FACTORS DETERMINING BANK RISK: A EUROPEAN PERSPECTIVE

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Abstract

This paper investigates the factors affecting bank operational risk and bank equity risk for European banks during 1996 to 2005. Pooled-OLS and panel data analysis is applied to 84 financial institutions across 15 European countries using credit risk, interest rate risk, total equity, systematic risk and idiosyncratic risk. Off-balance sheet activities are positively correlated with all the risk measures except for interest rate risk. Further, bank charter value is positively correlated with total risk and idiosyncratic risk though negatively correlated with credit risk. Uninsured deposits are negatively correlated with systematic risk, suggesting market disciplining effects. Finally, in general we find a non-linear relationship between bank capital and bank risk.
Preface

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Bank equity risk has drawn considerable attention with the number of bank failures over the decade in US as well as Europe. European bank equity risk is important primarily due to the formation of EMU in 1999. This deregulatory change has had a significant impact on the European banking sector in terms of competition and consolidation. Therefore, my thesis aims to first identify empirically the change in bank equity risk with the formation of EMU. Next, my thesis examines the important factors affecting bank equity risk measures.

The thesis is structured as follows:

- Chapter 1 Introduction
- Chapter 2 Literature review
- Chapter 3 European bank equity risk 1995-2006
- Chapter 4 Factors affecting European bank risk
- Chapter 5 Conclusion

The following paper is based on Chapter 4.
1. Introduction

This study investigates bank-specific characteristics such as market discipline, off-balance sheet activities, charter value and bank capital that affect bank equity risk and operational risk.

It is important to study the European bank risk measures and the factors affecting these risks for several reasons. The European banking industry is exposed to off-balance sheet activities. The regulators have proposed including off-balance sheet activities in the calculation of the minimum capital requirement. This is because these activities can lead banks to sudden liquidity crises, if the risk is not well managed. Yet, it has been argued that off-balance sheet activities can also improve bank performance specifically in the case of domestic mergers, since banks are homogenous and have less difficulty in integrating with new products (Harrison, Hitt, Hoskisson and Ireland 1991).

Furthermore, it has often been argued that the most important and dramatic change in the world financial market is the formation of European Monetary Union (EMU). This shift in monetary policy regime has made the issue relating to bank risk a matter of great concern. The other motivation of this paper concerns capital adequacy requirement particularly, the new directive or new capital adequacy requirement. This new directive mainly supports a risk-sensitive supervisory framework and strengthens the market discipline in order to facilitate the effectiveness of capital allocation and boost the competitiveness of the European banking industry. Herring (2004) argues that market discipline offers a way of enhancing the effectiveness of the bank capital regulation at a lower cost as it will deter regulatory arbitrage and reward banks for controlling or quantifying their overall risk of insolvency.

1 The main rationale for the establishment of EMU and the commencement of a single currency the Euro, was to ease trade, eliminate exchange rate risk, remove transaction costs incurred in exchanging currencies, enhance globalization through increased integration and competition along with maintenance and preservation of fiscal policy among the European markets. This modification has had a significant impact on the European financial system (banking industry and financial market) in terms of competition and consolidation (Francis and Hunter 2004).

2 In parallel to the revision of the capital adequacy requirement, regulatory bodies are considering the revision of the directive on deposit guarantee scheme. More importantly, the Lamfalussy process for banking sector is still under review. This process includes development of regulation that can adapt to the new market developments and practices and support integration, enhance competitiveness and strengthen cross border cooperation among supervisory authorities (Thomopoulos 2006).

3 Regulatory arbitrage occurs as banks engage in transactions in order to reduce risk weighted assets without reducing exposure to risk (Herring 2004).
This study contributes to literature in relation to bank risk in several important ways. First, this study takes into account of the period from 1996-2005, a decade of regulatory changes such as the formation of EMU in 1999. This study analyses the importance of the factors explaining bank risk with the formation of EMU. It has been argued that the formation of EMU has had a significant impact on the European banking industry both in terms of consolidation and competition. None of the studies so far have determined the factors explaining bank risk measures with the formation of EMU. Second, this study contributes to the market discipline literature with respect to bank equity risk and operational risk. Third, in line with the theoretical literature by Calem and Rob (1999), this study considers the existence of a non-linear relationship between bank equity risk and bank capital.

We examine the determinants of bank risk measures for 84 financial institutions across 15 European countries over the years 1996 to 2005. Our results show that off-balance sheet activities is a risk enhancing factor rather than a risk reducing factor as we observe a positive relationship with all five risk measures. A market disciplinary effect, measured by the sum of subordinated debt and uninsured deposits, is observed for the systematic risk only. We also observe a positive relationship with charter value and bank equity risk while credit risk and charter value is negatively related. Moreover, we find evidence that bank capital is non-linearly related with bank risk.

The rest of the paper is structured as follows. Section 2 discusses the relevant literature review which has helped to develop the testable hypotheses. Section 3 presents the data and methodology. Section 4 highlights the empirical results which are followed by a few robustness analyses as presented in section 5. Finally, section 6 draws the conclusion.

2. Literature review and hypotheses development

In this section we review the literature identifying the key factors that affect bank risk measures. We then develop testable hypotheses based on this literature review.

2.1 Theoretical background

Bank deposit insurance has proven successful in protecting banks from runs, but this is not without cost because one cost that accompanies deposit insurance arises from the moral hazard problem. Deposit insurance protects the depositors but diminishes the
depositor’s incentive to monitor the bank and demand an interest payment proportionate to the bank risk. Further, the banks generally provide a flat rate premium under the deposit insurance scheme but do not internalize the full cost of risk and thereby tend to take on excessive risk.

Merton (1977) analyzed the bank moral hazard problem associated with bank deposit insurance using an option pricing model. In this approach deposit insurance is viewed as a put option written on the value of the bank’s assets with a strike price equal to the promised maturity value of its debt. When the insurance risk premium is risk insensitive, the banks can increase the value of put option by increasing asset risk or decreasing the capital to asset ratio.

Chan, Greenbaum and Thakor (1992) consider a more complex framework where information asymmetry exists and the insurance provider requires the banks to hold a certain capital-assets ratio and (banks) are charged a given insurance premium per unit of deposits. In presence of adverse selection, it is almost impossible to set an incentive-compatible deposit price because banks are indifferent to their capital structure when insurance is priced fairly. Thus, the banks prefer a lower level of insurance premium for any positive level of deposits. High risk institutions prefer the contract as much as low risk institutions as long as the institution chooses a positive level of deposits.

It is evident that deposit insurance need not be fairly priced and this provides an incentive to increase risk. The existence of risk shifting and the possibility of bank failure are generally viewed as adequate justification for regulation of bank capital (Santos 2001). The other factor that can eliminate the moral hazard problem is the disciplining effect of charter value. In the next two sub-sections we discuss the relationship between bank risk and bank capital and bank risk and bank charter value. We then discuss the impact of market discipline with a focus on the level of uninsured deposits, the magnitude of off balance sheet activities and the impact of bank size.

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4 Kareken and Wallace (1978) and Dothan and William (1980) study the moral hazard related to deposit insurance using the state preference model.

5 Merton’s (1977) model is based on the premise that markets are complete and the provider of deposit insurance has full knowledge of the risk of the bank’s assets. Under this situation, there is no question of bank run or panics and moral hazard is explicitly or implicitly eliminated.
2.2 Relationship between bank risk and charter value

Bank charter value is defined as the present value of the future profits that a bank earns as a going concern (Demsetz, Saidenberg and Strahan 1996). It is well-known that charter value helps to eliminate moral hazard problems in relation to an explicit or implicit safety net. In this regard, Konishi and Yasuda (2004) for Japanese commercial banks, Anderson and Fraser (2000) and Demsetz, Saidenberg and Strahan (1996) for US bank holding companies find that charter value has a negative relationship with total risk, systematic risk and idiosyncratic risk. In contrast, studies also show a positive relationship between charter value and bank risk. Perhaps, this positive relationship is that charter value may be capturing growth opportunities. Indeed, a bank’s charter value may originate from taking on more risky, though positive NPV, activities and so if limits are placed on individual bank risk this could restrict the bank’s charter value (Saunders and Wilson 2001). An alternative explanation for this positive association with charter value and bank-specific risk reflects the impact of financial liberalization and increased competition which may have diminished the disciplining effect of charter value (Marcus 1984, Keeley 1990, Matutes and Vives 2000, Hellmann, Murdock and Stiglitz 2000 and Staikouras and Fillipaki, 2006). For example, competition among the Spanish banks increased with liberalization of the European banking industry and this has been noted more generally among European banks. The increase in competition has been associated with a massive reduction in European bank charter value as well as increases in bank risk taking (Salas and Saurina, 2003 and Gropp and Vesala 2004). Similar results are also observed in the US banking industry (Park 1994 and Galloway, Lee and Roden 1997). Yet, Stolz (2005) does not find any evidence that increased competition led to erosion of charter value or increased bank risk taking by European banks. This study finds that while charter value fell, banks also raised their capital buffers such that increasing competition does not appear to have weakened the European banking industry. Based on the above discussion, we take a more general approach and consider charter value as a bank disciplinary mechanism. This leads to our first testable hypothesis:

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6 Konishi and Yasuda (2004) find that market risk and interest rate risk is positively associated with Japanese commercial bank charter value.
**Hypothesis H**₁: There is a negative relation between charter value and both bank equity risk and operational risk measures.

2.3 Relationship between bank risk and bank capital

It is generally accepted that banks prefer to invest in higher risk portfolios where deposit insurance is in place and so the regulators require banks to maintain a capital buffer to allow the banks to absorb greater losses in the event of bank failure. Kim and Santomero (1988) argue that the recent development of risk-based capital regulation provide an upper bound on insolvency probability. Further, the weights attached to bank capital are independent of bank preferences which may provide an effective means of meeting the regulators safety goals.⁷ Similar arguments have been made by Furlong and Keeley (1987, 1989), Keeley and Furlong (1990) and Rime (2001).

However, the preservation of higher capital requirements for banks is not without dispute. For example, higher capital levels may induce banks to increase asset portfolio risk and the probability of default thereby defeating the original purpose of capital controls (Kahane 1977, Koehn and Santomero 1980, Gennette and Pyle 1991, Blum 1999). Capital adequacy requirements may also reduce bank profits. If future profits are expected to be low, the banks may not be motivated to avoid default, and indeed, the leverage effect of capital may lead banks to take on more profitable high risk loans in order to increase the value of equity. Thus it may be optimal for the bank to increase risk now in order to increase equity value (Blum 1999).

A more complex and novel model of bank capital and bank risk taking has been proposed by Calem and Rob (1999). This model predicts a U shaped relationship between bank capital and bank risk which implies that both undercapitalized and well capitalized banks are more risky than banks with intermediate levels of capital. Yet, for the undercapitalized banks, it is argued that as the capital tends to rise over the period, the banks become less inclined to take risk, but as capital continues to increase they will take on more risk. The undercapitalized banks can afford to take on higher level of risk because in the event of default they can easily transfer the costs to the authorities, as risky investments are subsidized. This reflects the moral hazard problem that exists in the banking system through exploitation of the benefits of deposit insurance. It has been

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⁷ Thus, the higher level of capital buffer may force bank shareholders to expose to the downside risk.
suggested that the well-capitalized banks tend to increase risk only if they believe that the probability of bank default is very remote.

Further, empirical work has been conducted by Saunders, Strock and Travlos (1990). Unexpectedly, they find no significant relationship between bank capital and bank risk (total risk, idiosyncratic risk, systematic risk and interest rate risk) during the period of 1978-1985 for US bank holding companies. In contrast, Kwan and Eisenbeis (1997) find that interest rate risk is positively and significantly related to bank capital while credit risk is negatively related to bank capital irrespective of bank size. Similar results are also observed for Japanese commercial banks (Konishi and Yasuda 2004) and for US bank holding companies (Galloway, Lee and Roden 1997).

From the above discussion it is evident that in the first instance, capital regulation is designed to reduce bank risk. However, it is also feasible that following Calem and Rob (1999), bank risk may initially reduce with increase in bank capital, but as the capital buffer builds-up banks may choose to eventually increase their risk levels. Thus, we formulate our second two testable hypotheses with respect to bank capital.

**Hypothesis H**$_{2A}$: Bank equity risk and operational risk is negatively related to bank capital.

**Hypothesis H**$_{2B}$: Bank risks and bank capital exhibit a U shaped relationship.

### 2.4 Relationship between bank risk and off-balance sheet items

Although financial institutions are involved in providing traditional banking services and interest generating activities, recently the European banks have moved towards off-balance sheet activities. These activities help banks, particularly in times of increased competition, to expand their revenue sources without altering their capital structure (Yildirim and Philippatos 2003). Hence, off-balance sheet activities are a contingent liability to the banks and it becomes important for the banks to honor such guarantees (Boot 2003). Yet, it has been observed that loan commitments generate an

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8 This result may imply either the regulatory authorities have met the desired goal of regulating the bank capital without increase in risk or specifically Japanese banks have changed their attitude towards bank risks due to the credit crunch that occurred during 1993-1999.

9 Banks with higher levels of off balance sheet items are found to be more cost and profit efficient (Yildirim and Philippatos 2003). It has been argued that off-balance sheet exposures promote a more diversified, margin generating asset-base compared to deposits or equity financing (Angbazo 1997).
inducement for banks to reduce their risk-taking (Boot and Thakor 1991, Angbazo 1997). For example, Esty (1998) argue that even at low levels of charter value the banks with contingent liabilities hold a smaller proportion of risky assets. Earlier studies show that off-balance sheet activities impose market discipline on bank management and serve to protect the bank investors from risk (Brewer, Koppenhaver and Wilson 1986, Lynge and Lee 1987 and Hassan, Karels and Peterson 1994).

However, the increase in the amount of off-balance sheet activities and the escalation in bank failures have raised issues about the possible relationship between bank risk and off-balance sheet items particularly with respect to loan commitments, contingent liabilities, standby letters of credit and commercial papers. It has been argued off balance sheet activities increase the opportunity to increase moral hazard problem (Wagster 1996). Angbazo (1997) find US commercial banks show a positive correlation between bank interest rate risk and off-balance sheet activities such as letters of credit, options and net securities lent. However, this supports the moral hazard hypothesis that off-balance sheet activities increase bank risk. Based on the argument that increased bank competition, engagement of balance sheet activities and argument on divergent capital rules we derive our next testable hypothesis:

**Hypothesis H3:** The bank equity risk and operational risk are positively related to off-balance sheet activities.

2.5 Relationship between bank risk and uninsured deposits

In our analysis we measure uninsured deposits as the sum of inter-bank deposits and subordinated debt, which are the two important market disciplinary devices. The inter-bank deposits are the deposits received from other banks are not covered by explicit or implicit insurance scheme. It has been argued that inter bank rates paid by large banks include default risk premium (Ellis and Flannery 1992). The market disciplinary role of subordinated debt is evident as banks move into riskier activities (Morgan and Stiroh

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10 The European bank subordinated debt market is concentrated. The largest European banks issue subordinated debt on average twice a year and the average ratio of outstanding subordinated debt to total assets is approximately 2%. This debt is traded in an illiquid secondary market, with few infrequent large transactions (Sironi 2003). However, some effort has been put into the implementation of market discipline mechanisms which help to prevent banks from undertaking excessive risk. For example, in the early 1980s a mandatory subordinated debt policy (MSDP) was drafted by academics and regulators and forms part of the 2000 Basel Capital Accord II revised proposal. The importance of market discipline is clear in both the documents.
2000). Flannery and Sorescu (1996) find that both asset quality and market leverage have an impact on subordinated debt. Yet, interest rate risk has no effect on the subordinated debt. However, these arguments should be judged with some caution as Calem and Rob (1999) show that subordinated debt fails to have any effect on the portfolio allocation decision of a well-capitalized bank. Further, Sironi (2003) and Gropp and Vesala (2004), Nier and Baumann (2006) find that subordinated debt investors in the European banking industry, excluding government owned or guaranteed institutions, are sensitive to bank risk. This study also finds that accounting proxies for bank risk have relatively poor explanatory power over European bank subordinated debt spread variability. Yet, ROA and leverage have a negative and positive relationship with bond spreads respectively. Based on the above discussion we can formulate our fourth testable hypothesis:

**Hypothesis H₄:** The bank equity risk and operational risk are negatively related to uninsured deposits.

2.6 Relationship between bank risk and size

The European banking industry faced profound changes with the merger waves that followed EMU. The most obvious outcome of the merger and acquisitions that occurred in the period is a sharp increase in the average size of the average banking organization. This leads to an empirical question of whether large banks are more risky than small banks. However, size is one of the motivations for mergers. Another important incentive for bank consolidation is to take advantage of the diversification benefits and simultaneously operate with greater leverage and pursue riskier and potentially more profitable lending (Demsetz and Strahan 1997). It is evident that large banks are internally diversified and this provides one means of reducing bank idiosyncratic risk (Stiroh 2006 and Konishi and Yasuda 2004).

Nevertheless, banks offset these gains by undertaking riskier activities (like commercial and industrial lending) and by employing more financial leverage. A shift toward risky non-interest generating activity is a way that large banks may choose to apply the benefits created from their internal diversification advantages (Saunders,

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11 No sensible relation with bank risk and bond spread was found when stand alone risk measures are used (Sironi 2003).

12 Staikouras and Fillipaki (2006) report that there was a major reduction in the number of credit institutions in France, Finland, and Ireland and while they noted, an increase in the number of financial institutions in Greece there was little change in the German banking sector.
Travlos and Strock 1990, Boyd and Runkle 1993, Demsetz, Saidenberg and Strahan 1996 and Demsetz and Strahan 1997). A similar result is also observed for bank total risk. Stiroh (2006) shows a negative relation between size and risk that appears to explain the diversification effect while the positive sign for the quadratic size term implies a diminishing diversification benefit. In relation to bank systematic risk, larger banks with higher sensitivity to the general market movements may exhibit a positive relationship with bank systematic risk (Saunders, Travlos and Strock 1990 and Anderson and Fraser 2000). Based on the above arguments we formulate our fifth testable hypothesis:

**Hypothesis H5A**: Systematic risk is positively related to size.

**Hypothesis H5B**: Credit risk, interest rate risk, idiosyncratic risk and total risk are negatively related to size.

### 2.7 Other important variables

The other variables of concern that form part of the following analysis include the ratio of loans to total assets, dividend yield, operating leverage, ownership, geographical proximity, legal origin, creditor rights and anti director rights. We would expect the loans to total assets to be positively related with bank risk measures. This is because our sample is dominated by commercial banks and these banks will tend to be more aggressive in credit markets (Marco and Fernandez 2005).

We include dividend yield in our model primarily for two reasons. First, dividend payments provide a signal concerning bank expectations about future income and second, high growth banks tend to retain a proportion of their net income which implies that more risky banks will pay less dividends. So, low dividend yield may reflect bank risk (Lee and Brewer 1986). Hence, we consider a negative association between dividend yield and bank risk measures. With regard to operating leverage, Mandelker and Rhee (1984), Saunders Strock and Travlos (1990) consider operating leverage in a similar way to financial leverage in terms of increasing bank risk. Thus, we consider that operating leverage is expected to be positively related to our bank risk measures.

Furthermore, our ownership dummy represents whether the institution is commercial bank or otherwise. We would expect a positive association between bank risk and ownership. Also, we would expect common-law countries to show lower bank risk compared to the civil-law countries (LaPorta, Lopez-de-Silanes, and Shleifer 1998 and...
González (2004). In countries where shareholder control is greater than managerial control we would expect the bank risk to be higher. Hence, we may expect creditor rights to be negatively related to bank systematic risk and positively related to the four other risk measures. Moreover, the antidirector rights index measures the interest of the minority shareholders against managers and dominant shareholders. Our hypothesis is similar to the one for creditor rights.

3. Data and methodology

3.1 Data

This study analyses cross-country bank-level data in order to determine the factors affecting bank equity risks and bank operational risk. The sample consists of banks operating in euro-zone and non-euro-zone European countries. We consider a range of financial institutions such as bank holding companies, commercial banks, cooperatives and savings banks across 15 European countries (Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom). It is worth to mention that focusing only on European commercial banks can restrict the study of bank risks because a greater proportion of publicly quoted cooperatives and savings banks offer similar commercial banking services and this is particularly observed in Italy, Norway, Spain, Sweden, and Switzerland.

Relative to other research a contribution of this study is the careful selection of the banks from 15 European countries. We extract the bank level information, such as the balance sheet and income statement from the Bankscope and the Osiris databases. We base our initial bank list on Bankscope which provides data on 228 listed bank shares. From this sample we at first eliminate ninety seven (97) banks due to inadequate market data or bank level accounting information. We then exclude financial institutions that are legally controlled by other institutions (subsidiaries) with a loss of a further 47 banks. The final sample consists of 84 listed banks. However, our sample is not survivorship bias free. Dead or de-listed bank shares are not available on either the

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13 We exclude subsidiaries in order to avoid double counting.
14 The comprehensive data information from Bankscope is equivalent to European Central Bank (ECB) declaration of number of banks and is often used by ECB to conduct cross-country analysis.
Bankscope or the Osiris databases. The number of banks from each country is reported in table 1.

We use weekly market data such as individual banks returns, MSCI market indices, market value of equity and the 10 year government bond yields. These are extracted from the Datastream International database. For comparability we convert the market value of equity into euro currency for non-euro-zone countries such as Denmark, Norway, Sweden, Switzerland and the United Kingdom. We use the EM exchange rate-USD per Euro (average) to convert the pre-euro market value of equity and the USD to Euro (GTIS)-exchange rate to convert the post-euro market value of equity into euro for non-euro-zone European countries.

Our data contains bank-level information which is likely to affect bank equity risk and bank operational risk. The independent variables include bank discipline variables such as bank charter value and bank capital as well as market discipline variables such as uninsured deposits. The list of explanatory variables and macroeconomic variables with their detailed definitions and sources are provided in table 2.

Our base model considers the following variables. We measure charter value based on Keeley (1990). Charter value is the sum of the market value of equity and book value of liabilities divided by the book value of total assets. The bank capital is total capital as a proportion of bank total assets. We also consider the possibility of a non-linear relationship between bank capital and bank risk and hence include the variable bank capital squared. The key measures of market discipline are uninsured deposits and off-balance sheet activities. Uninsured deposits are the sum of the subordinated debt and inter-bank deposits divided by the total liabilities. The other measure is off-balance sheet activities which is the total value of off-balance sheet activities divided by bank total liabilities. We also consider loans to total assets as a proxy for bank asset management. Size and economic freedom index are included as the control variables.

\footnote{In some cases we use the MSCI price indices where MSCI return indices were unavailable. We find the correlation between MSCI price index and MSCI return index ranges from 96\% to 98.99\%.}
Furthermore, we extend our primary (base) model by incorporating operating leverage (Saunders, Strock and Travlos 1990, Galloway, Lee and Roden 1997), dividend yield, ownership dummy (commercial banks versus other sample institutions), legal origin dummy (common law countries versus civil law countries), geographical dummy (euro-zone countries versus non-euro-zone European countries), creditor or shareholder rights index and anti-director rights index. We also provide the detailed definition of these variables in table 2.

Our sample coverage is from 1996 to 2005. This leads to a total 840 observations. The length of time period is chosen to include the formation of EMU in 1999. Further, we divide the sample period into pre-euro period (1996-1998) and post-euro period (1999-2005) in order to study the impact of changes in regulation on bank risks.

3.2 Model

We first conduct a cross-sectional analysis using a large number of explanatory variables based on our literature survey. We apply t-tests and F-tests in reducing this very general model down to a more parsimonious form. This is repeated for each of the 10 cross-sectional analyses (from 1996 through to 2005). Our final parsimonious model is represented in equation (1). Thus, we regress bank equity risks and bank operational risk on bank-specific factors and country-specific factors (as mentioned in section 3.1) using the following equation (1). We apply pooled-OLS\(^{16}\) and panel techniques for the full sample period\(^{17}\).

\[
\text{RISK}_{i,j,t} = \left[ \alpha_0 + \beta_1 UD_{i,j,t} + \beta_2 CV_{i,j,t-1} + \beta_3 BC_{i,j,t-1} + \beta_4 BC_{i,j,t-1}^2 + \beta_5 OBS_{i,j,t} + \beta_6 LTA_{i,j,t} + \beta_7 Size_{i,j,t-1} + \gamma_i EFI_{j,t} + \sum_{j,t} + \epsilon_{i,j,t} \right]
\]

where, \( \text{RISK}_{i,j,t} \) represents bank equity risk and operational risk measures. The bank equity risk measures include systematic risk, idiosyncratic risk, interest rate risk and total risk for individual bank \( i \) in country \( j \) at period \( t \). We take the natural log of bank total

\(^{16}\) The pooled OLS includes year dummies in the model presented in equation (1). However, the panel techniques do not include additional year dummies.

\(^{17}\) The appropriateness of the pooled-OLS and fixed effects is estimated by F-test probability, while the random effects model relative to the pooled-OLS is examined with the Breusche Pagan Langrange multiplier (LM) test. The Hausman test is used to compare the fixed effects with the random effects model. When time invariant dummy variables are included in the estimated model, the application of fixed effects is not possible and in such cases the alternatives are the pooled-OLS and random effects models as determined by the results of a Langrange multiplier (LM) test.
risk and bank idiosyncratic risk before including this in the model. With regards to bank interest rate risk we consider the absolute value of the interest rate risk as a proxy for risk. All bank equity risk measures use the two-index market model. The estimation techniques are presented at the end of this section in (equation (3) and equation (4)).

Further, the operational risk includes the credit risk which is measured using 
\[ CR_{i,j,t} = LLP_{i,j,t} / TA_{i,j,t} \]
where; \( CR_{i,j,t} \) is the credit risk measure for bank \( i \) in country \( j \) in period \( t \); or the ex-post realized risk. \( LLP_{i,j,t} \) is the loan loss provision for bank \( i \) in country \( j \) in period \( t \); \( TA_{i,j,t} \) is the total assets of bank \( i \) in country \( j \) in period \( t \).

The explanatory variables such as \( UD_{i,j,t} \) is the natural log of uninsured deposits for bank \( i \), in country \( j \) at period \( t \), \( CV_{i,j,t-1} \) is the natural log of charter value for bank \( i \), country \( j \) lagged one period. \( BC_{i,j,t-1} \) is the natural log of bank capital for bank \( i \), in country \( j \) lagged one period, \( BC^2_{i,j,t-1} \) is the square of the natural log of bank capital for bank \( i \), in country \( j \) lagged one period, \( OBS_{i,j,t} \) is the natural log of off-balance sheet activities for bank \( i \), in country \( j \) at period \( t \), \( LTA_{i,j,t} \) is the loan to total assets for bank \( i \), in country \( j \) at period \( t \), \( Size_{i,j,t-1} \) is the natural log of market value of equity for bank \( i \), in country \( j \), lagged one period and \( EFI_{j,t} \) is the economic freedom index for country \( j \) at period \( t \). 

\[ \sum Y_{i,j,t} \] represents the year dummies (1997 to 2005) only for the pooled-OLS analysis. Finally, \( \varepsilon_{i,j,t} \) is the random error term.

We believe that endogeneity is likely to affect the analysis particularly with respect to bank capital and charter value. As a result, we address this potential endogeneity bias by using the lag of bank charter value and the lag of bank capital as instruments for these variables (Saunders and Wilson 2001, Galloway, Lee and Roden 1997 and Gonzalez 2004).

We now discuss the model presented as follows in equation (2). This is an extended version of our base model given as equation (1). We expand the model by introducing operating leverage and dividend yield along with a number of dummy variables.
where, \( OPL_{i,j,t} \) is the operating leverage for bank \( i \), country \( j \) at period \( t \), \( DY_{i,j,t} \) is the dividend yield for bank \( i \), country \( j \) at period \( t \). \( D_{1j} \) is the ownership dummy, \( D_{1j}=1 \) if commercial banks or otherwise 0, \( D_{2j} \) is the legal origin dummy, \( D_{2j}=1 \) if common law countries or otherwise 0, \( D_{3j} \) is the geographical dummy, \( D_{3j}=1 \) if euro-zone countries or otherwise 0, \( D_{4j} \) is the creditor rights index. \( D_{5j} \) is the anti director rights index. \( \epsilon_{i,j,t} \) is the random error term.

We follow Konishi and Yasuda (2004) in estimating bank equity risks as mentioned above. We use the two index market model as presented in equation (3) as a return generating process to measure the three alternate bank equity risks. The model captures systematic risk, interest rate risk and residual variance (idiosyncratic risk) for each individual bank.

\[
R_{it} = \alpha_i + \beta_m R_{Mt} + \beta_2 R_{M} + \epsilon_{it}
\]

where \( R_{it} \) is the weekly stock return of bank \( i \) at date \( t \); \( R_{Mt} \) is the weekly stock return of the market indices. Based on the geographical exposure we use either the MSCI country index or the MSCI world index or the MSCI Europe index. \( R_{Mt} \) is the weekly change in the yield of ten (10) year government bonds for each country at date \( t \). \( \epsilon_{it} \) is the residual term. The idiosyncratic risk, or the bank-specific risk, is the variance of the residuals from equation (3). Finally, we measure total risk as follows:

\[
\sigma_{ri}^2 = 1/N \sum_{i=1}^{N} (R_i - \overline{R})^2
\]

where, \( \sigma_{ri}^2 \) is the total risk or variance of the bank returns for bank \( i \). \( R_i \) return of bank \( i \) and \( \overline{R} \) is the average return of bank \( i \). \( N \) is the number of observations.

Next we model whether the risk factors changed with the formation of EMU. For this analysis we split our sample in two parts for each event. We consider year 1999 to be the natural break point for the formation of EMU. So, we split the sample period pre
EMU period 1996-1998 and post EMU period 1999-2005. We apply OLS to the following model to analyze the changes in the factors with the formation of EMU.

\[
Risk_{i,j,t} = \alpha + \beta X_{i,j,t} + \beta_\Delta D_t \cdot X_{i,j,t} + \sum_i \delta_i Y_t + \varepsilon_{i,j,t}
\]

(5)

where, \(X_{i,j,t}\) represent the bank-specific characteristics for bank \(i\) in country \(j\) at period \(t\), however, the variables are same as the explanatory variables identified in equation (3). \(D_t\) is the time dummy, where \(D_t = 1\) for post-euro period and \(D_t = 0\) for pre-euro period. We interact each bank-specific variable \(X_{i,j,t}\) with the time dummy represented by \(\beta_\Delta D_t \cdot X_{i,j,t}\). This interaction term shows the changes in the determinants of the bank risk. \(Y_t\) is year dummy variable. Finally, \(\varepsilon_{i,j,t}\) is the random error term.

### 3.3 Descriptive Statistics and correlation analysis

The descriptive statistics for the sample used in this study are reported in table 3. The European banks engage in off-balance sheet activities and the average as a percentage of total assets is 52%. The financial leverage or bank capital ranges from 2% to 97%. We observe that European banks maintain a relatively high charter value. The charter value ranges from 0.87 to 1.79 and the average value stands at 1.02. In addition, uninsured deposits are also an important factor for the European banks. The uninsured deposits to total liabilities ratio stands at a maximum of 0.97.

The economic freedom index is provided for each country for each of the study period. The highest economic freedom index value is observed in Ireland and the lowest is for Greece. The creditor rights index ranges from 1 to 4. The maximum is observed in the United Kingdom and the minimum in France. However, the average values for English origin countries are 3.11, French origin countries are 1.58, German origin countries are 2.33 and Scandinavian origin countries are 2. The anti-director rights index ranges from 0 to 5. The maximum scale of 4 is observed in the United Kingdom and the minimum value of 0 is observed in Belgium.

Our correlation analysis shows two very large correlation coefficients. They are bank capital and size (-53%) and bank capital squared and size (-66%).

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18 To save space the correlation analysis results are not reported but are available upon request.
we re-run the model without the size variable and the results are essentially unchanged. Thus, these large size correlation coefficients do not indicate a problem with later analysis.

4. Empirical results

This section discusses the factors affecting bank equity risk and operational risk measures under different regression specifications. Section 4.1 represents the results on effects of risk factors related to our base model (equation 1) using pooled-OLS regression.19 We control for individual bank heterogeneity by applying the panel techniques to the same model (with out the year dummies) and the results are reported in section 4.2. Section 4.3 focuses on the extended version of the base model (equation 2) where additional bank-specific variables and country-specific variables are included. Finally, Section 4.4 analyses the impact of EMU on the risk factors. This also provides a check of the stability of the estimated models over the 10 year period of the study.

4.1 Effects of risk factors

We report the results for the empirical determinants of all five risk measures in table 4. Our findings show that bank charter value is negatively related with bank credit risk. This is consistent with the disciplining effect of bank charter value (Furlong and Kwan 2005). Yet, we find a positive and significant relationship between idiosyncratic risk and charter value and between total risk and bank charter value (Saunders and Wilson 2001). This result is contrary to the previous studies including Konishi and Yasuda (2004) for Japanese commercial banks and Anderson and Fraser (2000), Galloway, Lee and Roden (1997) and Demsetz, Saidenberg and Strahan (1996) for US bank holding companies. This result is also contrary to hypothesis 1. We also find a positive and significant relationship between systematic risk and bank charter value. One possible explanation for this relation is that charter value enhancing expansion took place over the study period and this may have resulted in increased European bank systematic risk, leading to greater levels of potential loss during the business cycle contraction that occurred after 2000 (Konishi and Yasuda 2004, Saunders and Wilson 2001, Demsetz and Strahan 1996 and Hughes, Lang, Mester and Moon 1996).

[INSERT TABLE 4 ABOUT HERE]

19 The pooled OLS includes year dummies. The joint F-test for the year dummies is statistically significant.
The other bank discipline variable, bank capital, although showing a negative relationship with all risk measures is statistically significant only for systematic risk. It appears that the higher the bank capital buffer the lower the bank risk and as such it would appear that bank capital has been helpful in maintaining the stability of the banking system (Kim and Santomero 1988, Furlong and Keeley 1987, 1989 and Keeley and Furlong 1990). Interestingly, the incorporation of the bank capital squared term in the model suggests the existence of a non-linear relationship with bank risk measures. This result is in line with Calem and Rob (1999), Blum (1999) and Gennotte and Pyle (1991). However, the result supports our hypotheses 2A and 2B.

Another important result is observed with the relationship between off-balance sheet items bank risk. We find that off-balance sheet activities show a positive and significant relationship with credit risk, systematic risk, total risk and idiosyncratic risk. The results are significant at 5% level or better. This outcome supports our hypothesis 3. The result is consistent with the argument that off-balance sheet activities are contingent claims or contracts that generate fee income for banks but also create a balance sheet or portfolio risk. This is definitely a concern for bank regulators as the risk of off-balance sheet activities, if not managed properly, can squeeze liquidity and create sudden losses. However, Basel Accord I & II proposals have also considered the off-balance sheet activities to be risky and have included them in the risk-weighted bank capital ratio. The results reported in table 4 provide support for the regulator’s concerns about off balance sheet based bank activities.

The measure of market discipline, uninsured deposits, exhibits a negative and statistically significant association with systematic risk and a positive and significant association with both credit risk and idiosyncratic risk. While the results for systematic risk support our hypothesis 4, the hypothesis is not supported for the other risk measures. This suggests that while market discipline may decrease risk relative to the market it could increase diversifiable bank specific risks. The negative systematic risk coefficient could be interpreted as implying that an increase in bank liabilities and subordinated debt provides a superior market discipline strategy, reducing the effects of explicit or implicit deposit insurance. However, the positive relationship for credit risk, total risk and idiosyncratic risk may be explained by the argument that longer debt maturity liabilities
such as the subordinated debt, can lead the banks to invest in sub-optimal risky investment (Jensen and Meckling 1977) thus generating greater bank specific risk, a risk that can be diversified away.

The other variable of interest is loans to total assets. Our findings on credit risk support our hypothesis that loans to total assets is positively associated with bank operational risk. However, loans to total assets is negatively related to systematic risk and total risk suggesting that bank shareholders view higher levels of loans differently. Perhaps, increase in the level of loans results in an increase in bank systematic risk through increased financial risk.

Size is negatively related to credit risk, idiosyncratic and interest rate risk but is statistically significant for credit risk measure. (Demsetz, Saidenberg and Strahan 1996 and Demsetz and Strahan 1997). The relationship between systematic risk and size and total risk and size is positive and significant at 1% significance level (Saunders, Strock and Travlos 1990, Demsetz, Saidenberg and Strahan 1996, Anderson and Fraser 2000). Perhaps, the positive relationship between total risk and size reflects that the positive affect of systematic risk more than off-sets the idiosyncratic risk effect, hence leading to an increase in total risk. Thus, the size effect on bank risk measures does support our hypotheses 5A and 5B.

Finally, the economic freedom index is negatively associated with all risk measures and is statistically significant at 5% level or better. This outcome supports our hypothesis 6. This result implies that greater levels of economic freedom, particularly in terms of lower levels of regulation and government intervention, generate lower bank equity risk and operational risk.

4.2 Effect of risk factors controlling for heterogeneity

In the following discussions we report the results of the risk measures under random effects and fixed effects models. We choose these standard methods to capture unobservable heterogeneity in the data. The results are reported in panel A and panel B of table 5.
Our findings on bank charter value using random effects show similar results to the pooled-OLS analysis as discussed in section 4.1. There is some variation between the two approaches. For example, there is less evidence of a statistically significant non-linear relationship between bank risk and bank capital though statistical significance remains for credit risk and systematic risk.

One important finding that is robust to the change in estimation method relates to off-balance sheet activities. The coefficients for this variable remain positive and statistically significant at 5% significance level or better reflecting the relation between off-balance sheet activities and the various measures of bank riskiness. We also find that bank charter value is positive and significant with bank total risk and idiosyncratic risk, (a similar result is also observed in section 4.1).

Further, the loans to total assets ratio results are little changed when the model is estimated using random effects. Credit risk is positively related while total risk is negatively related to loans to total assets. Considering that our sample to is dominated by commercial banks this result suggests that deregulation and increased involvement in non-interest generating activity may have helped them to be less aggressive in the credit market, resulting in reduced total risk. Both systematic risk and idiosyncratic risk measures are negatively related to loans to total assets but the coefficients are insignificant.

We also find that large banks have higher systematic risk, total risk and idiosyncratic risk (Stiroh 2006) and lower credit risk. This outcome is consistent with the results reported in section 4.1. The result is significant at 5% significance level or better. The result is consistent with the pooled OLS results.

Finally, the economic freedom index (EFI) is negatively related to bank credit risk and systematic risk and significant at 5% significance level. This is consistent with the results reported in section 4.1. However, we find a positive association with interest rate risk and economic freedom index when using random effects modeling. We are unable to explain the change in sign of this variable.

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The random effects model does not include year dummies and hence has been compared with the pooled OLS without year dummies. The Lagrange multiplier test indicates random effects model is favored to pooled OLS. Hence we do not report the results for the pooled OLS.
We also report the results for the fixed effects model in panel B of table 5. The results are similar to the pooled-OLS and random effects model for variables such as uninsured deposits, off-balance sheet activities, bank capital and bank capital squared. One point of difference is that we observe the economic freedom index is positively related to bank total risk and idiosyncratic risk. This result is contrary to our pooled-OLS estimation method.

In summary, the regression results reported in section 4.1 and 4.2 yields plausible results with regard to bank specific and country specific drivers of bank risk measures. The results show that bank charter value has a disciplining effect with respect to bank credit risk while we find that the growth opportunity effect of bank charter value is reflected in bank equity risk measures. The results are also consistent with the notion that off-balance sheet items can generate high bank risks. Moreover, the market discipline is unable to reduce the bank total risk and idiosyncratic risk. This may be due to the presence of deposit insurance, which requires further analysis. However, there is evidence that market discipline can reduce bank systematic risk. There appears to be a non linear relationship between bank capital and bank risks. Furthermore, large banks show higher total systematic and idiosyncratic risk and lower credit risk. Finally, economic freedom index is negatively associated with bank risk with some variation across the estimation methods.

### 4.3 Effects of additional risk factors

Though not reported separately we also fit the extended model to our data using both pooled-OLS (with year dummies) and random effects models. We only discuss the results of the additional variables as the results for the base variables remain basically unchanged. Our results show that dividend yield has a negative coefficient for bank total risk, interest rate risk and idiosyncratic risk (Lee and Brewer 1986). However, the result is significant only for bank total risk and idiosyncratic risk under the random effects model. We find a positive relationship between dividend yield and systematic risk under

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21 Due to large number of dummy variables at individual bank level and country level, we do not expect to generate a reliable result on only 84 banks. We simply report the results based on the LM test which indicates that fixed effects is preferred to pooled OLS and Hausman test which indicates that fixed effects is favored to random effects.

22 The pooled OLS includes the year dummies. The results are available upon request. The random effects is the preferred model to pooled OLS (with out year dummies) when an LM test is applied. The natural alternative specification would be fixed effects which is not feasible due to inclusion of several time invariant variables such as the legal origin, creditor right and anti-director rights.
the pooled-OLS method. This result may reflect uncertainty about the bank’s future income. The results are statistically significant at 5% level or better. We find operating leverage have a negative effect on bank systematic risk and interest rate risk. This is an unexpected outcome given the work of Saunders, Travlos and Strock (1990) and Galloway, Lee and Roden (1997). However, we do find a positive relationship between credit risk and operating leverage (Mandelker and Rhee 1984). These statistically significant results are only observed under the pooled-OLS method.

Furthermore, we find that common-law country banks have higher credit risk, systematic risk and total risk than the civil-law country banks. It is also evident from our analysis that euro-zone country banks show higher total risk, interest rate risk and idiosyncratic risk compared with the non-euro-zone European country banks. However, we find that credit risk and systematic risk is lower for euro-zone countries. All results are statistically significant at 5% level or better. Enforcement of laws such as creditor rights and anti-director rights seem to be important in explaining the variation in bank systematic risk, which is lower where these rights are strictly enforced. However, other risk measures also show a negative association with creditor rights (Nier and Baumann 2006). We find a positive association with anti-director rights and bank risk, which supports our hypothesis (La Port et al 1998).

In sum, the regression result of the extended model identifies some important variables that affect bank risk measures. Dividend yield and operating leverage show a negative association with risk measures. Moreover, euro-zone countries show higher total and idiosyncratic risk but lower systematic risk. These results are mainly observed under pooled-OLS method. Further, we find some contradictory results for creditor rights index and bank total risk and idiosyncratic risk. However, the antidirector rights variable is positively related to bank total and idiosyncratic risk.

4.4 Impact of EMU on risk: a test for stability of the model

We also test for the impact of EMU on the variation in bank risk. The changes in the explanatory variables are jointly significant for all risk measures except for total risk and idiosyncratic risk suggesting that EMU may have had an important impact on credit risk, total risk and systematic risk for our sample of banks. Our results show that charter value has fallen dramatically for all risk measures under both pooled- OLS and panel
techniques with EMU. This outcome may be interpreted in terms of the decline in the importance of charter value with the formation of EMU. Further, we find that the importance of off-balance sheet activities has decreased for credit risk though it has increased for interest rate risk. For remainder of the risk measures we do not find statistically significant results. There is also an increase in importance of off-balance sheet activities for systematic risk but the results are insignificant. The size variable has increased in importance after 1999 for all risk measures while remaining statistically insignificant.

5. Robustness

In our robustness analysis, first, we conduct a cross-sectional analysis year by year basis. The results confirm some of the evidence as reported in section 4. Second, we re-run the models excluding the 40 Danish banks. Our result remains unchanged for the base model (equation 1) and the extended model (equation 2).

6. Conclusion

In this study we analyze the determinants of bank equity risk and operational risk measures. Our sample consists of 84 listed financial institutions across 15 European countries from the period 1996-2005. We regress five risk measures such as total risk, systematic risk, interest rate risk, idiosyncratic risk and credit risk on a number of bank-specific and country-specific variables. We primarily apply the pooled-OLS (with year dummies) method and also conduct panel analysis to control for bank heterogeneity.

Our empirical analysis identifies the key results as follows. Off-balance sheet activities are an important factor for all five risk measures. This result is consistent with our expectation and is robust to all specifications. Further, consistent with our expectation we find statistically significant bank subordinated debt and inter-bank deposits effects on bank systematic risk consistent with the existence of market discipline effect. Yet, we find weak evidence of market discipline on the rest of the risk measures. We also find that bank capital appears to be non-linearly related to bank risk. However, it is less observable under the random effects model.

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23 Results available upon request.
The other important factor is bank charter value. We find a negative and significant relationship with credit risk, which implies a discipline effect of charter value on bank operational risk. Yet, we find a positive relationship with charter value and all the other risk measures. This positive relationship is contrary to our expectations. One possible explanation may be that this reflects the growth opportunity implicit in charter value. Moreover, consistent with our hypothesis, size is positively related to bank systematic risk and negatively related to bank credit risk. However, contrary to our expectation, size is also positively related to bank total and idiosyncratic risk. This relationship may explain the diminishing effect of internal diversification benefits. Finally, we find euro-zone banks show higher total risk and idiosyncratic risk and lower systematic risk compared to non-euro-zone banks.

These results are important particularly to regulators, policy makers and investors. The regulators and policy makers may need to reassess the market disciplinary effect of subordinated debt and inter-bank deposits. Moreover, they should also note the impact of off-balance sheet activities on bank risk. The investors should be aware of the impact of off-balance sheet activities, as they make decisions based on the financial strength of the guarantor (bank) rather than the borrower’s credibility.

A possible extension of this paper is to examine the joint impact of bank discipline on market discipline to delineate whether uninsured deposits can be a substitute to bank capital. Another extension could be to compare the determinants of bank risk for euro-zone and non-euro-zone country banks.
References


Table 1 Sample composition
This table presents the sample composition of this study. The sample includes 84 listed bank shares from both euro-zone and non-euro-zone European countries. The study includes bank holding companies, commercial banks, savings banks and co-operatives from Belgium, Finland, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. However, the complete sample is dominated by commercial banks followed by savings, bank holding companies and cooperative. The total number of bank in euro-zone countries stand at 39 which includes 3 bank holding companies, 29 commercial banks, 0 cooperatives and 7 savings banks. The total number of banks in non-euro-zone European countries stands at 45 which comprises of 2 bank holding companies, 37 commercial banks, 1 co-operative and 5 savings bank. The non-euro-zone commercial bank sample is dominated by Danish banks.

<table>
<thead>
<tr>
<th>Country</th>
<th>Bank Holding Company</th>
<th>Commercial banks</th>
<th>Co-operatives</th>
<th>Savings bank</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro zone countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Finland</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>France</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Germany</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Greece</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Ireland</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Portugal</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Spain</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>29</td>
<td>0</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td>Non euro zone countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>0</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>Norway</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Sweden</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>37</td>
<td>1</td>
<td>5</td>
<td>45</td>
</tr>
</tbody>
</table>

Total number of listed shares for both Euro-zone and non-euro-zone countries

|                    | 5 | 66 | 1 | 12 | 84 |
Table 2 Definition of selected variables

This table represents the definition of choice of risk measures and factors that affect these risk measures. The variable column presents the dependent variables, explanatory variables and control variables used in the models. The dependent variables are the four alternate risk measures which are the total risk, systematic risk, interest rate risk, idiosyncratic risk and credit risk. The base or primary model of this study includes a number of explanatory variables that are uninsured deposits, charter value, bank capital and bank capital squared, off balance sheet activities, loan to total assets and control variables such as size and economic freedom index. The extended version of the base model adds a few more variables. This includes operating leverage, dividend yield, ownership dummy, legal origin dummy, geographical dummy, creditor rights index and anti-director rights index along with the above mentioned explanatory and control variables. The definition column represents the detailed description of the variables. The table presents the potential references for these variables and the source of data.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Reference</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest rate risk</td>
<td>estimated from equation 1</td>
<td>Konishi and Yasuda (2004)</td>
<td>Datastream</td>
</tr>
<tr>
<td>Systematic risk</td>
<td>estimated from equation 1</td>
<td>Konishi and Yasuda (2004)</td>
<td>Datastream</td>
</tr>
<tr>
<td>Idiosyncratic risk</td>
<td>variance of the residual from the two index model from equation 1</td>
<td>Konishi and Yasuda (2004)</td>
<td>Datastream</td>
</tr>
<tr>
<td>Credit risk</td>
<td>loan loss provision /total liabilities – ex-post realized risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bank-specific variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating leverage</td>
<td>fixed assets/total assets</td>
<td>Saunders, Stock and Travlos (1990), Galloway, Lee and Roden (1997).</td>
<td>Bankscope and Osiris</td>
</tr>
<tr>
<td>Dividend yield</td>
<td></td>
<td></td>
<td>Datastream</td>
</tr>
<tr>
<td>Uninsured deposits</td>
<td>(subordinated debt + inter-bank deposits)/total liabilities</td>
<td>Nier and Baumann (2004)</td>
<td>Bankscope and Osiris</td>
</tr>
<tr>
<td>Bank capital or financial leverage</td>
<td>capital/total assets</td>
<td>Saunders, Stock and Travlos (1990)</td>
<td>Bankscope and Osiris</td>
</tr>
<tr>
<td>Bank capital squared</td>
<td>(capital/total assets)$^2$</td>
<td>Calem and Rob (1999)</td>
<td>Bankscope and Osiris</td>
</tr>
<tr>
<td>Off-balance sheet items</td>
<td>This includes contingent liabilities, loan commitments, standby letters of credit, (acceptances, guarantees, documentary and commercial LCs, operating leasing commitments)</td>
<td>Angbazo (1997)</td>
<td>Bankscope and Osiris</td>
</tr>
<tr>
<td>Loans/total assets</td>
<td>Total loans/total assets</td>
<td></td>
<td>Bankscope and Osiris</td>
</tr>
<tr>
<td>Size</td>
<td>ln (total market value of equity)</td>
<td></td>
<td>Datastream</td>
</tr>
<tr>
<td><strong>Country specific variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic freedom index</td>
<td>We take the overall score for our analysis. The score includes: business freedom, trade freedom, fiscal freedom, freedom from government, monetary freedom, investment freedom, financial freedom, property rights, freedom from corruption and labor freedom.</td>
<td>Gonzalez (2004)</td>
<td>Heritage foundation, WBRS, Barth et al (2001)</td>
</tr>
<tr>
<td>Ownership dummy ($D_1$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legal origin ($D_2$)</td>
<td>The legal origin dummy. $D_2=1$ for common law countries or English origin countries and $D_2=0$ for civil law countries. Civil law countries are under either French civil law, German civil law or Scandinavian civil law.</td>
<td>La Porta, Lopez de Silanes, Shleifer and Vishny (1998), Gonzalez (2004).</td>
<td></td>
</tr>
<tr>
<td>EMU vs. Non EMU ($D_3$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-director rights ($D_5$)</td>
<td>Law protection for minority shareholders. The anti-director rights index ranges from 0 to 6.</td>
<td>La Porta et. al 1998, Gonzalez (2004).</td>
<td>Company law or commercial code</td>
</tr>
</tbody>
</table>
Table 3 Descriptive statistics of the bank specific and country level variables

This table presents the descriptive statistics and the correlation of the raw variables. The study uses the annual observations of the bank specific variables and time invariant variables for listed bank shares in euro-zone and non-euro-zone countries. The total number of observation across the sample is 840. Panel A presents the descriptive statistics of the bank specific and country specific variables. The dividend yield is the dividend per share divided by price per share, operating leverage is the fixed assets divided by total assets, uninsured deposits is the sum of subordinated debt and inter-bank deposits divided by total liabilities. The charter value is calculated as the sum of market value of equity and book value of liabilities divided by book value of total assets, the financial leverage/ bank capital is estimated as equity by total assets, bank capital squared is the quadratic estimate of bank capital, off balance sheet activities is the total off balance sheet activities by total assets, loan to total assets is the net loan divided by total assets. The macroeconomic variable such as the economic freedom index is the overall score estimated. The highest economic freedom index is observed in Ireland and the lowest observed in Greece. The other explanatory variable such as the ownership dummy and euro zone dummy are dichotomous variables. D=1 for commercial banks and 0 otherwise under ownership dummy and D=1 for euro zone countries and 0 otherwise under euro zone dummy. However, the legal origin dummy presents the common law countries versus the civil law countries. D=1 for common law countries or otherwise 0. The creditor rights index ranges from 1 to 4. The maximum observed in the United Kingdom and the minimum in France. The anti-director rights index ranges from 0 to 5. The maximum scale of 4 is observed in the United Kingdom and the minimum value of 0 is observed in France. (N = 840)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. dev</th>
<th>Min</th>
<th>Max</th>
<th>Skew</th>
<th>Kurt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dividend yield</td>
<td>3.00</td>
<td>1.97</td>
<td>0</td>
<td>13.16</td>
<td>1.43</td>
<td>3.37</td>
</tr>
<tr>
<td>Operating leverage</td>
<td>0.02</td>
<td>0.20</td>
<td>0.00</td>
<td>5.71</td>
<td>28.86</td>
<td>835.08</td>
</tr>
<tr>
<td>Uninsured deposits</td>
<td>0.16</td>
<td>0.14</td>
<td>0.00</td>
<td>0.97</td>
<td>2.53</td>
<td>10.56</td>
</tr>
<tr>
<td>Charter value</td>
<td>1.02</td>
<td>0.07</td>
<td>0.87</td>
<td>1.79</td>
<td>4.41</td>
<td>35.68</td>
</tr>
<tr>
<td>Bank capital</td>
<td>0.09</td>
<td>0.06</td>
<td>0.02</td>
<td>0.95</td>
<td>6.38</td>
<td>84.13</td>
</tr>
<tr>
<td>Bank capital squared</td>
<td>0.01</td>
<td>0.04</td>
<td>0.00</td>
<td>0.90</td>
<td>20.40</td>
<td>447.46</td>
</tr>
<tr>
<td>Off balance sheet activities</td>
<td>0.52</td>
<td>1.37</td>
<td>0.01</td>
<td>21.51</td>
<td>9.98</td>
<td>126.99</td>
</tr>
<tr>
<td>Loan to total assets</td>
<td>0.60</td>
<td>0.15</td>
<td>0.01</td>
<td>0.92</td>
<td>-0.65</td>
<td>0.85</td>
</tr>
<tr>
<td>Size</td>
<td>5.77</td>
<td>2.50</td>
<td>1.17</td>
<td>11.33</td>
<td>0.36</td>
<td>-0.91</td>
</tr>
<tr>
<td>Economic freedom index</td>
<td>68.65</td>
<td>5.77</td>
<td>55.60</td>
<td>82.40</td>
<td>0.00</td>
<td>-0.67</td>
</tr>
<tr>
<td>Ownership dummy</td>
<td>0.77</td>
<td>0.42</td>
<td>0</td>
<td>1</td>
<td>-1.31</td>
<td>-0.28</td>
</tr>
<tr>
<td>Legal origin dummy</td>
<td>3.04</td>
<td>1.03</td>
<td>0</td>
<td>1</td>
<td>-0.33</td>
<td>-1.51</td>
</tr>
<tr>
<td>Euro-zone dummy</td>
<td>0.46</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>0.14</td>
<td>-1.98</td>
</tr>
<tr>
<td>Creditor rights index</td>
<td>2.12</td>
<td>1.01</td>
<td>0</td>
<td>4</td>
<td>-0.59</td>
<td>-0.82</td>
</tr>
<tr>
<td>Anti-director rights index</td>
<td>2.35</td>
<td>0.96</td>
<td>0</td>
<td>5</td>
<td>0.57</td>
<td>0.03</td>
</tr>
</tbody>
</table>
This table represents the pooled-OLS regression results for bank characteristics. The following equation has been applied to generate the results.

\[
RISK_{t,j,i} = a_0 + \beta_1 UD_{t,j,i} + \beta_2 CV_{t,j,i-1} + \beta_3 BC_{t,j,i-1} + \beta_4 LTA_{t,j,i} + \beta_5 OBS_{t,j,i} + \beta_6 Size_{t,j,i-1} + \\
\gamma_{t,j,i} + \epsilon_{t,j,i}
\]  

(1)

*RISK* \(_{t,j,i}\) presents the bank equity risks and operational risk. The bank equity risks include systematic risk, idiosyncratic risk, interest rate risk and total risk for individual bank \(i\) in country \(j\) at period \(t\). All bank equity risks are measured using the two-index market model. The estimation techniques are provided in equation (3) and equation (4). With regards to bank interest rate risk we consider the absolute value of the interest rate risk as a proxy for risk. Further, the operational risk includes the credit risk which is measured using 

\(CR_{t,j,i} = LLP_{t,j,i} / TA_{t,j,i}\),

where; \(CR_{t,j,i}\) is the credit risk measure for bank \(i\) in country \(j\) in period \(t\); or the ex-post realized risk. 

\(LLP_{t,j,i}\) is the loan loss provision for bank \(i\) in country \(j\) in period \(t\); \(TA_{t,j,i}\) is the total assets of bank \(i\) in country \(j\) in period \(t\). 

The explanatory variables such as \(UD_{t,j,i}\) is the natural log of uninsured deposits for bank \(i\) in country \(j\) in period \(t\), \(CV_{t,j,i}\) is the natural log of market value of equity for bank \(i\) in country \(j\) in period \(t\); lagged one period. \(BC_{t,j,i}\) is the natural log of bank capital squared for bank \(i\) in country \(j\) lagged one period, \(OBS_{t,j,i}\) is the natural log of off-balance sheet activities for bank \(i\) in country \(j\) at period \(t\); \(LTA_{t,j,i}\) is the loan to total assets for bank \(i\) in country \(j\) at period \(t\); is the economic freedom index for country \(j\) at period \(t\). Finally, \(\epsilon_{t,j,i}\) is the random error term. The joint F-test for the year dummies are statistically significant for all risk measures. All results are corrected for heteroscedasticity. The standard errors are reported in parentheses.

***significant at 1% significance level, **significant at 5% significance level, *significant at 10% significance level.  (N=840)

### Panel A: Pooled OLS analysis

<table>
<thead>
<tr>
<th>Credit risk</th>
<th>Systematic risk</th>
<th>Total risk</th>
<th>Interest rate risk</th>
<th>Idiosyncratic risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.019***</td>
<td>0.746***</td>
<td>-5.990***</td>
<td>370***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.206)</td>
<td>(0.615)</td>
<td>(0.117)</td>
</tr>
<tr>
<td>Uninsured</td>
<td>0.001***</td>
<td>-0.050***</td>
<td>0.009</td>
<td>-0.008</td>
</tr>
<tr>
<td>deposits</td>
<td>(0.000)</td>
<td>(0.014)</td>
<td>(0.042)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Charter value</td>
<td>-0.007**</td>
<td>0.505**</td>
<td>3.691***</td>
<td>0.204</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.208)</td>
<td>(0.610)</td>
<td>(0.173)</td>
</tr>
<tr>
<td>Bank capital</td>
<td>-0.000</td>
<td>-0.131**</td>
<td>-0.097</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.059)</td>
<td>(0.146)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Bank capital</td>
<td>0.001***</td>
<td>0.086**</td>
<td>-0.166*</td>
<td>-0.033</td>
</tr>
<tr>
<td>squared</td>
<td>(0.000)</td>
<td>(0.036)</td>
<td>(0.092)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Off balance sheet</td>
<td>0.000***</td>
<td>0.050***</td>
<td>0.106***</td>
<td>0.001</td>
</tr>
<tr>
<td>activities</td>
<td>(0.000)</td>
<td>(0.012)</td>
<td>(0.030)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Loan to total</td>
<td>0.003***</td>
<td>-0.218***</td>
<td>-0.588**</td>
<td>0.025</td>
</tr>
<tr>
<td>assets</td>
<td>(0.001)</td>
<td>(0.073)</td>
<td>(0.246)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Size</td>
<td>-0.000***</td>
<td>0.149***</td>
<td>0.087***</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.008)</td>
<td>(0.028)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Economic freedom index</td>
<td>-0.000*</td>
<td>-0.013***</td>
<td>-0.041***</td>
<td>-0.006***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.003)</td>
<td>(0.007)</td>
<td>(0.002)</td>
</tr>
</tbody>
</table>

Adj R² 0.20, 0.57, 0.30, 0.07, 0.17


Breusch Pagan χ² 558.70, 257.32, 103.87, 356.60, 100.44

Joint F-test 2.48, 7.61, 6.91, 1.89, 5.32
Table 5 Comparison of bank risk measures using Panel techniques

This table represents the results when panel techniques are applied to determine the relationship between bank risk and bank characteristics. The following equation has been applied to generate the results.

\[
RISK_{ijt} = \alpha + \beta_1 UD_{ij,t} + \beta_2 CV_{ij,t-1} + \beta_3 BC_{ij,t-1} + \beta_4 OBS_{ij,t} + \beta_5 LTA_{ij,t} + \beta_6 Size_{ij,t-2} + \gamma \cdot EFI_{ij,t} + \epsilon_{ij,t}
\]

(1)

\(RISK_{ijt}\) represents the bank equity risks and operational risk. The bank equity risks include systematic risk, idiosyncratic risk, interest rate risk and total risk for individual bank \(i\) in country \(j\) at period \(t\). All bank equity risks are measured using the two index market model. The estimation techniques are provided in equation (3) and equation (4). With regards to bank interest rate risk we consider the absolute value of the interest rate risk as a proxy for risk. Further, the operational risk includes the credit risk which is measured using

\(CR_{ij,t} = LLP_{ij,t}/TA_{ij,t}\)

where; \(CR_{ij,t}\) is the credit risk measure for bank \(i\) in country \(j\) at period \(t\); or the ex-post realized risk. \(LLP_{ij,t}\) is the loan loss provision for bank \(i\) in country \(j\) in period \(t\); \(TA_{ij,t}\) is the total assets of bank \(i\) in country \(j\) in period \(t\). The explanatory variables such as \(UD_{ij,t}\) is the natural log of uninsured deposits for bank \(i\) in country \(j\) lagged one period. \(BC_{ij,t}\) is the natural log of bank capital for bank \(i\) in country \(j\) lagged one period, \(OBS_{ij,t}\) is the natural log of off-balance sheet activities for bank \(i\) in country \(j\) at period \(t\); \(LTA_{ij,t}\) is the loan to total assets for bank \(i\) in country \(j\) at period \(t\); \(Size_{ij,t}\) is the natural log of market value of equity for bank \(i\) in country \(j\), lagged one period and \(EFI_{ij,t}\) is the economic freedom index for country \(j\) at period \(t\). Finally, \(\epsilon_{ij,t}\) is the random error term. Panel A and Panel B presents the results under the random effects and fixed effects respectively. Although fixed effects is preferred to the random effects based on the Hausman test we also report the results for random effects as random effects is preferred to the pooled OLS model based on the Lagrange Multiplier test. All results are corrected for heteroscedasticity. The standard errors are reported in parenthesis. \*** significant at 1% significance level, \** significant at 5% significance level, \* significant at 10% significance level. (N=840)

### Panel A: Random effects analysis

<table>
<thead>
<tr>
<th>Credit risk</th>
<th>Systematic risk</th>
<th>Total risk</th>
<th>Interest rate risk</th>
<th>Idiosyncratic risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.017***</td>
<td>0.414*</td>
<td>-7.708***</td>
<td>-0.205</td>
</tr>
<tr>
<td>Uninsured deposits</td>
<td>0.000</td>
<td>-0.045***</td>
<td>0.023</td>
<td>0.006</td>
</tr>
<tr>
<td>Charter value</td>
<td>-0.011***</td>
<td>-0.161</td>
<td>2.035***</td>
<td>-0.117</td>
</tr>
<tr>
<td>Bank capital</td>
<td>-0.000</td>
<td>-0.225***</td>
<td>-0.283</td>
<td>0.057</td>
</tr>
<tr>
<td>Bank capital squared</td>
<td>0.001***</td>
<td>0.096**</td>
<td>0.078</td>
<td>-0.022</td>
</tr>
<tr>
<td>Off balance sheet activities</td>
<td>0.000***</td>
<td>0.045***</td>
<td>0.100***</td>
<td>-0.009</td>
</tr>
<tr>
<td>Loan to total assets</td>
<td>0.003***</td>
<td>-0.081</td>
<td>-0.626*</td>
<td>0.031</td>
</tr>
<tr>
<td>Size</td>
<td>-0.000***</td>
<td>0.119***</td>
<td>0.142***</td>
<td>-0.005</td>
</tr>
<tr>
<td>Economic freedom index</td>
<td>-0.000**</td>
<td>-0.011***</td>
<td>-0.003</td>
<td>0.003**</td>
</tr>
<tr>
<td>Lagrange Multiplier test</td>
<td>58.92 (prob.&lt;0.00)</td>
<td>375.42 (prob.&lt;0.00)</td>
<td>355.04 (prob.&lt;0.00)</td>
<td>32.22 (prob.&lt;0.00)</td>
</tr>
</tbody>
</table>
### Panel B: Fixed effects analysis

<table>
<thead>
<tr>
<th></th>
<th>Credit risk</th>
<th>Systematic risk</th>
<th>Total risk</th>
<th>Interest rate risk</th>
<th>Idiosyncratic risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsured deposits</td>
<td>-0.000</td>
<td>-0.049***</td>
<td>0.014</td>
<td>-0.008</td>
<td>0.067</td>
</tr>
<tr>
<td>Charter value</td>
<td>-0.012***</td>
<td>-0.018</td>
<td>1.583**</td>
<td>-0.023</td>
<td>0.975</td>
</tr>
<tr>
<td>Bank capital</td>
<td>-0.000</td>
<td>-0.199*</td>
<td>-0.443*</td>
<td>-0.209***</td>
<td>-0.308</td>
</tr>
<tr>
<td>Bank capital squared</td>
<td>0.001</td>
<td>0.120**</td>
<td>0.292**</td>
<td>0.120***</td>
<td>0.225</td>
</tr>
<tr>
<td>Off balance sheet</td>
<td>0.000*</td>
<td>0.035*</td>
<td>0.062</td>
<td>0.017*</td>
<td>0.036</td>
</tr>
<tr>
<td>Loan to total assets</td>
<td>0.005***</td>
<td>0.382**</td>
<td>-0.067</td>
<td>0.072</td>
<td>0.046</td>
</tr>
<tr>
<td>Size</td>
<td>-0.001*</td>
<td>0.007</td>
<td>0.038</td>
<td>0.020</td>
<td>0.011</td>
</tr>
<tr>
<td>Economic freedom index</td>
<td>-0.000</td>
<td>0.002</td>
<td>0.038***</td>
<td>-0.003</td>
<td>0.036***</td>
</tr>
</tbody>
</table>

| Adj.R²                  | 0.31        | 0.73            | 0.54       | 0.21               | 0.43              |

| Model test             | F[91,748]=5.11 | F[91,748]=25.40 | F[91,748]=11.70 | F[91,748]=3.52 | F[91,748]=8.05 |
| Hausman test           | 16.32 (prob=0.04) | 74.79 (prob=0.00) | 46.50 (prob=0.000) | 32.22 (prob=0.00) | 43.52 (prob=0.000) |
| Lagrange Multiplier test | 58.92 (prob=0.000) | 375.42 (prob=0.00) | 355.04 (prob=0.000) | 32.22 (prob=0.00) | 305.55 (prob=0.000) |