They examine the relationship between the banks' risk and loan commitments using a sample of approximately 125 US banks over the 1975 to 1986 period, and suggest that loan commitments are associated with "no or very little real risk to banks". The authors further point that "banks' rationing or sorting of relatively risky borrowers out of commitment contracts offset the risk created by commitments".

In the light of this contradictory evidence the relationship between banks' off-balance sheet activities and their interest rate exposure is ambiguous. However, I hypothesise that because the existence and design of deposit protection schemes significantly alters the moral hazard risk-taking behaviour of banks, the motivations for derivative usage should differ across markets. The financial institutions in markets with explicitly adopted deposit protection scheme are more likely to use derivatives for speculating. The banks lacking such explicit protection, and the ones forced to share the costs of insolvency by providing some forms of explicitly specified risk-based premiums, would rather use derivatives for hedging. Based on this argument the next testable hypothesis is formulated in general form:

Hypothesis$_6$: *Banks' off-balance sheet activities significantly affect their exposure to interest rate risk.*

3.2.5 Country macroeconomic and regulatory characteristics

Finally I argue that bank risk exposure is also attributed to the market specific regulatory constraints and requirements. The quality of industry surveillance and supervision has long been recognised as a key driver of institutions' profitability and risk taking. The most prominent factors acknowledged by the existing literature include liquidity and diversification requirements, the deposit protection provision, accounting and information disclosure constraints, and the quality of the political and court system.

In this respect, many researchers report significant shifts in banks' interest rate sensitivities associated with various regulatory events[14], such as the introduction of new or amendment of existing requirements. Surprisingly, none of the studies to date has explicitly considered the role of the market specific regulatory environment in workhorse models of interest rate risk.

There are just a few notable works recognising the impact of cross-country differences in regulations on bank performance. Bartholdy, Boyle and Stover (1997) consider a sample of 13 OECD countries over 1985-1990 and find that the existence of explicit deposit insurance lowers the deposit interest rate by 25 basis points. Barth, Nolle and Rice (1997), using a sample of 19 developed countries, examine the impact of banking powers on bank returns on equity while also controlling for a number of bank and market characteristics. They report that neither explicit deposit insurance and bank concentration, nor variation in banking power significantly influence the returns on bank equity. Later, analysing a comprehensive sample of banks across 80 developed and developing countries over 1988-1995, Demirgüç-Kunt and Huizinga (1998) report that both the market financial structure as well as legal and institutional settings have a significant impact on the banks' profitability and interest margins. Their study concludes by reporting a positive association between foreign ownership, banks profitability and interest margins. This association is more pronounced in developing countries. The authors also find that indicators of better contract enforcement, efficiency of legal system and lack of corruption are also associated with lower realised interest margins and lower profitability. Further, they report that government regulations, such as the design of deposit insurance schemes significantly affect bank margins.

In this respect, the importance of the deposit insurance design to the stability of the banking sector has been meticulously scrutinised with voluminous literature

[14]See Madura (2000), Neuberger (1991), Brooks and Faff (1995), and Faff and Howard (1999) for relevant discussions and empirical findings.

available. It is commonly agreed that deposit guarantee schemes have two adverse effects. On the one hand, they boost public confidence in the safety of their funds thereby reducing the likelihood of bank runs and ensuring sound functioning of the economy. On the other hand they reduce the depositors' incentive to monitor banking risks. It has been well established both theoretically and empirically that risk insensitive deposit-protection schemes provide both depositors and bank managers with moral-hazard incentives to accept greater asset risk, thus gambling with taxpayers' money.

Analysing a sample of the US Texas based banks over the period 1919-1926, Hooks and Robinson (2002) conclude the likelihood of failure of the deposit insured banks exceeded that of the banks not covered by the protection scheme. The substantial costs of moral hazard are also evident from the US Savings & Loan crises, the banking problems of the Scandinavian countries, the crises in Japan, Korea and other Asian countries, as well as the recent financial turmoil of 2007-2010. While moral hazard alone was not the only factor at work in these crises, it nonetheless severely amplified the resolution costs in each case.

As it was mentioned in the introduction, one way to reduce the problem of moral hazard, and to minimise the likelihood of irresponsible behaviour by banks and depositors, is to set the amount of protection coverage at a moderate level. Another way is to charge insurance premiums on the basis of explicit risk assessment, or even to introduce coinsurance requirements with explicit coverage caps placed on the deposit account balances. This, in turn, would provide depositors with an incentive to police bank risk-taking and, if carefully designed, to reduce the likelihood of bank runs. Accordingly, one would expect the risk levels to be lower for countries recognising some of these or similar measures[15].

At the same time, any explicit form of deposit insurance has shown to decrease the degree of private market discipline that banks experience (Demirgüç-Kunt and Kane, 2002). Therefore, I argue that the risk exposure is greater in countries adopting the explicit form of deposit insurance scheme. Even higher risks are expected in countries with greater coverage limits and poor quality of legal institutions[16]:

[15] For example the deposit insurance fees charged to banks vary based on the assessment of risk in Belgium, Canada, France, Hong Kong, and Italy, while no such assessment is in place in Germany, Japan, Spain, Sweden, Switzerland and the UK

[16] Demirgüç-Kunt, Kane and Laeven (2008) demonstrate that in countries with poor quality of legal institutions, the potential for corruption is significantly greater. Therefore, it can be argued that the design, particularly coverage and imposed risk controls, of deposit insurance schemes may well be influenced by corrupt regulators serving the interests of bankers rather than the interests of the public.

Hypothesis$_7$: *Bank interest rate risk is influenced by the country-specific regulatory characteristics.*

Empirical research to date has also advocated a number of macroeconomic variables as determinants of banks risks [Kaminsky and Reinhart, 1999; Caprio and Klingebiel, 1997], profitability [Demirgüç-Kunt and Huizinga, 1998; Flamini, McDonald, and Schumacher, 2009; Albertazzi and Gambacorta, 2009], and interest rate margins (Chirwa and Mlachila, 2004). Evidence drawn from these works suggests a positive correlation between banks' profitability and the business cycle, and a negative correlation with inflation and exchange rate depreciation. For instance, in times of stagnated economic growth the riskiness of financial intermediation increases. This occurs because of adverse selection and moral hazard behaviour of individual borrowers, higher agency costs, eroded fee-generating revenue sources, and interest margins associated with low base rates. Accordingly, I expect the market specific macroeconomic environment to affect the structure and quality of the banks' balance sheets thus driving risk sensitivities. For this reason these factors are also included in the model framework.

To improve the fit of the empirical model I also include a number of bank- and industry-level control variables. These variables are thoroughly discussed in the following section.

3.3 Data and methodology

This study utilises a large data sample consisting of 289 financial intermediaries from 13 major financial markets. These include the member countries of the Basel Committee of Banking Supervision and other important regions of Asia (Hong Kong) and the Pacific Rim (Australia). The complete list of FIs with the corresponding market distribution is available in Appendix 3.1.

The requisite financial data are obtained from the BankScope, Bloomberg, DataStream, and WorldBank databases. The key requirement for the data collection is that there are at least three banks for each market, each with annual balance sheet and weekly share price data being continuously available from January 1997 to December 2007.

3.3.1 Data analysis

For each bank in the sample, the returns are calculated as the weekly logarithmic first difference transformations of Wednesday stock prices. The choice of the weekly sampling interval is justified in Chapter 2. The calculated return series are then used as dependent variable in the empirical model which is described later in this section. The descriptive statistics on the banks' weekly returns are available upon request.

The market portfolios are proxied by the broad domestic value-weighted equity market indices for each country in the sample. The necessary market data are obtained from Bloomberg Professional database, with the return series calculated in the same manner as for banks. The indices used are listed in Appendix 2.1.

As regards to interest rates, Chapter 2 demonstrates that the results may be biased to the choice of interest rate proxy. Accordingly, I employ four interest rate variables: short- and long-term interest rates; interest rate term spread; and the variable proxying the curvature of the interest rate yield curve. The first two variables are represented by the first difference in the market yields of two sovereign bonds with short- and long-term maturities respectively. These are obtained from the Bloomberg database for each market in the sample. The interest rate term spread is calculated as the difference between long-term and short-term interest rates. The yield curve curvature is estimated via the Diebold and Lee parameterisation of the Nelson and Siegel (1987, 1988) model discussed in detail in Section 2.2.2 of Chapter 2.

Sensitivity tests of banks' returns to the interest rate movements are performed using all four aforesaid interest rate proxies interchangeably. The use of these particular measures helps directly to identify the patterns in risk exposure across the whole term structure.

The first set of hypotheses (H_1-H_6) examines the underlying sources of banks' interest rate risk with respect to the company-specific financial characteristics. Hypothesis 7 examines the relevance of country specific regulatory and macroeconomic conditions. To this end, two groups of variables are constructed accordingly.

The first group of fundamental determinants consists of financial ratios separated into four categories as per the formulated hypotheses: (1) diversification, (2) capital adequacy, (3) asset-liability structure, and (4) off-balance sheet composition. The variables in each category are constructed based on the fiscal year-end information from the company public accounts, compiled by Bureau van Dijk and extracted from the Banksope database.

The second group consists of factors related to the structure and quality of the regulatory framework and macroeconomic environment. I consider the following six categories: (1) design of deposit insurance, (2) capital adequacy, diversification and liquidity requirements, (3) information disclosure, (4) political stability and regulatory quality, (5) financial development and economic freedom and (6) general macroeconomic indicators.

The final set of variables in each category and pertinent statistics are presented in Tables 3.1 and 3.2 respectively, and discussed below. Table 3.3 also reports the pairwise correlation between the independent variables.

Firm level financial structure

The first category of financial variables contains a set of revenue diversification ratios, constructed to test Hypothesis 1. I measure income diversification by employing the modification of the Hirschman Herfindahl Index originally proposed by Laeven and Levine (2007):

$$\text{ROID} = 1 - \left| \frac{\text{Interest income} - \text{Non-interest income}}{\text{Total operating income}} \right| \tag{3.1}$$

The index assumes values between 0 and 1, with 1 suggesting the highest degree of income diversification with different revenue sources yielding equal proportion of total revenue; and 0 implying bank concentration in a single revenue generating activity. I expect this measure to be negatively related to interest rate risk proxies, in support of the income diversification hypothesis and in line with Smith et al. (2003) and Chirazzo, Milani and Salvini (2008). To check my results for robustness, I also use a number of alternative measures. These include the ratio of non-interest income to the total operating revenues, denoted as (NOIR); and the ratio of net-interest to total operating income (NITR). Table 3.2 provides pertinent descriptive statistics for the outlined variables, while Figure 3.1 graphically represents the evolution in the levels of key revenue sources.

Generally, EMU based banks seem to better exploit diversification prospects as suggested by (ROID) measure. This is due to a comparatively larger proportion of non-interest income in the total operating revenues of these banks (NOIR), revealing their reliance on fee-based revenue sources. On the other hand, financial institutions in non-EMU countries seem to rely heavily on traditional intermediary activities. This is suggested by the ratio of net-interest to total operating income (NITR).

With respect to the indicators of bank capital adequacy, I follow the wide literature [Fraser, Madura and Weigand, 2002; Johnson and Madura, 2002; Au Yong, Faff and Chalmers, 2009; Ballester, et al., 2009] and compute the ratio of book value of equity capital to bank's total assets (CAP). To check the robustness of the CAP ratio I use a number of alternative proxies.

Table 3.1
Variables definition and data sources

This table presents variables considered in the research alongside their detailed definitions and the relevant data sources. All underlying variables are sourced from COMPUSTAT, BANKSCOPE, and WORLD BANK data. While the exact definition of all company specific financial variables is provided in Panel A below, Panels B and C present the macroeconomic and market specific regulatory variables respectively. The datasources are outlined in Panel D. All company specific financial variables in Panel A fall within five categories according to their specification and the effect they capture. These categories are Capital Adequacy; Asset Quality and Liquidity; Earnings, Efficiency and Profitability; Diversification; and Off-Balance Sheet Structure.

Panel A. Company Specific Financial Ratios	
Capital Adequacy	
CAP [Capital Ratio]	Equity Capital/Total Assets
TIER 1 [Tier 1 Capital Ratio]	Tier 1 Capital/Risk Adjusted Assets
TCA [Total Capital Ratio]	Total Capital [Tier 1 and Tier 2]/Risk Adjusted Assets
ETN [Ratio of Equity to Loans]	Equity Capital /Net Loans
ETD [Ratio of Equity to Short-Term Funding]	Equity Capital/(Cust. Dep. & Short-Term Funding)
Asset Quality and Liquidity	
LTA [Loan to Assets Ratio]	Net Loans/Total Assets
LCL [Low Cost Liabilities]	Customer Deposits/Total Deposits
LPTL [Loan Loss Provision to Net Loans]	Loan Loss Provision/Net Loans
LPTA [Loan Loss Provision to Assets]	Loan Loss Provision/Total Assets
LOLR [Loan Loss Ratio]	Net Charge-offs/Net Total Loans
TDNL [Intermediation Ratio]	Total Deposits/Net Total Loans
TDTA [Total deposits to total assets]	Total Deposits/Total Assets
TDTL [Total deposits to total liabilities]	Total Deposits/Total Liabilities
BDTD [Bank deposits to total deposits]	Bank Deposits/Total Deposits
UDTD [Bank's market discipline]	Bank Deposits+Subordinated Debt/Total Deposits
EITA [Proportion of Equity Investment]	Equity Investments/Total Assets
OETE [Other earning assets to total earning assets]	Other Earning Assets/Total Earning Assets
OETA [Other earning assets to total assets]	Other Earning Assets/Total Assets
SLLA [Short-term Liabilities to Liquid Assets]	(Deposits & ShortTerm Funding-Cust. Deposits)/Liquid Assets
BDCD [Bank Deposits to Customer Deposits]	Bank Deposits/Customer Deposits
LATA [Proportion of Liquid Assets]	Liquid Assets/Total Assets
DBDB [Interbank Ratio]	Due from Banks/Due to Banks
LASF [Deposit Run-off Ratio]	Liquid Assets/Deposits & Short-Term Funding
NLSF [Net Loans to Short-Term Funding]	Net Loans/Deposits & Short-Term Funding
DDTF [Low cost funding]	Total Deposits/Total Funding
COFU [Cost of Funds]	Interest Expense/Total Funding
ALER [Average Lending Rate]	Interest Income/Total Earning Assets
Earnings, Efficiency and Profitability	
NIM [Net Interest Margin]	Net Interest Income/Total Earning Assets
LTEA [Loans to total earning assets]	Net Total Loans/Total Earning Assets
CTI [Cost to Income Ratio]	Overheads/(NII + Other Operating Income)
ROAA [Return on Assets]	Net Income/Total Assets
ROAE [Return on Equity]	Net Income/Total Equity
BTTA [Profit before tax to total assets]	Before Tax Profit/Total Assets
PEOX [Personnel Expenses to Operating Expense]	Personnel Expenses/Total Operating Expense
Diversification	
SIZE [Value of bank's total assets]	log(Total assets)
NOIR [Proportion of non-interest income]	Non-interest Income/Total Operating Income
NOIN [Non-interest income to Net income]	Non-interest Income/Net Income
NOIT [Non-interest income to Total Assets]	Non-interest Income/Total Assets
NITR [Proportion of interest income]	Net interest Income/Total Operating Income
ROID [Income Diversity]	$1-\lvert(\text{NetInt Inc.} - \text{NonInt. Inc})/\text{Total Oper. Income}\rvert$
HERF [Herfindahl Index]	$1-[(\text{Inter. Income/TOR})^2 + (\text{Fee Income/TOR})^2 + (\text{Trading Income/TOR})^2 + (\text{Other Income/TOR})^2]$ TOR = Inter. Inc. + Fee Inc. + Trad. Inc. + Other Inc.
ROAD [Asset Diversity]	1-|(Net Loans-Other Earning Assets)/Tot. Earn. Assets|
Off–Balance Sheet Activities	
CLTA [Contingent Liabilities to Total Assets]	Total Contingent Liabilities/Total Assets
CLTL [Contingent Liabilities to Total Loans]	Total Contingent Liabilities/Total Loans

Panel B. Macroeconomic Variables		
M˙GGDG	[GDP growth]	Growth rate of nominal GDP adjusted for inflation
M˙GGDC	[GDP-per-capita growth]	Growth rate of nominal GDP – per – capita
M˙INFL	[Inflation]	Annualised change of the CPI index
GRCR	[Real credit growth]	Annual real credit growth
M˙UNEM	[Unemployment]	Country total unemployment as % of tot. labour force
M˙EXCI	[Exchange rate]	Real effective exchange rate index (2000=100)
M˙BCGD	[Credit to private sector]	Domestic credit provided by banking sector/GDP
Panel C. Market Specific Variables		
DELO	[English legal origin]	Dummy for counties with English legal origin
DFLO	[French legal origin]	Dummy for counties with French legal origin
DGLO	[German legal origin]	Dummy for counties with German legal origin
DSLO	[Scandinavian legal origin]	Dummy for counties with Scandinavian legal origin
D˙LAW	[Civil law legal origin]	Dummy for counties with civil law legal origin
RIGHT˙REG	[Creditors rights]	Ranges from 0 to 4 based on (yes=1, 0=no): (1) the country imposes restrictions, such as creditors' consent laws or minimum dividends to file for reorganization; (2) secured creditors are able to gain possession of their security once the reorganization petition has been approved (no automatic stay); (3) secured creditors are ranked first in the distribution of the proceeds that result from the disposition of the assets of a bankrupt firm; (4) the debtor does not retain the administration of its property pending the resolution of the reorganization.
INF˙REG	[Information disclosure]	The ratio of information disclosure ranges between 0 and 13 and is based on the following questions (yes=1, 0=no): (1) Does accrued, though unpaid, interest/principal enter the income statement while the loan is still non-performing? (2) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries (including affiliates of common holding companies)? (3) Are off-balance sheet items disclosed to the public? (4) Must banks disclose their risk management procedures to the public? (5) Are bank directors legally liable if information disclosed is erroneous or misleading? (6) Have they been enforced in the last 5 years? (7) Is an external audit a compulsory obligation for banks? (8) Are auditing practices for banks in accordance with international auditing standards? (9) Is it required by the regulators that bank audits be publicly disclosed? (10) Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? (11) Are external auditors legally required to report to the supervisory agency any other information discovered in an audit that could jeopardize the health of a bank? (12) Can supervisors take legal action against external auditors for negligence? (13) Has legal action been taken against an auditor in the last 5 years?
CAP˙REG	[Regulatory capital requirements]	The index of capital requirements is constructed based on the following set of questions (yes=1, 0=no): (1) Is this ratio risk weighted in line with the 1988 Basel guidelines? (2) Does the minimum ratio vary as a function of an individual bank's credit risk? (3) Does the minimum ratio vary as a function of market risk? (4) Does the minimum ratio vary as a function of operational risk? (5) Is there a simple leverage ratio that is required? Thus the ratio ranges between 0 and 5, with highest scores reflecting stringent capital requirements.
ACT˙REG	[Index of restricted activities]	The index ranges from 3 to 12 based on the following set of questions (unrestricted =1, permitted =2, restricted =3, prohibited =4): (1) What are the conditions under which

		banks can engage in securities activities? (2) What are the conditions under which banks can engage in insurance activities? (3) What are the conditions under which banks can engage in real estate activities? Higher scores reflect more restrictions.
DIV˙REG	[Diversification index]	The index assumes values between 0 and 5, based on (yes=1, 0=no): (1) Are there explicit, verifiable, and quantifiable guidelines regarding asset diversification? (for example, are banks required to have some minimum diversification of loans among sectors, or are their sectoral concentration limits)? (2) Are banks limited in their lending to single or related borrowers? (3) Are banks limited in their sectoral concentration? (4) Are banks required to hold either liquidity reserves or any deposits at the Central Bank? (5) Are banks allowed to hold reserves in foreign denominated currencies or other foreign denominated instruments?
DIS˙REG	[Index of banks discipline]	The index ranges between 0 and 13, based on (yes=1, 0=no): (1) Are there any mechanisms of cease and desist-type orders, whose infraction leads to the automatic imposition of civil and penal sanctions on the banks directors and managers? (2) Are bank regulators/supervisors required to make public formal enforcement actions, which include cease and desist orders and written agreements between a bank regulatory/supervisory body and a banking organization? (3) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? (4) Can the supervisory agency suspend the directors' decision to distribute dividends? (5) Can the supervisory agency suspend the directors' decision to distribute bonuses? (6) Can the supervisory agency suspend the directors' decision to distribute management fees? (7) Have any such actions been taken in the last 5 years? (8) Does the Banking Law establish predetermined levels of solvency (capital or net worth) deterioration which forces automatic actions (like intervention)? (9) Regarding bank restructuring and reorganization, can the supervisory agency or any other government supersede shareholder rights? (10) Can the supervisory agency or any other government remove and replace management? (11) Can the supervisory agency or any other government remove and replace directors? (12) Can the supervisory agency or any other government forbear certain prudential regulations? (13) Can the supervisory agency or any other government insure liabilities beyond any explicit deposit insurance scheme?
GDI˙REG	[Index of Generous Insurance]	The index ranges between 0 and 2, and is constructed based on following (yes=1, 0=no): (1) Is there an explicit deposit insurance protection system? (2) Is the county ratio of Deposit insurance coverage/GDP-per-capita ≥ median over all analysed countries (Deposit insurance coverage/GDP-per-capita) ratio?
SDI˙REG	[Index of Stringent Insurance]	The index assumes values between 0 and 2, with higher ratio reflecting more stringent deposit protection requirements imposed in the country. The index is calculated based on (yes=1, 0=no): (1) Do deposit insurance fees charged to banks vary based on the risk assessment? (2) Is there formal coinsurance, that is, are depositors explicitly insured for less than 100% of their deposits?

Note: The market specific regulatory variables are constructed based on La Porta et al. (1998), Kaufman et al. (2008), and the Heritage Foundation database. Individual questions and answers are from Barth et al. (2008), and the author's own calculations.

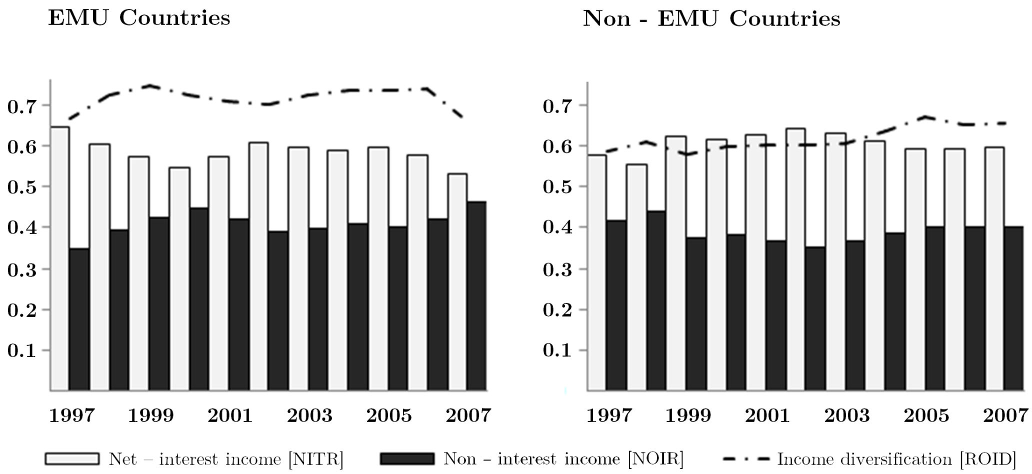
Panel D. Data Sources

Balance Sheet and Income Statement Items			
Banks Deposits	BankScope: Code 6060	Net Income	BankScope: Code 6815
Contingent Liabilities	BankScope: Code 7110	Net Trading Income	BankScope: Code 6620
Customer Deposits	BankScope: Code 6000	Net-Charge Offs	BankScope: Code 2150
Deposits & Short term fund.	BankScope: Code 2030	Other Operating Income	BankScope: Code 6630
Deposits with Banks	BankScope: Code 5350	Overheads	BankScope: Code 2090
Due from Banks	BankScope: Code 2180	Personnel Expenses	BankScope: Code 6650
Due to Banks	BankScope: Code 2185	Post Tax Profit	BankScope: Code 6800
Equity Investments	BankScope: Code 5530	Subordinated Debt	BankScope: Code 6210
Government Securities	BankScope: Code 5410	Tier 1 Capital Ratio	BankScope: Code 7040
Hybrid Capital	BankScope: Code 2160	Total Assets	BankScope: Code 5670
Interest Expense	BankScope: Code 6520	Total Customer Loans	BankScope: Code 5190
Interest Income	BankScope: Code 6510	Total Deposits	BankScope: Code 6080
Impaired Loans	BankScope: Code 2170	Total Earning Assets	BankScope: Code 2010
Liquid Assets	BankScope: Code 2075	Total Equity	BankScope: Code 6400
Loan Loss Provision	BankScope: Code 6690	Total Net Loans	BankScope: Code 5330
Loan Loss Reserves	BankScope: Code 5280	Total Operating Expense	BankScope: Code 6710
Net Commission Revenue	BankScope: Code 6560	Total Operating Income	BankScope: Code 6640
Net Fee Income	BankScope: Code 6590	Total Problem Loans	BankScope: Code 5240

Macroeconomic Data			
GDP Growth	World Bank	Unemployment	World Bank
Real GDP per capita Growth	World Bank	Exchange rate	World Bank
Inflation	World Bank	Credit to private sector	World Bank
Real Credit Growth	World Bank		

Country Specific Characteristics			
English legal origin	LaPorta et al. [2002]	Regulatory capital requirements	Barth et al. [2008]
French legal origin	LaPorta et al. [2002]	Index of restricted activities	Barth et al. [2008]
German legal origin	LaPorta et al. [2002]	Diversification index	Barth et al. [2008]
Scandinavian legal origin	LaPorta et al. [2002]	Index of banks discipline	Barth et al. [2008]
Civil law legal origin	LaPorta et al. [2002]	Index of Generous Insurance	Barth et al. [2008]
Creditors rights	LaPorta et al. [2002]	Index of Stringent Insurance	Barth et al. [2008]
Information disclosure	Barth et al. [2008]		

Figure 3.1
Key revenue sources



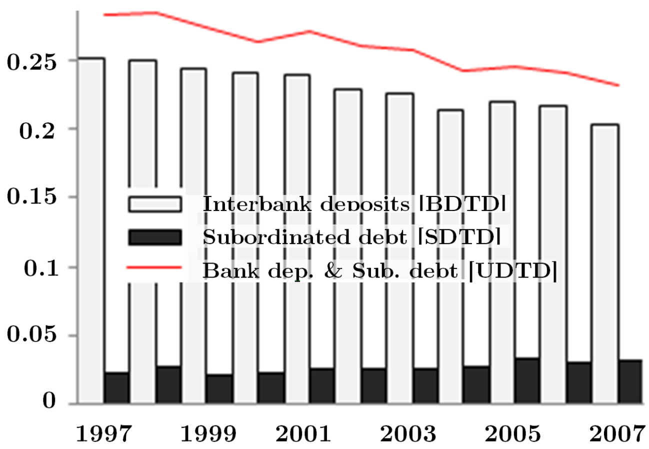
Source: Authors' calculations, based on the fiscal year-end financial information observable from bank financial accounts, compiled by Bureau van Dijk and extracted from the Banksope database for period 1997-2007.

This includes the Tier 1 (TIER) ratio defined as a fraction of Tier 1 bank capital in its risk adjusted assets; (TCAP) defined as the ratio of Tier 1 and Tier 2 capital to the bank's risk adjusted assets; and (ETNL) computed as the bank's equity capital to its net loans. Therefore, (ETNL) represents a bank's ability to cover unexpected losses on credit portfolio with uninsured private funds. As per Table 3.2, capital ratios just marginally differ across the countries. The average (CAP) value is around six percent.

The ratio of net total loans to total assets (LTA) serves as a measure of the bank's repriced assets and is used to address Hypothesis 4. As per Table 3.2, the proportion of loans in the banks' total assets is similar for both EMU and non-EMU firms and is at the level of 63 to 65 percent. Nonetheless, it seems that while non-EMU based banks mainly finance these loans with deposits, EMU based institutions utilise alternative financing sources and hence report higher ratio of net total loans to total deposits (TLTD). To proxy the bank's low cost liabilities I calculate the ratio of customer deposits to total deposits (LCL).

With respect to the banks' disciplinary effect, I compute the ratio of interbank deposits to total deposits (BDTD) and the ratio of subordinated debt to total bank's deposits (SDTD). The evolution of both measures is pictured in Figure 3.2 for cross-country averages, while Figure 3.3 presents the breakdown for selected aggregates. Both figures also show the aggregated measure of market discipline calculated as the ratio of uninsured interbank deposits and subordinated debt to

Figure 3.2
Uninsured deposits and subordinated debt



the total deposits (UDTD).

Both (SDTD) and (BDTD) are higher for EMU-based financial institutions indicating higher levels of market discipline in these markets. The lowest values are observed for countries lacking the explicit form of deposit protection scheme. The level of subordinated debt appears to be increasing with bank size, as per Figure 3.3.

I account for bank credit risk under Hypothesis 5 by constructing the ratio of loan loss provision to net loans (LPTL). With regards to bank specialisation, a dummy variable (DCAD) assuming a value of 1 for banks with the value of loan-to-asset ratio exceeding 80 percent ($LTA \geq 0.8$), and 0 otherwise is constructed. Only 17 percent of institutions in the sample can be characterised as specialised commercial banks at one time or another.

To condition interest rate risk to firms' off-balance sheet activities (Hypothesis 6), I use the ratio of bank i's total off-balance sheet exposure to its total assets (CLTA). BankScope does not report more specific information on the banks' derivative positions. The only reported value is classified as the bank's total contingent liabilities. The ratio is prominently higher for EMU based firms, perhaps because off-balance sheet activities is their only way of expanding revenue sources to remain competitive while not altering a tightly regulated capital structure. For non-EMU firms, the ratio ranges from 0.021 (for Japan) to 0.60 (for the UK).

To improve the fit of the empirical model, I control for further financial measures that may explain the variation in the banks' risk exposures. As banks with a greater fraction of liquid assets should be less risk-averse, I include the ratio of liquid assets to total assets (LATA). Banks may provision for losses to differing

Table 3.2
Descriptive statistics for company specific financial ratios

This table presents summary statistics (mean, median, and standard deviation) for the annual company specific financial ratios over 1997-2007, all supplied from the BankScope database. All financial ratios are calculated for each bank *i* (*i* =289) and then averaged across a sample period and either: (1) all banks [Full sample]; (2) across all EMU countries banks [EMU countries]; and (3) across all banks based in non-EMU countries [Non-EMU countries]. For an exact definition of each ratio see Appendix 2.

		Full sample			EMU countries			Non-EMU countries		
		Mean	Med.	St. dev.	Mean	Med.	St. dev.	Mean	Med.	St. dev.
Capital Adequacy										
CAP	[Capital Ratio]	0.064	0.057	0.029	0.062	0.056	0.026	0.069	0.064	0.035
TIER_	[Tier 1 Capital Ratio]	0.087	0.080	0.034	0.083	0.077	0.027	0.087	0.080	0.034
TCAP	[Total Capital Ratio]	0.114	0.108	0.033	0.109	0.106	0.025	0.116	0.108	0.034
ETN	[Equity to Loans]	0.124	0.092	0.172	0.115	0.108	0.052	0.127	0.087	0.199
ETD	[Equity to Short-Term Funding]	0.085	0.071	0.045	0.100	0.093	0.044	0.079	0.066	0.043
Asset Quality and Liquidity										
LTA	[Loan to Assets Ratio]	0.625	0.644	0.160	0.624	0.655	0.197	0.625	0.643	0.144
LCL	[Low Cost Liabilities]	0.796	0.895	0.229	0.611	0.656	0.231	0.864	0.958	0.187
LPTL	[Loan Loss Provision to Net Loans]	0.006	0.004	0.008	0.005	0.004	0.005	0.006	0.004	0.008
LPTA	[Loan Loss Provision to Assets]	0.004	0.003	0.004	0.003	0.003	0.003	0.004	0.003	0.004
LOL	[Loan Loss Ratio]	0.003	0.001	0.005	0.004	0.002	0.007	0.003	0.001	0.004
TDN	[Intermediation Ratio]	1.308	1.259	0.697	1.147	1.014	0.592	1.368	1.322	0.724
TDT	[Total deposits to total assets]	0.739	0.784	0.176	0.635	0.636	0.167	0.778	0.845	0.163
TDTL	[Total deposits to total liabilities]	1.308	1.259	0.697	0.687	0.681	0.197	0.829	0.923	0.172
BDT	[Bank deposits to total deposits]	0.164	0.067	0.209	0.364	0.304	0.237	0.087	0.026	0.133
UDT	[Bank's market discipline]	0.208	0.126	0.225	0.404	0.340	0.238	0.120	0.050	0.151
EITA	[Proportion of Equity Investment]	0.016	0.010	0.018	0.014	0.010	0.015	0.017	0.010	0.019
OET	[Other earning assets to total earning	0.334	0.321	0.165	0.330	0.291	0.203	0.335	0.326	0.148
OET	[Other earning assets to total assets]	0.312	0.301	0.151	0.305	0.273	0.186	0.314	0.310	0.135
SLLA	[Short-term Liabilities to Liquid Assets]	8.330	0.908	23.441	11.65	2.632	19.885	7.098	0.605	24.520
BDC	[Bank Deposits to Customer Deposits]	0.392	0.078	0.848	1.004	0.442	1.283	0.159	0.027	0.414
IETL	[Level of Interest Expenses]	0.022	0.021	0.018	0.030	0.028	0.015	0.019	0.013	0.018
LATA	[Proportion of Liquid Assets]	0.126	0.095	0.120	0.117	0.088	0.107	0.129	0.097	0.124
DBD	[Interbank Ratio]	23.062	1.495	361.7	1.104	0.591	4.312	31.975	2.721	428.6
LASF	[Deposit Run-off Ratio]	0.175	0.124	0.218	0.208	0.135	0.320	0.162	0.120	0.163
NLSF	[Net Loans to Short-Term Funding]	0.848	0.765	0.454	1.010	0.923	0.682	0.788	0.729	0.310
DDT	[Low cost funding]	0.834	0.892	0.173	0.728	0.738	0.183	0.870	0.949	0.154
COF	[Cost of Funds]	0.023	0.022	0.020	0.034	0.031	0.017	0.020	0.010	0.019
ALE	[Average Lending Rate]	0.042	0.041	0.021	0.052	0.050	0.015	0.038	0.029	0.021
Earnings, Efficiency and Profitability										
NIM	[Net Interest Margin]	0.020	0.019	0.008	0.021	0.022	0.011	0.019	0.018	0.007
LTEA	[Loans to total earning assets]	0.666	0.679	0.165	0.670	0.709	0.203	0.665	0.674	0.148
CTI	[Cost to Income Ratio]	0.950	0.785	0.958	0.990	0.902	0.524	0.936	0.756	1.074
ROA	[Return on Assets]	0.006	0.005	0.007	0.007	0.007	0.005	0.005	0.004	0.007
ROA	[Return on Equity]	0.057	0.077	0.720	0.095	0.101	0.151	0.043	0.066	0.838
BTTA	[Profit before tax to total assets]	0.008	0.007	0.009	0.011	0.010	0.008	0.007	0.006	0.009
PEO	[Personnel Expenses to Operating Ex-	0.480	0.488	0.105	0.482	0.490	0.103	0.479	0.487	0.106
Diversification										
SIZE	[Value of bank's total assets]	9.649	9.083	2.059	10.27	9.754	1.984	9.415	8.767	2.038
NOIR	[Proportion of non-interest income]	0.323	0.308	0.199	0.408	0.398	0.153	0.291	0.238	0.205
NOI	[Non-interest income to Net income]	2.144	1.483	7.814	2.596	1.835	6.012	1.976	1.353	8.379
NOIT	[Non-interest income to Total Assets]	0.011	0.009	0.013	0.013	0.014	0.006	0.010	0.006	0.014
NITR	[Proportion of interest income]	0.677	0.692	0.199	0.592	0.602	0.153	0.709	0.762	0.205
ROID	[Income Diversity]	0.542	0.550	0.273	0.708	0.750	0.206	0.480	0.425	0.269
HER	[Herfindahl Index]	0.402	0.438	0.173	0.510	0.530	0.126	0.364	0.367	0.171
ROA	[Asset Diversity]	0.593	0.610	0.229	0.534	0.538	0.251	0.615	0.630	0.217
Off-Balance Sheet Activities										
CLTA	[Contingent Liabilities to Total Assets]	0.256	0.044	1.216	0.639	0.182	2.216	0.132	0.023	0.549
CLTL	[Contingent Liabilities to Total Loans]	0.684	0.074	4.880	1.937	0.267	9.289	0.276	0.035	1.701

Table 3.3: Correlation matrix for selected variables

Company specific financial ratios:

	CAP	LTA	LCL	LPTL	LPTA	TDNL	TDTA	UDTD	EITA	OETA	SLLA	BDCD	IETL	LATA	LASF	NLSF	DDTF	COFU	ALER	NIM	LTEA	CTI	ROAA	ROAE	BTTA	SIZE	NOIR	NOIT	ROID	HERF	ROAD	CLTA
LTA	.02																															
LCL	.03	-.00																														
LPTL	.10*	-.11*	.06																													
LPTA	-.01	.13*	.09*	.78*																												
TDNL	.25*	-.73*	.14*	.12*	-.10*																											
TDTA	.22*	.19*	.30*	.01	.08*	.22*																										
UDTD	-.03	.00	-.94*	-.04	-.05	-.13*	-.32*																									
EITA	.11*	-.01	-.09*	-.07*	-.05	.05	.29*	.04																								
OETA	-.06	-.96*	.02	.11*	-.12*	.74*	-.10*	.01	.07*																							
SLLA	.19*	.14*	-.46*	-.09*	-.08*	-.05	.05	.44*	.21*	-.14*																						
BDCD	.02	.12*	-.83*	-.02	.01	-.14*	-.17*	.86*	.08*	-.09*	.41*																					
IETL	.03	-.00	-.50*	.02	.03	-.15*	-.44*	.54*	-.25*	-.06	.18*	.45*																				
LATA	.25*	-.53*	.21*	.19*	.06	.62*	.12*	-.16*	-.19*	.56*	-.38*	-.14*	-.03																			
LASF	.07	-.38*	-.06	.12*	.01	.29*	-.25*	.11*	-.20*	.41*	-.27*	.10*	.10*	.69*																		
NLSF	-.17*	.49*	-.22*	-.07*	.06	-.54*	-.46*	.25*	-.18*	-.46*	.01	.28*	.22*	-.24*	.37*																	
DDTF	.41*	.04	.27*	.04	.05	.34*	.94*	-.29*	.26*	-.02	.07*	-.18*	-.38*	.21*	-.20*	-.55*																
COFU	.01	-.07*	-.49*	.01	.00	-.12*	-.47*	.52*	-.25*	-.02	.17*	.42*	.99*	-.03	.09*	.18*	-.38*															
ALER	.15*	.12*	-.36*	.04	.09*	-.22*	-.28*	.40*	-.29*	-.22*	.15*	.31*	.91*	-.04	.02	.16*	-.20*	.90*														
NIM	.39*	.38*	.14*	.07*	.18*	-.24*	.30*	-.10*	-.16*	-.45*	.04	-.11*	.15*	-.01	-.14*	-.03	.35*	.12*	.53*													
LTEA	.04	.98*	-.01	-.11*	.13*	-.75*	.13*	-.01	-.04	-.99*	.14*	.10*	.04	-.56*	-.40*	.48*	.02	-.02	.19*	.43*												
CTI	.32*	-.58*	.01	.22*	-.07*	.71*	-.11*	.02	-.05	.57*	-.02	-.04	-.11*	.53*	.34*	-.33*	.05	-.08*	-.21*	-.27*	-.59*											
ROAA	.53*	-.15*	-.02	-.32*	-.47*	.24*	.01	-.00	-.08*	.08*	.06	-.05	.13*	.19*	.09*	-.17*	.19*	.15*	.23*	.29*	-.11*	.23*										
ROAE	.11*	-.12*	-.03	-.32*	-.48*	.07	-.02	.01	-.07	.07*	.03	-.04	.12*	.01	-.01	-.16*	.05	.14*	.17*	.13*	-.09*	.02	.63*									
BTTA	.57*	-.12*	-.03	-.31*	-.44*	.25*	.03	.02	-.09*	.05	.08*	-.03	.12*	.21*	.10*	-.17*	.21*	.14*	.25*	.37*	-.08*	.27*	.96*	.56*								
SIZE	-.29*	-.32*	-.26*	-.07*	-.15*	-.06	-.55*	.26*	-.18*	.23*	-.00	.04	.45*	-.14*	-.04	.01	-.48*	.49*	.33*	-.21*	-.26*	-.06	.12*	.23*	.04							
NOIR	.20*	-.56*	-.26*	.02	-.15*	.42*	-.40*	.23*	.00	.44*	.13*	.07*	.21*	.17*	.06	-.32*	-.20*	.28*	.11*	-.25*	-.49*	.62*	.32*	.20*	.33*	.33*						
NOIT	.48*	-.42*	-.07*	.09*	-.09*	.47*	-.20*	.05	-.07	.29*	.05	-.03	.09*	.37*	.24*	-.23*	.04	.14*	.11*	.04	-.35*	.70*	.54*	.19*	.58*	-.02	.74*					
ROID	.02	.11*	-.36*	-.06	-.02	-.24*	-.18*	.38*	-.09*	-.18*	.24*	.19*	.36*	-.29*	-.27*	-.05	-.13*	.36*	.40*	.22*	.16*	-.16*	.09*	.17*	.10*	.47*	.35*	-.00				
HERF	.05	-.22*	-.32*	-.02	-.07*	.04	-.29*	.36*	-.05	.15*	.20*	.16*	.35*	-.11*	-.16*	-.21*	-.19*	.36*	.30*	-.00	-.18*	.15*	.17*	.20*	.17*	.51*	.65*	.20*	.83*			
ROAD	-.27*	-.49*	.04	.04	-.00	-.00	-.00	-.04	.12*	.49*	-.25*	-.11*	-.03	.28*	.24*	-.21*	-.01	-.00	-.06	-.14*	-.49*	-.14*	-.11*	.06	-.17*	.27*	-.05	-.17*	.02	.04		
CLTA	-.14*	-.23*	-.10*	-.01	-.06	.08*	-.17*	.12*	.06	.24*	.02	.02	.10*	-.06	-.05	-.12*	-.20*	.09*	.01	-.18*	-.23*	.14*	-.09*	-.03	-.08*	.23*	.21*	.02	.07*	.19*	.05	1.00

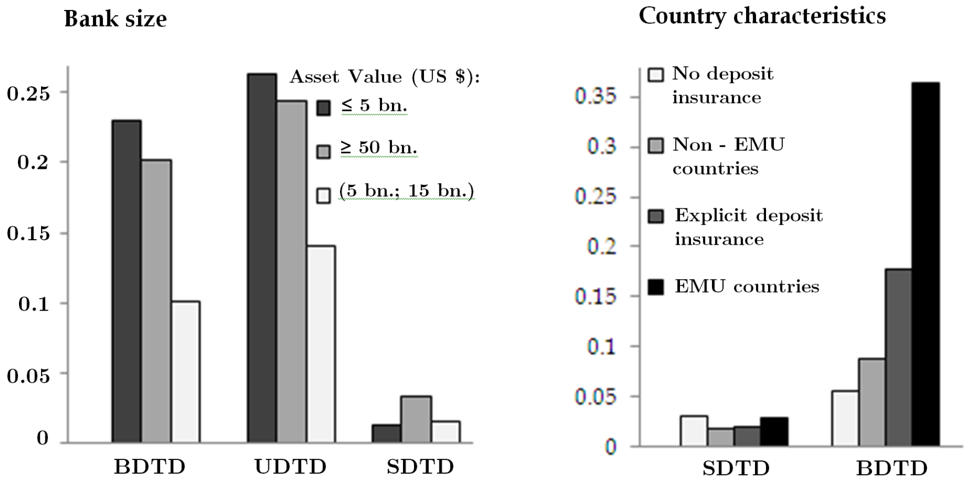
Country level variables:

	KRL_REG	KRC_REG	KPS_REG	SDI_REG	GDI_REG	DIS_REG	DIV_REG	ACT_REG	CAP_REG	INF_REG	RIGHT	M_BCGD	M_EXCI	M_UNEM	M_INFL	M_GDPC	M_GDPG
EFI_REG	.71*	.48*	.43*	.29*	.38*	.25*	.38*	.33*	.26*	.03	.22*	.11*	.13*	.55*	.05	.07*	.01
KRL_RE		.55*	.58*	.12*	.45*	.06*	.02	.49*	.39*	.31*	.03	.05*	.04	.33*	.02	.16*	.18*
KRC_RE			.05*	.28*	.54*	.42*	.10*	.65*	.62*	.38*	.07*	.54*	.26*	.08*	.48*	.41*	.49*
KPS_REG				.40*	.11*	.40*	.22*	.16*	.22*	.15*	.13*	.42*	.14*	.62*	.52*	.15*	.21*
SDI_REG					.19*	.89*	.61*	.35*	.25*	.10*	.06*	.62*	.12*	.40*	.47*	.14*	.14*
GDI_REG						.03	.43*	.27*	.29*	.38*	.12*	.50*	.05	.22*	.38*	.25*	.36*
DIS_REG							.58*	.34*	.38*	.13*	.09*	.81*	.13*	.54*	.62*	.27*	.31*
DIV_REG								.32*	.48*	.40*	.27*	.30*	.03	.23*	.17*	.12*	.11*
ACT_RE									.73*	.49*	.37*	.41*	.13*	.25*	.45*	.30*	.35*
CAP_RE										.76*	.12*	.59*	.15*	.28*	.53*	.35*	.45*
INF_REG											.17*	.46*	.05	.24*	.30*	.20*	.25*
RIGHT												.18*	.05	.11*	.00	.02	.11*
M_BCGD													.11*	.65*	.77*	.37*	.48*
M_EXCI														.02	.20*	.03	.03
M_UNE															.47*	.36*	.40*
M_INFL																.26*	.40*
M_GDPC																	.97*

	CAP	LTA	LCL	LPTL	LPTA	TDNL	TDTA	UDTD	EITA	OETA	SLLA	BDCD	IETL	LATA	LASF	NLSF	DDTF	COFU	ALER	NIM	LTEA	CTI	ROAA	ROAE	BTTA	SIZE	NOIR	NOIT	ROID	HERF	ROAD	CLTA
M_GDPG	.04	.02	-.01	-.20*	-.21*	-.05	.05	-.04	.01	-.08*	.07*	-.06	.11*	-.13*	-.13*	-.07*	.09*	.13*	.16*	.11*	.06	-.14*	.31*	.22*	.26*	.19*	.06	.05	.15*	.11*	.06	-.11*
M_GDPC	-.04	-.03	-.01	-.20*	-.20*	-.01	.11*	-.02	.06	.01	.05	-.03	.03	-.07*	-.08*	-.09*	.11*	.05	.07	.05	-.02	-.13*	.22*	.17*	.19*	.12*	-.01	-.01	.07*	.04	.16*	-.08*
M_INFL	-.01	.01	-.24*	-.12*	-.12*	-.15*	-.32*	.22*	-.23*	-.11*	.09*	.06	.38*	-.18*	-.07	.10*	-.26*	.40*	.45*	.26*	.08*	-.06	.26*	.23*	.26*	.36*	.25*	.17*	.41*	.35*	-.07*	.00
M_UNE	-.03	-.03	-.50*	-.04	-.03	-.09*	-.02	.51*	.09*	.02	.23*	.35*	.35*	-.08*	-.02	.01	-.02	.34*	.47*	.37*	-.02	-.16*	.02	.06	.08*	.08*	.03	-.06	.30*	.26*	.13*	.07
M_EXCI	.10*	-.04	-.20*	.03	-.01	-.07	-.35*	.20*	-.30*	-.03	.06	.08*	.35*	-.04	.04	.10*	-.26*	.36*	.37*	.16*	.00	.03	.18*	.15*	.17*	.37*	.27*	.17*	.36*	.33*	-.09*	.05
M_BCGD	-.19*	.07	.48*	.05	.08*	.10*	.51*	-.53*	.37*	.05	-.23*	-.30*	-.73*	.04	-.06	-.13*	.37*	-.74*	-.76*	-.31*	-.01	-.04	-.28*	-.20*	-.31*	-.49*	-.43*	-.29*	-.58*	-.55*	.12*	-.10*
RIGHT	-.20*	-.21*	.25*	.06	.07*	-.04	-.02	-.20*	-.20*	.25*	-.29*	-.22*	.02	.21*	.17*	-.02	-.08*	-.01	.01	.00	-.23*	-.18*	.03	.09*	-.04	.29*	-.20*	-.21*	-.05	-.06	.52*	.13*
INF_REG	.17*	.05	-.45*	-.11*	-.17*	.05	-.10*	.45*	-.05	-.10*	.39*	.35*	.38*	-.24*	-.16*	.00	.02	.39*	.30*	-.05	.08*	.10*	.28*	.19*	.23*	.31*	.33*	.19*	.35*	.37*	-.33*	.00
CAP_RE	.17*	.08*	-.19*	-.07*	-.13*	.06	-.07	.21*	-.21*	-.13*	.20*	.10*	.22*	-.10*	-.12*	-.03	.05	.24*	.24*	.12*	.10*	.15*	.32*	.23*	.30*	.24*	.29*	.24*	.38*	.37*	-.29*	-.12*
ACT_RE	-.07*	.18*	.08*	-.01	.04	-.10*	.08*	-.11*	.26*	-.20*	-.02	-.06	-.29*	-.11*	-.11*	.02	.04	-.26*	-.19*	.09*	.20*	-.01	-.25*	-.17*	-.16*	-.40*	-.08*	.02	-.15*	-.20*	-.16*	-.12*
DIV_REG	.15*	-.06	-.46*	.00	-.02	.07*	.13*	.53*	.12*	.09*	.42*	.42*	.22*	-.11*	-.11*	-.13*	.20*	.22*	.16*	.00	-.09*	-.01	.06	.07	.05	.15*	.10*	-.09*	.33*	.36*	.04	-.02
DIS_REG	-.03	.12*	.54*	.01	.02	.10*	.39*	-.64*	.25*	-.08*	-.24*	-.39*	-.57*	.04	-.07	-.10*	.32*	-.56*	-.56*	-.20*	.10*	.01	-.09*	-.12*	-.12*	-.42*	-.28*	-.07*	-.55*	-.54*	-.08*	-.16*
GDI_REG	-.17*	.03	-.06	.05	.09*	.03	.35*	.12*	.27*	.05	.07*	.11*	-.37*	-.03	-.08*	-.14*	.29*	-.37*	-.29*	.07*	-.02	-.02	-.26*	-.11*	-.18*	-.35*	-.17*	-.18*	.01	-.01	.13*	-.10*
SDI_REG	.03	-.20*	-.45*	.04	.05	-.02	-.19*	.55*	-.15*	.22*	.26*	.40*	.47*	-.01	.08*	.00	-.16*	.44*	.43*	.12*	-.21*	-.06	.01	.04	.03	.26*	.16*	-.03	.40*	.40*	.24*	.17*
KPS_REG	-.05	.02	.20*	-.05	-.10*	.14*	-.04	-.20*	.02	-.01	-.13*	-.10*	-.14*	.09*	.06	.03	-.04	-.13*	-.27*	-.38*	.01	.25*	-.09*	-.12*	-.10*	-.14*	.05	.11*	-.28*	-.20*	-.22*	.06
KRC_RE	.06	-.09*	.14*	-.06	-.13*	.04	-.23*	-.14*	-.31*	.05	-.12*	-.14*	.16*	.04	.07*	.07	-.18*	.16*	.06	-.20*	-.07*	.08*	.27*	.18*	.17*	.42*	.14*	.11*	.05	.07*	-.03	.09*
KRL_RE	-.11*	-.01	-.01	-.15*	-.25*	.10*	-.23*	-.01	-.13*	.00	-.02	.02	.08*	-.07	.03	.11*	-.21*	.09*	-.10*	-.42*	-.01	.23*	.13*	.09*	.07	.23*	.19*	.16*	-.08*	-.01	-.28*	.11*
EFI_REG	.16*	-.05	.50*	.01	-.03	.08*	.01	-.52*	-.22*	.04	-.25*	-.40*	-.08*	.16*	.08*	-.03	.04	-.08*	-.13*	-.15*	-.04	.03	.22*	.11*	.12*	.15*	-.05	.05	-.19*	-.17*	.05	-.07*

Note: This table presents the bivariate correlation between explanatory variables used in the research. Variable definitions and sources are provided in Table 1. * represent significance at the 5% level.

Figure 3.3
Uninsured deposits and subordinated debt by country and bank size



Source: Authors' calculations, based on the fiscal year-end financial information observable from bank financial accounts, compiled by Bureau van Dijk and extracted from the Banksope database for period 1997-2007. The information of deposit insurance system is extracted from the database compiled by Barth et al. (2008).

degrees and we might expect banks that provision more for losses to intend to take on more risk. I therefore include the ratio of net loan-loss provision to net loans (LPTL) to capture this influence. Finally, as more profitable banks may have less incentive to take risk I include the return on bank equity (ROE) as a control variable as well.

Country regulatory framework and macroeconomic environment

To characterise the structure and quality of the country-specific banking supervisory system, I use a database compiled by Barth et al. (2004), La Porta et al. (1998), Kaufmann et al. (2008), and the Heritage Foundation. The detailed definitions for each variable, including information sources and computational issues, are outlined in Table 3.1.

The database of Barth et al. (2004) provides detailed information on the structure of the bank regulation and deposit insurance system. Based on this database, I construct a set of measures addressing the quality of the regulatory system from six distinctive dimensions.

The first indicator, named the Index of Capital Requirements (CAP_REG), addresses the stringency of capital regulations enforced by authorities. This index ranges from 0 to 5 with the higher score reflecting greater restrictiveness. Similarly, the Index of Restricted Activities (ACT_REG) ranges from 3 to 12 based on the degree to which banks can engage in security underwriting, insurance and real estate activities. The Index of Information Disclosure (INF_REG) measures the strictness of regulatory imposed audit and disclosure requirements. This index ranges from 1 to 13. To proxy the enforcement of existing regulations (i.e. the degree of supervisory power to discipline banks), I calculate the Index of Bank Discipline (DIS_REG). The index ranges from 0 to 13. In a similar vein, the Diversification Index (DIV_REG) assigns higher scores to a bank regulatory system explicitly enforcing some form of liquidity and diversification requirements. This measure takes values from 0 to 5.

Finally, I construct a set of variables capturing the design features of the deposit protection scheme. Particularly, I distinguish between the "generous" and the "risk-based" deposit insurances. The former characterises a system extending automatic deposit coverage to failing banks with comparatively high or even blanket coverage limits. The latter represents a scheme with some forms of risk-based insurance premiums or co-insurance requirements. To this end two indices are constructed accordingly: Index of Generous Insurance (GDI_REG) and Index of Stringent Deposit Insurance (SDI_REG). Both indices range from 0 to 2. To robust check these measures, I also include the explicit maximum coverage limit provided by insurance weighted by the GDP-per-capita (DIC_REG). I deconstruct further the Index of Stringent Deposit Insurance into its elemental components assuming a value of 1 if: (a) there is an explicit co-insurance requirement (CDI_REG); and (b) the insurance premium is tied to bank risks (RBI_REG).

I also utilise a deposit insurance dummy EDI_REG, assuming a value of 1 for the countries with explicitly adopted deposit protection scheme, and 0 otherwise. A substantial distinction in the attitudes towards risk can be expected in the two groups of countries. Uninsured depositors have greater risk monitoring incentives. Higher risk-shifting incentives are expected in countries covered by provision. Therefore, I anticipate a differential impact of regulatory restriction on curtailing bank risks in these markets.

Particularly, regulatory restrictions on bank activities deem to better improve the risk profile of protected banks. The unprotected at-risk debtholders will adequately discipline the riskier banks provided improved information disclosure requirements. Accordingly, in my empirical framework I also examine an asymmetric impact of bank regulatory provision in curtailing bank risk in insured versus uninsured countries.

From La Porta et al. (1998) I include dummies of a country's "legal origin", taking a value of 1 if the legal origin of the target bank country is either English, German, French, or Scandinavian; and 0 otherwise. These variables are labelled (D_ENG), (D_GER), (D_FREN), and (D_SCAN) respectively.

To capture countries' development, I extract the Index of Political Stability (KPS_REG) from the database of worldwide governance indicators supplied by Kaufman et al. (2008). This index measures the likelihood that the government may be destabilised by "unconstitutional or violent means". From the same source, I also obtain the measures of Regulatory Quality (KRC_REG), and the Rule of Law Index (KRL_REG). Each variable lies between -2.5 to 2.5 with higher scores corresponding to better outcomes.

Finally, I include the overall score for the Economic Freedom Index (EFI_REG) supplied by the Heritage Foundation. By its construction, the index's score is based on the country's business, trade, monetary, investment, financial, labour, and corruption freedom as well as property rights and freedom from government.

The macroeconomic conditions are proxied by three key measures. These include GDP growth (M_GDPG), inflation measured as the current period CPI growth rate (M_INFL), and the real effective exchange rate (M_EXCI).

The summary statistics for regulatory framework and macroeconomic variables are presented in Table 3.2. Table 3.3 reports the correlation matrix between these variables, company specific financial ratios and countries' macroeconomic characteristics across the whole period covered by this study.

3.3.2 Methodology

To address the underlying determinants of bank risks, I follow a two-stage estimation procedure in line with the available literature [Fraser, Madura and Weigand, 2002; Johnson and Madura, 2002; Au Yong, Faff and Chalmers, 2009]. In the first step I model the pertinent risk sensitivities for each bank in the sample via Stone's two-factor model. The GARCH based econometric framework is employed to account for the presence of a time-varying element in the distribution of the banks' stock returns:

$$R_{it} = \alpha + X'_{it}\beta + \varepsilon_{it} \tag{3.2}$$

$$h_{it} = \omega_0 + \sum_{i=1}^{n} \gamma_1 \varepsilon^2_{i,t-1} + \sum_{j=1}^{m} \gamma_2 h_{i,t-1} \tag{3.3}$$

$$\varepsilon_{it}|\Omega_{t-1} \sim N(0, h_{it}) \tag{3.4}$$

where R_{it} is the return on bank i ($i = 1$ to 289) at time t; α is a scalar, β is a $K \times 1$ vector of coefficients and X_{it} is the it-th observation on K explanatory variables: $X' = (RM, R_{IR})$. R_{IR} is the interest rate factor which represents the unexpected changes in the underlying interest rate proxy. I use four interest rate proxies interchangeably. These are the domestic short- and long-term interest rates, interest rate term spread, and the curvature of the domestic zero-coupon yield curve at time t. The yield curve curvature is estimated via the Diebold and Lee factorisation of the Nelson-Siegel model in Equation 2.1. The unanticipated changes are calculated as the difference between the actual changes in the respective factor at time t and ones forecasted via the appropriate specification of the $ARMA$ model. ε_{it} is the estimated error term from the mean equation of portfolio i, and h_{it} is a conditional variance of portfolio i over week t.

The model is estimated on an annual basis for the entire sample period from January 1997 to December 2007[17] resulting in 11 annualised coefficients for each interest rate factor. The coefficient estimates on the interest rate factors measure the sensitivity of bank i's stock returns to unanticipated changes in the considered interest rate. The sign and magnitude of the estimated interest rate betas indicate the direction and extend of the bank's on- and off-balance sheet repricing mismatches. A negative sign would suggest a positive duration mismatch between interest sensitive assets and liabilities in the respective maturity bracket.

In the second step, I treat the estimated interest rate coefficients as dependent variables and relate them to factors theoretically justified in previous sections. With the exception of a few company specific financial ratios, the majority of the explanatory variables I use have been neglected in the literature on interest rate risk. By examining the appropriateness of these variables to serve as suitable indicators of the institutions' risk exposures, this study develops a platform potentially powerful enough to guide analysts and investors in their assessment of banks' interest rate risk. From the firms' management perspective, the patterns reported are to guide decision making, as well as risk adjustment and control. From the point of view of policy makers the model might provide considerably improved information for formulating banking sector policies.

Given these constraints, each type of interest rate exposure is tested under two empirical model specifications. The first model is solely based on the firms' specific financial characteristics including but not limited to the ones analysed in previous studies. The second specification allows me to also account for the individual country characteristics. These include the quality of regulatory supervision and market development, as well as macroeconomic conditions. The empirical investigation is built upon these benchmark models, serving to answer salient research questions and thus, in times, tailored to facilitate the validation

[17] For individual markets, the adjustments to the estimation horizon are made to account for the differences in a fiscal year periods.

of research hypotheses.

Further, due to the nature of the data samples I depart from typical time series or cross-section analysis as carried out in previous research, and use a panel data framework. Compared to cross-sectional analysis, panel data provide unbiased parameter estimates, while also controlling for unobservable cross-sectional and time heterogeneity (Baltagi, 2001, 2005).

Indexing financial institutions with i, countries with j and years with t, the empirical analysis for individual hypotheses in the second step is carried out utilising the following benchmark model:

$$\left|\beta_{jit}^{k}\right| = \varphi + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + G'_{j,t-1}\xi + T'_{t}\theta + \varepsilon_{it} \tag{3.5}$$

where, β_{jit}^{k} represents country j's bank i's interest rate risk measure k at time t. As discussed above, $k = 4$, representing the measures of FIs' equity return sensitivity to unanticipated term-structure developments. λ is an $M \times 1$ vector of coefficients and X_{jit} is the it-th observation on M company specific financial ratios, served as explanatory variables. Similarly, ξ is an $L \times 1$ and G_{jt} is the jt-th observation on L country specific macroeconomic characteristics; while ψ is an $S \times 1$ and S_{jt} is the jt-th observation on S country specific variables characterising the design of existing bank regulations. T_t is a vector of year-dummies of dimension $T-1$, and the the disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{jit}); L county macroeconomic regressors (G_{jt}), and S regulatory characteristics (S_{jt}). To avoid the "sign confusion effect" and to ease the economic interpretation of statistical results I use an absolute value of interest rate beta estimated from (3.3) as dependent variable in the second step regressions (3.6 and 3.7). Besides, both positive and negative interest rate exposures represent the risk to the bank economic value and should be appropriately managed. The use of absolute values is also supported by Au Yong, Faff and Chalmers (2009), and Ballester, et al. (2009).

Following the formal examination of empirical hypotheses via (3.6), the model specification is generalised to allow for the time-invariant company specific effect η_i:

$$\left|\beta_{jit}^{k}\right| = \varphi + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + G'_{j,t-1}\xi + T'_{t}\theta + \eta_i + \varepsilon_{it} \tag{3.6}$$

This model is estimated by either treating η_i as fixed (fixed effect model), thus assuming $(N + M + L)$ unknown coefficients, with $\eta = (\eta_1, \ldots, \eta_N)\prime$ being company specific intercepts; or random (random effect model). In the random effect specification $\eta_i \sim IID(0, \sigma_\eta^2)$ and is independent of $\varepsilon_i \sim IID(0, \sigma_\varepsilon^2)$. Further, both η_i and ε_{it} are independent of (X_{jit}, G_{jt}) for all j, i and t. Therefore, for the random effect model, the representation in (3.7) can be conventionalized as (3.6) with composite disturbance term $\nu_{it} = \eta_i + \varepsilon_{it}$ and $(2 + M + L)$ parameters to be estimated.

Every effort is taken to detect and address any outliers arising as a result of measurement or coding errors. Other non-technical representative outliers, depicting genuine variability in the behaviour of the population units, are retained in the estimate. They are presumed to convey constitutive information about the time and cross-sectional heterogeneity of panel units. To get more stable estimates I reduce the impact of these extreme observations by type I winsorization[18], with fixed cut-off points of $\bar{\omega} \pm 4\hat{\sigma}$ for all time-variant variables $(\omega = X_{ji}, G_j)$.

Several tailored specifications of (3.6) and (3.7) are estimated to expedite hypotheses evaluation. The Hausman specification test for correlated random effect guides the choice between fixed- or random-effect models. Each parameterisation is rigorously addressed in the empirical results section.

3.4 Empirical results

The discussion starts with results obtained in the first stage estimation. It continues thereon with testing the empirical hypotheses addressing the underlying determinants of interest rate risk.

3.4.1 Bank interest rate sensitivities

The risk exposure of in-sample financial institutions is assessed via GARCH two-factor model presented by (3.3). The model is estimated on an annual basis for a sample of 289 financial intermediaries, based on weekly return observations as per the outlined methodology. The estimation period spans the years from 1997 to 2007, resulting in 11 annual coefficient estimates for each institution and each interest rate proxy. We use interchangeable four interest rate proxies. Accordingly, 44 risk betas are obtained for each bank in the sample, with a total of 12,716 coefficients for the whole sample and reference period.

Table 3.4 presents pertinent statistics for estimated coefficients for selected aggregates. These include the breakdown by: (a) the economic area (EMU/non-EMU countries); (b) bank size; (c) countries with or without explicit deposit insurance; and (d) pre-/post- 2000 time period.

[18]Type I winsorization commonly refers to the procedure of replacing outliers with exact value of interval limit, whereas with Type II outliers are transformed to predestined weighted average between their original and the cut-off values.

Table 3.4
Descriptive statistics for the estimated risk coefficients

This table presents summary statistics for the market measures of interest rate risk by: the firm size; economic area; provision of deposit insurance guarantees; and considered time period. The market measures of interest rate risk are represented by the coefficients estimate from a two-factor GARCH market model. Specifically, for each bank-year, I run a two-factor time series regression of the banks' weekly returns on the market returns (MRK), and unanticipated changes in either the domestic short-term, long-term, or spread-term interest rates, or the zero-coupon yield curve curvature (CUR). The estimation requires at least 30 weekly return observations for each bank-year. The corresponding US zero-coupon yield curve curvature is estimated using Diebold and Lee (2006) parameterization of the Nelson and Siegel (1987) model. The unanticipated changes in the interest rate factors at time t are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively for an appropriate mean, median, or variance equality test.

Panel A: All firms

	β_{SR}	β_{LR}	β_{SPR}	β_{Curv}
Mean	0.003	-0.003	-0.011	0.004
Median	-0.001	-0.005	-0.006	0.001
St. Dev	0.465	0.079	0.066	0.033
	% Level of Significance:			
1% level	*6.17%*	*7.47%*	*6.11%*	*6.82%*
5% level	*10.82%*	*14.29%*	*12.88%*	*14.18%*
10% level	*15.31%*	*20.18%*	*18.18%*	*19.97%*
% Negat.	*53.71%*	*57.10%*	*64.58%*	*42.82%*

Panel B: Statistics for selected aggregates

	β_{SR}	β_{LR}	β_{SPR}	β_{Curv}	β_{SR}	β_{LR}	β_{SPR}	β_{Curv}
	Small firms				Large firms			
Mean	0.018	-0.002	-0.012	0.005	-0.021*	-0.006	-0.008	0.001**
Median	0.001	-0.004	-0.007	0.002	-0.004	-0.008	-0.004	0.0001***
St. Dev	0.459	0.075	0.067	0.037	0.386***	0.077	0.062	0.021***
	EMU countries				Non - EMU countries			
Mean	0.008	-0.001	-0.003	0.003	0.006	-0.004	-0.013***	0.004
Median	0.001	-0.002	-0.003	0.001	-0.002	-0.006	-0.008***	0.002
St. Dev	0.136	0.064	0.050	0.045	0.503***	0.079***	0.070***	0.027***
	Countries with deposit protection				Countries with NO deposit protection			
Mean	0.009	-0.001	-0.003	0.004	-0.014	-0.004***	-0.013	0.002
Median	0.001	-0.003	-0.003	0.001	-0.010**	-0.006***	-0.008	0.000
St. Dev	0.462	0.078	0.050	0.034	0.065***	0.079***	0.070***	0.017***
	1997 - 2000 period				2000 - 2008 period			
Mean	0.006	-0.008	-0.001	-0.001	0.007	-0.0003**	-0.016***	0.006***
Median	-0.002	-0.008	0.000	0.000	0.000	-0.004**	-0.010***	0.002***
St. Dev	0.112	0.073	0.053	0.019	0.543***	0.077	0.072***	0.038***

The results reveal a number of interesting patterns. The majority of the analysed companies are significantly affected by the unanticipated movements in at least one interest rate proxy. This indicates the managers' inability to take accurate views regarding the changes in the entire shape of the term structure and adopt comprehensive hedging strategies.

To further elaborate, approximately 20 percent of the analysed companies are found to be significantly exposed to all unanticipated shocks in the short-, and long-term interest rates, interest rate term spread, and curvature of the interest rate yield curve. The majority of the significant interest rate coefficients are negative. This supports the widespread view that banks tend to maintain a positive mismatch between the maturity of their assets and liabilities. The variance of the estimated coefficients appears to be greater over the second part (2000-2007) of the sample period, and for non-EMU countries. Notably, the provision of deposit insurance seems to markedly improve institutions' risk profile.

3.4.2 Determinants of interest rate risk

On the basis of the discussion so far, we established the theoretical links between bank risks and a set of company specific, and country level macroeconomic and regulatory framework variables. In this section I seek to validate the theory by empirically addressing the outlined hypotheses.

The hypotheses are addressed using two complementary models. I begin by conditioning the interest rate betas to the firm level financial data under appropriate parameterisation of Equations (3.6) and (3.7). This exercise is then repeated for the remaining models, accounting for the design of implemented deposit protection, as well as previously discussed macroeconomic and country-specific characteristics.

Company level financial data and interest rate risk

Tables 3.5 and 3.6 demonstrate the impact of bank specific financial characteristics on its exposure to unanticipated changes in the interest rate term structure. Two types of regressions are estimated.

First, in Table 3.5 I conduct a stepwise regression experiment. In columns 1 to 10, I regress each of the interest rate betas on firm financial indicators following the pooled ordinary least squares procedure with clustering at the firm level. This yields a benchmark model in column 11. Based on this model, a more general random effect specification is estimated in column 12. This specification accounts for individual firm heterogeneity as per Equation 3.7. In some cases I include the interaction terms to facilitate the empirical assessment of the research hypotheses.

Second, the regression in Table 3.6 examines whether the association between market and accounting measures of interest rate risk depends on the provision of deposit insurance in the target bank country. This asymmetry is modelled by the interaction dummy variable (EDI_REG) marking the existence of deposit insurance with a value of 1, and 0 otherwise. In both regressions, period- and country-specific effects are modelled accordingly. A number of company specific control variables are included in all specifications.

The first empirical hypothesis refers to the relationship between bank interest rate risks and their alternative revenue sources. Table 3.5 indicates that a higher degree of revenue heterogeneity reduces the amount of interest rate exposure banks have. However, Hypothesis 1 is only validated when long- and spread-term interest rate coefficients are considered as the dependent variable (Panels B and C).

I argue that such marked improvement in the bank risk profile is only associated with the fact that revenue diversification facilitates stabilisation of the operating income, owing to imperfect correlation between non-interest activities and those generating interest revenues. Following monetary policy shocks, however, both sources of revenue are expected to be severely affected. My results are in line with Barth et al. (2004) who demonstrate that diversifying to non-traditional revenue generating activities improves bank stability. A similar view is also articulated by Stiroh and Rumble (2006) who report certain diversification benefits for bank holding companies. These benefits however are offset by greater exposure to a more volatile non-interest revenue generating activities.

To enrich the statistical inference, I re-estimate the equation assuming the level of banks' income derived from non-traditional revenue generating sources as measured by variable NOIR. This ratio is positively correlated with the analysed market measures of interest rate risk, as in Fraser, Madura and Weigand (2002). Nonetheless, this relationship is not robust to controlling for further bank financial characteristics. For this reason, I do not report this regression in Table 3.5.

Accordingly, the reported findings cannot be used to assess the risk implications of tilting the bank product mix towards either revenue generating activity. The fact, however, that non-interest income is an aggregated accounting item, including different revenue streams, calls for further research in the area. For instance, Lepetit et al. (2008) analyse a sample of European banks and conclude that the positive correlation between banks' risk and the levels of non-interest income is mainly due to the commission and fee income but not the trading ac-

Table 3.5: Panel A

Determinants of banks' interest rate exposure [short-term IR]

This table shows the panel estimation results for the regression:

$$|\beta^{SR}_{it}| = \varphi + X'_{it}\gamma + C_j\xi + T_t'\theta + \varepsilon_{it}, \qquad i = 1,\ldots, N;\ j = 1,\ldots, C;\ t = 1,\ldots, T$$

where β^{LR}_{it} represents the stock returns sensitivity of country j's bank i to the unanticipated changes in the domestic short-term interest rate at time t. γ is an M x 1 vector of coefficients and X_{it} is the it-th observation on M company specific financial ratios, served as explanatory variables. T_t and C_j are vectors of year- and country-dummies of dimension T-1 and C-1 respectively. The disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{it}). For each estimated model $j=13$, $i=289$ and $t=11$ resulting in 3179 observations. The regressions are estimated for the following company specific financial measures, all calculated at time t-1:

$$ROID = 1 - \left|\frac{(\text{NetInt Inc.} - \text{NonInt.Inc})}{\text{Total Oper. Income}}\right| \quad LCL = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \quad CLTA = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}} \quad LPTL = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

$$CAP = \frac{\text{Equity Capital}}{\text{Total Assets}} \quad BDTD = \frac{\text{Bank Deposits}}{\text{Total Deposits}} \quad ROAE = \frac{\text{Net Income}}{\text{Total Equity}} \quad ALER = \frac{\text{Interest Income}}{\text{Total Earning Assets}}$$

$$LTA = \frac{\text{Net Loans}}{\text{Total Assets}} \quad UDTD = \frac{\text{Bank Depos.+Subord. Debt}}{\text{Total Deposits}} \quad LATA = \frac{\text{Liquid Assets}}{\text{Total Assets}} \quad TLTD = \frac{\text{Net Loans}}{\text{Total Deposits}}$$

DCAD is a bank specialisation dummy, taking a value of 1 for banks with LTA $\geq$ 0.8 (spec. commercial bank), 0 otherwise; and LARGE is a dummy assuming a value of 1 for banks with assets in excess of 50 bn. US dollars, and 0 otherwise. The test statistics (*F-statistics*) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficient estimates is reported under WALD, with the associated *p-value* reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	**(11)**	**(12)**
Const.	0.503	0.672	0.654	0.586	0.652	0.637	0.638	0.667	0.651	0.681	0.688	0.670
	*13.60****	*6.81****	*7.37****	*5.95****	*7.07****	*6.15****	*5.00****	*7.32****	*6.99****	*6.83****	*6.83****	*6.46****
ROID	0.013	0.027	0.034	0.021	0.033							
	0.22	*0.46*	*0.58*	*0.35*	*0.54*							
CAP		-4.404	-4.430	-4.121	-4.422	-4.376	-4.721	-4.485	-4.637	-4.873	-5.240	-5.405
		*-2.14***	*-2.07***	*-1.88**	*-2.06***	*-2.07***	*-2.00***	*-2.10***	*-2.24***	*-2.20***	*-2.29***	*-2.39***
CAP^2		21.536	21.504	20.658	21.462	21.145	23.771	21.809	22.568	23.463	25.091	25.672
		*2.15***	*2.05***	*1.93**	*2.04***	*2.05***	*2.08***	*2.08***	*2.25***	*2.19***	*2.27***	*2.39***
LTA			0.008	0.154		0.008	0.023	0.008	0.016	-0.006	0.003	0.002
			0.15	*1.69**		*0.15*	*0.39*	*0.15*	*0.30*	*-0.11*	*0.06*	*0.03*
LCL						0.026	0.141					
						0.48	*1.04*					
BDTD								-0.074				
								-1.43				
UDTD									-0.097	-0.109	-0.098	-0.142
									*-1.86**	*-1.89**	*-1.85**	*-2.36***
CLTA										-0.007		
										-1.56		
ROAE	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.007	0.007	0.007	0.010
	*2.62****	*2.44***	*2.44***	*2.59****	*2.43***	*2.47***	*2.42***	*2.48***	*2.08***	*2.09***	*2.11***	*3.37****
LATA	-0.123	-0.120										
	*-1.70**	*-1.56*										
LPTL	-1.463	-2.184	-2.258	-1.975	-2.261	-2.264	-2.483	-2.254	-2.133	-2.240	-2.196	-2.497
	-1.26	*-1.60*	*-1.68**	*-1.49*	*-1.68**	*-1.70**	*-1.73**	*-1.69**	*-1.60*	*-1.62*	*-1.60*	*-1.59*
LTA*ALER				-2.620								
				*-2.20***								
LTA*DCAD					0.008							
					0.15							
LTA*(1-DCAD)					0.011							
					0.16							
WALD					0.013							
p-value					*(0.909)*							
TLTD							-0.006					
							-0.28					
CLTA*LARGE											-0.009	-0.011
											*-2.28***	*-2.80****
CLTA*Others											0.012	0.007
											1.49	*1.12*
WALD											8.490	8.388
p-value											*(0.004)*	*(0.004)*
Country effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.23
F - stats.	*25.72****	*24.20****	*24.29****	*23.30****	*23.37****	*24.34****	*21.71****	*24.10****	*19.26****	*17.39****	*16.82****	*12.97****
Hausman test:												22.792
												(0.156)

Table 3.5: Panel B

Determinants of banks′ interest rate exposure [long-term IR]

This table shows the panel estimation results for the regression:

$$|\beta^{LR}_{it}| = \varphi + X'_{it}\gamma + C_j\xi + T_t'\theta + \varepsilon_{it}, \quad i = 1,\ldots, N; j = 1,\ldots, C; t = 1,\ldots, T$$

where β^{LR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the domestic long-term interest rate at time *t*. γ is an *M* x *1* vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. T_t and C_j are vectors of year- and country-dummies of dimension *T-1* and *C-1* respectively. The disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The regressions are estimated for the following company specific financial measures all calculated at time *t-1*:

$$ROID = 1 - \left|\frac{(\text{NetInt Inc.} - \text{NonInt.Inc})}{\text{Total Oper. Income}}\right| \quad LCL = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \quad CLTA = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}} \quad LPTL = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

$$CAP = \frac{\text{Equity Capital}}{\text{Total Assets}} \quad BDTD = \frac{\text{Bank Deposits}}{\text{Total Deposits}} \quad ROAE = \frac{\text{Net Income}}{\text{Total Equity}} \quad ALER = \frac{\text{Interest Income}}{\text{Total Earning Assets}}$$

$$LTA = \frac{\text{Net Loans}}{\text{Total Assets}} \quad UDTD = \frac{\text{Bank Depos.+Subord. Debt}}{\text{Total Deposits}} \quad LATA = \frac{\text{Liquid Assets}}{\text{Total Assets}} \quad TLTD = \frac{\text{Net Loans}}{\text{Total Deposits}}$$

DCAD is a bank specialisation dummy, taking a value of 1 for banks with LTA ≥ 0.8 (spec. commercial bank), 0 otherwise; and LARGE is a dummy assuming a value of 1 for banks with assets in excess of 50 bn. US dollars, and 0 otherwise. The test statistics (*F-statistics*) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficient estimates is reported under WALD, with the associated *p-value* reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	**(11)**	**(12)**
Const.	0.066	0.091	0.114	0.141	0.113	0.113	0.124	0.110	0.114	0.125	0.116	0.129
	*14.77****	*8.37****	*10.42****	*11.20****	*9.76****	*6.00****	*5.29****	*10.02****	*9.75****	*7.23****	*10.11****	*10.04****
ROID	-0.026	-0.023	-0.026	-0.022	-0.026						-0.024	-0.026
	*-2.43***	*-2.23***	*-2.55***	*-2.20***	*-2.48***						*-2.35***	*-2.51***
CAP		-0.656	-0.549	-0.710	-0.546	-0.577	-0.750	-0.572	-0.686	-0.607	-0.521	-0.469
		*-2.57***	*-2.01***	*-2.60****	*-2.01***	*-2.10***	*-2.34***	*-2.08***	*-2.22***	*-2.14***	*-1.81**	*-1.62*
CAP²		3.437	3.042	3.553	3.031	3.248	3.995	3.160	3.877	3.472	2.924	2.651
		*2.47***	*2.11***	*2.44***	*2.11***	*2.23***	*2.38***	*2.19***	*2.38***	*2.31***	*1.94**	*1.76**
LTA			-0.030	-0.086		-0.030	-0.031	-0.034	-0.032	-0.036	-0.036	-0.036
			*-3.19****	*-5.29****		*-3.19****	*-2.94****	*-3.64****	*-3.16****	*-4.15****	*-4.05****	*-3.86****
LCL						-0.006	-0.033			-0.014		
						-0.41	*-1.67**			*-1.10*		
BDTD								0.016				
								1.36				
UDTD									0.010			
									0.84			
CLTA										-0.002		
										-1.56		
ROAE	-0.004	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	-8.92***	*-5.27****	*-5.24****	*-5.78****	*-5.25****	*-4.84****	*-4.50****	*-5.26****	*-5.68****	*-5.51****	*-5.75****	*-5.37****
LATA	0.075	0.072										
	5.28***	*5.25****										
LPTL	0.474	0.319	0.351	0.229	0.350	0.343	0.326	0.353	0.187	0.310	0.325	0.312
	2.28**	*1.64*	*1.80**	*1.11*	*1.79**	*1.71**	*1.55*	*1.77**	*0.89*	*1.53*	*1.63*	*1.55*
LTA*ALER				1.013								
				*3.75****								
LTA*DCAD					-0.030							
					*-3.22****							
LTA*(1-DCAD)					-0.028							
					*-2.22***							
WALD					0.044							
p-value					*(0.833)*							
TLTD							0.007					
							*1.64**					
CLTA*LARGE											-0.001	-0.001
											-1.32	*-1.09*
CLTA*Others											-0.004	-0.003
											*-2.25***	*-2.29***
WALD											2.742	2.875
p-value											*(0.098)*	*(0.090)*
Country effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.12	0.12	0.11	0.12	0.11	0.10	0.10	0.11	0.10	0.11	0.11	0.10
F - stats.	*9.05****	*8.70****	*8.01****	*8.43****	*7.71****	*7.64****	*6.91****	*7.68****	*6.11****	*7.26****	*7.25****	*6.18****
Hausman test												11.008
												(0.201)

Table 3.5: Panel C

Determinants of banks' interest rate exposure [IR term-spread]

This table shows the panel estimation results for the regression:

$$|\beta^{SPR}_{it}| = \varphi + X'_{it}\gamma + C_j\xi + T_t\theta + \varepsilon_{it}, \qquad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{SPR}_{it} represents the stock returns sensitivity of country j's bank i to the unanticipated changes in the domestic interest rate term spread at time t. γ is an M x 1 vector of coefficients and X_{it} is the it-th observation on M company specific financial ratios, served as explanatory variables. T_t and C_j are vectors of year- and country-dummies of dimension T-1 and C-1 respectively. The disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{it}). For each estimated model j=*13*, i=*289* and t=*11* resulting in *3179* observations. The regressions are estimated for the following company specific financial measures all calculated at time t-1:

$$\text{ROID} = 1 - \left|\frac{\text{(NetInt Inc.} - \text{NonInt.Inc)}}{\text{Total Oper. Income}}\right| \quad \text{LCL} = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \quad \text{CLTA} = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}} \quad \text{LPTL} = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

$$\text{CAP} = \frac{\text{Equity Capital}}{\text{Total Assets}} \quad \text{BDTD} = \frac{\text{Bank Deposits}}{\text{Total Deposits}} \quad \text{ROAE} = \frac{\text{Net Income}}{\text{Total Equity}} \quad \text{ALER} = \frac{\text{Interest Income}}{\text{Total Earning Assets}}$$

$$\text{LTA} = \frac{\text{Net Loans}}{\text{Total Assets}} \quad \text{UDTD} = \frac{\text{Bank Depos.+Subord. Debt}}{\text{Total Deposits}} \quad \text{LATA} = \frac{\text{Liquid Assets}}{\text{Total Assets}} \quad \text{TLTD} = \frac{\text{Net Loans}}{\text{Total Deposits}}$$

DCAD is a bank specialisation dummy, taking a value of 1 for banks with LTA≥ 0.8 (spec. commercial bank), 0 otherwise; and LARGE is a dummy assuming a value of 1 for banks with assets in excess of 50 bn. US dollars, and 0 otherwise. The test statistics (*F-statistics*) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficient estimates is reported under WALD, with the associated *p-value* reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	**(11)**	**(12)**
Const.	0.065	0.085	0.103	0.110	0.101	0.128	0.144	0.099	0.100	0.148	0.102	0.108
	*15.52****	*6.80****	*7.35****	*7.70****	*6.80****	*5.38****	*4.88****	*7.44****	*6.89****	*5.71****	*6.84****	*7.84****
ROID	-0.022	-0.020	-0.022	-0.021	-0.022						-0.022	-0.021
	*-2.03***	*-1.85**	*-2.05***	*-1.91**	*-2.06***						*-2.11***	*-2.00***
CAP		-0.563	-0.484	-0.524	-0.481	-0.463	-0.625	-0.502	-0.426	-0.576	-0.353	-0.539
		*-2.11***	*-1.78**	*-1.92**	*-1.77**	*-1.72**	*-1.97***	*-1.85**	*-1.42*	*-2.14***	*-1.29*	*-1.95**
CAP^2		2.979	2.676	2.791	2.662	2.599	3.610	2.775	2.518	3.124	1.949	2.919
		*2.29***	*1.99***	*2.08***	*1.99***	*1.93**	*2.28***	*2.06***	*1.70**	*2.34***	*1.46*	*2.17***
LTA			-0.022	-0.039		-0.023	-0.019	-0.026	-0.033	-0.027	-0.029	-0.027
			*-1.97***	*-2.73****		*-2.11***	*-1.52*	*-2.22***	*-2.60****	*-2.42***	*-2.50***	*-2.24***
LCL						-0.033	-0.039			-0.046		
						*-2.00***	*-1.66**			*-2.53***		
BDTD								0.024				
								*2.06***				
UDTD									0.030			
									*2.37***			
CLTA										0.001		
										0.83		
ROAE	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000
	*-2.08***	*-0.15*	*-0.31*	*-0.34*	*-0.33*	*-0.37*	*-0.26*	*-0.30*	*-1.00*	*-0.22*	*-2.03***	*-0.13*
LATA	0.052	0.050										
	*3.97****	*3.90****										
LPTL	0.171	0.037	0.056	0.024	0.055	0.051	-0.015	0.053	-0.011	0.031	0.118	0.047
	1.34	*0.26*	*0.40*	*0.17*	*0.39*	*0.35*	*-0.09*	*0.36*	*-0.07*	*0.21*	*0.86*	*0.33*
LTA*ALER				0.289								
				1.57								
LTA*DCAD					-0.023							
					*-1.99***							
LTA*(1-DCAD)					-0.021							
					-1.45							
WALD					0.092							
p-value					*(0.762)*							
TLTD							0.010					
							*2.02***					
CLTA*LARGE											0.000	0.000
											0.17	*0.37*
CLTA*Others											-0.002	-0.001
											-1.40	*-1.04*
WALD											3.967	2.831
p-value											*(0.047)*	*(0.093)*
Country effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.13	0.14	0.13	0.13	0.13	0.13	0.14	0.13	0.11	0.28	0.13	0.13
F - stats.	*10.32****	*9.81****	*9.52****	*9.19****	*9.16****	*9.71****	*8.97****	*9.28****	*6.93****	*17.39****	*8.24****	*8.08****
Hausman test:												16.164
												(0.512)

Table 3.5: Panel D

Determinants of banks' interest rate exposure [yield curve curvature]

This table shows the panel estimation results for the regression:

$$|\beta^{CURV}_{it}| = \varphi + X'_{it}\gamma + C_j\xi + T_t'\theta + \varepsilon_{it}, \qquad i = 1,\ldots, N;\ j = 1,\ldots, C;\ t = 1,\ldots, T$$

where β^{CURV}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the curvature of domestic zero-coupon yield curve at time *t*. γ is an *M* x *1* vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. T_t and C_j are vectors of year- and country-dummies of dimension *T-1* and *C-1* respectively. The disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The regressions are estimated for the following company specific financial measures all calculated at time *t-1*:

$$\text{ROID} = 1 - \left|\frac{\text{(NetInt Inc.} - \text{NonInt.Inc)}}{\text{Total Oper. Income}}\right| \quad \text{LCL} = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \quad \text{CLTA} = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}} \quad \text{LPTL} = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

$$\text{CAP} = \frac{\text{Equity Capital}}{\text{Total Assets}} \quad \text{BDTD} = \frac{\text{Bank Deposits}}{\text{Total Deposits}} \quad \text{ROAE} = \frac{\text{Net Income}}{\text{Total Equity}} \quad \text{ALER} = \frac{\text{Interest Income}}{\text{Total Earning Assets}}$$

$$\text{LTA} = \frac{\text{Net Loans}}{\text{Total Assets}} \quad \text{UDTD} = \frac{\text{Bank Depos.+Subord. Debt}}{\text{Total Deposits}} \quad \text{LATA} = \frac{\text{Liquid Assets}}{\text{Total Assets}} \quad \text{TLTD} = \frac{\text{Net Loans}}{\text{Total Deposits}}$$

DCAD is a bank specialisation dummy, taking a value of 1 for banks with LTA ≥ 0.8 (spec. commercial bank), 0 otherwise; and LARGE is a dummy assuming a value of 1 for banks with assets in excess of 50 bn. US dollars, and 0 otherwise. The test statistics (*F-statistics*) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficient estimates is reported under WALD, with the associated *p-value* reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	**(11)**	**(12)**
Const.	0.024	0.031	0.035	0.040	0.035	0.035	0.036	0.036	0.037	0.037	0.037	0.039
	*18.63****	*8.14****	*8.62****	*8.70****	*8.03****	*7.29****	*6.06****	*8.81****	*8.28****	*6.67****	*8.27****	*8.44****
ROID	-0.002	-0.001	-0.002	-0.001	-0.002						-0.001	-0.001
	-0.72	*-0.31*	*-0.56*	*-0.27*	*-0.59*						*-0.46*	*-0.42*
CAP		-0.208	-0.199	-0.233	-0.197	-0.202	-0.264	-0.199	-0.197	-0.217	-0.218	-0.211
		*-2.37***	*-2.21***	*-2.53***	*-2.18***	*-2.22***	*-2.67****	*-2.16***	*-1.96***	*-2.24***	*-2.16***	*-2.05***
CAP^2		1.182	1.155	1.275	1.149	1.178	1.433	1.153	1.167	1.243	1.241	1.215
		*2.73****	*2.63****	*2.85****	*2.60****	*2.65****	*3.04****	*2.55***	*2.38***	*2.66****	*2.56***	*2.51***
LTA			-0.004	-0.013		-0.004	-0.003	-0.005	-0.005	-0.005	-0.005	-0.006
			-1.17	*-2.86****		*-1.16*	*-0.84*	*-1.42*	*-1.43*	*-1.51*	*-1.47*	*-1.72**
LCL						-0.001	-0.013			-0.001		
						-0.21	*-1.95**			*-0.26*		
BDTD								0.003				
								1.03				
UDTD									0.003			
									0.82			
CLTA										0.000		
										-1.42		
ROAE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.07	*-0.06*	*0.27*	*-0.13*	*0.26*	*0.28*	*0.26*	*0.24*	*-0.08*	*0.27*	*0.28*	*3.22****
LATA	0.016	0.016										
	*3.73****	*3.69****										
LPTL	0.050	0.014	0.022	0.003	0.022	0.022	0.034	0.020	-0.037	0.023	0.024	0.012
	0.92	*0.26*	*0.43*	*0.05*	*0.42*	*0.43*	*0.60*	*0.39*	*-0.93*	*0.43*	*0.45*	*0.26*
LTA*ALER				0.172								
				*2.97****								
LTA*DCAD					-0.004							
					-1.19							
LTA*(1-DCAD)					-0.003							
					-0.85							
WALD					0.084							
p-value					*(0.772)*							
TLTD							-0.000					
							-0.22					
CLTA*LARGE											-0.001	0.000
											-1.53	*-1.40*
CLTA*Others											0.000	-0.001
											-0.53	*-1.46*
WALD											0.225	0.398
p-value											*(0.635)*	*(0.528)*
Country effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.18	0.19	0.18	0.19	0.18	0.18	0.19	0.18	0.18	0.18	0.18	0.15
F - stats.	*14.85****	*14.16****	*13.71****	*13.38****	*13.20****	*13.71****	*12.38****	*13.47****	*11.24****	*12.54****	*12.07****	*9.43****
Hausman test:												15.315
												(0.573)

tivities. Similarly, analysing the determinants of market risk for a sample of US bank holding companies, Stiroh (2006) reports a differential impact of different non-interest income streams on the bank risks.

In contrast the results for short- and medium-term interest rate exposure (Panels A and D) suggest that banks do no benefit in any meaningful way from diversifying their revenue streams. Once, however, I account for the country legal origin and macroeconomic characteristics in the following section, a significantly negative association is reported.

To test Hypotheses 2 and 3, concerning the impact of equity capital levels on bank risk taking, I reformulate the parameterisation of (3.6) in a non-linear form:

$$\left|\beta^k_{jit}\right| = \varphi + \lambda_1 CAP_{ji,t-1} + \lambda_2 CAP^2_{ji,t-1} + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + C_j\chi + T'_t\theta + \varepsilon_{it} \quad (3.7)$$

where, β^k_{jit}, as before, the stock returns sensitivity of country j's bank i to unanticipated changes in the selected interest rate proxy k at time t. CAP is the ratio of bank i's book value of equity to its total assets. X_{jit} is the it-th observation on $(M-2)$ additional company specific financial ratios with λ being $(M-2)\times 1$ vector of coefficients. T_t and C_j are vectors of year- and country-dummies of dimension $T-1$ and $C-1$ respectively.

In particular, we test the null hypothesis that better capitalised banks are generally safer, although excessive capital levels instigate higher risk-taking. In other words, I test whether the capital-risk relationships are in fact U-shaped: $\lambda_1 < 0$ and $\lambda_2 > 0$.

The estimation results reported in Table 3.5 suggest a negative association between the banks' capital levels and all four measures of interest rate risk. It appears that firms with higher capital buffers enjoy lower exposure to the unanticipated interest rate movements and, through this channel, foster the stability to the banking sector.

Nonetheless, the realised benefits diminish as banks continue to accumulate excessive capital levels. This implies U-shape capital-risk relationships as per Hypothesis 1, and in line with Calem and Rob (1999) and Haq and Heaney (2009). These results are robust to controlling for further financial variables in columns (3) to (11).

I also find that the level of equity capital is more important in curtailing interest rate exposures in countries without explicit depositor insurance as reported in Table 3.6. This is most likely due to a higher level of market discipline prevailing in these markets, with managers being forced to set aside capital buffers in accordance to expected risk exposures. Accordingly, following the monetary policy shocks these banks appear to be more protected. This outcome validates Hypothesis 2.

To test Hypothesis 4, I modify the model in (3.8) by also incorporating the measures of loan-to-assets (LTA) and low cost deposits (LCL). The pertinent results are reported in column 3 of Table 3.5.

In line with theoretical predictions and the findings of Fraser, Madura and Weigand (2002), the loan-to-assets ratio is negatively related to the measures of interest rate risk. The only exception is reported for the short-term beta. This implies an increased concentration of adjustable-rate, frequently repriced, products in the bank loan book resulting in a lower interest rate sensitivity of these assets. These products are most likely of medium- or long-term maturity, explaining the insignificant results for short-term beta.

It also appears that banks with a higher level of low cost liabilities (LCL), such as customer deposits, exhibit lower interest rate risk. However, this relationship is only supported in countries with explicitly adopted deposit protection mechanisms. As reported in columns 2, 10, and 14 of Table 3.6, in countries without such protection bank risks are considerably higher, owing to the unstable character of at-risk deposit liabilities and increased probability of bank runs. Accordingly, companies in these countries rely more on alternative, frequently repriced funds. This results in higher exposure to interest rate risk.

Given these results, it is only justified to closely investigate how the degree of bank intermediation affects its exposure to interest rates. For this purpose I employ the ratio of bank net total loans to its total deposits (TLTD).

The ratio bears a positive sign, implying a higher interest rate risk for institutions relying more on expensive borrowed funds to finance their loan portfolio (column 7 of Table 3.5). Following the term-structure shock, these liabilities are repriced, thereby depressing the banks' interest margins. These findings are particularly alarming amidst the global financial crisis, characterised by increased costs of term funding and constrained liquidity. In attempts to revive the economy, governments worldwide encourage deposit-starved banks to further extend their lending activities, bringing the loan-to-deposit ratio to its highest level in decades. Of even more concern is that banks' loan-to-deposit ratio is rising in line with declining net-interest margins (e.g. the UK example presented in the introductory note), and crisis-induced decline in non-interest income.

Hypothesis 5 states that the relationships between accounting and market measures of risk can be altered by the banks' excessive credit risk or specialisation. I account for these characteristics by introducing relevant interactive terms as follows:

$$\left|\beta^k_{jit}\right| = \varphi + \lambda_1 LTA_{ji,t-1} * DCAD + \lambda_2 LTA_{ji,t-1} * (1 - DCAD) + \\ + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + C_j\chi + T'_t\theta + \varepsilon_{it} \quad (3.8)$$

$$\left|\beta^k_{jit}\right| = \varphi + \lambda_1 LTA_{ji,t-1} + \lambda_2 LTA_{ji,t-1} * ALER_{ji,t-1} + \\ + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + C_j\chi + T'_t\theta + \varepsilon_{it} \quad (3.9)$$

where DCAD is a bank specialisation dummy, taking a value of 1 for banks with $LTA \geq 0.8$ (specialised commercial bank), 0 otherwise. Approximately 64 percent of specialised institutions in our sample are small banks with an asset value of under USD \$5 billion. The significance of the asymmetry in (3.9) is addressed using the Wald coefficient restriction test with the null hypothesis stating the equality of coefficients λ_1 and λ_2.

ALER proxies the bank average lending rate calculated as the ratio of interest income to total earning assets. This variable is used as a forward looking measure of bank credit risk, arising as a result of increased loan rates and consequential deterioration in the asset credit quality. Accordingly, I anticipate higher interest rate exposure for banks which increased chargeable lending rates in recent years and have a greater proportion of repriced assets. Under the specifications in (3.10), the impact of loan book concentration on bank risk exposure $f(\partial\beta^k/\partial LTA)$ is determined by the bank forward looking measure of credit risk $ALER$: $\partial\beta^k/\partial LTA = \lambda_1 + \lambda_2 ALER$. The results are outlined in columns 4 and 5 of Tables 3.5.

Interesting findings are reported for the banks' specialisation ratio DCAD. It emerges that specialisation does not markedly improve the bank risk profile. Both diversified and specialised lenders enjoy a statistically identical reduction in interest rate exposure associated with the size of loans portfolio. This suggests that benefits introduced by the strict asset-liability management practices and well established interest rate transmission mechanism, commonly found in specialised financial institutions, are counterbalanced by the diversification advantages enjoyed by their non-specialised peers.

As per specification (3.10), I find that banks which recently increased their chargeable lending rates do not significantly benefit from a higher proportion of repriced assets (column 4 of Table 3.5). In fact these institutions exhibit higher exposure to the shocks in either medium- or long-term interest rates. This supports my empirical hypothesis and accentuates the link between credit and interest rate risks previously emphasised by Jarrow and Turnbull (2000), and Drehmann, Sorensen, and Stringa (2006).

Finally, I argue that institutions with higher proportion of large depositors are less risky. This is because the majority of deposit insurance schemes introduced in analysed countries enforce coverage limits leaving large depositors (such as other banks and subordinated debt-holders) unprotected. Therefore, the exposure to a potential loss encourages large depositors to closely monitor and possibly alter the risk-taking behaviour of banks.

Surprisingly, I find only weak evidence to support this view. Table 3.5 reports conflicting results, with the significant coefficients for variables proxying the market disciplinary effect (BDTD, UDTD) taking either positive or negative sign. The results in Table 3.6, however, suggest that this significant association is mainly attributed to the markets providing explicit deposit coverage. For these countries, I find only some evidence of monitoring by at-risk depositories translating to a lower short-term interest rate exposure.

Contrary to the theoretical prediction, institutions attracting a higher proportion of interbank deposits show greater exposure to movements in the interest rate term-spread. Interestingly, this effect is more pronounced when I use an aggregate measure of uninsured deposits and subordinated debt (UDTD), suggesting that interest rate risk may be a function increasing with the maturity of the bank's uninsured liabilities. Clearly, more research is needed in this area, as well as in investigating the bank performance attributes guiding unprotected at-risk claimholders in their decision to invest.

With respect to Hypothesis 6 concerning banks' activities off-balance, I include the ratio of the bank's total off-balance sheet exposure to its total assets (CLTA) in specification (3.6).

The estimation results, reported in Table 3.5, provide weak evidence in support of the hypothesised relationship. In the presence of such weak evidence, I reformulate the regression allowing for a separate treatment of small versus medium and large banks. Furthermore, as the existence and design of deposit insurance schemes significantly alters the moral hazard risk-taking behaviour of banks [Hooks and Robinson, 2002; Demirgüç-Kunt and Huizinga,1998], the motivations for derivative usage would also differ across the markets. For instance, firms in markets with explicitly adopted deposit protection schemes are more likely to use derivatives for speculating. Banks lacking such explicit protection and the ones forced to share the costs of insolvency by providing some forms of explicitly specified risk-based premiums would rather use derivatives for hedging.

Table 3.6
Bank financials, deposit insurance and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{IR}_{it}| = \varphi + [X'_{it}*EDI\_REG + X'_{it}*(1-EDI\_REG)]\gamma + C_j\xi + T_t'\theta + \varepsilon_{it}, \quad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{IR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the pertinent interest rate proxy (IR = SR, LR, SPR, CURV) at time *t*. There are four panel regressions for each interest rate proxy as per the first row of the Table. γ is a $2M$ x 1 vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. *EDI_REG* is a dummy variable assuming a value of 1 for countries adopted an explicit deposit protection scheme, and 0 otherwise. T_t and C_j are vectors of year- and country-dummies of dimension *T-1* and *C-1* respectively. The disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The regressions are estimated for the following company specific financial measures all calculated at time *t-1*:

$$\text{ROID} = 1 - \left|\frac{(\text{NetInt Inc.} - \text{NonInt.Inc})}{\text{Total Oper. Income}}\right| \qquad \text{LCL} = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \qquad \text{CLTA} = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}}$$

$$\text{CAP} = \frac{\text{Equity Capital}}{\text{Total Assets}} \qquad \text{BDTD} = \frac{\text{Bank Deposits}}{\text{Total Deposits}} \qquad \text{ROAE} = \frac{\text{Net Income}}{\text{Total Equity}}$$

$$\text{LTA} = \frac{\text{Net Loans}}{\text{Total Assets}} \qquad \text{UDTD} = \frac{\text{Bank Depos.+Subord. Debt}}{\text{Total Deposits}} \qquad \text{LPTL} = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

The (+) sign in the second column of the Table corresponds to the coefficient estimates for countries adopting an explicit deposit insurance, while (-) corresponds to the coefficients for countries with no explicit deposit protection. The test statistics (*F-statistics*) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated *p-value* reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

		Short - term interest rate				Long - term interest rate				Interest rate spread term				Yield curve curvature			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Const.		0.696	0.706	0.704	0.688	0.112	0.120	0.105	0.105	0.096	0.133	0.089	0.090	0.036	0.038	0.037	0.038
		*6.90****	*5.62****	*6.81****	*6.58****	*13.62****	*7.14****	*12.45****	*11.53****	*10.96****	*6.25****	*11.47****	*10.66****	*8.50****	*7.34****	*8.55****	*8.00****
ROID	(+)	0.067				-0.026				-0.020				-0.001			
		0.96				*-2.33***				*-1.83**				*-0.26*			
ROID	(-)	-0.101				-0.041				-0.046				-0.005			
		-1.06				*-2.40***				*-3.27****				*-0.82*			
WALD		2.083				0.611				2.760				0.452			
p-value		*(0.149)*				*(0.435)*				*(0.097)*				*(0.502)*			
CAP	(+)	-4.856	-4.574	-4.658	-5.037	-0.308	-0.270	-0.276	-0.272	-0.286	-0.201	-0.249	-0.149	-0.207	-0.195	-0.207	-0.190
		*-1.89**	*-1.83**	*-1.86**	*-2.07***	*-2.20***	*-1.90**	*-1.95**	*-1.70**	*-2.21***	*-1.65**	*-2.01***	*-1.13*	*-1.94**	*-1.85**	*-1.94**	*-1.61*
CAP	(-)	-6.034	-6.861	-6.559	-5.495	-0.606	-0.512	-0.480	-0.372	0.021	-0.106	0.125	0.137	-0.338	-0.528	-0.331	-0.404
		*-3.48****	*-3.53****	*-3.70****	*-3.25****	*-3.12****	*-2.78****	*-2.86****	*-2.42***	*0.15*	*-0.52*	*1.19*	*1.05*	*-1.77**	*-2.54***	*-1.81**	*-2.25***
WALD		0.281	0.953	0.871	0.062	1.945	1.236	1.076	0.267	4.600	0.188	8.268	3.918	0.381	2.136	0.375	1.125
p-value		*(0.596)*	*(0.329)*	*(0.351)*	*(0.803)*	*(0.163)*	*(0.266)*	*(0.300)*	*(0.605)*	*(0.032)*	*(0.665)*	*(0.004)*	*(0.048)*	*(0.537)*	*(0.144)*	*(0.540)*	*(0.289)*
CAP^2	(+)	23.703	21.884	22.608	24.667	1.840	1.748	1.778	1.834	1.544	1.164	1.398	1.012	1.170	1.118	1.165	1.108
		*1.84**	*1.76**	*1.81**	*2.06***	*2.91****	*2.70****	*2.74****	*2.54***	*2.61****	*1.93**	*2.38***	*1.73**	*2.20***	*2.12***	*2.19***	*1.88**
CAP^2	(-)	26.921	30.161	28.920	23.426	2.536	2.273	2.277	2.000	-0.216	-0.266	-0.472	-0.254	1.992	2.770	1.955	2.298
		*3.11****	*3.37****	*3.49****	*3.10****	*2.49***	*2.67****	*2.64****	*2.41***	*-0.41*	*-0.43*	*-0.91*	*-0.44*	*1.69**	*2.33***	*1.73**	*2.18***
WALD		0.068	0.458	0.324	0.016	0.350	0.248	0.222	0.023	5.375	2.931	6.229	2.689	0.376	1.530	0.380	0.923
p-value		*(0.795)*	*(0.499)*	*(0.569)*	*(0.899)*	*(0.554)*	*(0.618)*	*(0.638)*	*(0.878)*	*(0.021)*	*(0.087)*	*(0.013)*	*(0.101)*	*(0.540)*	*(0.216)*	*(0.538)*	*(0.337)*
LTA	(+)	-0.031	-0.027	-0.023	-0.004	-0.043	-0.046	-0.045	-0.043	-0.024	-0.026	-0.026	-0.033	-0.005	-0.005	-0.006	-0.007
		-0.52	*-0.45*	*-0.38*	*-0.06*	*-4.54****	*-4.85****	*-4.49****	*-4.04****	*-2.97****	*-3.12****	*-3.11****	*-3.55****	*-1.50*	*-1.46*	*-1.68**	*-1.78**

LTA	(-)	0.076	-0.048	-0.010	-0.043	0.007	-0.009	-0.015	-0.028	-0.097	-0.158	-0.125	-0.143	-0.005	-0.032	-0.009	-0.011
		1.00	-0.51	-0.19	-0.88	0.29	-0.28	-0.74	-1.94*	-2.42**	-2.12**	-2.32**	-2.70***	-0.38	-1.72*	-0.59	-0.83
WALD		1.156	0.036	0.024	0.219	3.763	1.086	1.786	0.754	3.503	3.250	3.603	4.634	0.004	2.095	0.029	0.111
p-value		(0.283)	(0.849)	(0.878)	(0.640)	(0.053)	(0.298)	(0.182)	(0.385)	(0.062)	(0.072)	(0.058)	(0.032)	(0.949)	(0.148)	(0.865)	(0.739)
LCL	(+)		-0.004				-0.014				-0.046				-0.003		
			-0.05				-1.00				-2.41**				-0.88		
LCL	(-)		0.049				-0.011				0.018				0.027		
			0.56				-0.54				0.55				2.65***		
WALD			0.275				0.016				2.726				6.778		
p-value			(0.600)				(0.900)				(0.099)				(0.009)		
BDTD	(+)			-0.079				0.012				0.026				0.002	
				-1.35				0.78				2.03**				0.55	
BDTD	(-)			-0.055				-0.022				0.001				-0.010	
				-0.30				-0.80				0.04				-0.77	
WALD				0.015				1.173				0.523				0.802	
p-value				(0.903)				(0.279)				(0.470)				(0.371)	
UDTD	(+)				-0.110				0.006				0.033				0.001
					-1.83*				0.36				2.22**				0.12
UDTD	(-)				-0.077				-0.029				-0.020				-0.003
					-0.50				-0.96				-0.40				-0.23
WALD					0.041				1.037				1.078				0.068
p-value					(0.840)				(0.309)				(0.299)				(0.794)
CLTA	(+)	-0.006	-0.005	-0.007	-0.006	-0.002	-0.002	-0.002	-0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	-0.001
		-1.34	-1.17	-1.58	-1.46	-1.75*	-1.78*	-1.68*	-1.87*	-0.17	0.53	0.10	-0.07	-1.50	-1.26	-1.27	-1.42
CLTA	(-)	-0.017	-0.057	-0.061	-0.126	0.014	-0.008	-0.006	-0.024	0.031	0.012	0.008	0.001	-0.005	-0.004	-0.007	-0.010
		-0.18	-0.79	-0.83	-1.93*	1.16	-0.53	-0.45	-1.18	1.26	0.57	0.38	0.06	-0.77	-0.66	-1.28	-1.80*
WALD		0.013	0.511	0.534	3.365	1.720	0.149	0.088	1.142	1.602	0.294	0.144	0.004	0.480	0.351	1.438	2.882
p-value		(0.911)	(0.475)	(0.465)	(0.067)	(0.190)	(0.700)	(0.767)	(0.286)	(0.206)	(0.588)	(0.705)	(0.949)	(0.489)	(0.553)	(0.231)	(0.090)
ROAE	(+)	0.007	0.007	0.007	0.006	-0.004	-0.004	-0.004	-0.004	0.000	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000
		2.27**	2.33**	2.34**	1.94*	-7.30***	-7.43***	-7.38***	-8.12***	-0.89	-1.39	-1.05	-1.98**	0.07	0.06	0.06	-0.23
ROAE	(-)	0.018	-0.044	-0.019	0.133	0.010	0.008	0.022	0.033	0.087	0.038	0.087	0.098	0.025	0.015	0.025	0.032
		0.07	-0.17	-0.07	0.49	0.20	0.17	0.42	0.52	2.09**	0.83	1.57	1.52	1.08	0.79	1.07	1.36
WALD		0.002	0.037	0.009	0.214	0.077	0.062	0.244	0.333	4.405	0.712	2.483	2.356	1.164	0.622	1.151	1.865
p-value		(0.966)	(0.847)	(0.925)	(0.644)	(0.782)	(0.803)	(0.622)	(0.564)	(0.036)	(0.399)	(0.115)	(0.125)	(0.281)	(0.430)	(0.284)	(0.172)
LPTL	(+)	-2.843	-2.801	-2.773	-2.639	0.337	0.333	0.337	0.221	0.084	0.068	0.076	0.034	0.012	0.013	0.009	-0.043
		-1.74*	-1.75*	-1.73*	-1.63	1.42	1.36	1.38	0.80	0.55	0.43	0.47	0.21	0.23	0.24	0.16	-0.97
LPTL	(-)	2.847	3.142	3.269	2.723	1.320	1.448	1.475	1.022	1.468	1.456	1.662	1.419	0.279	0.266	0.295	0.249
		1.33	1.54	1.55	1.34	1.29	1.38	1.38	1.06	2.25**	2.03**	2.28**	2.20**	1.60	1.44	1.47	1.38
WALD		4.628	5.341	5.350	4.260	0.864	1.065	1.064	0.636	4.271	3.593	4.467	4.325	2.125	1.736	1.886	2.430
p-value		(0.032)	(0.021)	(0.021)	(0.039)	(0.353)	(0.302)	(0.303)	(0.425)	(0.039)	(0.058)	(0.035)	(0.038)	(0.145)	(0.188)	(0.170)	(0.119)
Country effect:		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effect:		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2		0.29	0.29	0.29	0.28	0.11	0.11	0.10	0.09	0.13	0.14	0.13	0.12	0.18	0.18	0.18	0.18
F - stats.		17.41***	17.40***	17.19***	13.79***	6.13***	5.83***	5.63***	4.47***	7.20***	7.45***	6.90***	5.35***	9.97***	10.17***	9.85***	8.34***

Accordingly, the following regressions are estimated:

$$\left|\beta_{jit}^{k}\right| = \varphi + \lambda_1 CLTA_{ji,t-1} * D\_LARGE + \lambda_2 CLTA_{ji,t-1} * OTHERS + \\ + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + C_j\chi + T'_t\theta + \varepsilon_{it} \quad (3.10)$$

$$\left|\beta_{jit}^{k}\right| = \varphi + \lambda_1 CLTA_{ji,t-1} * EDI\_REG + \lambda_2 CLTA_{ji,t-1} * (1 - EDI\_REG) + \\ + X'_{ji,t-1}\lambda + S'_{j,t-1}\psi + C_j\chi + T'_t\theta + \varepsilon_{it} \quad (3.11)$$

where D_LARGE is a bank size dummy, taking a value of 1 for banks with total value of assets in excess of 50 billion US dollars in a respective year, and 0 otherwise; EDI_REG is a dummy variable taking value of 1 for countries adopted an explicit deposit protection scheme, and 0 otherwise. The significance of the asymmetry is addressed using the Wald coefficient restriction test with the null hypothesis stating the equality of coefficients λ_1 and λ_2.

The empirical results for the modified models are outlined in Tables 3.5. There is strong evidence to conclude that large banks are likely to use off-balance sheet activities for hedging their short-term interest rate exposures. This observation is consistent with Au Yong, Faff, and Chalmers (2009) who also relate an increase in derivative activities of Asia-Pacific banks to a lower short-term interest rate exposure. The small and medium size banks, on the other hand, appear to more effectively use derivatives in reducing their long-term interest rate exposure.

I further conclude that the provision of deposit insurance plays some role in shaping the bank risk taking behaviour. Conversely to my expectations it appears that only explicitly protected institutions tend to use derivatives for hedging, while non-protected banks do not benefit from off-balance sheet transactions.

Design of deposit insurance and interest rate risk

The relationship between market and accounting measures of risk depends on the provision of deposit insurance (Table 3.6). Therefore, it seems sensible to further examine the differential impact of the deposit insurance design features on bank interest rate exposure. Table 3.7 presents the regression results when interchangeably including a wide range of variables, each representing a particular attribute of the adopted insurance scheme.

I report a strongly positive association between bank interest rate risk and the generosity of the deposit insurance. Both proxies of "generous" provision (GDI_REG and DIC_REG) are positive and strongly significant for all interest

Table 3.7: Panel A
Deposit insurance design and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{IR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + T_t'\theta + \varepsilon_{it}, \quad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{IR}_{it} represents the stock returns sensitivity of country j's bank i to the unanticipated changes in the pertinent interest rate proxy (IR = SR, LR) at time t. There are five panel regressions for each interest rate proxy as per the first row of the Table. γ is an M x 1 vector of coefficients and X_{it} is the it-th observation on M company specific financial ratios, served as explanatory variables. Similarly, ξ is an S x 1 vector of coefficients and S_{jt} is the jt-th observation on S country specific variables describing the design of existing deposit protection scheme. T_t is a vector of year-dummies of dimension T-1, and the disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{it}) and S country level regressors (S_{jt}). For each estimated model j=13, i=289 and t=11 resulting in 3179 observations. The regressions are estimated for the following company- and market- specific varibales all calculated at time t-1:

$$ROID = 1 - \left|\frac{(\text{NetInt Inc.} - \text{NonInt.Inc})}{\text{Total Oper. Income}}\right| \qquad LCL = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \qquad LPTL = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

$$CAP = \frac{\text{Equity Capital}}{\text{Total Assets}} \qquad CLTA = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}} \qquad DIC\_REG = \frac{\text{Protection coverage}}{\text{GDP-per-capita}}$$

$$LTA = \frac{\text{Net Loans}}{\text{Total Assets}} \qquad ROAE = \frac{\text{Net Income}}{\text{Total Equity}}$$

GDI_REG is a dummy variably assuming a value of 1 if the county's j ratio of insurance coverage/GDP-per-capita ≥ median over all analysed countries, and 0 otherwise; RBI_REG is a dummy taking a value of 1 if the deposit insurance fees charged to banks vary based on some assessment of risk, and 0 otherwise; and CDI_REG takes a value of 1 if there is a formal coinsurance requirements, and 0 otherwise. SDI_REG = RBI_REG+CDI_REG (Index of Stringent Insurance). The market macroeconomic conditions are proxied by the following measures, all calculated at time t-1: M_GDPG represents year-on-year GDP growth, M_INFL measures the inflation as the current period CPI growth rate, and M_EXCI is the real effective exchange rate. D_FREN, D_GERM, and D_SCAN are time-invariant "legal origin" dummy variables assuming the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. Heteroskedasticity and autocorrelation consistent t-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	Short - term interest rate						Long - term interest rate					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
GDI_REG	-0.001					0.244	0.028					0.043
	-0.03					*5.04****	*5.59****					*4.20****
DIC_REG		-0.004						0.011				
		-0.40						*5.29****				
RBI_REG			-0.195						0.008			
			*-5.30****						*1.18*			
CDI_REG				0.081						0.020		
				*3.65****						*4.36****		
SDI_REG					-0.014	0.154					0.014	-0.015
					-0.84	*3.35****					*3.83****	*-1.80**
GDI_REG*SDI_REG						-0.309						0.001
						*-5.45****						*0.15*
D_FREN	-0.009	-0.004	0.026	-0.027	-0.004	-0.042	0.007	-0.011	0.002	-0.002	-0.003	0.016
	-0.38	*-0.12*	*1.24*	*-1.13*	*-0.14*	*-1.79**	*1.72**	*-2.69****	*0.35*	*-0.38*	*-0.63*	*2.49***
D_GERM	-0.137	-0.143	-0.283	-0.076	-0.157	-0.207	0.027	0.016	0.002	0.011	0.017	0.025
	*-2.60****	*-3.02****	*-5.38****	*-1.70**	*-3.13****	*-3.48****	*3.44****	*2.18***	*0.24*	*1.60*	*2.12***	*3.08****
D_SCAN	-0.265	-0.269	-0.187	-0.187	-0.272	-0.431	0.039	0.019	0.005	0.026	0.015	0.051
	*-5.80****	*-7.78****	*-5.22****	*-5.40****	*-7.89****	*-5.07****	*3.89****	*2.17***	*0.49*	*2.71****	*1.68**	*4.01****
M_GDPG	-0.842	-1.071	-3.397	-0.421	-1.083	-3.133	0.663	0.811	0.306	0.297	0.451	0.708
	-0.81	*-0.94*	*-3.43****	*-0.50*	*-1.16*	*-2.44***	*3.02****	*3.71****	*1.55*	*1.53*	*2.20***	*3.27****
M_INFL	-13.513	-13.731	-16.641	-11.520	-14.050	-14.281	0.638	0.306	-0.182	0.168	0.249	0.663
	*-6.85****	*-7.67****	*-8.50****	*-7.38****	*-7.46****	*-6.85****	*2.56***	*1.25*	*-0.68*	*0.72*	*0.98*	*2.57***
M_EXCI	-0.823	-0.829	-0.848	-0.843	-0.822	-0.896	0.007	0.018	0.004	-0.002	0.001	0.012
	*-3.48****	*-3.49****	*-3.57****	*-3.61****	*-3.47****	*-3.79****	*0.19*	*0.47*	*0.12*	*-0.05*	*0.03*	*0.31*
Const.	0.759	0.777	0.929	0.632	0.791	0.751	0.062	0.069	0.113	0.089	0.086	0.060
	*6.01****	*6.21****	*7.87****	*5.54****	*6.56****	*5.65****	*3.29****	*4.10****	*6.25****	*5.31****	*4.75****	*3.18****
ROID	-0.146	-0.147	-0.060	-0.125	-0.144	-0.049	-0.031	-0.030	-0.036	-0.027	-0.035	-0.028
	*-2.37***	*-2.39***	*-0.91*	*-2.03***	*-2.30***	*-0.75*	*-3.81****	*-3.60****	*-4.05****	*-3.29****	*-4.22****	*-3.30****
CAP	-5.335	-5.274	-4.800	-5.571	-5.258	-4.497	-0.639	-0.730	-0.586	-0.628	-0.639	-0.617
	*-2.29***	*-2.23***	*-2.08***	*-2.41***	*-2.24***	*-1.93**	*-2.28***	*-2.59****	*-1.97***	*-2.24***	*-2.24***	*-2.17***
CAP^2	22.572	22.085	19.608	25.090	21.946	20.440	3.149	3.744	2.492	3.058	3.027	2.991
	*1.86**	*1.79**	*1.65**	*2.07***	*1.80**	*1.69**	*2.03***	*2.43***	*1.56*	*1.98***	*1.95**	*1.90**
LTA	0.049	0.046	-0.003	0.050	0.045	0.016	-0.037	-0.034	-0.040	-0.041	-0.038	-0.038
	0.74	*0.68*	*-0.05*	*0.78*	*0.67*	*0.28*	*-3.82****	*-3.72****	*-3.67****	*-4.25****	*-3.79****	*-3.86****
LCL	0.144	0.145	0.024	0.140	0.136	0.029	0.012	0.007	0.015	0.009	0.017	0.006
	*3.18****	*3.24****	*0.48*	*3.05****	*2.82****	*0.58*	*1.07*	*0.66*	*1.17*	*0.81*	*1.48*	*0.46*
CLTA	-0.008	-0.008	-0.008	-0.006	-0.008	-0.005	-0.001	-0.002	-0.002	-0.002	-0.002	-0.001
	-1.63	*-1.67**	*-1.79**	*-1.14*	*-1.72**	*-1.15*	*-1.61*	*-1.95**	*-2.46***	*-1.84**	*-1.93**	*-1.63*
ROAE	0.009	0.009	0.009	0.008	0.009	0.008	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	*2.19***	*2.20***	*2.32***	*2.07***	*2.21***	*2.22***	*-5.83****	*-5.38****	*-5.57****	*-6.03****	*-5.71****	*-5.88****
LPTL	-1.686	-1.647	-1.725	-2.195	-1.605	-2.063	0.334	0.328	0.459	0.322	0.365	0.354
	-1.38	*-1.34*	*-1.44*	*-1.69**	*-1.31*	*-1.62*	*1.65**	*1.65*	*2.45***	*1.58*	*1.87**	*1.76**
Country effect:	No	No	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.30	0.30	0.31	0.31	0.30	0.32	0.12	0.12	0.10	0.11	0.11	0.12
F - stats.	24.72***	24.73***	25.95***	25.11***	24.74***	24.25***	8.31***	8.39***	6.84***	7.66***	7.52***	7.83***

Table 3.7: Panel B
Deposit insurance design and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{IR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + T_t'\theta + \varepsilon_{it}, \quad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{IR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the pertinent interest rate proxy (IR = SPR, CURV) at time *t*. There are five panel regressions for each interest rate proxy as per the first row of the Table. γ is an M x 1 vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. Similarly, ξ is an S x 1 vector of coefficients and S_{jt} is the *jt*-th observation on *S* country specific variables describing the design of existing deposit protection scheme. T_t is a vector of year-dummies of dimension *T-1,* and the disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}) and *S* country level regressors (S_{jt}). For each estimated model *j=13, i=289* and *t=11* resulting in *3179* observations. The regressions are estimated for the following company- and market- specific variables all calculated at time *t-1*:

$$ROID = 1 - \left|\frac{\text{(NetInt Inc.–NonInt.Inc)}}{\text{Total Oper. Income}}\right| \qquad LCL = \frac{\text{Customer Deposits}}{\text{Total Deposits}} \qquad LPTL = \frac{\text{Loan Loss Provision}}{\text{Net Loans}}$$

$$CAP = \frac{\text{Equity Capital}}{\text{Total Assets}} \qquad CLTA = \frac{\text{Total Contingent Liabilities}}{\text{Total Assets}} \qquad DIC\_REG = \frac{\text{Protection coverage}}{\text{GDP-per-capita}}$$

$$LTA = \frac{\text{Net Loans}}{\text{Total Assets}} \qquad ROAE = \frac{\text{Net Income}}{\text{Total Equity}}$$

GDI_REG is a dummy variably assuming a value of 1 if the county's *j* ratio of insurance coverage/GDP-per-capita ≥ median over all analysed countries, and 0 otherwise; RBI_REG is a dummy taking a value of 1 if the deposit insurance fees charged to banks vary based on some assessment of risk, and 0 otherwise; and CDI_REG takes a value of 1 if there is a formal coinsurance requirements, and 0 otherwise. SDI_REG = RBI_REG+CDI_REG (Index of Stringent Insurance). The market macro-economic conditions are proxied by the following measures, all calculated at time *t-1*: M_GDPG represents year-on-year GDP growth, M_INFL measures the inflation as the current period CPI growth rate, and M_EXCI is the real effective exchange rate. D_FREN, D_GERM, and D_SCAN are time-invariant "legal origin" dummy variables assuming the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	Interest rate term spread						Yield curve curvature					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
GDI_REG	0.014					0.055	0.007					0.019
	*3.36******					*4.90****	*4.46****					*5.59****
DIC_REG		0.002						0.002				
		1.39						*2.87****				
RBI_REG			-0.014						-0.002			
			*-2.27***						*-1.75**			
CDI_REG				0.014						0.005		
				*3.17****						*3.51****		
SDI_REG					0.003	-0.005					0.002	-0.005
					0.99	*-0.73*					*2.28***	*-2.03***
GDI_REG*SDI_REG						-0.024						-0.005
						*-3.35****						*-1.96***
D_FREN	-0.005	-0.009	-0.004	-0.010	-0.008	0.003	0.003	0.000	0.003	0.001	0.001	0.007
	-1.00	*-1.90**	*-0.93*	*-2.01***	*-1.60*	*0.56*	*2.36***	*0.19*	*2.37***	*0.80*	*0.99*	*4.70****
D_GERM	0.011	0.000	-0.015	0.006	0.001	0.003	0.010	0.006	0.001	0.007	0.006	0.008
	1.63	*-0.07*	*-1.94**	*0.94*	*0.14*	*0.49*	*3.44****	*2.10***	*0.32*	*2.62****	*2.20***	*2.78****
D_SCAN	0.005	-0.009	-0.005	0.002	-0.009	0.007	0.004	-0.002	-0.002	0.002	-0.002	0.008
	0.94	*-2.10***	*-1.02*	*0.39*	*-2.21***	*0.88*	*1.71**	*-0.78*	*-1.18*	*0.76*	*-0.96*	*2.66****
M_GDPG	0.270	0.151	-0.143	0.101	0.099	0.136	0.194	0.167	0.047	0.106	0.122	0.175
	1.30	*0.67*	*-0.65*	*0.55*	*0.48*	*0.64*	*2.85****	*2.26***	*0.73*	*1.87**	*1.93**	*2.51***
M_INFL	0.169	-0.194	-0.533	0.015	-0.172	0.137	0.018	-0.128	-0.256	-0.086	-0.121	0.017
	0.51	*-0.61*	*-1.54*	*0.05*	*-0.52*	*0.41*	*0.24*	*-1.61*	*-2.94****	*-1.15*	*-1.60*	*0.22*
M_EXCI	0.041	0.041	0.037	0.035	0.038	0.041	-0.006	-0.005	-0.007	-0.008	-0.007	-0.005
	0.86	*0.87*	*0.79*	*0.75*	*0.81*	*0.87*	*-0.50*	*-0.39*	*-0.62*	*-0.71*	*-0.62*	*-0.42*
Const.	0.074	0.094	0.116	0.083	0.095	0.071	0.016	0.023	0.033	0.022	0.025	0.015
	*3.75****	*5.04****	*6.88****	*4.42****	*4.93****	*3.84****	*2.41***	*3.84****	*5.65****	*3.61****	*3.95****	*2.34***
ROID	-0.034	-0.035	-0.029	-0.032	-0.036	-0.023	-0.009	-0.009	-0.008	-0.008	-0.010	-0.006
	*-3.28****	*-3.41****	*-2.93****	*-2.89****	*-3.54****	*-2.13***	*-2.99****	*-3.06****	*-2.94****	*-2.54***	*-3.32****	*-1.95**
CAP	-0.494	-0.489	-0.431	-0.499	-0.476	-0.388	-0.236	-0.244	-0.214	-0.236	-0.234	-0.202
	*-1.74**	*-1.71**	*-1.51*	*-1.78**	*-1.67**	*-1.37*	*-2.44***	*-2.44***	*-2.14***	*-2.45***	*-2.38***	*-2.07***
CAP^2	2.352	2.220	1.804	2.421	2.126	1.927	1.237	1.270	1.049	1.253	1.195	1.068
	1.62	*1.53*	*1.25*	*1.70**	*1.47*	*1.34*	*2.48***	*2.43***	*2.04***	*2.50***	*2.34***	*2.12***
LTA	-0.018	-0.019	-0.024	-0.020	-0.019	-0.022	-0.002	-0.002	-0.004	-0.003	-0.002	-0.003
	-1.43	*-1.48*	*-1.98***	*-1.62*	*-1.52*	*-1.88**	*-0.46*	*-0.47*	*-0.87*	*-0.72*	*-0.55*	*-0.77*
LCL	-0.014	-0.016	-0.024	-0.016	-0.013	-0.032	0.007	0.006	0.005	0.006	0.008	0.002
	-1.29	*-1.42*	*-2.01***	*-1.45*	*-1.18*	*-2.67****	*2.60****	*2.33***	*1.69**	*2.35***	*2.72****	*0.60*
CLTA	0.000	-0.001	-0.001	0.000	-0.001	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	-0.38	*-0.72*	*-0.95*	*-0.36*	*-0.71*	*-0.11*	*-2.21***	*-2.46***	*-2.67****	*-2.26***	*-2.48***	*-2.00***
ROAE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.43	*-0.27*	*-0.39*	*-0.50*	*-0.33*	*-0.86*	*-0.13*	*0.09*	*0.14*	*-0.18*	*0.02*	*-0.17*
LPTL	0.033	0.071	0.094	0.003	0.073	0.029	0.041	0.053	0.068	0.034	0.054	0.044
	0.23	*0.47*	*0.60*	*0.02*	*0.49*	*0.20*	*0.63*	*0.72*	*0.84*	*0.52*	*0.73*	*0.69*
Country effect:	No	No	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.12	0.11	0.11	0.12	0.11	0.13	0.17	0.16	0.16	0.17	0.16	0.18
F - stats.	8.21***	7.85***	8.05***	8.24***	7.83***	8.41***	12.26***	11.66***	11.41***	11.99***	11.55***	11.97***

rate proxies, with an exception of the short-term beta. This result is consistent with a view that depositors, assured in the safety of their wealth, will most conceivably induce banks to engage in more profitable and riskier activities. This will alter banks' risk exposures and aggravate moral hazard. It is also in line with a view commonly articulated in the literature. For instance, controlling for a variety of regulatory provisions, Barth et al. (2006) relate the increased likelihood of banking crises to the generosity of deposit insurance.

To reflect on the economic significance of the outlined findings, I estimate approximately a 3.5 percent reduction in the long-term interest rate exposure of Italian banks, should the Italian government decrease the explicit deposit coverage ratio (DIC_REG) from its current level of 4.96 to the sample mean of 1.93.

In light of this evidence, the most recent proposal under the Deposit Guarantee Schemes Directive (DGSD) to increase the levels of deposit coverage in the countries members of the European Union seems alarming at best. Specifically, following the turbulent market conditions over the 2007-2008, on 15 October 2008 the European Commission issued a proposal to improve DGSD. Under this proposal, the minimum level of deposit coverage is proposed to be increased from EUR $20,000$ to EUR $100,000$ within one year, and to EUR $50,000$ as of 15 October 2008. Surprisingly, the Basel Committee of Banking Supervision has not formally issued any recommendation regarding deposit protection arrangements.

Another reason why deposit protection may induce moral hazard is associated with banks generally paying only a flat-rate premium. Accordingly, I analyse whether the provision of stringent insurance requirements, such as risk based premiums and coinsurance, may be the answer to this problem.

Intuitively, the perception seems to be that it is risk based premiums, rather than coinsurance requirements, that offer greater risk-reduction benefits. In terms of coinsurance requirements, it can be argued that risk monitoring incentives should increase together with the proportion of depositors' wealth at risk. Nonetheless, provided that in the majority of past bank systemic failures governments extended blanket guarantees irrespective of coinsurance requirements, the depositors' risk monitoring incentive diminishes.

The results in Table 3.7 support the aforementioned arguments. The results are robust to all analysed risk proxies. It is also worth noting that bank interest rate exposure, induced by the provision of generous insurance, may be offset by imposing stringent deposit requirements. The interaction term GDIREG*SDIREG enters both regressions 6 and 12 of Table 3.7 significantly negative.

With respect to the macroeconomic conditions, I include the measure of GDP growth (M_GDPG) accounting for the cyclical output effect, and the measure of inflation computed as the current period CPI growth rate (M_INFL). I argue that GDP-growth affects several factors related to the supply and demand for loans and deposits, as well as the credit quality of the bank's loan book. Specifically, in the contracting economic environment, asset credit quality commonly deteriorates and default rates rocket. This paves the way for reduced bank profitability and increased risk sensitivities. Accordingly, I expect a negative association between GDP-growth and bank interest rate exposure. Given, however, recent evidence documenting a positive link between bank stock returns and economic growth (Cole, Moshirian, and Wu, 2008), the lagged M_GDPG variable is used in the model framework to relax simultaneity bias.

Despite my expectations, the negative coefficients are only reported for the short-term interest rate betas. For the remaining factors, the coefficient is positive. This suggests that amidst macroeconomic expansion banks may pursue riskier activities and show lower discipline of risk management practices.

The lagged changes in inflation rates are also included in the regression since unexpected changes in interest rates are mainly driven by unanticipated inflationary shocks. I assume that banks can reasonably foresee inflationary shocks and timely execute relevant hedges. Therefore, I anticipate a negative relationship between bank interest rate risk and inflation. Results in Table 3.7 support these expectations.

Finally, I use a set of "legal origin" dummy variables to account for differences in the countries' financial development. The dummies take a value of one if the legal origin of the target bank country is either German, French, or Scandinavian, and 0 otherwise. These variables are jointly significant with, though, diverse coefficient signs reported for different interest rate proxies. It appears that institutions in countries of English legal origin exhibit highest exposure to the shocks in the short-term interest rates, while lowest to changes in medium- and long-term rates.

Country regulatory characteristics and interest rate risk

In Table 3.8 I include a set of country regulatory characteristics that are believed to affect significantly bank behaviour.

First, I consider the index of regulatory restrictions on bank activities. I only find weak evidence that restricting banks' activities affect their interest rate exposure. The only significant coefficient (ACT_REG) is reported for the medium-term interest rate beta (Panel D). This is surprising at best, especially given that

Table 3.8: Panel A [Short-term IR]
Bank financials, bank regulations and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{SR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + G'_{jt}\lambda + T_t'\theta + \varepsilon_{it}, \quad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{SR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the domestic short-term interest rate at time *t*. γ is an M x 1 vector of coefficients and X_{it} is the *it*-th observation on M company specific financial ratios, served as explanatory variables. Similarly, ξ is an S x 1 vector of coefficients and S_{jt} is the *jt*-th observation on S country specific variables describing the design of existing bank regulations; and λ is an L x 1 and G_{jt} is the *jt*-th observation on L country specific macroeconomic characteristics. T_t is a vector of year-dummies of dimension *T-1*, and the disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{it}), S country level regulatory characteristics (S_{jt}), and L county specific macroeconomic factors (G_{jt}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The market-specific regulatory variables are as follows: ACT_REG is the Index of Restricted activities, CAP_REG is the *Index of Regulatory capital requirements*, DIS_REG is the *Index of Bank discipline*, DIV_REG is the *Diversification Index*, and INF_REG is the *Index of Information disclosure*. The detailed definitions for each index, including information sources and computational issues, are outlined in Table 3.1.

Each regression also includes the following company- and country-specific variables which are not reported: the measure of revenue diversification ROID, the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP (CAP^2), the ratio of net total loans to total assets LTA, the ratio of customer deposits to total deposits LCL, the ratio of bank *i's* total off-balance sheet exposure to its total assets CLTA, the ratio of net income to total equity ROAE, the ratio of loan loss provision to net loans LPTL, year-on-year GDP growth M_GDPG, M_INFL which measures the inflation as the current period CPI growth rate, and the real effective exchange rate M_EXCI, all calculated at time *t-1*. For details see Table 3.1. The regression also includes time-invariant "legal origin" dummy variables D_FREN, D_GERM, and D_SCAN which assume the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. The **(+)** sign in the second column of the Table corresponds to the coefficient estimates for countries adopting an explicit deposit insurance, while **(-)** corresponds to the coefficients for countries with no explicit deposit protection. The test statistics (*F*-statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated *p*-value reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ACT_REG	-0.006									
	-1.02									
CAP_REG		-0.017								
		-1.56								
DIS_REG			0.027							
			*4.61****							
DIV_REG				-0.051						
				*-2.98****						
INF_REG					-0.007					
					-1.43					
ACT_REG **(+)**						-0.011				
						-1.29				
ACT_REG **(-)**						-0.005				
						-0.94				
WALD						1.356				
p-value						*(0.245)*				
CAP_REG **(+)**							-0.019			
							-1.57			
CAP_REG **(-)**							-0.029			
							-1.21			
WALD							0.401			
p-value							*(0.527)*			
DIS_REG **(+)**								0.037		
								*5.60****		
DIS_REG **(-)**								0.021		
								*4.09****		
WALD								31.006		
p-value								*(0.000)*		
DIV_REG **(+)**									-0.093	
									*-4.41****	
DIV_REG **(-)**									-0.248	
									*-4.71****	
WALD									20.010	
p-value									*(0.000)*	
INF_REG **(+)**										-0.008
										-1.48
INF_REG **(-)**										-0.006
										-1.18
WALD										0.320
p-value										*(0.572)*
Country effect:	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.30	0.30	0.31	0.31	0.30	0.30	0.30	0.32	0.31	0.30
F - stats.	24.75***	24.80***	25.70***	25.10***	24.77***	23.77***	23.80***	25.01***	24.35***	23.77***

Table 3.8: Panel B [Long-term IR]
Bank financials, bank regulations and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{LR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + G'_{jt}\lambda + T_t'\theta + \varepsilon_{it}, \quad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{LR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the domestic long-term interest rate at time *t*. γ is an M x 1 vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. Similarly, ξ is an S x 1 vector of coefficients and S_{jt} is the *jt*-th observation on *S* country specific variables describing the design of existing bank regulations; and λ is an L x 1 and G_{jt} is the *jt*-th observation on *L* country specific macroeconomic characteristics. T_t is a vector of year-dummies of dimension *T-1,* and the disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}), *S* country level regulatory characteristics (S_{jt}), and *L* county specific macroeconomic factors (G_{jt}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The market-specific regulatory variables are as follows: ACT_REG is the Index of Restricted activities, CAP_REG is the *Index of Regulatory capital requirements*, DIS_REG is the *Index of Bank discipline*, DIV_REG is the *Diversification Index*, and INF_REG is the *Index of Information disclosure*. The detailed definitions for each index, including information sources and computational issues, are outlined in Table 3.1.

Each regression also includes the following company- and country-specific variables which are not reported: the measure of revenue diversification ROID, the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP (CAP²), the ratio of net total loans to total assets LTA, the ratio of customer deposits to total deposits LCL, the ratio of bank *i's* total off-balance sheet exposure to its total assets CLTA, the ratio of net income to total equity ROAE, the ratio of loan loss provision to net loans LPTL, year-on-year GDP growth M_GDPG, M_INFL which measures the inflation as the current period CPI growth rate, and the real effective exchange rate M_EXCI, all calculated at time *t-1*. For details see Table 3.1. The regression also includes time-invariant "legal origin" dummy variables D_FREN, D_GERM, and D_SCAN which assume the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. The **(+)** sign in the second column of the Table corresponds to the coefficient estimates for countries adopting an explicit deposit insurance, while **(-)** corresponds to the coefficients for countries with no explicit deposit protection. The test statistics (*F-statistics*) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated *p-value* reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ACT_REG	0.001									
	0.89									
CAP_REG		-0.005								
		*-2.10***								
DIS_REG			-0.002							
			-1.63							
DIV_REG				0.002						
				0.61						
INF_REG					-0.003					
					*-2.47***					
ACT_REG **(+)**						0.006				
						*3.01****				
ACT_REG **(-)**						0.000				
						0.37				
WALD						20.304				
p-value						*(0.000)*				
CAP_REG **(+)**							-0.008			
							*-3.40****			
CAP_REG **(-)**							-0.024			
							*-4.87****			
WALD							24.514			
p-value							*(0.000)*			
DIS_REG **(+)**								0.000		
								-0.22		
DIS_REG **(-)**								-0.002		
								*-2.65****		
WALD								8.304		
p-value								*(0.004)*		
DIV_REG **(+)**									-0.007	
									-1.51	
DIV_REG **(-)**									-0.038	
									*-3.19****	
WALD									14.999	
p-value									*(0.000)*	
INF_REG **(+)**										-0.002
										*-1.99***
INF_REG **(-)**										-0.004
										*-3.49****
WALD										9.950
p-value										*(0.002)*
Country effect:	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.10	0.10	0.10
F - stats.	6.82***	7.04***	6.91***	6.79***	7.12***	7.43***	7.46***	6.85***	6.96***	7.06***

Table 3.8: Panel C [IR term-spread]
Bank financials, bank regulations and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{SPR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + G'_{jt}\lambda + T_t'\theta + \varepsilon_{it}, \quad i = 1,\ldots, N; j = 1,\ldots, C; t = 1,\ldots, T$$

where β^{SPR}_{it} represents the stock returns sensitivity of country j's bank i to the unanticipated changes in the domestic interest rate term spread at time t. γ is an M x 1 vector of coefficients and X_{it} is the it-th observation on M company specific financial ratios, served as explanatory variables. Similarly, ξ is an S x 1 vector of coefficients and S_{jt} is the jt-th observation on S country specific variables describing the design of existing bank regulations; and λ is an L x 1 and G_{jt} is the jt-th observation on L country specific macroeconomic characteristics. T_t is a vector of year-dummies of dimension T-1, and the disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{it}), S country level regulatory characteristics (S_{jt}), and L county specific macroeconomic factors (G_{jt}). For each estimated model $j=13$, $i=289$ and $t=11$ resulting in *3179* observations. The market-specific regulatory variables are as follows: ACT_REG is the Index of Restricted activities, CAP_REG is the *Index of Regulatory capital requirements*, DIS_REG is the *Index of Bank discipline*, DIV_REG is the *Diversification Index*, and INF_REG is the *Index of Information disclosure*. The detailed definitions for each index, including information sources and computational issues, are outlined in Table 3.1.

Each regression also includes the following company- and country-specific variables which are not reported: the measure of revenue diversification ROID, the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP (CAP^2), the ratio of net total loans to total assets LTA, the ratio of customer deposits to total deposits LCL, the ratio of bank *i's* total off-balance sheet exposure to its total assets CLTA, the ratio of net income to total equity ROAE, the ratio of loan loss provision to net loans LPTL, year-on-year GDP growth M_GDPG, M_INFL which measures the inflation as the current period CPI growth rate, and the real effective exchange rate M_EXCI, all calculated at time t-1. For details see Table 3.1. The regression also includes time-invariant "legal origin" dummy variables D_FREN, D_GERM, and D_SCAN which assume the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. The (+) sign in the second column of the Table corresponds to the coefficient estimates for countries adopting an explicit deposit insurance, while (-) corresponds to the coefficients for countries with no explicit deposit protection. The test statistics (F-statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated p-value reported in brackets below. Heteroskedasticity and autocorrelation consistent t-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ACT_REG	0.002									
	1.59									
CAP_REG		-0.003								
		-1.60								
DIS_REG			0.005							
			*3.61****							
DIV_REG				-0.002						
				-0.94						
INF_REG					-0.001					
					-0.50					
ACT_REG (+)						0.003				
						1.58				
ACT_REG (-)						0.002				
						1.47				
WALD						0.473				
p-value						*(0.492)*				
CAP_REG (+)							-0.003			
							-1.28			
CAP_REG (-)							-0.003			
							-0.47			
WALD							0.001			
p-value							*(0.981)*			
DIS_REG (+)								0.006		
								*4.36****		
DIS_REG (-)								0.004		
								*2.93****		
WALD								14.574		
p-value								*(0.000)*		
DIV_REG (+)									-0.002	
									-0.70	
DIV_REG (-)									-0.004	
									-0.28	
WALD									0.013	
p-value									*(0.910)*	
INF_REG (+)										-0.001
										-0.67
INF_REG (-)										0.000
										-0.18
WALD										0.385
p-value										*(0.535)*
Country effect:	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.11	0.11	0.13	0.11	0.11	0.11	0.11	0.13	0.11	0.11
F - stats.	7.90***	7.86***	8.95***	7.81***	7.80***	7.60***	7.54***	8.91***	7.50***	7.49***

Table 3.8: Panel D [Yield curve curvature]
Bank financials, bank regulations and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{CURV}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + G'_{jt}\lambda + T_t'\theta + \varepsilon_{it}, \quad i = 1,\ldots, N;\ j = 1,\ldots, C;\ t = 1,\ldots, T$$

where β^{CURV}_{it} represents the stock returns sensitivity of country's *j* bank *i* to the unanticipated changes in the curvature of domestic zero-coupon yield curve at time *t*. γ is an *M* x *1* vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. Similarly, ξ is an *S* x *1* vector of coefficients and S_{jt} is the *jt*-th observation on *S* country specific variables describing the design of existing bank regulations; and λ is an *L* x *1* and G_{jt} is the *jt*-th observation on *L* country specific macroeconomic characteristics. T_t is a vector of year-dummies of dimension *T-1,* and the disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}), *S* country level regulatory characteristics (S_{jt}), and *L* county specific macroeconomic factors (G_{jt}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The market-specific regulatory variables are as follows: ACT_REG is the Index of Restricted activities, CAP_REG is the *Index of Regulatory capital requirements*, DIS_REG is the *Index of Bank discipline*, DIV_REG is the *Diversification Index*, and INF_REG is the *Index of Information disclosure*. The detailed definitions for each index, including information sources and computational issues, are outlined in Table 3.1.

Each regression also includes the following company- and country-specific variables which are not reported: the measure of revenue diversification ROID, the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP (CAP^2), the ratio of net total loans to total assets LTA, the ratio of customer deposits to total deposits LCL, the ratio of bank *i's* total off-balance sheet exposure to its total assets CLTA, the ratio of net income to total equity ROAE, the ratio of loan loss provision to net loans LPTL, year-on-year GDP growth M_GDPG, M_INFL which measures the inflation as the current period CPI growth rate, and the real effective exchange rate M_EXCI, all calculated at time *t-1*. For details see Table 3.1. The regression also includes time-invariant "legal origin" dummy variables D_FREN, D_GERM, and D_SCAN which assume the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. The **(+)** sign in the second column of the Table corresponds to the coefficient estimates for countries adopting an explicit deposit insurance, while **(-)** corresponds to the coefficients for countries with no explicit deposit protection. The test statistics (*F*-statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated *p*-value reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ACT_REG	0.001									
	*2.25***									
CAP_REG		-0.001								
		*-2.33***								
DIS_REG			0.001							
			*3.36****							
DIV_REG				0.000						
				0.06						
INF_REG					0.000					
					-0.49					
ACT_REG **(+)**						0.001				
						*2.66****				
ACT_REG **(-)**						0.001				
						*2.05***				
WALD						2.141				
p-value						*(0.144)*				
CAP_REG **(+)**							-0.002			
							*-2.25***			
CAP_REG **(-)**							-0.002			
							-1.27			
WALD							0.167			
p-value							*(0.683)*			
DIS_REG **(+)**								0.001		
								*3.75****		
DIS_REG **(-)**								0.001		
								*2.75****		
WALD								5.000		
p-value								*(0.026)*		
DIV_REG **(+)**									0.001	
									0.52	
DIV_REG **(-)**									0.003	
									0.68	
WALD									0.487	
p-value									*(0.486)*	
INF_REG **(+)**										0.000
										-0.63
INF_REG **(-)**										0.000
										-0.15
WALD										0.430
p-value										*(0.512)*
Country effect:	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.16	0.16	0.17	0.16	0.16	0.16	0.16	0.17	0.16	0.16
F - stats.	11.56***	11.57***	11.88***	11.34***	11.35***	11.16***	11.10***	11.52***	10.90***	10.90***

the empirical literature has repeatedly highlighted the importance of activities' restrictions on bank risks. Accordingly, I consider the regulatory restrictions on bank insurance and securities activities separately in Table 3.9.

It emerges that financial institutions only benefit from regulatory impediments to engaging in insurance activities. Restricting banks' operations in the securities market actually increases their exposure to interest rate shocks. Instinctively, increased bank risk taking may be driven by owners seeking to compensate for the utility loss associated with more stringent restrictions. On the other hand, introducing an additional source of non-interest income from operations in the securities market would increase the degree of bank revenue diversification and arguably lower its risks. Yet, alternative theoretical views suggest that banks will have greater prospects to increase their risks if a larger scope of activities is allowed. In this respect, Laeven and Levine (2009) stress that the relationship between bank risk and activity restrictions depends on the institution ownership structure. Regrettably, due to data unavailability, I am unable to control for the ownership structure. This will need to be addressed in future research.

As per the insurance activities, the size of the coefficient is economically large. In the case of Switzerland, if regulators loosen the tight restrictions on bank insurance operations from a current level of 4 to a level of 1, implying no restrictions, the Swiss banks' short-term interest rate exposure would increase by approximately 20 percent.

Assuming a marked distinction in the attitudes towards risk in countries with and without deposit insurance, I anticipate a differential impact of regulatory activity restriction on curtailing bank interest rate risk. This asymmetry is modelled by an interactive deposit insurance dummy EDI_REG, assuming a value of 1 for countries with explicitly adopted deposit protection scheme, and 0 otherwise. The empirical results in Table 3.9 support these predictions, suggesting that banks with protected depositors are generally more responsive to the regulatory impediments. In particular, it seems that these banks benefit from insurance activities restrictions to a much greater extent than their non-protected peers. Controlling for this asymmetry might also complement the findings of Laeven and Levine (2009) in the sense that the bank ownership structure may have distinctively different impacts on the effectiveness of national regulations in countries with and without explicit insurance provision. Such a consideration is particularly appealing as the authors, in their work, provide the evidence of the differential impact the explicit deposit protection has on the risk taking behaviour of widely held banks relative to institutions with concentrated ownership.

Second, I examine the effect of capital regulations on bank interest rate risk.

Table 3.9

Bank financials, activity restrictions and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{IR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + G'_{jt}\lambda + T_t'\theta + \varepsilon_{it}, \quad i = 1,\dots, N;\ j = 1,\dots, C;\ t = 1,\dots, T$$

where β^{IR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the pertinent interest rate proxy (IR = SR, LR, SPR, CURV) at time *t*. There are four panel regressions for each interest rate proxy as per the first row of the Table. γ is an M x *1* vector of coefficients and X_{it} is the *it*-th observation on M company specific financial ratios, served as explanatory variables. Similarly, ξ is an S x *1* vector of coefficients and S_{jt} is the *jt*-th observation on S country specific variables describing the design of existing bank regulations; and λ is an L x *1* and G_{jt} is the *jt*-th observation on L country specific macroeconomic characteristics. T_t is a vector of year-dummies of dimension T-*1*, and the disturbance term ε_{it} is assumed to be independently distributed from the M firm level regressors (X_{it}), S country level "activity restriction" variables (S_{jt}), and L county specific macroeconomic factors (G_{jt}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The country level "activity restriction" variables are as follows: INS_REG is the index of restrictions on insurance activities ranging from 1 to 3 based on the following question (unrestricted =1, permitted =2, restricted =3, prohibited =4): What are the conditions under which banks can engage in insurance activities?; and SEC_REG is the index of restrictions on security activities also ranging from 0 to 3 based on question (unrestricted =1, permitted =2, restricted =3, prohibited =4): What are the conditions under which banks can engage in securities activities? Each regression also includes the following company- and country-specific variables which are not reported: the measure of revenue diversification ROID, the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP (CAP²), the ratio of net total loans to total assets LTA, the ratio of customer deposits to total deposits LCL, the ratio of bank *i's* total off-balance sheet exposure to its total assets CLTA, the ratio of net income to total equity ROAE, the ratio of loan loss provision to net loans LPTL, year-on-year GDP growth M_GDPG, M_INFL which measures the inflation as the current period CPI growth rate, and the real effective exchange rate M_EXCI, all calculated at time *t-1*. For details see Table 3.1. The regression also includes time-invariant "legal origin" dummy variables D_FREN, D_GERM, and D_SCAN which assume the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. The **(+)** sign in the second column of the Table corresponds to the coefficient estimates for countries adopting an explicit deposit insurance, while **(-)** corresponds to the coefficients for countries with no explicit deposit protection. The test statistics (*F*-statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated *p*-value reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	Short - term interest rate				Long - term interest rate				Interest rate spread term				Yield curve curvature			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
INS_REG	-0.069				-0.014				-0.012				-0.004			
	*-5.31******				*-5.93******				*-4.87******				*-4.61******			
SEC_REG		0.042				0.012				0.012				0.004		
		*1.72**				*2.33***				*2.70****				*3.10****		
INS_REG **(+)**			-0.109				-0.015				-0.019				-0.007	
			*-6.52****				*-4.47****				*-5.88****				*-7.05****	
INS_REG **(-)**			-0.050				-0.014				-0.008				-0.003	
			*-5.59****				*-6.34****				*-3.67*				*-3.81*	
WALD			19.339				0.138				11.768				24.515	
p-value			*(0.000)*				*(0.710)*				*(0.001)*				*(0.000)*	
SEC_REG **(+)**				0.045				0.018				0.013				0.005
				*1.74**				*3.30****				*2.64****				*3.21****
SEC_REG **(-)**				0.036				0.003				0.011				0.004
				1.48				*0.58*				*2.23*				*2.48*
WALD				0.403				22.579				0.207				0.414
p-value				*(0.526)*				*(0.000)*				*(0.649)*				*(0.520)*
Country effect:	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.31	0.30	0.31	0.30	0.11	0.10	0.11	0.11	0.12	0.12	0.13	0.12	0.17	0.17	0.18	0.17
F - stats.	25.45***	24.83***	24.85***	23.83***	7.94***	7.15***	7.62***	7.53***	8.66***	8.18***	8.98***	7.86***	12.50***	11.83***	12.84***	11.37***

Table 3.10

Bank financials, governance quality and interest rate risk

This table shows the panel estimation results for the regression:

$$|\beta^{IR}_{it}| = \varphi + X'_{it}\gamma + S'_{jt}\xi + G'_{jt}\lambda + T_t'\theta + \varepsilon_{it}, \quad i = 1,\ldots, N;\ j = 1,\ldots, C;\ t = 1,\ldots, T$$

where β^{IR}_{it} represents the stock returns sensitivity of country *j*'s bank *i* to the unanticipated changes in the pertinent interest rate proxy (IR = SR, LR, SPR, CURV) at time *t*. There are four panel regressions for each interest rate proxy as per the first row of the Table. γ is an *M* x *1* vector of coefficients and X_{it} is the *it*-th observation on *M* company specific financial ratios, served as explanatory variables. Similarly, ξ is an *S* x *1* vector of coefficients and S_{jt} is the *jt*-th observation on *S* country specific variables describing the design of existing bank regulations; and λ is an *L* x *1* and G_{jt} is the *jt*-th observation on *L* country specific macroeconomic characteristics. T_t is a vector of year-dummies of dimension *T-1,* and the disturbance term ε_{it} is assumed to be independently distributed from the *M* firm level regressors (X_{it}), *S* country level regulatory characteristics (S_{jt}) supplied from Kaufman et al. (2008) and the Heritage Foundation, and *L* county specific macroeconomic factors (G_{jt}). For each estimated model *j=13*, *i=289* and *t=11* resulting in *3179* observations. The market-specific regulatory variables are as follows: EFI_REG is the *Economic Freedom Index* with scores based on the country's business, trade, monetary, investment, financial, labour, and corruption freedom as well as property rights and freedom from government, KRC_REG is the measure of *Regulatory Quality* capturing the governments' ability to originate and implement sound regulations to promote the development of the private sector, KPS_REG is the *Index of Political Stability* measuring the likelihood that the government may be destabilised, and KRL_REG is the *Rule of Law Index* capturing the "extent to which agents have confidence in and abide by the rules of society" including contract enforcement, police, courts, etc. Variables KRC_REG, KPS_REG, and KRL_REG lie between -2.5 to 2.5 with higher scores corresponding to better outcomes. For more details see Table 3.1.

Each regression also includes the following company- and country-specific variables which are not reported: the measure of revenue diversification ROID, the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP (CAP^2), the ratio of net total loans to total assets LTA, the ratio of customer deposits to total deposits LCL, the ratio of bank *i's* total off-balance sheet exposure to its total assets CLTA, the ratio of net income to total equity ROAE, the ratio of loan loss provision to net loans LPTL, year-on-year GDP growth M_GDPG, M_INFL which measures the inflation as the current period CPI growth rate, and the real effective exchange rate M_EXCI, all calculated at time *t-1*. For details see Table 3.1. The regression also includes time-invariant "legal origin" dummy variables D_FREN, D_GERM, and D_SCAN which assume the value of 1 if the legal origin of the target bank country is German, French, or Scandinavian respectively; and 0 otherwise. The test statistics (*F*-statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of these coefficient estimates is reported under WALD, with the associated *p*-value reported in brackets below. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics below each coefficient estimate. ***, ** and * represent significance at the 1%, 5% and 10%, respectively.

	Short - term interest rate				Long - term interest rate				Interest rate spread term				Yield curve curvature			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
EFI_REG	-0.014				-0.002				0.000				-0.001			
	*-4.27****				*-3.92****				*-0.07*				*-5.06****			
KRC_REG		-0.595				-0.018				-0.038				-0.015		
		*-8.97****				*-1.88**				*-3.97****				*-4.61****		
KPS_REG			-0.305				-0.034				-0.024				-0.007	
			*-4.87****				*-3.68****				*-2.24***				*-2.13***	
KRL_REG				-0.271				-0.049				-0.026				-0.013
				*-4.98****				*-5.07****				*-3.25****				*-4.50****
Country effect:	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Time effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.31	0.34	0.31	0.31	0.11	0.10	0.10	0.12	0.11	0.12	0.12	0.12	0.18	0.17	0.16	0.17
F - stats.	25.55***	29.42***	25.92***	25.79***	7.49***	6.93***	7.33***	8.09***	7.79***	8.55***	8.09***	8.19***	12.58***	12.38***	11.54***	12.23***

In particular, I consider the stringency of regulatory oversight of bank capital CAP_REG and predict that more strict capital regulation will foster bank stability.

As predicted, the capital stringency is negatively related to bank medium- and long-term interest rate exposure. When I consider the long-term interest rate betas, the stricter requirements seem to benefit uninsured banks more. This suggests a greater importance of capital buffers for countries without explicit deposit insurance. The magnitude of the reported coefficient is economically significant. For instance, if regulators in Australia restrict their capital requirements from the current CAP_REG index value of 2 to a value of 4 (as in the UK), Australian banks will benefit from almost a 5 percent reduction in their exposure to the shocks in the long-term interest rates.

Next I account for the degree of official supervisory power to enforce regulations and undertake corrective actions when necessary (DIS_REG). Empirical results in Table 3.8 suggest that banks do not benefit in any way from greater supervisory power. On the contrary, for the majority of the analysed interest rate measures of risk the coefficient is positive. This implies higher interest rate exposure for banks headquartered in countries where regulators are given broad regulatory powers.

Some supervisory agencies enforce various liquidity and diversification requirements. Therefore, I construct the Diversification Index (DIV_REG) to test the effect of such provisions on bank interest rate risk. There is a negative relationship between the degree of diversification enforcement and bank short-term interest rate exposure. The effect is even more pronounced for countries with unprotected depositors, with the reported coefficient being economically large. Similar conclusions are extended to the long-term interest rate beta, with, however, banks in countries with deposit protection not benefiting from stricter diversification requirements.

A growing body of studies highlights the importance of transparency in financial markets. Yu (2005) reports the instrumental impacts of better disclosure on corporate credit spreads. Accordingly I include the ratio of information disclosure proxying the strictness of regulatory imposed audit and disclosure requirements (INF_REG). The level of information disclosure is negatively related to banks' long-rate interest rate exposure. The effect is more pronounced in countries without explicit deposit insurance. These results are consistent with a view that uninsured depositors greatly value accurate disclosure of bank activities, resulting in a higher level of market discipline and more efficient and prudent banks.

Market development and interest rate risk

I use a set of governance indicators supplied by Kaufman et al. (2008) to capture the impact of country development on banks interest rate exposures.

First, I extract the Index of Political Stability (KPS_REG) to capture countries' political environment. The index measures the likelihood that the government may be destabilised by "unconstitutional or violent means". From the same source I also obtain the measures of Regulatory Quality (KRC_REG). This measure represents the governments' ability to originate and successfully implement "sound policies and regulations that permit and promote private sector development". In addition, I calculate the Rule of Law (KRL_REG) measure which captures the "extent to which agents have confidence in and abide by the rules of society" including contract enforcement, police, courts, etc. Each variable lies between -2.5 to 2.5 with higher scores corresponding to better outcomes.

Finally, I include the overall score for the Economic Freedom Index (EFI_REG) supplied by the Heritage Foundation. By its construction, the index's score is based on the country's business, trade, monetary, investment, financial, labour, and corruption freedom as well as property rights and freedom from government. Hence, the qualitative information captured by this index is most likely incorporated in the measures supplied by Kaufman et al. (2008). Nonetheless, I include this index given its popularity in the empirical literature [e.g. González, 2005; Haq and Heaney, 2009], and given that all regulatory framework measures are utilised interchangeably in the empirical model. The estimation results are presented in Table 3.10.

The market development variables all enter the Table 3.10 regressions significantly negative. This outcome implies that greater levels of economic freedom, better governance and efficiency of the legal system, and higher quality of government supervision are associated with more stable and prudent functioning of the financial system and lessen bank equity risks.

3.5 Concluding remarks

The exposure of financial intermediaries to interest rate risk has been the subject of considerable empirical research since the inception of Stone's (1974) two factor model. This interest has led to the development of a substantial body of literature. The researchers have offered useful insights to modelling the interest rate risk exposure under different asset pricing and econometric frameworks.

In contrast, there is a shortage of studies examining the underlying determinants of bank interest rate risk. Even though several empirical works have identified certain company-specific determinants of interest rate risk, none of the existing papers has explicitly related cross-market variations in banks' interest rate risk exposure to differences in country level regulations. Nor has any robustness check of the proposed financial measures to the individual country regulatory environment been conducted hitherto. This chapter fills this important gap in the literature analysing an international sample of financial institutions over the period 1997-2007.

The findings provided in this chapter confirm and extend previous evidence regarding the interest rate risk exposure of financial intermediaries. Particularly, I find the majority of the analysed companies are negatively affected by unexpected interest rate movements. An evaluation of these risks indicates their close linkage to the company specific financial characteristics such as bank income and asset-liability structure, capital, and the off-balance sheet composition. I, however, conclude that this association between market and accounting measures of interest rate risk depends crucially on the provision and design of deposit insurance in the target bank country.

The chapter also reports the vital role of institutional and regulatory characteristics in explaining the cross-market variability in banks' exposure to interest rate risk. Interestingly, the provision of explicit deposit insurance may alter this role, markedly affecting the efficacy of national regulations.

Particularly, I observe a differential impact of regulatory activity restrictions on curtailing bank interest rate risk in countries providing the deposit protection relative to the markets with unprotected depositors. Financial institutions only benefit from regulatory impediments to engaging in insurance activities. On the other hand, restricting bank operations in the securities market actually increases their exposures to the interest rate shocks. Banks with protected depositors, however, benefit from the restrictions to a much greater extent than their non-protected peers.

More stringent capital regulation seems to also foster bank stability. The evidence of this is more pronounced for the countries with no explicit deposit insurance. For these countries, the diversification and information disclosure requirements also yield material benefits in curtailing interest rate risk.

Finally, I also observe that greater levels of economic freedom, better governance, efficiency of the legal system, and higher quality of government supervision are all associated with lower bank exposure to interest rate risk.

Appendix 3.1

List of analysed banks and countries

Bank name	Ticker	Bank name	Ticker
AUSTRALIA		**FRANCE (cont'd)**	
Australia and New Zealand Banking Gr. Ltd.	ANZ AU	CA Ile de France	CAF FP
Bank of Queensland Ltd.	BOQ AU	CA Ile et Vilaine	CIV FP
National Australia Bank Ltd.	NAB AU	CA Toulouse	CAMT FP
Suncorp-Metway Ltd.	SUN AU	CA Mutuel du Morbihan	CMO FP
Westpac Banking Corp.	WBC AU	CA Loire - Haute - Loire	CRLO FP
Commonwealth Bank of Australia	CBA AU	CA Oise	CROI FP
St George Bank Limited	SGB AU	CA du Midi	CRMI FP
Bendigo and Adelaide Bank Ltd.	BEN AU	CA Touraine Poitou	CRTO FP
Macquarie Group Ltd	MQG AU	CA Centre Loire	CRCL FP
		CA Sud Rhone Alpes	CRSU FP
BELGIUM			
Fortis	FORB BB	**GERMANY**	
KBC Groep NV	KBC BB	Bayerische Hypo - und Vereinsban AG	HVM GR
Dexia SA	DEXB BB	Commerzbank AG	CBK GR
		Deutsche Bank AG	DBK GR
CANADA		DVB Bank AG	DVB GR
Bank of Montreal	BMO CN	HSBC Trinkaus & Burkhardt AG	TUB GR
Bank of Nova Scotia	BNS CN	Berlin - Hannoversche Hypothekenbank AG	BHH GR
Canadian Imperial Bank of Commerce	CM CN	Eurohypo AG	EHY GR
Laurentian Bank of Canada	LB CN	IKB Deutsche Industriebank AG	IKB GR
National Bank of Canada	NA CN	Oldenburgische Landesbank AG	OLB GR
Quest Capital Corp.	QC CN		
Royal Bank of Canada	RY CN	**HONG KONG**	
Toronto Dominion Bank	TD CN	Bank of East Asia Ltd.	23 HK
Canadian Western Bank	CWB CN	Hang Seng Bank Ltd.	11 HK
Home Capital Group Inc.	HCG CN	CITIC International Financial Holdings Ltd.	183 HK
		Dah Sing Financial Holdings Ltd.	440 HK
FRANCE		Industrial and Comm. Bank of China (Asia) Ltd.	349 HK
Societe Generale	GLE FP	Wing Lung Bank	96 HK
Natixis	KN FP	Wing Hang Bank Ltd.	302 HK
Credit Agricole SA	ACA FP	Fubon Bank (Hong Kong) Ltd.	636 HK
Banque Tarneaud SA	TRNO FP	Chong Hing Bank Ltd.	1111 HK
BNP Paribas	BNP FP		

Appendix 3.1

List of analysed banks and countries (CONT'D)

Bank name	Ticker	Bank name	Ticker
ITALY		**JAPAN (cont'd)**	
Credito Bergamasco S.p.A.	CB IM	The Eighteenth Bank Ltd	8396 JT
Banco di Sardegna S.p.A.	BSRP IM	The Fukui Bank Ltd	8362 JT
Banca Popolare di Milano Scarl	PMI IM	The Gunma Bank Ltd	8334 JT
Credito Emiliano S.p.A.	CE IM	The Hachijuni Bank Ltd	8359 JT
UniCredit S.p.A.	UCG IM	The Higashi-Nippon Bank Ltd	8536 JT
Intensa SanPaolo Spa	ISP IM	The Gunma Bank Ltd	8334 JT
Banca Popolare di Sondrio Scarl	BPSO IM	The Hachijuni Bank Ltd	8359 JT
Banca Popolare di Intra Scrl	PIN IM	The Higashi-Nippon Bank Ltd	8536 JT
Banco di Desio e della Brianza S.p.A.	BDB IM	The Higo Bank Ltd	8394 JT
Banca Popolare di Spoleto S.p.A.	SPO IM	The Hiroshima Bank Ltd	8379 JT
Piccolo Credito Valtellinese Scarl.	CVAL IM	The Hokkoku Bank Ltd	8363 JT
Banca Popolare dell'Emilia Romagna Scrl	BPE IM	The Hokuetsu Bank Ltd	8325 JT
Banca Carige S.p.A.	CRG IM	The Hyakugo Bank Ltd	8368 JT
		The Hyakujushi Bank Ltd	8386 JT
JAPAN		The Iyo Bank Ltd	8385 JT
The Akita Bank Ltd	8343 JT	The Joyo Bank Ltd	8333 JT
The Aomori Bank Ltd	8342 JT	The Juroku Bank Ltd	8356 JT
The Awa Bank Ltd	8388 JT	The Kagawa Bank Ltd	8556 JT
The Bank of Ikeda Ltd	8375 JT	The Kagoshima Bank Ltd	8390 JT
The Bank of Iwate Ltd	8345 JT	The Kanto Tsukuba Bank Ltd	8338 JT
The Bank of Kyoto Ltd	8369 JT	The Keiyo Bank Ltd	8544 JT
The Bank of Nagoya Ltd	8522 JT	The Kita-Nippon Bank Ltd	8551 JT
The Bank of Okinawa Ltd	8397 JT	The Michinoku Bank Ltd	8350 JT
The Bank of Saga Ltd	8395 JT	The Miyazaki Bank Ltd	8393 JT
Bank of the Ryukyus Ltd	8399 JT	Mizuho Trust & Banking Co Ltd	8404 JT
The Bank of Yokohama Ltd	8332 JT	The Musashino Bank Ltd	8336 JT
The Chiba Bank Ltd	8331 JT	The Nishi-Nippon City Bank Ltd	8327 JT
The Chiba Kogyo Bank Ltd	8337 JT	The Ogaki Kyoritsu Bank Ltd	8361 JT
The Chugoku Bank Ltd	8382 JT	The Oita Bank Ltd	8392 JT
The Chukyo Bank Ltd	8530 JT	The San-In Godo Bank Ltd	8381 JT
The Daisan Bank Ltd	8529 JT	The Shiga Bank Ltd	8366 JT
The Daishi Bank Ltd	8324 JT	The Shikoku Bank Ltd	8387 JT
The Ehime Bank Ltd	8541 JT	The Shimizu Bank Ltd	8364 JT

Appendix 3.1

List of analysed banks and countries (CONT'D)

Bank name	Ticker	Bank name	Ticker
JAPAN (cont'd)		**SWEDEN**	
The Shizuoka Bank Ltd	8355 JT	Skandinaviska Enskilda Banken AB	SEBA SS
The Sumitomo Trust & Banking Co Ltd	8403 JT	Svenska Handelsbanken AB	SHBA SS
Suruga Bank Ltd	8358 JT	Swedbank AB	SWEDA SS
The Tochigi Bank Ltd	8550 JT		
The Toho Bank Ltd	8346 JT	**SWITZERLAND**	
The Tokyo Tomin Bank Ltd	8339 JT	Banque Privee Edmond de Rothschild SA	RLD SW
The Yamagata Bank Ltd	8344 JT	Verwalt & Privat - Bank AG	VPB SW
The Yamanashi Chuo Bank Ltd	8360 JT	Bank Sarasin & Cie AG	BSAN SW
The Towa Bank Ltd	8558 JT	Bank Coop AG	BC SW
The Daito Bank Ltd	8563 JT	Vontobel Holding AG	VONN SW
The Fukushima Bank Ltd	8562 JT	Hypothekarbank Lenzburg	HBLN SW
The Mie Bank Ltd	8374 JT	Basellandschaftliche Kantonalbank	BLKB SW
The Nagano Bank Ltd	8521 JT	Basler Kantonalbank	BSKP SW
The Tohoku Bank Ltd	8349 JT	Bank Linth	LINN SW
The Tokushima Bank Ltd	8561 JT	Zuger Kantonalbank AG	ZG SW
The Aichi Bank Ltd	8527 JT	Banque Cantonale de Geneve	BCGE SW
		Banque Cantonale Vaudoise	BCVN SW
SPAIN			
Banco De Vasconia SA	VAS SM	**UK**	
Banco De Credito Balear SA	CBL SM	Barclays Plc	BARC LN
Banco De Galicia SA	GAL SM	Lloyds TSB Group Plc	LLOY LN
Banco De Castilla SA	CAS SM	Royal Bank of Scotland Group Plc	RBS LN
Banco De Valencia SA	BVA SM	Standard Chartered Plc	STAN LN
Banco Bilbao Vizcaya Agrentaria SA	BBVA SM	Allied Irish Banks Plc	ALBK LN
Banco Santander SA	SAN SM	The Bank of Ireland	BKIR LN
Banco Pastor SA	PAS SM	Anglo Irish Bank Corp Plc	ANGL LN
Banco Popular Espanol SA	POP SM	HSBC Holdings Plc	HSBA LN
Bankinter SA	BKT SM	Alliance & Leicester Plc	AL/ LN
Banco Espanol de Credito SA	BTO SM		
Banco Guipuzcoano SA	GUI SM	**US Money Center**	
Banco de Andalucia SA	AND SM	The Bank of New York Mellon Corp.	BK US

Appendix 3.1

List of analysed banks and countries (CONT'D)

Bank name	Ticker	Bank name	Ticker
US Money Center (cont'd)		**US Regional (cont'd)**	
Wachovia Corp.	WB US	Ames National Corp.	ATLO US
Wells Fargo & Co.	WFC US	Amcore Financial Inc.	AMFI US
JP Morgan Chase & Co.	JPM US	Banner Corp.	BANR US
Citigroup Inc.	C US	City Holding Co.	CHCO US
Bank of America Corp.	BAC US	Chemical Financial Corp.	CHFC US
National City Corp.	NCC US	Commerce Bancshares Inc.	CBSH US
PNC Financial Services Group Inc.	PNC US	Commercial Bancshares Inc.	CMOH US
		Community Trust Bancorp Inc.	CTBI US
US Regional		Farmers Capital Bank Corp.	FFKT US
Horizon Financial Corp.	HRZB US	VIST Financial Corp.	VIST US
Sterling Financial Corp.	STSA US	North Bay Bancorp	NBAN US
Alabama National Bancorporation	ALAB US	Sandy Spring Bancorp Inc.	SASR US
Coastal Financial Corp.	CFCP US	Surety Capital Corp.	SRYPQ US
Ameris Bancorp.	ABCB US	Wilber Corp.	GIW US
The First of Long Island Corp.	FLIC US	First Merchants Corp.	FRME US
Bank of Hawaii Corp.	BOH US	First Midwest Bancorp Inc.	FMBI US
WesBanco Inc.	WSBC US	Patriot National Bancorp Inc.	PNBK US
University Bancorp Inc.	UNIB US	Penns Woods Bancorp Inc.	PWOD US
Sun Bancorp Inc.	SNBC US	Princeton National Bancorp Inc.	PNBC US
Pinnacle Bancshares Corp.	PPBN US	Seacoast Banking Corp of Florida	SBCF US
Provident Bankshares Corp.	PBKS US	Smithtown Bancorp Inc.	SMTB US
Regions Financial Corp.	RF US	Northern Trust Corp.	NTRS US
PSB Bancorp Inc.	PSBI US	Trico Bancshares	TCBK US
Ohio Valley Banc Corp.	OVBC US	Univest Corp. Of Pennsylvania	UVSP US
Northern States Financial Corp.	NSFC US	Whitney Holding Corp.	WTNY US
Monroe Bancorp.	MROE US	Old National Bancorp	ONB US
Mercantile Bankshares Corp.	MRBK US	Old Second Bancorp Inc.	OSBC US
Integra Bank Corp.	IBNK US	Nara Bancorp Inc.	NARA US
Fulton Financial Corp.	FULT US	Hancock Holding Co.	HBHC US
Great Southern Bancorp Inc.	GSBC US	Fremont General Corp.	FMNTQ US
Harleysville National Corp.	HNBC US	Compass Bancshares Inc.	CBSS US
Capitol Bancorp Ltd.	CBC US	Center Bancorp Inc.	CNBC US
Cascade Bancorp	CACB US	Marshall & Ilsley Corp.	MI US

Appendix 3.1

List of analysed banks and countries (CONT'D)

Bank name	Ticker	Bank name	Ticker
US Regional (cont'd)		**US Savings & Loans (cont'd)**	
Popular Inc.	BPOP US	Astoria Financial Corp.	AF US
Simmons First National Corp.	SFNC US	New York Community Bancorp Inc.	NYB US
Summit Bancshares Inc.	SBIT US	HMN Financial Inc.	HMNF US
Tompkins Financial Corp.	TMP US	Northwest Bancorp Inc.	NWSB US
International Bancshares Corp.	IBOC US	Camco Financial Corp.	CAFI US
Doral Financial Corp.	DRL US	Imperial Capital Bancorp Inc.	IMP US
Arrow Financial Corp.	AROW US	Flushing Financial Corp.	FFIC US
Yardville National Bancorp.	YANB US	BankAtlantic Bancorp Inc.	BBX US
Zions Bancorp.	ZION US	PFF Bancorp Inc.	PFFB US
First Bancorp.	FBNC US	First Federal Bancshares of Arkansas Inc.	FFBH US
Comerica Inc.	CMA US	Provident Financial Holdings Inc.	PROV US
First Horizon National Corp.	FHN US	Dime Community Bancshares	DCOM US
Keycorp	KEY US	OceanFirst Financial Corp.	OCFC US
Abigail Adams National Bancorp.	AANB US	United Western Bancorp Inc.	UWBK US
		Chester Bancorp Inc.	CNBA US
US Savings & Loans		CKF Bancorp Inc.	CKFB US
Ameriana Bancorp.	ASBI US	Fidelity Federal Bancorp.	FDLB US
Downey Financial Corp.	DWNQF US	Home Financial Bancorp.	HWEN US
First Financial Holdings Inc.	FFCH US	Meta Financial Group Inc.	CASH US
FirstFed Financial Corp.	FED US	South Street Financial Corp.	SSFC US
LSB Corp.	LSBX US	Webster City Federal Bancorp.	WCFB US
Pamrapo Bancorp Inc.	PBCI US	WVS Financial Corp.	WVFC US
Parkvale Financial Corp.	PVSA US	Wells Financial Corp.	WEFP US
People's United Financial Inc.	PBCT US	ASB Fiancial Corp.	ASBN US
Sovereign Bancorp Inc.	SOV US	Great American Bancorp Inc.	GTPS US
Washington Federal Inc.	WFSL US	Park Bancorp Inc.	PFED US
Washington Mutual Inc.	WAMUQ US	IndyMac Bancorp Inc.	IDMCQ US
WSFS Financial Corp.	WSFS US	Hingham Institution for Savings	HIFS US
Anchor Bancorp Wisconsin	ABCW US		

Chapter 4

Securitization and Bank Intermediation Function

4.1 Introduction

Banks are leveraged entities whose owners face limited liability and whose opaque activities are subsidised by virtue of the deposit insurance guarantee and a financial safety net. These provisions unavoidably amplify owners of banks incentives to undertake excessive risk.

The policymakers have long recognised this predilection, introducing various mechanisms conducive to the optimal resolution of the agency problems, curbing bank risk-taking, and fostering greater market discipline. Incidentally, some of these provisions may have inadvertently increased the scope for regulatory arbitrage, whereby financial intermediaries exploit loopholes in the regulations and, as a result, undermine the stability of the financial system.

Historically, the systematic exploitation of those regulatory loopholes was driven, to a large extent, by the managers' desire to increase the leverage of a financial institution without reducing its capital ratios. Fortuitously, the Basel accord provided a simple means of exploiting the regulatory capital subsidies, through, for instance, securitization. This raised a question about its prudency and paved the way for its evolutionary successor (Calomiris and Mason, 2004). As pointed out by Jones (2000), under certain conditions, banks may enhance their regulatory capital ratios by resorting to purely "cosmetic capital adjustments", which have little or no impact on the firm's overall stability. For instance, by providing explicit credit enhancements and guarantees for assets securitized off the balance sheet, a bank retains its credit exposure. However, it no longer requires holding the on-balance sheet capital necessary to support this risk. In the run up to the most recent financial crisis, many have explicitly demonstrated that such incomplete risk transfer proliferates systemic risk in the financial sector, hence rendering the effectiveness of securitization in fostering bank stability rather elusive [Higgins and Mason, 2004; Franke and Krahnen, 2005; Instefjord, 2005].

In this respect, the recent financial turmoil prompted by the US subprime mortgage meltdown clearly demonstrated the detrimental impact a troubled banking sector has on the wider economy both domestically and internationally. The financial markets worldwide suffered disastrous losses, with massive declines in portfolio values of various, including highly rated, securities. The crisis also led to a severe liquidity shortfall that adversely affected all economic agents. As credit tightened, the myriad of formally prosperous businesses were forced to file for bankruptcy, resulting in soaring unemployment and unprecedented decline in international trade.

Mortgage securitization is generally regarded as the key culprit in the subprime debacle, thus provoking copious discussions on possible remedies for the market for securitized assets. Recently, a plethora of contributions addressed these issues both empirically and analytically[1]. Together these works suggest that the root causes of the crisis are by no means exogenous, and reside in managers' opportunistic behaviour, propensity to short-termism, and concomitant regulatory policies that abetted these trends. Beyond this point of agreement, the issue remains an ongoing debate among academics, practitioners, and policymakers with many of the underlying causes yet to be fully understood.

Interestingly, none of the aforementioned causes is new, and they have all been previously regarded as the primary determinants of the major financial crises in the past. Three common causes are particularly emphasised: moral hazard and information asymmetries; global imbalances[2]; and a poorly designed multi-layered regulatory framework which further aggravated an already present misalignment of incentives.

What, however, makes the current crisis different is a contagion which was manifested due to highly developed inter-linkages between international financial corporations, their complexity, multi-sector involvement, and a speedy transmission of news and investment flows. What started as a relatively isolated US subprime mortgage episode was then propagated to the rest of the financial sector worldwide, affecting all major asset classes. In response, a great deal of research

[1] A detailed discussion on the mechanisms of the subprime mortgage crisis is offered by Brunnermeier (2009).

[2] See Caballero and Krishnamurty (2008).

has focused on examining the market mechanism by which the financial contagion is proliferated, proposing even more solutions to contain the shock spill-overs in the future [Brunnermeier and Pedersen, 2009; Longstaff, 2010].

Further contributions have also addressed the role of rating agencies, condemning their inability to properly rate the securitised products (Skreta and Veldkamp, 2009). Agencies' incentives, and conflict of interest are also emphasised (Bolton, Freixas, and Shapiro, 2008). The design of the compensation structure, with managers' rewards being tied to short-term mark-to-market profits rather than the long-term profitability and solvency of created positions, has also been acknowledged for contributing to the crisis (Erkens, Hung, and Matos, 2009). In a similar vein, the regulatory architecture which allowed, and in some instances abetted, such short-termist behaviour has also been denounced (Acharya and Richardson, 2009).

While much has been learnt from these contributions, they have predominantly concentrated, with few exceptions, on the underlying causes of the current events, not the risks facing the financial system in the aftermath of the crisis. For instance, none has explicitly addressed the issue of bank interest rate exposure, the importance of which was reasserted by recent developments in the monetary environment.

Following an unprecedented reduction in the nominal interest rates, today the concern exists that banks may have relaxed their asset-liability management practices and are less protected than ever against rising interest rates[3]. As emphasised by the Vice Chairman of the Board of Governors of the Federal Reserve System, Donald L. Kohn[4], "... interest rate risk is inherent in the business of banking..." and "... it is especially important now for institutions to have in place sound practices to measure, monitor, and control this risk". He further cautions that as the economy recovers, it is reasonable to expect a tightening in monetary policy, with associated developments in the entire shape of the term structure being hard to predict, and "...especially so in current circumstances". In this respect, the unprecedentedly high issuance of government debt worldwide, coupled with increasing inflationary pressure, may trigger sharp changes in the interest rate environment. As suggested by Kohn, it is highly unlikely that the

[3]Over the last two years, the US yield curve has experienced a considerable steepening, with the interest rate spread widening to a multi-decade level high. This steepening poses a significant challenge to the asset-liability managers, particularly in addressing possible non-parallel shifts in the term structure. The empirical evidence on the adverse impacts of low interest rates on bank risk is provided in Altunbas, Gambacorta, and Marqués-Ibáñez (2010).

[4]Donald L. Kohn. Focusing on Bank Interest Rate Risk Exposure. Federal Deposit Insurance Corporation's Symposium on Interest Rate Risk Management, Arlington, Virginia, January 29, 2010.

interest rate volatilities will "...return to their previous quiescent state", thereby posing further concerns for the stability of the financial sector. The shape of the term structure is also likely to undergo significant changes. As the investors return to higher risk leveraged positions, the yields offered on sovereign instruments will have to be revisited in order successfully to finance the fiscal deficit. Furthermore, due to the crisis-induced liquidity constraints, many institutions were forced to shorten the maturity of their liabilities and are accordingly exposed to greater refinancing risk[5]. And while the prudently managed companies will presumably access the required funds, the increased competition for credit may escalate its cost. On the asset side, as many households find the value of their debt exceeding the value of the underlying equity, the rate of defaults is likely to peak with interest rates.

Such economic conditions raise the fundamental question of what are the most effective and appropriate ways to hedge against unanticipated developments in the yield curve. In this respect, the theoretical benefits of securitization for efficient management of bank interest rate risk (IRR hereafter) are unambiguous. On the one hand, securitization serves as a channel to transfer interest rate risk from the financial intermediary to parties better equipped to bear and manage this exposure. On the other hand, it provides an opportunity to align the duration of interest rate sensitive assets and liabilities, thereby reducing the balance sheet duration gap and concomitant exposure to interest rate movements. Further, securitization income offers the potential to improve revenue diversification, thus reducing bank reliance on interest-generating activities[6]. Despite these sound theoretical grounds, no empirical account of the impact of securitization on bank interest rate risk has hitherto been conducted.

Accordingly, the objective of the work reported here is to circumvent the aforementioned issues in addressing the impact of securitization on bank interest rate risk. In particular, the study offer three major contributions to the literature.

First, utilising an extensive sample of publically traded US bank holding companies, this work empirically verifies the importance of interest rate exposure for

[5]Further to this, according to the Office of Thrift Supervision Quarterly Review of Interest Rate Risk, in the first quarters of 2010 the median percentage ratio of fixed-rate mortgage loans held by the US thrifts to their total assets was at the level of 40.6%, while the corresponding proportion of all adjustable-rate mortgage loans to total assets was at only 22.3%. The effective duration gap in the thrift industry also remained positive, highlighting the firms' susceptibility to rising interest rates.

[6]As argued by Keswani, Marsh, and Zagonov (2009), since activities that generate non-interest income are imperfectly correlated with those generating interest revenues, with raising interest rates, the diversification of revenue sources should help stabilizing operating income and give rise to a more stable stream of profits. This view is supported by the empirical findings of Smith et al. (2003) and Chiorazzo, Milani and Salvini (2008).

the majority of analysed institutions over the 2001 to 2009 period. Nearly 95% percent of analysed financial intermediaries are adversely affected by yield curve shocks at one time or another, with the yield curve slope being the most significant source of risk. Interestingly, the banks resorting to asset securitization are affected to a higher degree by unanticipated term-structure developments than their non-securitizing counterparts.

Second, this is the first study which explicitly relates the level of bank securitization activities to its interest rate exposure. While the empirical evidence to date suggests that securitization affects the level of bank credit risk, its solvency, and efficiency, no empirical test to assert its impact on bank interest rate risk has been conducted. Accordingly, the results reported here offer a valuable insight to both managers and regulators seeking to utilise securitization in a bid to curb bank interest rate risk. This is particularly important in the aftermath of the global financial crisis, with the monetary policy decisions creating a unique environment for interest rate exposure.

The third goal of this chapter is to study whether the securitization of assets with different maturities and risk characteristics has a heterogeneous impact on bank interest rate exposure. The empirical tests suggest that interest rate risk generally increases with the maturity of assets securitized. To decouple the effect of securitization from other factors, I consider further channels that may have affected bank risk. These include numerous bank-specific characteristics and the macroeconomic environment in which the intermediaries operate. Further, the research covers both pre-crisis and crisis episodes, thereby offering a unique opportunity to compare the effectiveness of securitization in curbing bank interest rate risk between the two periods. The empirical findings reported in this work suggest that banks resorting to asset securitization are subject to greater interest rate exposure in the second, crisis sub-period.

The remainder of the chapter is organised as follows: Section 4.2 provides a brief review of the literature and outlines a set of testable hypotheses. Section 4.3 presents a theoretical model of financial intermediary interest rate exposure, while Section 4.4 continues by outlining the supporting empirical framework. The description of the data sample follows in Section 4.5. Empirical results are discussed in Section 4.6, and Section 4.7 concludes the chapter.

4.2 Literature review and hypotheses formulation

Securitization is a relatively straightforward process of transforming a pool of illiquid assets into marketable securities via cash flow repackaging; yet it has substantially reshaped the credit markets in recent decades. While originally confined to the US residential mortgages, today, securitization is applied to a wide range of asset classes, including credit card, commercial and industrial, automobile, and home equity loans, among others. Since its inception in the late 1960s, the issuance of securitized assets in the US has been growing steadily to amount to nearly US $2.11 trillion as of the year end 2009[7].

On the theoretical front, access to the market for securitised products may substantially benefit the originator by (a) allowing to efficiently diversify its credit portfolio; (b) improving asset-liability management; (c) reducing the cost of financial intermediation; and (d) providing an opportunity to profit by specialising in operations in which it enjoys a comparative advantage[8]. As suggested by Loutskina and Strahan (2009), securitization eases the influence of bank financial conditions and local funding shocks on credit supply. As a result, it increases liquidity and facilitates the reduction of funding, and therefore banks' intermediation costs. Further, securitization provides a means to efficiently transfer the risk from the banks' balance sheet to other economic players better equipped to bear it, thereby removing the impediment to further growth implied by capital and balance sheet constraints. In this respect, there is a vast literature embracing the benefits of increased liquidity and risk sharing [Merton, 1987; Kadlec and McConnell, 1994].

In terms of bank interest rate risk, securitization offers an opportunity effectively to tailor the balance sheet duration gap induced by the banks' asset transformation function. Thanks to heterogeneity in the maturity of assets admissible for securitization, the duration of rate sensitive assets can be perfectly matched to that of corresponding liabilities. Further, by securitizing assets with embedded prepayment provisions, the lender, in effect, resells the position held in these options and therefore hedges its exposure to unanticipated increases in interest rate volatility.

[7]Aggregate of the US mortgage-related (MBS) and asset-backed securities (ABS) issuance, based on the data compiled by the Securities Industry and Financial Markets Association, http://www.sifma.org. The fastest growth was enjoyed by the MBS sector, with a nearly 11.2% [15.8%] compound annual growth rate between 1996 and 2009 [1996 and 2006]. The corresponding growth rates for the US ABS issuance are -0.8% and 16.3% respectively. The declining trend in MBS is likely to persist in the foreseeable future, owed to weak house sales, mortgage loan origination, and new housing start-ups following the crisis. The number of house sales in the US has reached its peak of 1.28 million in 2005, and declined since to 0.38 million in 2009. The same is true for new housing start-ups, declining at a compound rate of 28.1% per year between 2005 and 2009 (source: US Census Bureau, http://www.census.gov).

[8]For more insightful discussion on the benefits of securitization, see Greenbaum and Thakor (1987, 2007), and Gorton and Metrick (2009). The reference to further aspects of bank securitization and asset sales activities is offered in Schipper and Yohn (2007).

Despite the unambiguous theoretical benefits offered by securitization, the empirical evidence and the state of market predicament to date suggest that financial institutions may have been unable fully to enjoy such advantages. With many firms moving from an "originate-to-hold" to "originate-to-distribute" business model, the agency problems become ever more apparent and a vast literature analyses this issue in depth [Mishkin, 2008; Berndt and Gupta, 2009; Drucker and Puri, 2009]. In particular, due to the separation of asset ownership and control functions, the loan originator lacks the incentive to exert enough effort in monitoring the credit quality of pursued projects. Provided with a channel to alleviate its credit exposure, the intermediary is more concerned with the fees it extracts from the new loan origination rather than the underlying quality of these loans. As demonstrated by Keys et al., (2010), the likelihood of originating sub-quality loans increases with the probability of the loans being sold. Furthermore, the funds released from asset shifts are commonly used to finance more profitable, yet riskier avenues [Cebenoyan and Strahan, 2004; Purnanandam , 2009]. And while various mechanisms were introduced to minimise moral hazard and to better align the interests of bankers and investors (Gorton and Pennacchi, 1995), inefficient contractual environment and misplaced regulatory efforts precluded a complete resolution of these problems.

Besides, under poorly designed regulatory capital charges, banks have an incentive to securitize safer, low-yield assets while retaining riskier and more profitable ones. As demonstrated by Ambrose, Lacour-Little and Sanders (2004), intermediaries commonly securitize safer mortgages and retain the more risky ones on the balance sheet. An extensive scope of works provides further empirical evidence to support this "regulatory arbitrage hypothesis" for asset securitization. Many also agree that even with no capital distortion, the banks are likely to shift safer assets, owed to excessive costs involved in distribution of riskier instruments due to the "lemons" problem (Akerlof, 1970). Additionally, despite the fact that under FASB140 rule (Financial Accounting Standards Board) securitization is classified as an asset sale, in practice, this transaction resembles a typical financing arrangement with securitizers commonly retaining their credit exposure by providing various credit enhancements and guarantees. For this reason, the off-balance sheet treatment of such transactions has been greatly criticised in the literature.

Moreover, with the increased popularity of securitized products, a myriad of non-depository market players entered the lending business directly to compete with traditional intermediaries. This translated into increased market competition, forcing many financial institutions to accept higher risks to remain competitive. Under this perspective, securitization is unlikely to be utilised as a risk-transfer mechanism, but is rather motivated by the desire for greater profitability.

On the basis of the discussion so far, and following the recent events in global financial markets, the possibility of banks utilizing securitization to curb interest rate risk seems rather elusive. This view is reflected in the first testable hypothesis:

Hypothesis$_1$: *Banks resorting to asset securitization face greater interest rate exposure. The extent of this exposure varies with the duration of assets securitized.*

Against this background, there is evidence to suggest that in the run up to the subprime crisis banks successfully shifted a great deal of riskier assets owing to favourable monetary and regulatory conditions. This trend was majorly fuelled by a low interest rate environment, the increased market demand for securitized products, and investors' excessive reliance on credit ratings reinforced by copious regulatory provisions. This view is empirically supported by Mian and Sufi (2009) and Dell'Ariccia, Igan, and Laeven (2008). However, both papers report a pronounced decline in the lending standards associated with higher securitization rates. The former contribution also reports a significant upturn in bank "disintermediation" over the 2001-2005 period, with a substantial increase in loans sold shortly after origination.

In the same vein, many have argued that in the last decade banks have moved from a traditional spread generating strategy to a new equity-maximisation fees-generating strategy. By assertively strengthening its involvement in the "originate-to-distribute" market, many intermediaries, in effect, function as brokers who extract the fees for joining borrowers and lenders. And while the asset repackaging and sale is costly to the originator, the costs associated with joining the complementary transactions between borrowers and securitized-debt investors are considerably reduced through the standardisation of securitized products. Besides, the company achieves economies of scale by specialising in structured finance transactions. It also enjoys increasing returns to scale in evaluating the borrowers' credit quality due to lax monitoring. Furthermore, the active players in the securitization market enjoy better access to derivative instruments which, as demonstrated by Purnanandam (2007), enable these companies to preserve the extent of loan origination even as monetary conditions tighten.

With this business model, the importance of interest generating revenues declines, and does the effective duration of assets held on the balance sheet. Accordingly, the duration gap remains at minimal levels, and the intermediary is less exposed to the risk of changing interest rates. On the basis of this argument, the following hypothesis is added into the analysis:

Hypothesis$_2$: *The relationship between bank interest rate risk and asset securitization is non-linear. The risk initially increases with the value of assets securitized, but declines with bank "disintermediation".*

4.3 Theoretical background

The interest rate exposure represents a natural risk faced by all financial intermediaries due to the nature of their maturity transformation business model. In particular, this type of risk may arise from three key sources. First, by transforming the short-term savings to long-term investments, banks unavoidably mismatch the duration of the interest sensitive assets and liabilities. The "Duration Theorem" independently proposed by Samuelson (1945) and Hicks (1946) states that if the weighted duration of the asset stream is greater (less) than the weighted duration of the liability stream, the interest rate increase (decrease) will reduce the individual's net worth. With therefore a positive duration gap, measured as the difference between the durations of assets and liabilities, rising interest rates reduce the value of assets more than the value of corresponding liabilities. The earlier attempt to formalise the practical applications of the proposed theory can be traced to the work of Redington (1952) who introduces the so-called "immunisation rule". Under this simplified rule, the agent chooses to always hedge against interest rate shocks by matching the durations of rate sensitive assets and liabilities.

Second, when the rates earned on the underlying assets are not perfectly correlated with the rates paid on the liabilities, the bank's earnings are exposed to interest rate fluctuation. This is referred to as the interest rate margin risk. Following the Federal Reserve's decision to reduce the interest rates to unprecedentedly low levels, the bankers have enjoyed a substantial increase in the interest rate margins. These conditions may substantially change as the monetary policy tightens, with many banks finding it difficult to refinance some of their fixed rate assets with variable rate liabilities. Finally, the third source of interest rate risk arises from optionality embedded in some assets and liabilities (e.g. prepayment options).This asymmetric source of interest rate risk gained its prominence in recent decades.

To theoretically formalise the aforementioned sources of interest rate risk, and to see how securitization may be used in curtailing these exposures, this section presents the model of bank intermediation and describes its key attributes. For simplicity, the model concentrates on the banks' duration transformation function and discounts any other claim attributes and risks. Formally, I assume that the interests of shareholders and managers are aligned in their combined utility maximisation (**A.1**). Accordingly, the bank pursues the strategy of maximising its after-tax profits. The credit market is perfectly competitive a la Besanko and Thakor (1987), with the credit contracts designed to maximise the expected utility of borrowers.

At each planning date t the manager can choose the amount to be invested in assets and liabilities of different maturities, conditional on her choices in preceding periods. The maturity of available projects is limited by T, which represents the manager's investment horizon. Some divergences from the target asset mix are inevitable in the short-run, though the bank's choice of principal specialisation determines the market condition it faces and its ability to promptly adjust the composition of the asset portfolio. Bank liabilities are subject to similar constraints, with relatively stable, manager controlled federal funds, though volatile deposit base. The latter contracts represent a relatively stable funding source in the presence of a deposit insurance guarantee. Assuming further that t is continuously defined on the closed interval $[0, T]$, the bank's asset and liability streams over the investment horizon are $A(t)$ and $L(t)$ respectively. The interest rates are stochastic and independent of the banks' choice of balance sheet structure, with the function $R(t)$ characterising the market term structure over the interval $[0, T]$. The intermediary can nonetheless negotiate favourable rate conditions on its assets and liability contracts (e.g., spreads over index rates such as LIBOR) owing to its market power. The BHC's equity value Q is therefore simply the difference between the present values of its asset and liability streams:

$$Q = \int_0^T A(t)e^{-R(t)t}dt - \int_0^T L(t)e^{-R(t)t}dt = A - L \tag{4.1}$$

where the present values of asset and liability streams are denoted by A and L respectively.

In a similar manner, the BHC's net income $\forall t > 0$ is defined as:

$$I(t) = R^a(t)A(t) - R^l(t)L(t) \tag{4.2}$$

where $R^a(t)$ and $R^l(t)$ are interest rates charged on assets and liabilities respectively. For convenience, the regulatory capital charges, as well as the operational costs of servicing the asset and liability portfolios are assumed away in this specification.

Accordingly, following Assumption 1 (**A.1**) above, the bank shareholders are concerned with maximising the value of bank profits:

$$\pi(t) = R^a(t)A(t) - R^l(t)L(t) + \triangle Q \tag{4.3}$$

Note that the equity value Q is unaffected if the yield curve remains unchanged over the period; and the bank profits are driven by the net interest margin.

As, however, the term structure evolves, both the bank interest margin and its equity value would be affected in a number of ways. The exact nature of such response is convoluted due to the direction of rate movements, the occurrence of non-parallel shifts in the term structure, and the relationships between the bank assets and liabilities rates. These considerations unnecessary complicate the model, and a number of simplifying assumptions are introduced as follows:

A.2 The shifts in the interest rate yield curve are parallel in nature: given a continuous random variable q with a probability density function $f(q) \geq 0$ and $a \leq q \leq b$, the future yield curve can be described by $R(t) + q$, $\forall t \in [0, T]$.

Accordingly, assuming $R(t) = R$ in (3), the bank interest income remains unaffected as long as the adjustment speed of the rates charged on assets and the rates paid on liabilities is the same:

$$\frac{\partial R^a(t)}{\partial R} = \frac{\partial R^l(t)}{\partial R} \tag{4.4}$$

Under this condition, the profits are determined by the term-structure driven changes in the market values of the intermediary's assets (A) and liabilities (L):

$$\frac{\partial \pi}{\partial R} = \frac{\partial Q}{\partial R} = -\int_0^T A(t)e^{-R(t)t}dt \times \frac{\int_0^T tA(t)e^{-R(t)t}dt}{\int_0^T A(t)e^{-R(t)t}dt} + \\ + \int_0^T L(t)e^{-R(t)t}dt \times \frac{\int_0^T tL(t)e^{-R(t)t}dt}{\int_0^T L(t)e^{-R(t)t}dt} \tag{4.5}$$

It is easy to see that

$$\frac{\int_0^T tA(t)e^{-R(t)t}dt}{\int_0^T A(t)e^{-R(t)t}dt} \text{ and } \frac{\int_0^T tL(t)e^{-R(t)t}dt}{\int_0^T L(t)e^{-R(t)t}dt}$$

are simply the weighted average time to maturity, or durations, of assets and liability streams respectively. Denoting the duration of assets with MD_A and the duration of liabilities with MD_L, we get:

$$\frac{\partial \pi}{\partial R} = \frac{\partial Q}{\partial R} = L \times MD_L - A \times MD_A \tag{4.6}$$

It therefore follows that the manager's decision problem is to choose the MD_L and MD_A that maximise the value of bank equity Q. Assuming, however, the stochastic nature of the interest rate movements $[E(q)= \int_a^b qf(q)dq]$, adjusting the durations is barely an improvement over the immunisation strategy. Hence, in equilibrium, the manager chooses to always immunize.

Since banks commonly assume a positive asset-liability duration mismatch, to reduce the sensitivity of a company's value to interest rate fluctuation, the risk manager must either reduce the duration of assets MD_A or increase the duration of liabilities MD_L. In this respect, securitization offers an elegant solution to the first problem, owed to heterogeneity in the assets admissible for securitization. In particular, the lender with a positive duration mismatch can use securitization in at least two ways to curtail its interest rate exposure: (a) it can securitize the long term-assets, such as mortgages, off the balance sheet, thereby reducing the effective duration gap; (b) it can securitize assets with embedded prepayment provisions and thus hedge its exposure to unanticipated increases in interest rate volatility.

4.4 Methodological framework

4.4.1 Yield curve modelling

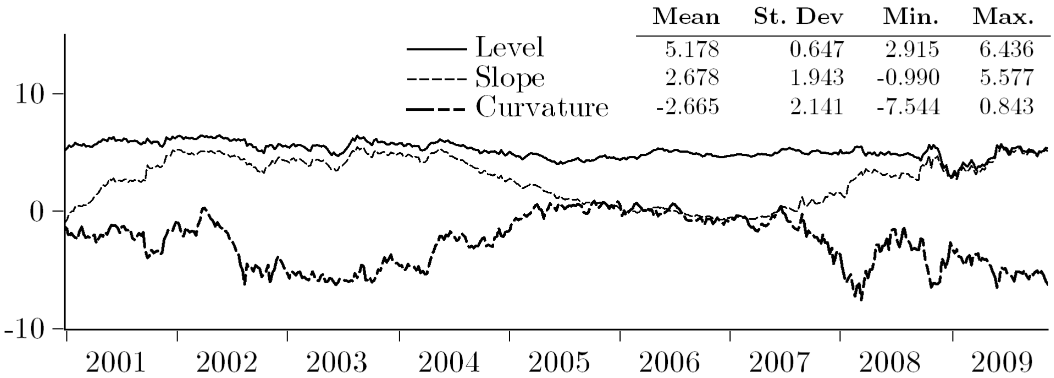
TThe standard research methodology of assessing the interest rate exposure proposes to use a single interest rate factor (Stone, 1974). Therefore, it fails to recognize the time-varying nature of the yield curve shape.

In this study, I account for the sensitivity of BHCs' stock returns to the changes in the entire shape of the term structure by employing simultaneously the level, slope and curvature of the interest rate yield curve. These measures are calculated via the Diebold and Lee factorization of the Nelson and Siegel (1987, 1988) model discussed in Chapter 2.

Figure 4.1 plots the estimated level, slope and curvature factors, with the pertinent statistics outlined in the corresponding table.

Compared to the yield curve slope and curvature, the level factor is less volatile. This observation is not surprising since the yield curve level serves as a proxy for the long-term interest rate, with the yields at the long end of the term structure being generally less volatile.

Figure 4.1
US zero-coupon yield curve level, slope, and curvature



Note: The figure depicts time-series plots of the Nelson and Siegel (1978) zero-coupon yield curve factors for the US over the 2001 to 2009 period. Shown are the estimates of the interest rate yield curve level (β_1), slope (β_2) and curvature (β_3).

4.4.2 Interest rate exposure

To address the underlying empirical hypotheses, I follow a two-stage estimation procedure in line with previous literature in the area. In the first step, the interest rate exposure of BHCs' stock returns is modelled via a four-factor GARCH(n, m) parameterisation[9] of the market model formalised as:

$$R_{it} = \alpha + X_{it}'\beta + \varepsilon_{it} \tag{4.7}$$

$$h_{it} = \omega_0 + \sum_{i=1}^{n} \gamma_1 \varepsilon_{i,t-1}^2 + \sum_{j=1}^{m} \gamma_2 h_{i,t-1} \tag{4.8}$$

$$\varepsilon_{it}|\Omega_{t-1} \sim N(0, h_{it}) \tag{4.9}$$

where R_{it} represent the weekly logarithmic returns on BHC $i(i = 1 \text{ to } 304)$ at time t; α is a scalar, β is a $K \times 1$ vector of coefficients and X_{it} is the it-th observation on K explanatory variables: $X\prime = (R_M, R_{Level}, R_{Slope}, R_{Curvature})$. R_M is return on the $S\&P500$ market index. R_{Level}, R_{Slope},and $R_{Curvature}$ represent unanticipated changes in the level, slope, and curvature of the domestic sovereign zero-coupon yield curve at time t respectively. The unanticipated changes are estimated as the difference between the actual changes in the respective factor at time t and ones forecasted via the appropriate specification of the $ARMA$ model. ε_{it} is the estimated error term from the mean equation of portfolio i, and h_{it} is a

[9]The GARCH based econometric framework is used to account for a time-varying element in the distribution of BHCs' stock returns. See Chapter 2 and 3 for more details.

conditional variance of portfolio i over week t. The order of lags (n, m) ensures the adequate treatment of serial correlation in squared returns, with the formal Engle ARCH Lagrange multiplier and Ljung-Box Q-statistics determining the correct lag structure.

The estimated coefficients measure the sensitivity of bank i's stock returns to changes in the considered interest rate factor. They are treated as independent variables in the empirical framework to follow.

4.4.3 Securitization and interest rate risk

In the second step, the estimated measures of interest rate risk are related to proxies of bank securitization and asset sales activities. I use panel data techniques to fully exploit the potential of the data sample, and to control for unobserved cross-sectional and time heterogeneity [Baltagi, 2005]. The workhorse model specification accounts for both company specific financial characteristics and the overall economic and business conditions in which these firms operate:

$$\left|\beta_{it}^{k}\right| = \varphi + SEC'_{i,t-1}\lambda + Y'_{i,t-1}\psi + G'_{t-1}\xi + T'_{t}\theta + \eta_i + \varepsilon_{it} \tag{4.10}$$

where, β_{it}^{k} represents the interest rate risk measure k in year t for bank i. As discussed above, these measures represent the BHCs' equity return sensitivity to unanticipated changes in the yield curve level, slope, and curvature. λ is an $S \times 1$ vector of coefficients and SEC_{it} is the it-th observation on S securitization proxies. Similarly, ψ is an $M \times 1$ and Y_{it} is the it-th observation on M company specific financial characteristics; while ξ is an $L \times 1$ and G_t is the t-th observation on L macroeconomic characteristics. T_t is a vector of year-dummies of dimension $T-1$, and the company-specific effect is measured by η_i. The model is estimated by either treating η_i as fixed (fixed effect model), thus assuming $(N + M + L)$ unknown coefficients, with $\eta = (\eta_1, \ldots, \eta_N)\prime$ being company specific intercepts; or random (random effect model). In the random effect specification $\eta_i \sim IID(0, \sigma_{\eta}^{2})$ and is independent of $\varepsilon_i \sim IID(0, \sigma_{\varepsilon}^{2})$. Further, both η_i and the disturbance term ε_i are independent of (SEC_{it}, Y_{it}, G_t) for all i and t. For both model specifications the robust standard errors adjusted for serial correlation and heteroskedasticity are calculated.

In line with Keswani, Marsh, and Zagonov (2009) and Au Yong, Faff and Chalmers (2009), the absolute values of interest rate betas are used as dependent variable in the second step regressions. This aids an economic interpretation of the estimated results and can be reconciled with the notion that both positive and negative exposures to yield curve shocks represent the risk to bank economic value and should be treated accordingly. Further, to facilitate the validation of the proposed hypotheses, various parameterisations of the baseline model are introduced through empirical investigation.

4.5 Sample Selection

The dataset spans the 2001 to 2009 period and consists of the US publicly traded bank holding companies (BHC). The choice of sample period is driven by the availability of required data on BHCs' securitization activities. I identified publicly traded BHCs by cross-referencing the institutions appearing both in the Federal Reserve Bank of Chicago Bank Holding Company database and in the dataset supplied by the University of Chicago's Centre for Research in Security Prices (CRSP). The requisite dataset is accordingly constructed by merging the income statement and balance sheet data from the Consolidated Financial Statement for Bank Holding Companies (FR Y-9C form) with the equity market data from CRSP on the basis of company name and its geographical location. The equity returns are of weekly frequency, all adjusted for dividend reinvestment and stock splits by CRSP. I further check for the dataset consistency with Compustat using the CUSIP identifier.

The focus on BHCs instead of their commercial bank subsidiaries is determined by two factors. First, the share price data is commonly available for only the BHC and not individual banks. Second, as noted by Thomas and Wang (2004), the decisions concerning the company's capital and risk management strategies are ordinarily undertaken at the highest level, and are not necessarily directed at a single subsidiary.

To ease illiquidity concerns, the banks with nil share price changes for more that 20% of trading days are excluded from the sample. The same applies for the acquired entities and firms with missing data on securitization and asset sales activities, derivative transactions, total loans and assets, and equity capital. Further effort is taken to detect and address any outliers arising as a result of measurement or reporting errors in the underlying datasets. Other non-technical representative outliers, depicting genuine variability in the considered variables, are dealt with accordingly as per the discussion to follow. This yields a total of 304 bank holding companies with the required information being continuously available across the entire sample period. The list of analysed banks is in Appendix 4.1, while the considered variables alongside their detailed definitions can be found in Appendix 4.2. For each BHC, the annual aggregates of the underlying data are used. The average value of total assets for these institutions ranges between \$16,524 million in 2001 and \$35,682 million in 2009, with the median for two years being \$1,017 billion and \$2,023 billion respectively.

Bank attributes related to securitization and loan sales activities are from Schedule HC-S of FR Y-9C filings. For each BHC, I measure the aggregate value of assets, by category, securitized and sold, or sold but not securitized, within a given fiscal year. Additionally, the value of the outstanding principle balance of assets securitized or sold for each bank-year is also considered. The pertinent statistics on these measures, by year, are reported in Table 4.1, with a detailed definition for each variable available in Appendix 4.2. Evidently, the loans secured by 1-4 family residential real estate dominate securitizations and loan sales. This is followed by commercial and industrial, and credit cards receivable loans.

To account for further bank characteristics and the macroeconomic environment in which these institutions operate, I introduce two sets of control variables accordingly.

4.5.1 Bank specific control variables

There are six firm level controls, all constructed using FR Y-9C filings. First, given the evidence of significant U-shaped relationships between bank capital and interest rate risk (Keswani, Marsh, and Zagonov, 2009), the ratio of equity capital to BHC's total assets (CAP) is deployed. Here, it should be noted that by facilitating the diminution in regulatory capital requirements, securitization may render the capital ratios an unreliable approximation of the true bank capital constraints. This, however, should not significantly alter the importance of this factor in explaining the banks' interest rate sensitivity because the equity capital itself represents not-interest rate sensitive liability. Accordingly, firms with higher capital levels are expected to be less sensitive to interest rate shocks.

Second, following the rationale outlined in previous works, the measure of bank liquidity (LATA) is also considered. In line with empirical literature, a positive relationship between banks' liquidity and risk are expected. Care should be taken in interpreting this variable, since securitization may affect the short-term fund inflows and hence inflate the bank liquidity ratios. Third, the ratio of non-performing loans[10] (NPL) is used to measure the quality of the bank asset portfolio. Fourth, based on the theoretical underpinning outlined in the previous section and in line with Flannery and James (1984b), the measure of balance sheet asset - liability mismatch (GAP) is calculated as the difference between

[10] A loan is considered delinquent if it fails to acquire interest, or when a payment is 90 days or more overdue but interest is still acquired.

Table 4.1
Bank loan sales and securitization activities by year

This table presents the summary statistics of the US publically traded bank holding companies (BHCs) securitization and assets sales activities by year. Reported are the average values of assets by category, expressed as a proportion of BHCs' total assets, securitized or sold within a given year, and the percentage of BHCs (*in italics*) involved in issuance of new securitization and loan sales transactions in the same year. The respective data are compiled from Schedule HC-S of the Federal Reserve System's FY-9C filings for a sample of 304 financial intermediaries analysed in this study.

	2001	2002	2003	2004	2005	2006	2007	2008
Loan sales								
1-4 family residential	0.0424	0.0226	0.0129	0.0164	0.0146	0.0075	0.0062	0.0087
	13.36%	*11.30%*	*11.82%*	*12.58%*	*12.58%*	*12.58%*	*13.25%*	*13.71%*
Home equity lines	0.0000	0.0000	0.0000	0.0000	0.0001	0.0040	0.0024	0.0002
	0.00%	*0.00%*	*0.00%*	*0.00%*	*0.33%*	*0.99%*	*0.66%*	*0.67%*
Credit card receivables	0.0005	0.0000	0.0003	0.0004	0.0000	0.0001	0.0000	0.0006
	2.53%	*1.37%*	*2.36%*	*2.65%*	*1.99%*	*1.99%*	*2.32%*	*2.34%*
Auto loans	0.0000	0.0001	0.0000	0.0000	0.0000	0.0014	0.0000	0.0152
	0.00%	*0.34%*	*0.00%*	*0.33%*	*0.00%*	*0.33%*	*0.00%*	*0.33%*
Other consumer loans	0.0044	0.0091	0.0003	0.0000	0.0000	0.0000	0.0000	0.0003
	1.08%	*0.34%*	*0.34%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.33%*
C&I loans	0.0126	0.0020	0.0028	0.0018	0.0051	0.0017	0.0107	0.0001
	2.53%	*2.40%*	*2.36%*	*2.65%*	*2.32%*	*1.99%*	*0.66%*	*0.33%*
Other loans	0.0143	0.0019	0.0033	0.0089	0.0040	0.0100	0.0312	0.0168
	0.72%	*1.03%*	*1.69%*	*2.65%*	*1.66%*	*1.32%*	*1.99%*	*3.34%*
Loan securitization								
1-4 family residential	0.2218	0.0708	0.0641	0.0342	0.0412	0.0562	0.0325	0.0497
	11.55%	*8.22%*	*6.42%*	*6.29%*	*4.97%*	*4.30%*	*4.30%*	*5.35%*
Home equity lines	0.0086	0.0021	0.0033	0.0093	0.0120	0.0037	0.0000	0.0033
	1.81%	*0.68%*	*1.01%*	*1.66%*	*1.32%*	*0.99%*	*0.33%*	*1.67%*
Credit card receivables	0.0274	0.0049	0.0055	0.0147	0.0101	0.0160	0.0108	0.0060
	1.44%	*1.03%*	*0.68%*	*0.99%*	*0.99%*	*1.99%*	*1.32%*	*1.67%*
Auto loans	0.0147	0.0133	0.0286	0.0119	0.0086	0.0126	0.0203	0.0118
	5.42%	*1.71%*	*2.03%*	*1.99%*	*0.99%*	*1.32%*	*0.33%*	*1.67%*
Other consumer loans	0.0110	0.0031	0.0036	0.0041	0.0040	0.0074	0.0007	0.0011
	2.89%	*1.03%*	*0.68%*	*0.66%*	*1.32%*	*1.66%*	*0.99%*	*1.00%*
C&I loans	0.0264	0.0111	0.0046	0.0036	0.0048	0.0043	0.0029	0.0006
	3.61%	*3.08%*	*2.36%*	*1.66%*	*1.32%*	*1.99%*	*1.32%*	*1.67%*
Other loans	0.0128	0.0055	0.0138	0.0054	0.0094	0.0096	0.0069	0.0246
	2.53%	*2.05%*	*2.70%*	*2.98%*	*2.98%*	*3.97%*	*3.97%*	*2.01%*

interest-earning assets and interest-bearing liabilities maturing or being repriced within one year, scaled by the bank's total assets. As per the outlined theory, a positive sign on this variable is expected. Fifth, since the originator commonly retains an equity-like interest in the transaction, thus maintaining its exposure to credit and prepayment risks, the bank purchase of credit protection (e.g. credit default swaps) can be seen as an attempt to hedge this exposure. To this end, I calculate the bank's net credit protection purchase (NECP) as the difference between the credit protection it buys and sells in a given fiscal year.

Finally, to control for the effect of bank activity diversification, a set of asset and revenue diversification measures is constructed. In line with Laeven and Levine (2007), the diversification of net operating revenue (ROID) is proxied via a modified specification of a Herfindahl-Hirschman Index (HHI) as follows:

$$ROID = 1 - \left| \frac{\text{Interest income} - \text{Non-interest income}}{\text{Total operating income}} \right| \tag{4.11}$$

This measure assumes values between 0 and 1, with a higher value suggesting greater degree of income diversification. In support of the "income diversification hypothesis" in Keswani, Marsh, and Zagonov (2009), ROID is expected to be negatively related to interest rate risk proxies.

In addition, the income concentration in both interest and non-interest revenue streams is also captured via a Herfindahl-Hirschman Index. In particular, I consider a broad eight part breakdown for non-interest revenues (H_NOIR), and a twelve part breakdown for the interest income (H_NITR). In a similar manner, the loan concentration HHI (H_LOAN) is computed considering five major categories of loans. These include agricultural, commercial and industrial, consumer, real estate, and other loans. More information on the construction of these variables is given in Appendix 4.2.

To improve the fit of the empirical model, I control for further bank characteristics that may explain the variation in the risk exposures. Namely, the return on assets (ROA) is utilised to proxy the bank operational performance and efficiency, while the return on equity (ROE) is discounted in the analysis due to its deceptiveness for firms with highly leveraged balance sheet. It may also be argued that the level of bank securitization, as well as its risk exposure, is determined by the growth rate of its assets base. Accordingly, the asset growth rate (AGR) is added to account for this supposition. Finally, as securitization alters the value of banks' on-balance sheet assets, the size indicator becomes less relevant (DeYoung and Rice, 2004b) and it is omitted from the analysis.

To this end, Panel A of Table 4.2 provides key comparative statistics for the outlined measures between securitizers and non-securitizers, while Table 4.3 presents pairwise correlations for these variables.

BHCs resorting to asset securitization are larger, retain higher capital buffers, and have better diversified non-interest revenues, while their non-securitizing counterparts excel in diversifying the interest income. Generally, securitizers seem to better balance the shares of interest and fee-generating revenues in their total operating income (ROID). Securitizers also maintain a better diversified loan portfolio, which, however, seems to be of a lower credit quality as suggested by loan-loss provision and non-performing loan ratios. Further, these firms purchase more credit protection than their non-securitizing peers. This provides evidence to support the "regulatory arbitrage hypothesis" for asset securitization discussed above. Finally, BHCs not involved in the originate-to-distribute market maintain a lower asset-liability mismatch on the balance sheet, suggesting that these firms resort to stricter asset-liability management practices.

4.5.2 Economic environment

In the second group of controls, the overall economic and business conditions are captured by the annual growth rate in the gross domestic product (GDPG), and the Aruoba-Diebold-Scotti Business Conditions Index (ADSI) sourced from the Federal Reserve Bank of Philadelphia database [Aruoba, Diebold, and Scotti, 2009; and Aruoba and Diebold, 2010], respectively. The latter measure accounts for the real economic activity at high frequency, on the basis of both high- and low-frequency information on six major economic indicators (i.e. weekly initial jobless claims, monthly payroll employment, industrial production, personal income less transfer payments, manufacturing and trade sales, and quarterly real GDP). This index has an average value of zero, with progressively greater values indicating better than average business conditions and vice versa. The descriptive statistics for both figures are outlined in Table 4.2: Panel B.

To get more stable estimates in the empirical model, all considered explanatory variables ($\omega = Y, G$) are treated for outliers via type I winsorization[11], with fixed cut-off points of $\bar{\omega} \pm 4\hat{\sigma}$. Alternatively, the variables are winsorized at the 1 and 99 percentiles, with the results being robust to the variable winsorization.

[11] Type I winsorization commonly refers to the procedure of replacing outliers with the exact value of the interval limit, while with Type II outliers are transformed to predestined weighted average between their original and the cut-off values.

Table 4.2
Selected characteristics of bank holding companies

This table provides a comparison of selected financial characteristics for securitizers and non-securitizers over the 2001 to 2009 period. A bank holding company (BHC) is defined as securitizer if it reports at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings. Reported are the mean [median] values of the considered accounting variables. This includes an institution's asset growth rate (AGR); equity capital (CAP) calculated as the ratio of BHC's book value of equity capital to its total assets; the Herfindahl-Hirschman (non)interest revenue concentration index H_NITR(H_NOIR) calculated on the basis of twelve (eight) part breakdown of the (non)interest income; the proportion of total assets that are liquid (LATA); the Herfindahl-Hirschman loan concentration index (H_LOAN) computed considering five loan categories; the bank's provision for loan and lease losses scaled by total loans (LLP); maturity gap (GAP) calculated as the difference between interest-earning assets and interest-bearing liabilities maturing or being repriced within one year, scaled by the bank's total assets; the net credit protection (protection bought minus sold) NECP purchased by a bank; the ratio of non-performing loans to total loans is NPL; return on assets (ROA); the measure of bank revenue diversification (ROID); and the ratio of the institution's risk-weighted to total assets (TRA). The economic environment is proxied by the annual growth rate in the gross domestic product (GDPG), and the Aruoba-Diebold-Scotti Business Conditions Index (ADSI).***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively for an appropriate mean [median] equality test.

Variable	Securitizers mean/[median]	Non-securitizers mean/[median]	All BHCs mean/[median]	Equality test mean/[median]
Panel A: BHC financial characteristics				
Asset growth rate	0.101	0.126	0.121	1.04
AGR	[0.077]	[0.091]	[0.088]	[3.03***]
Capitalisation	0.098	0.091	0.093	-3.20***
CAP	[0.088]	[0.088]	[0.088]	[0.34]
Interest income HHI	0.076	0.064	0.067	-1.96*
H_NITR	[0.019]	[0.016]	[0.017]	[4.54***]
Liquidity	0.264	0.261	0.262	-0.45
LATA	[0.242]	[0.238]	[0.239]	[0.37]
Loan HHI	0.530	0.608	0.590	10.51***
H_LOAN	[0.530]	[0.601]	[0.582]	[10.34***]
Loan loss provision	0.006	0.004	0.005	-5.66***
LLP	[0.004]	[0.003]	[0.003]	[6.34***]
Maturity gap	0.177	0.160	0.164	-2.56**
GAP	[0.141]	[0.130]	[0.132]	[2.09**]
Net credit protection	6.54E-04	1.38E-05	1.61E-04	-3.66***
NECP	[0.000]	[0.000]	[0.000]	[0.48]
Non-interest income HHI	0.177	0.213	0.205	5.02***
H_NOIR	[0.142]	[0.191]	[0.177]	[6.72***]
Non-performing loans	0.012	0.010	0.010	-4.16***
NPL	[0.008]	[0.006]	[0.006]	[7.77***]
Return on assets	0.012	0.009	0.009	-4.78***
ROA	[0.011]	[0.010]	[0.010]	[3.59***]
Revenue Diversification	0.427	0.330	0.352	-10.56***
ROID	[0.409]	[0.300]	[0.315]	[9.94***]
Total risk adjusted assets	0.749	0.740	0.742	-1.37
TRA	[0.758]	[0.748]	[0.750]	[1.58]
Panel B: Economic environment characteristics				
GDP growth	0.017	0.023	0.021	13.93***
GDPG	[0.020]	[0.025]	[0.025]	[14.21***]
Business conditions index	-0.952	-0.095	-0.422	57.01***
ADSI	[-1.077]	[-0.130]	[-0.155]	[35.79***]

Table 4.3
Correlation matrix for selected variables

This table presents the bivariate correlations between the considered explanatory variables. Spearman(Pearson) correlation coefficients are above (below) the diagonal. Variable definitions and sources are provided in Appendix 4.2. $p-$values are in parentheses.

	AGR	CAP	H_NITR	LATA	H_LOAN	LLP	GAP	NECP	H_NOIR	NPL	ROA	ROID	TRA	GDPG	ADSI	TSEC
AGR		-0.134	-0.138	-0.087	0.133	-0.064	0.058	0.013	-0.057	-0.228	-0.007	-0.111	0.086	0.084	0.141	-0.030
		(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.002)*	*(0.007)*	*(0.545)*	*(0.007)*	*(0.000)*	*(0.740)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.163)*
CAP	0.022		-0.028	-0.059	0.006	-0.079	0.073	-0.047	-0.022	0.050	0.257	0.079	0.085	-0.019	-0.068	0.037
	(0.309)		*(0.190)*	*(0.006)*	*(0.771)*	*(0.000)*	*(0.001)*	*(0.027)*	*(0.308)*	*(0.019)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.366)*	*(0.001)*	*(0.083)*
H_NITR	0.100	0.046		0.593	-0.092	0.150	-0.120	0.045	0.069	0.170	-0.194	0.070	-0.505	-0.345	-0.135	0.121
	(0.000)	*(0.032)*		*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.033)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
LATA	0.091	0.037	0.135		-0.156	-0.198	-0.135	0.044	0.074	-0.126	0.087	0.093	-0.800	0.052	0.220	0.037
	(0.000)	*(0.079)*	*(0.000)*		*(0.000)*	*(0.000)*	*(0.000)*	*(0.040)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.014)*	*(0.000)*	*(0.083)*
H_LOAN	0.029	-0.038	0.106	-0.046		-0.244	-0.141	-0.022	0.084	-0.154	-0.152	-0.346	-0.003	0.047	-0.051	-0.258
	(0.167)	*(0.071)*	*(0.000)*	*(0.029)*		*(0.000)*	*(0.000)*	*(0.309)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.890)*	*(0.027)*	*(0.015)*	*(0.000)*
LLP	-0.053	0.055	0.416	-0.160	-0.146		0.023	-0.044	-0.035	0.552	-0.276	0.036	0.195	-0.420	-0.194	0.170
	(0.012)	*(0.009)*	*(0.000)*	*(0.000)*	*(0.000)*		*(0.276)*	*(0.039)*	*(0.098)*	*(0.000)*	*(0.000)*	*(0.091)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
GAP	-0.004	0.161	-0.059	-0.096	-0.131	-0.004		-0.014	-0.115	-0.070	0.121	0.149	0.238	0.064	0.078	0.084
	(0.840)	*(0.000)*	*(0.006)*	*(0.000)*	*(0.000)*	*(0.838)*		*(0.514)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.003)*	*(0.000)*	*(0.000)*
NECP	-0.001	-0.021	0.026	0.018	-0.086	0.087	-0.031		0.045	-0.037	-0.002	0.067	-0.048	-0.003	-0.029	0.052
	(0.964)	*(0.320)*	*(0.216)*	*(0.391)*	*(0.000)*	*(0.000)*	*(0.147)*		*(0.032)*	*(0.081)*	*(0.911)*	*(0.002)*	*(0.025)*	*(0.874)*	*(0.177)*	*(0.015)*
H_NOIR	-0.012	-0.010	0.021	0.011	-0.041	0.133	-0.026	0.451		-0.006	-0.087	-0.186	-0.160	-0.013	-0.069	-0.210
	(0.575)	*(0.636)*	*(0.313)*	*(0.616)*	*(0.052)*	*(0.000)*	*(0.229)*	*(0.000)*		*(0.767)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.550)*	*(0.001)*	*(0.000)*
NPL	-0.079	-0.043	0.445	-0.082	-0.008	0.603	-0.078	0.031	0.057		-0.274	0.007	0.100	-0.341	-0.242	0.161
	(0.000)	*(0.043)*	*(0.000)*	*(0.000)*	*(0.718)*	*(0.000)*	*(0.000)*	*(0.140)*	*(0.007)*		*(0.000)*	*(0.751)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
ROA	0.006	0.609	-0.253	0.132	-0.102	-0.355	0.147	-0.022	-0.048	-0.334		0.241	-0.004	0.229	0.253	0.089
	(0.764)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.307)*	*(0.022)*	*(0.000)*		*(0.000)*	*(0.859)*	*(0.000)*	*(0.000)*	*(0.000)*
ROID	0.003	-0.050	-0.052	0.086	-0.341	0.010	0.150	0.055	-0.040	-0.083	0.105		-0.061	0.088	0.183	0.219
	(0.871)	*(0.017)*	*(0.014)*	*(0.000)*	*(0.000)*	*(0.653)*	*(0.000)*	*(0.009)*	*(0.059)*	*(0.000)*	*(0.000)*		*(0.004)*	*(0.000)*	*(0.000)*	*(0.000)*
TRA	-0.074	-0.047	-0.118	-0.813	-0.092	0.136	0.205	-0.042	-0.042	0.075	-0.098	-0.017		0.005	-0.151	0.028
	(0.001)	*(0.025)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.049)*	*(0.049)*	*(0.000)*	*(0.000)*	*(0.421)*		*(0.804)*	*(0.000)*	*(0.187)*
GDPG	0.022	-0.008	-0.506	0.069	0.037	-0.379	0.067	-0.016	-0.036	-0.336	0.203	0.093	-0.005		0.644	-0.023
	(0.295)	*(0.714)*	*(0.000)*	*(0.001)*	*(0.078)*	*(0.000)*	*(0.001)*	*(0.444)*	*(0.090)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.818)*		*(0.000)*	*(0.274)*
ADSI	0.052	-0.042	-0.337	0.211	-0.080	-0.244	0.060	-0.065	-0.027	-0.273	0.182	0.117	-0.177	0.479		0.009
	(0.014)	*(0.046)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.004)*	*(0.002)*	*(0.195)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*		*(0.664)*
TSEC	-0.004	0.039	0.013	-0.013	-0.073	0.106	0.057	0.086	0.069	0.103	0.051	0.212	0.001	-0.029	0.011	
	(0.867)	*(0.067)*	*(0.525)*	*(0.536)*	*(0.001)*	*(0.000)*	*(0.008)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.016)*	*(0.000)*	*(0.959)*	*(0.170)*	*(0.606)*	

4.6 Empirical Results

The discussion begins with the results obtained in the first stage estimation in Section 4.6.1. The multivariate regression analysis is discussed in section 4.6.2.

4.6.1 Bank interest rate sensitivities

The interest rate exposure of analysed BHCs is assessed via a four-factor GARCH(n, m) model formalised in (4.8). This model is estimated for each bank-year, with Table 4.4 presenting comparative statistics of estimated interest rate factors for securitizers and their non-securitizing peers.

At least 10% of the examined BHCs are significantly affected by the adverse movements in different components of the interest rate yield curve, thereby indicating the inability of risk managers to timely adopt adequate hedging strategies. Notably, while the effect of interest rate shocks on the values of both securitizers and non-securitizers is similar in its magnitude, the proportion of securitizers significantly affected by these shocks is appreciably higher. This, in a way, supports the first empirical hypothesis which argues that securitization is unlikely to be employed as a risk-transfer mechanism.

The majority of the significant interest rate factors are negative, suggesting that BHCs maintain a positive duration mismatch between their interest sensitive assets and liabilities.

4.6.2 Securitization and interest rate risk

For the main research hypotheses, the panel model in (4.11) is first estimated with time- and state-fixed effects applied to the entire sample of BHCs. The sensitivities of equity values to unanticipated changes in the yield curve level, slope, and curvature estimated from (4.8) are interchangeably used as the endogenous variable in this model. The explanatory variables that control for the company financial characteristics, and the country economic conditions, are as discussed in previous section. All right-hand side measures are lagged to avoid simultaneity bias. When the economic environment proxies are added into the model, the time-fixed effect is relaxed.

Considering first the intermediaries' exposure to changes in the long end of the yield curve, Table 4.5 outlines the empirical results for Hypothesis 1. The proxy for bank securitization activities (TSEC) enters Table 4.5 positively and significantly at the one percent level. This implies that BHCs with a greater outstanding value of securitized assets tend to increase interest rate exposure, with this

Table 4.4
Selected BHCs' market measures of risk

This table provides a comparison of selected measures of market risk for securitizers and non-securitizers over the 2001 to 2009 period. A bank holding company (BHC) is defined as securitizer if it reports at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings. Reported are the mean [median] values of pertinent risk measures. The market measures of risk are represented by the coefficient estimates from a four factor GARCH market model. Specifically, for each bank-year, I run a four-factor time series regression of BHC weekly returns on the market returns (MRK), and unanticipated changes in zero-coupon yield curve level (LEV), slope (SLO), and curvature (CUR). The estimation requires at least 30 weekly return observations for each bank-year. The corresponding US zero-coupon yield curve level, slope, and curvature are estimated using Diebold and Lee (2006) parameterization of the Nelson and Siegel (1987) model. The unanticipated changes in the yield curve factors at time t are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. The percentage of coefficients significant at the 5% level (% of which is negative) is in italics. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively for an appropriate mean [median] equality test.

Variable	Securitizers mean/[median]	Non-securitizers mean/[median]	All BHCs mean/[median]	Equality test mean/[median]
Systematic risk	9.72E-01	6.62E-01	7.32E-01	-8.78***
	[9.04E-01]	[5.78E-01]	[6.63E-01]	[8.99***]
Significance at 5% level	*75.00%*	*49.62%*	*55.35%*	
IR Level	7.14E-04	1.16E-03	1.06E-03	0.15
	[2.66E-03]	[2.24E-04]	[7.29E-04]	[0.58]
Significance at 5% level	*9.51%*	*7.30%*	*7.80%*	
% negative	*-47.06%*	*-46.27%*	*-46.49%*	
IR Slope	-9.94E-03	-8.57E-03	-8.88E-03	0.35
	[-9.88E-03]	[-9.44E-03]	[-9.61E-03]	[0.02]
Significance at 5% level	*11.94%*	*9.64%*	*10.16%*	
% negative	*-68.75%*	*-72.88%*	*-71.78%*	
IR Curvature	6.27E-05	-8.60E-04	-6.52E-04	-0.86
	[3.84E-04]	[-4.95E-07]	[-6.78E-08]	[0.77]
Significance at 5% level	*13.99%*	*7.24%*	*8.77%*	
% negative	*-61.33%*	*-67.67%*	*-65.39%*	

evidence providing additional support for the proposed hypothesis. This is also consistent with the view that securitization is unlikely to serve as a risk-transfer mechanism, and is instead motivated by the desire for greater profitability.

To attest the second part of the hypothesis, concerning the duration of assets securitized, I aggregate securitizations by the maturity of the underlying assets into three categories: long-term (1-4 family residential mortgages), medium term (home equity lines of credit and commercial and industrial loans), and short-term (auto loans, credit card receivables, and other consumer and commercial loan and leases). Given that commercial and industrial loans commonly include short- and medium- term lending to businesses, they enter both short- and medium-term categories interchangeably. The results, also reported in Table 4.5, are robust to either specification.

It appears that increases in interest rate exposure are mainly driven by securitization of long-term assets, which are mainly represented by residential mortgages. This is not surprising given that these type of loans dominate securitizations and asset sales, and the funds released from these transactions are likely to be reutilized to extend the loans of similar long-term maturity, yet lower quality. This is in line with the "regulatory arbitrage hypothesis", which suggests that banks commonly securitize safer, low-yield, assets and retain more profitable, though riskier, ones on the balance sheet. This also is consistent with the empirical findings of Ambrose, Lacour-Little and Sanders (2004), and is further supported by the observation of higher proportion of non-performing loans and the asset-liability maturity gap measure for securitizing firms. Besides, the distribution of riskier, opaque, assets would incur a heavy discount due to the "lemons" problem suggested by Akerlof (1970), and would introduce an impediment to the bank's external funding channel once the market participants learn about the underlying quality of securitized products.

Accordingly, the retained mortgages are subjected to greater interest rate risk, with their credit quality likely to further deteriorate as the interest rate shocks are passed on to customers [Drehmann, Sorensen and Stringa, 2006; Keswani, Marsh, and Zagonov, 2009].

Against this background, it can be argued that banks with high involvement in the originate-to-distribute market function more as brokers, who generate fees by matching the complementary transactions between borrowers and securitized-debt investors, than financial intermediaries. Under this "disintermediation" business model, the bank shifts the majority of originated loans, and, therefore, has a comparative advantage in selecting the projects most suitable for securitization. Further, given that loans exit the balance sheet soon after origination, the

Table 4.5
Yield curve level exposure and securitization by maturity category

This table presents the panel estimation results for the regression which evaluates bank holding companies' (BHC) interest rate risk with respect to the maturity of securitized assets over the 2001 to 2009 period. The dependent variable is the absolute value of the coefficient measuring the sensitivity of BHC's *i* equity returns to unanticipated changes in the level of the US sovereign zero-coupon yield curve at year *t*. This coefficient is estimated from a four factor GARCH market model. Specifically, for each bank-year, I run a four-factor time series regression of BHC weekly returns on the market returns (MRK), and unanticipated changes in zero-coupon yield curve level (LEV), slope (SLO), and curvature (CUR). The estimation requires at least 30 weekly return observations for each bank-year. The corresponding US zero-coupon yield curve level, slope, and curvature are estimated using Diebold and Lee (2006) parameterization of Nelson and Siegel (1987) model. The unanticipated changes in the yield curve factors at time *t* are calculated as the difference between the actual changes in these factors and the ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. A bank holding company is defined as securitizer (columns 1 to 4) if it reports at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings. The explanatory variables on the right-hand side are as follows: TSEC is the outstanding principle balance of assets securitized or sold measured as the proportion of total assets; the outstanding balance of securitized long-, medium-, and short-term loans are LT_SEC, MT_SEC, and ST_SEC respectively; the asset growth rate (AGR); equity capital (CAP) calculated as the ratio of BHC's book value of equity capital to its total assets; H_NITR(H_NOIR) is the Herfindahl-Hirschman (non)interest revenue concentration index calculated on the basis of twelve (eight) part breakdown of the (non)interest income; the proportion of total assets that are liquid (LATA); H_LOAN is the Herfindahl-Hirschman loan concentration index computed considering five loan categories; GAP is the balance sheet maturity gap calculated as the difference between interest-earning assets and interest-bearing liabilities maturing or being repriced within one year, scaled by the bank's total assets; NECP is the net credit protection (protection bought minus sold) purchased by a bank; the ratio of non-performing loans to total loans is NPL; ROID is the measure of bank revenue diversification; and return on assets is represented by ROA. The regression also includes year- and state-dummies which are not reported. Heteroskedasticity - and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Securitizers				All bank holding companies			
TSEC	0.053				0.025			
	3.61***				2.59***			
LT_SEC		0.053				0.028		
		3.52***				2.76***		
MT_SEC			-0.015				-0.091	
			-0.04				-0.33	
ST_SEC				0.196				-0.026
				1.44				-0.49
AGR	-0.028	-0.028	-0.026	-0.030	0.004	0.004	0.004	0.004
	-2.06**	-2.00**	-1.79*	-2.04**	1.95*	1.96**	1.98**	1.97**
CAP	-0.197	-0.199	-0.100	-0.081	-0.180	-0.179	-0.177	-0.176
	-1.02	-1.02	-0.51	-0.41	-2.89***	-2.88***	-2.84***	-2.82***
CAP^2	0.564	0.570	0.440	0.375	0.292	0.295	0.292	0.296
	2.14**	2.14**	1.65	1.38	3.14***	3.17***	3.14***	3.17***
H_NITR	-0.060	-0.059	-0.072	-0.074	-0.039	-0.038	-0.041	-0.040
	-1.75*	-1.70*	-2.06**	-2.14**	-2.29**	-2.25**	-2.38**	-2.35**
LATA	0.063	0.061	0.062	0.068	0.010	0.010	0.010	0.009
	2.19**	2.12**	2.13**	2.31**	1.08	1.05	1.02	0.99
H_LOAN	0.050	0.048	0.064	0.071	0.030	0.030	0.031	0.031
	2.30**	2.18**	2.93***	3.18***	4.09***	4.00***	4.16***	4.08***
GAP	0.004	0.004	0.003	0.002	0.015	0.014	0.015	0.015
	0.20	0.19	0.14	0.11	1.97**	1.95*	2.04**	2.02**
NECP	0.476	0.484	0.552	0.530	0.819	0.825	0.875	0.883
	1.42	1.44	1.62	1.56	3.19***	3.21***	3.41***	3.43***
H_NOIR	0.000	0.000	0.000	0.000	0.005	0.006	0.005	0.005
	1.37	1.41	1.67*	1.50	0.73	0.78	0.67	0.69
NPL	0.702	0.718	0.810	0.751	0.796	0.795	0.817	0.819
	3.21***	3.28***	3.68***	3.36***	8.56***	8.55***	8.81***	8.82***
ROA	-1.574	-1.551	-1.506	-1.472	-0.411	-0.410	-0.401	-0.403
	-4.55***	-4.46***	-4.27***	-4.18***	-3.23***	-3.22***	-3.15***	-3.16***
ROID	-0.008	-0.008	0.005	-0.001	-0.010	-0.010	-0.007	-0.006
	-0.54	-0.49	0.32	-0.03	-1.68*	-1.66*	-1.13	-1.03
Constant	0.027	0.028	0.007	0.003	0.006	0.006	0.005	0.004
	0.93	0.95	0.24	0.10	0.33	0.34	0.24	0.24
Observations	516	516	516	516	2225	2225	2225	2225
BHCs	68	68	68	68	304	304	304	304
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.23	0.23	0.21	0.22	0.14	0.14	0.14	0.14

Table 4.6
Yield curve slope exposure and securitization by maturity category

This table presents the panel estimation results for the regression which evaluates the bank holding companies' (BHC) interest rate risk with respect to the maturity of securitized assets over the 2001 to 2009 period. The dependent variable is the absolute value of the coefficient measuring the sensitivity of BHC's *i* equity returns to unanticipated changes in the slope of the US sovereign zero-coupon yield curve at year *t*. This coefficient is estimated from a four factor GARCH market model. Specifically, for each bank-year, I run a four-factor time series regression of BHC weekly returns on the market returns (MRK), and unanticipated changes in zero-coupon yield curve level (LEV), slope (SLO), and curvature (CUR). The estimation requires at least 30 weekly return observations for each bank-year. The corresponding US zero-coupon yield curve level, slope, and curvature are estimated using Diebold and Lee (2006) parameterization of Nelson and Siegel (1987) model. The unanticipated changes in the yield curve factors at time *t* are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. A bank holding company is defined as securitizer (columns 1 to 4) if it reports at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings. The explanatory variables on the right-hand side are as follows: TSEC is the outstanding principle balance of assets securitized or sold measured as the proportion of total assets; the outstanding balance of securitized long-, medium-, and short-term loans are LT_SEC, MT_SEC, and ST_SEC respectively; the asset growth rate (AGR); equity capital (CAP) calculated as the ratio of BHC's book value of equity capital to its total assets; H_NITR(H_NOIR) is the Herfindahl-Hirschman (non)interest revenue concentration index calculated on the basis of twelve (eight) part breakdown of the(non)interest income;the proportion of total assets that are liquid (LATA); H_LOAN is the Herfindahl-Hirschman loan concentration index computed considering five loan categories; GAP is the balance sheet maturity gap calculated as the difference between interest-earning assets and interest-bearing liabilities maturing or being repriced within one year, scaled by the bank's total assets; NECP is the net credit protection (protection bought minus sold) purchased by a bank; the ratio of non-performing loans to total loans is NPL; ROID is the measure of bank revenue diversification; and return on assets is represented by ROA. The regression also includes year- and state-dummies which are not reported. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Securitizers				All bank holding companies			
TSEC	0.083				0.053			
	*3.98****				*4.00****			
LT_SEC		0.085				0.056		
		*3.98****				*4.12****		
MT_SEC			0.057				-0.422	
			0.11				*-1.12*	
ST_SEC				*0.223*				*0.004*
				1.14				0.05
AGR	-0.037	-0.036	-0.033	-0.037	0.000	0.000	0.000	0.000
	*-1.90**	*-1.81**	*-1.59*	*-1.76**	*-0.16*	*-0.14*	*-0.09*	*-0.12*
CAP	-0.151	-0.148	0.023	0.044	-0.011	-0.009	-0.003	-0.005
	-0.55	*-0.54*	*0.08*	*0.16*	*-0.13*	*-0.10*	*-0.04*	*-0.06*
CAP^2	0.376	*0.374*	*0.150*	*0.077*	0.057	*0.062*	*0.056*	*0.057*
	1.00	0.99	0.39	0.20	*0.45*	0.50	0.44	0.45
H_NITR	0.022	*0.026*	*0.005*	*0.001*	0.000	*0.001*	*-0.004*	*-0.004*
	0.46	0.53	0.09	0.03	*-0.01*	0.04	-0.16	-0.15
LATA	0.087	*0.085*	*0.088*	*0.094*	0.017	*0.016*	*0.015*	*0.016*
	*2.14***	2.09**	2.11**	2.25**	*1.32*	1.27	1.20	1.24
H_LOAN	0.034	*0.029*	*0.054*	*0.061*	0.017	*0.015*	*0.018*	*0.018*
	1.10	0.92	1.73*	1.93*	*1.67**	1.54	1.74*	1.79*
GAP	-0.010	-0.009	-0.011	-0.012	-0.001	-0.001	0.000	0.000
	-0.35	*-0.33*	*-0.40*	*-0.43*	*-0.12*	*-0.12*	*0.01*	*0.00*
NECP	0.324	0.334	0.443	0.419	0.061	0.078	0.184	0.175
	0.68	*0.70*	*0.91*	*0.86*	*0.18*	*0.23*	*0.53*	*0.50*
H_NOIR	0.000	*0.000*	*0.000*	*0.000*	-0.007	*-0.006*	*-0.008*	*-0.007*
	*-1.81**	-1.79*	-1.45	-1.57	*-0.67*	-0.60	-0.79	-0.75
NPL	0.345	*0.362*	*0.513*	*0.445*	0.490	*0.489*	*0.535*	*0.535*
	1.11	1.16	1.63	1.39	*3.89****	3.88***	4.25***	4.24***
ROA	-1.516	*-1.480*	*-1.402*	*-1.365*	-0.472	*-0.473*	*-0.457*	*-0.454*
	*-3.07****	-2.99***	-2.79***	-2.71***	*-2.74****	-2.75***	-2.64***	-2.62***
ROID	-0.031	-0.033	-0.013	-0.019	-0.014	-0.014	-0.007	-0.007
	-1.42	*-1.51*	*-0.61*	*-0.85*	*-1.69**	*-1.67**	*-0.84*	*-0.88*
Constant	0.037	0.038	0.005	0.000	0.047	0.047	0.044	0.043
	0.89	*0.93*	*0.11*	*0.01*	*1.84**	*1.85**	*1.71**	*1.69**
Observations	516	516	516	516	2225	2225	2225	2225
BHCs	68	68	68	68	304	304	304	304
Period Fixed Effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.18	0.19	0.16	0.16	0.10	0.10	0.10	0.10

effective duration of assets and liabilities held on the balance sheet is short-term and can be closely matched. Given this background, the active players in securitization markets are expected to be less exposed to the risk of changing interest rates, with this view being reflected in the second research hypothesis.

To test this idea empirically, I reformulate the model in (4.11) in a non-linear form as follows:

$$\left|\beta_{it}^{k}\right| = \varphi + \lambda_1 TSEC_{i,t-1} + \lambda_2 TSEC_{i,t-1}^{2} + Y_{i,t-1}'\psi + G_{t-1}'\xi + T_t'\theta + \eta_i + \varepsilon_{it} \quad (4.12)$$

where, β_{it}^{k} represents the stock return sensitivity of bank i to unanticipated changes in the yield curve level, slope, and curvature at year t. $TSEC_{it}$ is the it-th observation on the company securitization proxy, and Y_{it} is the it-th observation on M company specific financial characteristics. T_t and η_i are vectors of year- and state-dummies respectively.

Given the model parameterization, I predict a negative sign on the coefficient estimate for the squared securitization proxy ($TSEC^2$), and a positive sign on $TSEC$ variable: $\lambda_1 > 0$ and $\lambda_2 < 0$.

The estimation results in Table 4.8 support the hypothesized relationship, implying that interest rate risk initially increases with the value of assets securitized, but declines with bank "disintermediation". A graphic representation of the relationship between the BHCs' exposure to shocks at the long end of the term structure, its capitalization, and securitization activities are portrayed in Figure 4.2. Once again, the results are driven by the securitization of long-term assets, with non-linearity being only confirmed for the long-term interest rates represented by the yield curve level.

In a similar manner, the remaining interest rate factors (yield curve slope and curvature) are evaluated in Tables 4.6 and 4.7. For all three measures of interest rate risk the results are consistent with the theoretical prediction that banks do not necessarily resort to securitization to curb their risk exposure. As discussed above the parameter estimate for the securitization proxy (TSEC) enters all Tables significantly positive. In this respect, the magnitudes of $\partial IRR/\partial TSEC$ suggest a great economic significance. Thus, a one percent increase in the proportion of total assets securitized translates into about 0.053 percent increase in BHCs' exposure to shocks in the yield curve level. This, in turn, would imply that a typical US securitizer will incur an additional \$1.79 million decline in its market value following a typical shock in the yield curve level. The corresponding values for interest rate slope and curvature are \$4.01 million and \$1.17 million respectively.

Table 4.7
Yield curve curvature exposure and securitization by maturity category

This table presents the panel estimation results for the regression which evaluates the bank holding companies' (BHC) interest rate risk with respect to the maturity of securitized assets over the 2001 to 2009 period. The dependent variable is the absolute value of the coefficient measuring the sensitivity of BHC's *i* equity returns to unanticipated changes in the curvature of the US sovereign zero-coupon yield curve at year *t*. This coefficient is estimated from a four factor GARCH market model. Specifically, for each bank-year, I run a four-factor time series regression of BHC weekly returns on the market returns (MRK), and unanticipated changes in zero-coupon yield curve level (LEV), slope (SLO), and curvature (CUR). The estimation requires at least 30 weekly return observations for each bank-year. The corresponding US zero-coupon yield curve level, slope, and curvature are estimated using Diebold and Lee (2006) parameterization of Nelson and Siegel (1987) model. The unanticipated changes in the yield curve factors at time *t* are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. A bank holding company is defined as securitizer (columns 1 to 4) if it reports at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings. The explanatory variables on the right-hand side are as follows: TSEC is the outstanding principle balance of assets securitized or sold measured as the proportion of total assets; the outstanding balance of securitized long-, medium-, and short-term loans are LT_SEC, MT_SEC, and ST_SEC respectively; the asset growth rate (AGR); equity capital (CAP) calculated as the ratio of BHC's book value of equity capital to its total assets; H_NITR(H_NOIR) is the Herfindahl-Hirschman (non)interest revenue concentration index calculated on the basis of twelve (eight) part breakdown of the (non)interest income; the proportion of total assets that are liquid (LATA); H_LOAN is the Herfindahl-Hirschman loan concentration index computed considering five loan categories; GAP is the balance sheet maturity gap calculated as the difference between interest-earning assets and interest-bearing liabilities maturing or being repriced within one year, scaled by the bank's total assets; NECP is the net credit protection (protection bought minus sold) purchased by a bank; the ratio of non-performing loans to total loans is NPL; ROID is the measure of bank revenue diversification; and return on assets is represented by ROA. The regression also includes year- and state-dummies which are not reported. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

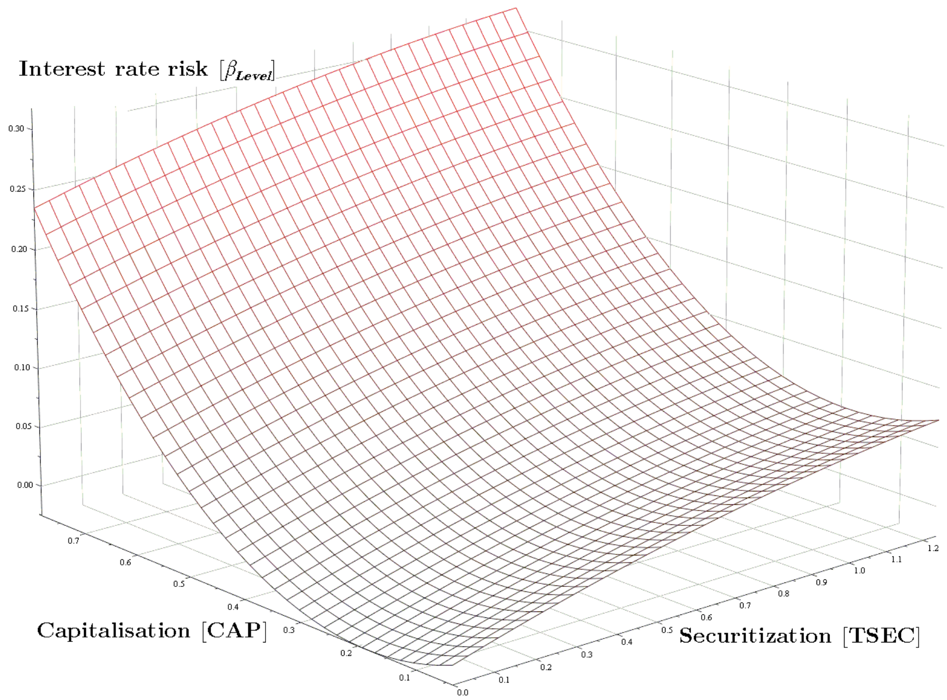
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Securitizers				All bank holding companies			
TSEC	0.013				0.008			
	*2.61****				*2.50***			
LT_SEC		0.013				0.008		
		*2.58***				*2.19***		
MT_SEC			0.028				0.006	
			0.23				*0.06*	
ST_SEC				*0.076*				*0.034*
				1.68*				1.84*
AGR	-0.002	-0.002	-0.002	-0.003	0.003	0.003	0.003	0.003
	-0.55	*-0.51*	*-0.41*	*-0.68*	*4.52****	*4.51****	*4.51****	*4.51****
CAP	-0.089	-0.086	-0.056	-0.049	-0.021	-0.021	-0.020	-0.022
	-1.38	*-1.33*	*-0.87*	*-0.76*	*-0.97*	*-0.98*	*-0.95*	*-1.05*
CAP²	0.174	*0.168*	*0.129*	*0.104*	0.040	*0.041*	*0.040*	*0.036*
	*1.97***	*1.90**	*1.46*	*1.17*	*1.25*	*1.28*	*1.25*	*1.13*
H_NITR	-0.023	*-0.022*	*-0.026*	*-0.027*	-0.013	*-0.013*	*-0.014*	*-0.014*
	*-2.00***	*-1.93**	*-2.22***	*-2.33***	*-2.29***	*-2.27***	*-2.37***	*-2.45***
LATA	0.013	*0.013*	*0.014*	*0.016*	-0.003	*-0.003*	*-0.003*	*-0.002*
	1.39	*1.37*	*1.41*	*1.63*	*-0.85*	*-0.88*	*-0.88*	*-0.74*
H_LOAN	0.002	*0.001*	*0.004*	*0.007*	0.000	*0.000*	*0.001*	*0.001*
	0.24	*0.11*	*0.60*	*0.94*	*0.15*	*0.10*	*0.24*	*0.47*
GAP	-0.002	-0.002	-0.003	-0.003	0.002	0.002	0.002	0.002
	-0.38	*-0.33*	*-0.41*	*-0.44*	*0.63*	*0.70*	*0.75*	*0.81*
NECP	0.079	0.081	0.097	0.090	-0.021	-0.016	-0.003	-0.016
	0.70	*0.72*	*0.87*	*0.80*	*-0.24*	*-0.18*	*-0.03*	*-0.18*
H_NOIR	0.000	*0.000*	*0.000*	*0.000*	0.000	*0.001*	*0.000*	*0.000*
	*-2.07***	*-2.07***	*-1.87**	*-2.04***	*0.12*	*0.20*	*0.12*	*0.09*
NPL	-0.021	*-0.020*	*0.004*	*-0.019*	0.128	*0.128*	*0.134*	*0.132*
	-0.29	*-0.27*	*0.05*	*-0.26*	*4.01****	*4.02****	*4.23****	*4.14****
ROA	-0.344	*-0.332*	*-0.318*	*-0.306*	-0.102	*-0.100*	*-0.098*	*-0.094*
	*-2.98****	*-2.88****	*-2.74****	*-2.64****	*-2.33***	*-2.30***	*-2.23***	*-2.15***
ROID	-0.011	-0.012	-0.009	-0.011	-0.007	-0.007	-0.006	-0.006
	*-2.13***	*-2.30***	*-1.75**	*-2.09***	*-3.18****	*-3.15****	*-2.78****	*-3.09****
Constant	0.031	0.031	0.026	0.025	0.018	0.018	0.018	0.018
	*3.25****	*3.26****	*2.75****	*2.60****	*2.80****	*2.79****	*2.71****	*2.72****
Observations	516	516	516	516	2225	2225	2225	2225
BHCs	68	68	68	68	304	304	304	304
Period Fixed Effect:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.15	0.16	0.14	0.15	0.11	0.11	0.11	0.11

Table 4.8
Nonlinearity between interest rate risk and securitization

This table presents the panel estimation results for the regression which evaluates the bank holding companies' (BHC) interest rate risk with respect to the maturity of securitized assets over the 2001 to 2009 period. The dependent variable is the absolute value of the coefficient measuring the sensitivity of BHC's *i* equity returns to unanticipated changes in the level (columns 1-5), slope (columns 6-10), and curvature (columns 11-15) of the US sovereign zero-coupon yield curve at year *t*. These coefficients are estimated from a four factor GARCH market model. Specifically, for each bank-year, I run a four-factor time series regression of BHC weekly returns on the market returns (MRK), and unanticipated changes in yield curve level (LEV), slope (SLO), and curvature (CUR). The estimation requires at least 30 weekly return observations for each bank-year. The corresponding US zero-coupon yield curve level, slope, and curvature are estimated using Diebold and Lee (2006) parameterization of Nelson and Siegel (1987) model. The unanticipated changes in the yield curve factors at time *t* are calculated as the difference between the actual changes in these factors and ones forecasted via an appropriate specification of the autoregressive moving average (ARMA) model. Only BHCs reporting at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings are considered. The explanatory variables on the right-hand side are as follows: TSEC is the outstanding principle balance of assets securitized or sold measured as the proportion of total assets; the outstanding balance of securitized long-, medium-, and short-term loans are LT_SEC, MT_SEC, and ST_SEC respectively; the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP. Each regression also includes year- and state- dummies, and the following firm-specific variables which are not reported: the asset growth rate (AGR); the proportion of total assets that are liquid (LATA); H_LOAN is the Herfindahl-Hirschman loan concentration index computed considering five loan categories; NECP is the net credit protection (protection bought minus sold) purchased by a bank; the ratio of non-performing loans to total loans is NPL; ROID is the measure of bank revenue diversification; and return on assets is represented by ROA. The regressions in columns 2, 7, and 12 also incorporate the economic environment proxies (not reported) as follows: annual growth rate in the gross domestic product (GDPG), and the Aruoba-Diebold-Scotti Business Conditions Index (ADSI). When the economic environment proxies are added into the model, the time-fixed effect is relaxed. Heteroskedasticity and autocorrelation consistent *t*-values based on White's robust standard error are reported in italics. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Level					Slope					Curvature				
TSEC	0.102	0.093				0.112	0.098				0.014	0.013			
	*3.95****	*3.47****				*3.06****	*2.66****				*1.65**	*1.43*			
$TSEC^2$	-0.028	-0.027				-0.026	-0.026				-0.003	-0.003			
	*-1.80**	*-1.65**				*-1.15*	*-1.12*				*-0.52*	*-0.60*			
LT_SEC			0.103					0.115					0.014		
			*3.79****					*3.02****					*1.61*		
LT_SEC^2			-0.028					-0.027					-0.003		
			*-1.74**					*-1.16*					*-0.51*		
MT_SEC				0.610					0.748					0.365	
				0.71					*0.62*					*1.30*	
MT_SEC^2				-11.013					-14.521					-6.705	
				-0.71					*-0.67*					*-1.34*	
ST_SEC					0.342					0.352					0.026
					*2.08***					*1.53*					*0.48*
ST_SEC^2					-0.269					-0.713					0.070
					-0.55					*-1.04*					*0.44*
CAP	-0.271	-0.197	*-0.274*	*-0.108*	-0.094	-0.187	-0.008	-0.190	0.013	0.030	-0.122	-0.089	-0.121	-0.094	-0.089
	-1.40	*-0.99*	*-1.40*	*-0.55*	*-0.48*	*-0.68*	*-0.03*	*-0.69*	*0.05*	*0.11*	*-1.89**	*-1.36*	*-1.87**	*-1.47*	*-1.40*
CAP^2	0.726	0.678	*0.741*	*0.502*	0.429	0.490	0.466	0.506	0.213	0.140	0.232	0.222	0.231	0.190	0.180
	*2.79****	*2.52***	*2.82****	*1.91**	*1.65**	*1.33*	*1.25*	*1.37*	*0.58*	*0.38*	*2.68****	*2.52***	*2.66****	*2.23***	*2.09***
Observations	516	516	516	516	516	516	516	516	516	516	516	516	516	516	516
BHCs	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Period fixed effect	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.22	0.16	0.22	0.18	0.19	0.18	0.15	0.18	0.16	0.16	0.14	0.10	0.14	0.13	0.13

Figure 4.2
Effect of securitization and capitalisation on BHCs' interest rate exposure



Turning to the remaining bank characteristics in (4.11), the majority of coefficients estimates are statistically significant and bear the expected sign. Consistent with prior empirical research, the relationship between equity capital and bank risk taking are U-shaped. That is, both undercapitalised and well capitalised intermediaries are generally riskier than banks with intermediate, optimal capital levels. Further, the institutions with higher degree of revenue heterogeneity also enjoy lower risk exposures, and so are the companies with higher asset base growth rate. Not surprisingly, the coefficient on the ratio of non-performing loans enters the table negative, owed to the intrinsic link between credit and interest rate risks (Drehmann, Sorensen and Stringa, 2006).

4.6.3 Robustness checks

To corroborate the findings from the basic model in (4.11), I perform a comprehensive set of robustness checks. These include the use of different time horizons and subsamples; the assumption of alternative model specification and distributional properties; and an extensive treatment of endogeneity and simultaneity biases.

In the context of this study, endogeneity may arise when the BHC's decision to participate in the market for securitized products does not only influence, but is influenced by its interest rate exposure. In this scenario, the exogenous treatment of securitization activities would introduce simultaneity bias in the regression estimates. Furthermore, additional factors may jointly influence the variability in both measures, biasing the ordinary least squares estimation and making it difficult to infer causal relationship. To address these concerns, I detect potential endogeneity via a Hausman test and resort to a two-stage least squares ($2SLS$) panel estimation procedure by introducing a set of instruments for the BHCs' securitization activities as appropriate. To identify suitable instruments, I address the bank's decision to securitize by analysing its financial characteristics in the probit framework (not reported). The results remain robust to the choice of estimation technique. Column 1 of Table 4.9 details the empirical output for the $2SLS$ regression assuming the BHCs' exposure to the shocks in the yield curve level as an endogenous variable. Although not reported, the results for the remaining interest rate proxies also remain statistically unchanged.

Furthermore, caution should also be taken in isolating the risk management motives of asset securitization from auxiliary inducements. In particular, the incentive to securitize may be circumscribed by the level of loan demand and current economic conditions. Faced with unusually high demand for loans, banks would resort to asset sales to extract higher loan origination rents, and to satisfy the existing customer demand for funds. On the other hand, weaker loan demand conditions following the economic downturn make it difficult for an intermediary to successfully perform the securitization transaction. This is due to low liquidity and demand for ABS, and higher credit risk of the underlying asset mix resulting in market mispricing. Such economic conditions would also affect the level of bank interest rate exposure.

In this respect, the analysed sample period provides a unique opportunity to explicitly test this supposition by separating the time horizon into pre-crisis and crisis episodes. This also provides a comparison of the effectiveness of securitization in curbing interest rate risk between the two periods. In addition, the sample of companies is separated into a number of sub-samples on the basis of ranking by the bank's (1) size, (2) liquidity, and (3) net derivative usage (hedging − trading). Selected are the top 25% and the bottom 75% of values in each category, with a total of six portfolios constructed.

The pertinent results for these tests are also reported in Table 4.9. The coefficients estimates on the bank securitization proxy remain robust to the considered time horizon, thus reconfirming the findings in the previous section. Not surprisingly, it appears that BHCs are subjected to greater risk exposure in the second

Table 4.9
Robustness test (yield curve level)

This table presents the panel estimation results for the regressions which evaluate the bank holding companies' (BHC) interest rate risk with respect to securitization, using different time horizons (column "Crisis"); subsamples (columns "SIZE", "LATA", "NDUS"); and the model econometric specifications (column "2SLS"). The dependent variable is the absolute value of the coefficient measuring the sensitivity of BHC's i equity returns to unanticipated changes in the level of the US sovereign zero-coupon yield curve at year t. These coefficients are estimated from a four factor GARCH market model (4.8). Only BHCs reporting at least one securitization transaction over the analysed period in Schedule HC-S of the Federal Reserve System's FY-9C filings are considered. Reported are the coefficients estimate for the TSEC explanatory variable, which represents the outstanding principle balance of assets securitized or sold as the proportion of total assets. Each regression also includes year- and state-dummies, and the following firm-specific variables which are not reported: the ratio (and the squared ratio) of book value of equity capital to bank's total assets CAP; the asset growth rate (AGR); the proportion of total assets that are liquid (LATA); H_LOAN is the Herfindahl-Hirschman loan concentration index computed considering five loan categories; NECP is the net credit protection (protection bought minus sold) purchased by a bank; the ratio of non-performing loans to total loans is NPL; ROID is the measure of bank revenue diversification; and return on assets is represented by ROA. All BHCs are split into a number of sub-samples on the basis of ranking by the bank's size (column "SIZE"); liquidity (column "LATA"); and net derivative usage (column "NDUS"). Selected are the top 25% and the bottom 75% of values in each category with a total of six portfolios. Coefficients on TSEC are reported for each portfolio. The test statistics ($F-$statistics) for the Wald coefficient restriction test with the null hypothesis testing the equality of coefficient estimates for the "Top 25%" and the "Bottom 75%" portfolios in each category is reported in column entitled "WALD", with the associated $p-$value reported in brackets below. Heteroskedasticity - and autocorrelation consistent $t-$values based on White's robust standard error are reported in italics. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	2SLS	Crisis	SIZE	LATA	NDUS	WALD
TSEC	0.192					
	*3.77****					
Pre-crisis (2001-2006)		0.035				67.5
		*2.59****				*(0.000)*
Crisis (2007-2009)		0.244				
		*9.50****				
Top 25%			0.023			3.73
			0.94			*(0.054)*
Bottom 75%			0.084			
			*4.74****			
Top 25%				0.153		20.93
				*6.37****		*(0.000)*
Bottom 75%				0.018		
				1.04		
Top 25%					0.007	36.79
					0.40	*(0.000)*
Bottom 75%					0.177	
					*7.63****	
Observations	516	516	516	516	516	
BHCs	68	68	68	68	68	
Period fixed effect	Yes	No	Yes	Yes	Yes	
State fixed effect	Yes	Yes	Yes	Yes	Yes	
Adj. R^2	0.08	0.31	0.22	0.25	0.27	

crisis-episode. Turning to the measure of bank size, the estimate on the securitization proxy remains significant only for the smaller companies. This might be explained by the fact that larger BHCs are better equipped to weather the yield curve shocks owed to better diversified portfolios and unrestricted access to the markets for derivative products. On the other hand, these firms might also pursue the "disintermediation" business model, therefore reducing the balance sheet duration gap and concomitant exposure to interest rate movements. Once the bank liquidity and derivative activities are considered the estimation suggests that the risk exposure is greater for the companies retaining higher liquidity buffers and for BHCs which are the net traders of derivative instruments. The intermediary is classified as the net-trader if the notional amount of all derivative instruments held for trading exceeds that of instruments held for hedging.

4.7 Concluding remarks

The recent turmoil in global financial markets, prompted by the US subprime mortgage meltdown, has once again accentuated the importance of banking sector prudency for overall economic stability worldwide. Securitization is consensually regarded as the key culprit in the subprime debacle, with a plethora of works addressing possible remedies for the market for securitized assets. These contributions, however, are largely concerned with the underlying causes of the current events, not the risks facing the financial system in the aftermath of the crisis. None has explicitly addressed the issue of bank interest rate risk, the importance of which becomes increasingly apparent in the current monetary environment. This concern has been recently flagged by regulatory authorities both in the US and in Europe, with supervisors emphasising the necessity of establishing robust practices to measure, monitor, and control bank interest rate exposures.

In this context, the move from the originate-to-hold to originate-to-distribute model of lending profoundly transformed the natural asset intermediation function performed by banks for centuries and compromised the importance of traditional asset-liability practices of interest rate risk management. Against this background, this work empirically examines the impact of securitization on bank interest rate risk. In particular, the research questions whether securitization is conducive to the optimal hedging of bank interest rate risk, or is merely a funding source enabling these companies to pursue more profitable, yet riskier, projects

The empirical results reported in this work suggest that banks resorting to asset securitization do not, on average, achieve an unambiguous reduction in their exposure to the term structure developments. It appears that interest rate risk generally increases with the maturity of assets securitized, with securitization of long-term assets driving the results.

In addition, banks with very high involvement in the originate-to-distribute market enjoy lower interest rate risk, thereby suggesting an asymmetric U-shape relationship between bank risk and securitization. This observation, however, does not imply superior risk management practices in these institutions but is merely a result of disintermediation. In particular, I argue that BHCs with high involvement to the market for securitized products function more as brokers, who generate fees by matching the complementary transactions between borrowers and securitized-debt investors, than financial intermediaries. Under this "dis-intermediation" business model, the importance of interest generating revenues declines, and so is the effective duration of assets held on the balance sheet. Accordingly, the duration gap remains at minimal levels, and the intermediary is better protected against term structure developments.

Appendix 4.1

Panel A: Securitisers

BHC name	RSSD ID	Ticker	BHC name	RSSD ID	Ticker
1st Source Corporation	1199602	SRCE	Guaranty Federal Bancshares, Inc.	2618940	GFED
AMCORE Financial, Inc.	1208661	AMFI	Huntington Bancshares, Inc.	1068191	HBAN
Arrow Financial Corporation	1048812	AROW	Independent Bank Corporation	1201925	IBCP
Associated Banc-Corp	1199563	ASBC	Indiana United Bancorp.	1209109	MSFG
Auburn National Bancorporation, Inc.	1129533	AUBN	International Bancshares Corporation	1104231	IBOC
Bank of America Corporation	1073757	BAC	Key Corp.	1068025	KEY
Bank of New York Company, Inc.	1033470	BK	LNB Bancorp, Inc.	1071669	LNBB
BOK Financial Corporation	1883693	BOKF	Marshall & Ilsley Corporation	1199497	MI
Camden National Corporation	1130249	CAC	MB Financial, Inc.	1090987	MBFI
Capital One Financial Corporation	2277860	COF	Mid Penn Bancorp, Inc.	1944204	MPB
Capitol Bancorp Ltd.	1247334	CBC	Monroe Bancorp	1210299	MROE
Carolina First Corporation	1141599	TSFG	Northern States Financial Corporation	1210589	NSFC
Charles Schwab Corporation	1026632	SCHW	Northrim Bancorp Inc.	3025385	NRIM
Citigroup, Inc.	1951350	C	Norwest Corporation	1120754	WFC
City Holding Company	1076262	CHCO	Pacific Capital Bancorp.	1029884	PCBC
Comm Bancorp, Incorporated	1118229	CCBP	Popular, Inc.	1129382	BPOP
Doral Financial Corporation	2184164	DRL	Regions Financial Corporation	1078332	RF
Eagle Bancorp, Inc.	2652104	EGBN	Republic Bancorp, Inc.	1097025	RBCAA
East West Bancorp, Inc.	2734233	EWBC	S.Y. Bancorp, Inc.	1249730	SYBT
Exchange National Bancshares, Inc.	2038409	HWBK	Santander Bancorp.	2847115	SBP
Fifth Third Bancorp	1070345	FITB	State Street Boston Corporation	1111435	STT
First BanCorp	2744894	FBP	SunTrust Banks, Inc.	1131787	STI
First Busey Corporation	1203602	BUSE	Susquehanna Bancshares, Inc.	1117156	SUSQ
First Citizens BancShares, Inc.	1075612	FCNCA	The Chase Manhattan Bank	1039502	JPM
First Empire State Corporation	1037003	MTB	The PNC Financial Services Group, Inc.	1069778	PNC
First Financial Bancorp.	1071276	FFBC	TIB Financial Corp.	2457943	TIBB
First Financial Corporation	1208595	THFF	U.S. Bancorp.	1119794	USB
First Horizon National Corporation	1094640	FHN	UnionBancorp, Inc.	1206591	TRUE
First Midwest Bancorp, Inc.	1208184	FMBI	United Bancorp, Inc.	1071502	UBCP
FirstMerit Corporation	1070804	FMER	United Bancshares, Inc.	1136009	UBOH
FNB Corp.	1133473	FNBN	United Bankshares, Inc.	1076217	UBSI
Franklin Resources, Inc.	1246216	BEN	W Holding Company Incorporated	2801546	WHI
Fulton Financial Corporation	1117129	FULT	Wintrust Financial Corporation	2260406	WTFC
German American Bancorp	1098620	GABC	Zions Bancorporation	1027004	ZION

Appendix 4.1

Panel B: Non-Securitisers

BHC name	RSSD ID	Ticker	BHC name	RSSD ID	Ticker
1st Constitution Bancorp.	2784920	FCCY	Carrollton Bancorp.	1469800	CRRB
ABC Bancorp	1082067	ABCB	Cascade Bancorp.	1848003	CACB
Access National Corp.	3109904	ANCX	Cascade Financial Corp.	2568362	CASB
Alliance Bankshares Corp.	3123638	ABVA	Cass Information Systems, Inc.	1098648	CASS
Alliance Financial Corp.	1140510	ALNC	Cathay General Bancorp, Inc.	1843080	CATY
American National Bankshares Inc.	1076691	AMNB	Center Bancorp, Inc.	1048764	CNBC
American River Bankshares	2312837	AMRB	Center Financial Corp.	3003178	CLFC
AmeriServ Financial, Inc.	1117316	ASRV	Centerstate Banks of Florida, Inc.	2868129	CSFL
Annapolis Bancorp, Inc.	1472257	ANNB	Central Virginia Bankshares, Inc.	1140677	CVBK
Banc Corp.	2731858	SUPR	Century Bancorp, Inc.	1111088	CNBKA
BancFirst Corp.	1133286	BANF	Chemical Financial Corp.	1201934	CHFC
Bancorp Rhode Island, Inc.	2896458	BARI	Citizens Banking Corp.	1205688	CRBC
BancorpSouth, Inc.	1097614	BXS	Citizens Holding Company	1083475	CIZN
Bancshares of Florida, Inc.	2796624	BOFL	City National Corp.	1027518	CYN
Bank of Commerce Holdings	1030040	BOCH	CNB Financial Corp.	1118340	CCNE
Bank of Granite Corp.	1143481	GRAN	CoBiz Inc.	1060328	COBZ
Bank of Hawaii Corp.	1025309	BOH	Codorus Valley Bancorp, Inc.	1142475	CVLY
Bank of South Carolina Corp.	2297701	BKSC	Colony Bankcorp, Inc.	1085170	CBAN
Bank of the Ozarks, Inc.	1097089	OZRK	Columbia Bancorp.	2378440	CBBO
Banner Corp.	2126977	BANR	Columbia Banking System, Inc.	2078816	COLB
Bar Harbor Bankshares	1115385	BHB	Comerica Incorporated	1199844	CMA
BB&T Corp.	1074156	BBT	Commerce Bancshares, Inc.	1049341	CBSH
Berkshire Bancorp, Inc.	2728157	BERK	Commercial Bancorp.	1029893	WCBO
BNC Bancorp.	3141650	BNCN	Commercial National Financial Corp.	1823738	CNAF
Boston Private Bancorp, Inc.	1248078	BPFH	Commonwealth Bankshares, Inc.	1250606	CWBS
Bridge Capital Holdings	3280988	BBNK	Community Bank Shares of Indiana, Inc.	2356073	CBIN
Britton & Koontz Capital Corp.	1084212	BKBK	Community Bank System, Inc.	1048867	CBU
Bryn Mawr Bank Corp.	1140994	BMTC	Community Capital Corp.	1398937	CPBK
C&F Financial Corp.	2183493	CFFI	Community Central Bank Corp.	2443526	CCBD
Camco Financial Group	1251256	CAFI	Community Trust Bancorp, Inc.	1070644	CTBI
Capital Bank Corp.	2741156	CBKN	Community West Bancshares	2626299	CWBC
Capital City Bank Group, Inc.	1085509	CCBG	Cowlitz Bancorp.	1984040	CWLZ
Cardinal Financial Corp.	2682996	CFNL	CPB Inc.	1022764	CPF
Carolina Bank Holdings, Inc.	2943473	CLBH	Crescent Banking Company	1958827	CSNT

Appendix 4.1

Panel B: Non-Securitisers (CONT'D)

BHC name	RSSD ID	Ticker	BHC name	RSSD ID	Ticker
Crescent Financial Corp.	3027709	CRFN	Greene County Bancshares, Inc.	1133277	GRNB
Cullen&Frost Bankers, Inc.	1102367	CFR	Hancock Holding Company	1086533	HBHC
CVB Financial Corp.	1029222	CVBF	Hanmi Financial Corp.	2900261	HAFC
Dearborn Bancorp, Inc.	2193906	DEAR	Harleysville National Corp.	1117192	HNBC
Eastern Virginia Bankshares, Inc.	2626691	EVBS	Harleysville Savings Financial Corp.	2861492	HARL
ECB Bancorp, Inc.	2686659	ECBE	Heartland Financial USA, Inc.	1206546	HTLF
EuroBancshares, Inc.	3106864	EUBK	Heritage Commerce Corp.	2634874	HTBK
Evans Bancorp, Inc.	1401190	EVBN	Heritage Financial Corp.	2166124	HFWA
F.N.B. Corp.	3005332	FNB	Heritage Oaks Bancorp.	2253529	HEOP
Farmers Capital Bank Corp.	1098732	FFKT	Home Federal Bancorp.	3059504	INCB
Fauquier Bankshares, Inc.	1076600	FBSS	Horizon Bancorp.	1209136	HBNC
Fidelity Southern Corp.	1081118	LION	Hudson City Bancorp, Inc.	2792680	HCBK
Financial Institutions, Inc.	1032464	FISI	Independent Bank Corp.	1136803	INDB
First Bancorp.	1076431	FBNC	Independent Community Bancshares, Inc.	2176413	MBRG
First Citizens Banc Corp.	1246533	FCZA	Integra Bank Corp.	1132654	IBNK
First Commonwealth Financial Corp.	1071306	FCF	Intervest Bancshares Corp.	2049302	IBCA
First Community Bancorp.	2875332	PACW	ISB Financial Corp.	2291914	IBKC
First Community Corp.	2337401	FCCO	Jacksonville Bancorp, Inc.	2737766	JAXB
First Financial Bankshares, Inc.	1102312	FFIN	Jeffersonville Bancorp.	1048504	JFBC
First Financial Service Corp.	3150997	FFKY	Lakeland Bancorp, Inc.	1404799	LBAI
First M & F Corp.	1095982	FMFC	Lakeland Financial Corp.	1208906	LKFN
First Mariner Bancorp.	2322304	FMAR	Landmark Bancorp, Inc.	3030307	LARK
First Merchants Corp.	1208559	FRME	Leesport Financial Corp.	1136139	VIST
First National Lincoln Corp.	1133932	FNLC	LSB Bancshares, Inc.	1076002	NBBC
First Regional Bancorp.	1029428	FRGB	Macatawa Bank Corp.	2634696	MCBC
First State BanCorp.	1364071	FSNM	MBT Financial Corp.	2907822	MBTF
First United Corp.	1132672	FUNC	Mercantile Bank Corp.	2608763	MBWM
First West Virginia Bancorp, Inc.	1070336	FWV	Merchants Bancshares, Inc.	1023239	MBVT
Firstbank Corp.	1134322	FBMI	MetLife, Inc.	2945824	MET
Friedman, Billings, Ramsey Group, Inc.	2926636	FBR	MetroCorp Bancshares, Inc.	2344799	MCBI
Frontier Financial Corp.	1031346	FTBK	MidSouth Bancorp, Inc.	1086654	MSL
Glacier Bancorp, Inc.	2003975	GBCI	Midwest Banc Holdings, Inc.	1209828	MBHI
Glen Burnie Bancorp.	2001328	GLBZ	Monmouth Community Bancorp.	2910055	CJBK
Great Southern Bancorp, Inc.	2339133	GSBC	Nara Bancorp, Inc.	2961879	NARA

Appendix 4.1

Panel B: Non-Securitisers (CONT'D)

BHC name	RSSD ID	Ticker	BHC name	RSSD ID	Ticker
National Bankshares, Inc.	1139925	NKSH	Princeton National Bancorp, Inc.	1207600	PNBC
National Penn Bancshares, Inc.	1117026	NPBC	PrivateBancorp, Inc.	1839319	PVTB
NB&T Financial Group, Inc.	1070756	NBTF	Prosperity Bancshares, Inc.	1109599	PRSP
NBC Capital Corp.	1100037	CADE	Provident Financial Services, Inc.	3133637	PFS
NBT Bancorp Inc.	1139279	NBTB	Quad City Holdings, Inc.	2125813	QCRH
New York Community Bancorp, Inc.	2132932	NYB	Republic First Bancorp, Inc.	1398807	FRBK
NewSouth Bancorp, Inc.	2521509	FSBK	Corus Bankshares, Inc.	1200393	CORS
North Country Financial Corp.	1123933	MFNC	Royal Bancshares of Pennsylvania, Inc.	2324429	RBPAA
North Valley Bancorp.	1029334	NOVB	Rurban Financial Corp.	1071454	RBNF
Northern Trust Corp.	1199611	NTRS	S&T Bancorp, Inc.	1071397	STBA
Norwood Financial Corp.	2365356	NWFL	Salisbury Bancorp, Inc.	2693273	SAL
Ohio Legacy Corp.	2873039	OLCB	Sandy Spring Bancorp, Inc.	1248304	SASR
Ohio Valley Banc Corp.	2012436	OVBC	Savannah Bancorp, Inc.	1493560	SAVB
Old National Bancorp.	1098303	ONB	SCBT Financial Corp.	1133437	SCBT
Old Point Financial Corp.	1076673	OPOF	Seacoast Banking Corp. of Florida	1085013	SBCF
Old Second Bancorp, Inc.	1206911	OSBC	Shore Bancshares, Inc.	2429838	SHBI
OptimumBank Holdings, Inc.	3251661	OPHC	Sierra Bancorp.	2976396	BSRR
Oriental Financial Group Inc.	2490575	OFG	Silicon Valley Bancshares	1031449	SIVB
PAB Bankshares, Inc.	1083934	PABK	Simmons First National Corp.	1094828	SFNC
Pacific Continental Corp.	2762973	PCBK	Smithtown Bancorp, Incorporated	1048997	SMTB
Pacific Mercantile Bancorp.	2869733	PMBC	Somerset Hills Bancorp.	2950480	SOMH
Park National Corp.	1142336	PRK	South Alabama Bancorp.	1138012	BTFG
Parke Bancorp.	3347292	PKBK	Southern Community Financial Corp.	2981831	SCMF
Patriot National Bancorp, Inc.	2840479	PNBK	Southern Missouri Bancorp, Inc.	3266227	SMBC
Peapack-Gladstone Financial Corp.	2651590	PGC	Southside Bancshares, Inc.	1245068	SBSI
Penns Woods Bancorp, Inc.	1117688	PWOD	Southwest Bancorp, Inc.	1062621	OKSB
Pennsylvania Commerce Bancorp, Inc.	2807614	COBH	Southwest Georgia Financial Corp.	1081538	SGB
Peoples Bancorp of North Carolina, Inc.	2818245	PEBK	State Bancorp, Inc.	1138861	STBC
Peoples Bancorp, Inc.	1070578	PEBO	Sterling Bancorp.	1039454	STL
Peoples Financial Corp.	1133174	PFBX	Sterling Bancshares, Inc.	1105425	SBIB
Peoples Holding Company	1098844	RNST	Suffolk Bancorp.	1130865	SUBK
Pinnacle Financial Partners, Inc.	2925657	PNFP	Sun Bancorp, Inc.	1139242	SNBC
Premier Financial Bancorp, Inc.	2007647	PFBI	Sussex Bancorp.	2461463	SBBX
PremierWest Bancorp.	2867542	PRWT	Synovus Financial Corp.	1078846	SNV

Appendix 4.1

Panel B: Non-Securitisers (CONT'D)

BHC name	RSSD ID	Ticker	BHC name	RSSD ID	Ticker
Taylor Capital Group, Inc.	2495039	TAYC	United Security Bancshares, Inc.	1086168	USBI
TCF Financial Corp.	2389941	TCB	Univest Corp. of Pennsylvania	1116609	UVSP
Texas Capital Bancshares, Inc.	2706735	TCBI	Valley National Bancorp.	1048773	VLY
The First of Long Island Corp.	1048894	FLIC	Village Bank and Trust Financial Corp.	3251027	VBFC
The Wilber Corp.	1048670	GIW	Virginia Commerce Bancorp, Inc.	2856377	VCBI
Tompkins Trustco, Inc.	2367921	TMP	Virginia Financial Group, Inc.	2502049	STEL
Tower Financial Corp.	2745604	TOFC	Waccamaw Bankshares, Inc.	3004689	WBNK
TriCo Bancshares	1030170	TCBK	Washington Banking Company	2406174	WBCO
TrustCo Bank Corp of NY	1048513	TRST	Washington Trust Bancorp, Inc.	1115349	WASH
Trustmark Corp.	1079562	TRMK	Webster Financial Corp.	1145476	WBS
Umpqua Holdings Corp.	2747644	UMPQ	WesBanco, Inc.	1070448	WSBC
Union Bankshares Corp.	1971693	UBSH	West Bancorporation, Inc.	1210066	WTBA
Union Bankshares, Inc.	1114940	UNB	Westamerica Bancorp.	1025541	WABC
Union Financial Bancshares, Inc.	3177341	PCBS	Whitney Holding Corp.	1079740	WTNY
United Community Banks, Inc.	1249347	UCBI	Wilmington Trust Corp.	1888193	WL
United Missouri Bancshares, Inc.	1049828	UMBF	Wilshire Bancorp, Inc.	3248513	WIBC
United Security Bancorp.	1031627	AWBC	WVS Financial Corp.	2140115	WVFC
United Security Bancshares	3015975	UBFO			

Appendix 4.2

Variable names and definitions

Variable		FR-Y9C Form data item
Capital Adequacy		
CAP	Capital ratio	BHCK3210/BHCK2170
Asset Quality		
GAP	1Y maturity gap	abs[(BHCK3197 – (BHCK3296 + BHCK3298))/(BHCK2170 – (BHCK2145 + BHCK2150 + BHCK2130 + BHCK3163 + BHCK0426))]
LATA	Liquid assets to total assets	(BHCK0010 + BHDMB987 + BHCKB989 + BHCK1754 + BHCK1773) / BHCK2170
H_LOAN	Loan Herfindahl index	$(TCI+UCI)^2 + REL^2 + AGL^2 + CLR^2 + TOL^2$
TCI	Total C&I loans ratio	(BHCK1763 + BHCK1764) / (BHCK2122 + BHCK2123)
UCI	US C&I loans ratio	BHCK1763 / (BHCK2122 + BHCK2123)
REL	Loans secured by real estate	BHCK1410 / (BHCK2122 + BHCK2123)
AGL	Agriculture loans	BHCK1590 / (BHCK2122 + BHCK2123)
CLR	Consumer loans	(BHCKB538 + BHCKB539 + BHCK2011) / (BHCK2122 + BHCK2123)
TOL	Total other loans	[BHCK2122 - (BHCK1410 + BHCK1590 + BHCK1763 + BHCK1764 + BHCK1296 + BHCK2081 + BHCKB538 + BHCKB539 + BHCK2011)] / (BHCK2122 + BHCK2123)
NPL	Non-performing loans	(BHCK5526 + BHCK5525 - BHCK3507 - BHCK3506) / BHCK2122
Earnings, Efficiency & Profitability		
ROA	Return on assets	BHCK4340/BHCK2170
ROID	Revenue diversification	1-|(BHCK4107 - BHCK4079)/(BHCK4107 + BHCK4079)|
H_NOIR	Non-interest income diversification (8 parts)	(BHCK4070/BHCK4079) + (BHCK4483/BHCK4079) + (BHCKA220/BHCK4079) + (BHCKB490/BHCK4079) + (BHCKB491/BHCK4079) + (BHCKB492/BHCK4079) + (BHCKB493/BHCK4079) + (BHCKB494/BHCK4079)
H_NITR	Interest income diversification (12 parts)	(BHCK4435/BHCK4107) + (BHCK4436/BHCK4107) + (BHCKF821/BHCK4107) + (BHCK4059/BHCK4107) + (BHCK4065/BHCK4107) + (BHCK4115/BHCK4107) + (BHCKB488/BHCK4107) + (BHCKB489/BHCK4107) + (BHCK4060/BHCK4107) + (BHCK4069/BHCK4107) + (BHCK4020/BHCK4107) + (BHCK4518/BHCK4107)
Off - Balance Sheet Activities		
TSEC	Outstanding principal value of assets securitized	(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711) / BHCK2170
RSEC	1-4 family residential securitization	BHCKB705/BHCK2170
HSEC	Home equity lines securitization	BHCKB706/BHCK2170
CRSEC	Credit cards receivable securitization	BHCKB707/BHCK2170
ASEC	Auto loans securitization	BHCKB708/BHCK2170
CSEC	Other consumer loans securitization	BHCKB709/BHCK2170
CISEC	C&I loans securitization	BHCKB710/BHCK2170
AOSEC	All other loans, leases, and other assest securitization	BHCKB711/BHCK2170
LT_SEC	Long-term assets securitized	**RSEC**
MT_SEC	Medium-term assets securitized	**HSEC + CISEC**
ST_SEC	Short-term assets securitized	**CRSEC + ASEC + CSEC + AOSEC**
NECP	Net credit protection (Bought-Sold)	[(BHCKC969 + BHCKC971 + BHCKC973 +BHCKC975) - (BHCKC968 + BHCKC970 + BHCKC972 +BHCKC974)] / BHCK2170

Chapter 5

Concluding remarks

Interest rate risk exposure of financial intermediaries has been a subject of considerable research since the 1970s. A substantial body of literature has been developed since. The researchers have addressed many pressing issues regarding the measurement and modelling of the firms' interest rate risk.

Despite extensive research in the area, the majority of existing contributions offer rather contrasting results regarding the effect of interest rate changes on financial institutions' equity returns. Numerous reasons have been put forward to explain these inconsistencies, but none has been explicitly examined. There is also a shortage of works analysing the key determinants of the financial institutions' interest rate exposure.

Furthermore, following the global financial crisis of 2007-2010, the attention of practitioners and academics has been mostly on the credit, liquidity and operational risks, and not on interest rate risk. As a result, the oversight and management of interest rate risk has fallen in priority at many financial firms.

This potentially detrimental development has been recently highlighted by the Basel Committee of Banking Supervision (2008) and regulatory authorities both in the US and in Europe. These regulators emphasise that interest rate risk remains one of the most important risks faced by financial institutions and stress the importance of accurately measuring and managing this risk. They further conclude that banks have accepted greater levels of interest rate risk in recent years.

Motivated by these issues, this thesis studies the relationship between interest rate changes and financial intermediaries' equity returns in three empirical chapters. Each chapter examines this relationship from a different perspective, but they all share the same goal of enhancing theoretical and practical knowledge about the subject and identifying important avenues for further research.

In Chapter 2, I employ an international sample of banks and insurance companies and empirically address the exposure of these institutions to interest rate movements. All G-10 countries and other important regions of Asia (Hong Kong) and Pacific Rim (Australia) are considered in this analysis. This chapter explores whether the growing quantity and popularity of innovative risk management instruments has influenced the interest rate exposure of financial institutions in recent years. The inadequacies of the presently popular methods used to quantify the exposure of the financial intermediaries to interest rate risk are also examined. In addition, I question the researchers' choice of interest rate proxy in the previous studies.

The empirical results presented in this chapter reveal two important findings. First, the majority of analysed financial institutions remain significantly exposed to fluctuations in different components of the interest rate yield curve. This indicates the inability of risk managers to forecast accurately the developments in the entire shape of the term structure and implement appropriate hedging strategies. Second, the statistical inferences regarding the interest rate factor significance are affected by the choice of interest rate proxy and econometric specification of the model adopted in the research. This finding points to the importance of the interest rate proxy and model choice for future research. This also sheds light to the origins of the disparity in the previous works.

Chapter 3 examines the link between interest rate risk faced by banking institutions, their balance sheet composition and national bank regulation. The work presented in this chapter analyses the key determinants of bank interest rate risk and employs both company level and market specific information. Among the company level measures I consider the banks' income structure, their capitalisation, balance sheet composition, and off-balance sheet activities. Many of these measures have been disregarded by previous research in the area. As regards to the market specific information, both country macroeconomic characteristics, country bank regulation and institutional development are considered. These regulatory characteristics have not been used in the interest rate risk literature to date.

The findings outlined in this chapter suggest a close link between banks' interest rate exposures and their financial characteristics. The compositions of banks' balance and off-balance sheet portfolios are particularly important in explaining their interest rate risk. Accordingly, future research in the area should pay a closer attention to factors determining the structure of these portfolios. It is also important to analyse whether and to what extent managerial compensation schemes affect on- and off-balance sheet positions. From a theoretical viewpoint, managers with larger equity holdings aim to minimise a bank's interest rate exposure and hence support a less aggressive balance sheet structure. The opposite is true for managers with large stock option holdings.

The results also suggest that regulatory and supervisory characteristics have a significant impact on bank interest rate risk. This impact, however, depends on the provision and design of deposit insurance in the target bank country. For instance, stringent capital, diversification and information disclosure requirements seem to reduce banks' interest rate exposure by more in countries with no explicit deposit insurance. From the perspective of policy makers, these results provide improved information for formulating banking sector policies.

In addition, banks with insured depositors benefit to a greater extent from regulatory impediments to engaging in insurance activities. Against this background, restricting banks' operations in the securities market increases their interest rate risk exposure. This effect is stronger for banks with insured depositors.

The latter observation is surprising and contradicts the view that banks tend to increase their risks when a larger scope of activities is allowed. However, as Laeven and Levine (2009) suggest, the relationship between bank risk and activity restrictions depends on the institution ownership structure. Accordingly, future research analysing the relationship between banks' interest rate exposure and regulatory characteristics should introduce controls for the ownership structure.

Chapter 4 considers in depth the impact of securitization on bank interest rate risk. In this respect, the theoretical benefits of securitization for efficient management of bank interest rate risk are unambiguous. Nonetheless, no empirical study to support this theory has hitherto been conducted.

I address this by answering empirically three key questions, using an extensive sample of the US publicly traded bank holding companies over 2001 to 2009. First, I analyse whether and to which degree the US bank holding companies are affected by interest rate risk. Second, I question if securitization can be used to manage effectively banks' interest rate risk. Finally, I examine whether the interest rate exposure varies among banks securitizing assets of different maturities and risk characteristics.

The findings of this analysis suggest that banks resorting to asset securitization do not achieve a visible reduction in their interest rate risk exposure. The interest rate risk increases with the maturity of assets securitised. It is higher for intermediaries securitizing actively long-term loans, such as residential mortgages. Accordingly, it appears that while securitization helps banks in matching better the duration of their assets and liabilities, the funds released from these transactions are reinvested in lower quality assets. This observation offers a valuable insight to both managers and policymakers seeking to utilise securitization in a bid to curb bank interest rate risk.

Against this background, banks with a very high involvement in securitization activities enjoy lower interest rate risk. These institutions commonly securitized the majority of loans soon after origination. Therefore, the importance of interest generating revenues declines, and so is the effective duration of their assets and liabilities on the balance sheet. Accordingly, the duration gap remains minimal resulting in lower interest rate risk.

It is important to remember that the analysis in this chapter is based on a sample of U.S. banks. Therefore, the reported evidence cannot be used to infer the relationship between banks' securitization activities and their interest rate exposure for other countries. This should be analysed in future research.

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