The impact of Risk, Fees, Corporate Governance and Unconventional Monetary Policy on Investment Bank Performance.

Theodora Bermpei

Thesis submitted for the Degree of Doctor of Philosophy

April, 2016

Department of Finance

University of Sussex

WORK NOT SUBMITTED ELSEWHERE FOR EXAMINATION

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature:……………………………………………………….

UNIVERSITY OF SUSSEX

THEODORA BERMPEI

DEGREE OF DOCTOR OF PHILOSOPHY

The impact of Risk, Fees, Corporate Governance and Unconventional Monetary Policy on Investment Bank Performance.

SUMMARY

This thesis examines the effect of bank-specific variables on investment bank performance, as estimated by efficiency and financial indicators, in the G7 and Switzerland countries, over the 1997-2012 period. Moreover, we investigate the impact of expansionary monetary policies on the risk-taking of investment banks between 2007 and 2014.

Firstly, we investigate the impact of risk, liquidity and fee-based income on cost efficiency prior to and during the crisis. Then, we examine the presence of possible threshold effects of bank-specific variables on performance (cost efficiency). Moreover, we investigate whether there is difference between the impact of liquidity on the performance of stand-alone investment banks and on investment banks that belong to a larger banking entity. Secondly, we assess the impact of corporate governance on the performance (profitability and profit efficiency) of the US investment banks. We focus on five different categories of governance measures: i) board structure, ii) executive compensation, iii) ownership, iv) CEO power and v) operational complexity. We put emphasis on the impact of board size and board ownership on performance by examining for threshold effects of these variables.

Thirdly, we examine the impact of M&A advisory fees on bank performance, as estimated by technical inefficiency, using a methodology that includes as an undesirable output the bank-individual level of risk. Then we test the level of convergence in terms of M&A advisory fees and technical inefficiency of investment banks in the G7 and Switzerland prior to (1997-2007) during (2007-2010) and after the financial crisis (2010-2012).

Fourthly, we study the effect of unconventional monetary policies (UMPs) on the risk-taking of investment banks in the US over the 2007-2014 period. We employ a number of alternative proxies that capture both directly UMPs: i) central bank's assets over gross domestic product ratio ii) monetary aggregates iii) Taylor gap; and indirectly through the usage of low-interest rates: i) federal fund rate and ii) shadow short rate.

Finally, we provide conclusions together with limitations of this research and a plan for a future work.

Acknowledgements

This thesis would not have been possible without the tremendous support of a number of people. First and foremost, I would like to express my honest gratitude to my supervisor and advisor, Professor Emmanuel Mamatzakis, for his continuous interest and guidance on my research, his encouragement and for the endless time he dedicated supporting me.

I also wish to thank Dr. Jory Surendranath for giving me initially the opportunity to pursue a career in the UK.

Last but not least, I am grateful to my parents, Sotiris and Dimitra, and my brothers, Giannis and Kostas, for all their genuine love and encouragement.

Table of Contents

Chapter 1: Introduction

This thesis examines the effect of bank-specific characteristics on investment bank performance, as proxied by efficiency and accounting-based indicators, in the G7 and Switzerland countries over the 1997-2012 period. Moreover, we examine the impact of unconventional monetary policies on investment bank risk during the 2007-2014 period, when major economies have implemented numerous expansionary monetary policies aiming to boost the economic growth and wither the crisis. This section is an introductory one and will briefly show why it is important to examine the determinants of the performance of investment banks in the G7 and Switzerland and also why we focus on both the micro-level and macro-level, i.e., monetary characteristics, which can have a significant impact on the performance of these financial institutions.[1]

A well-functioning and developed financial market in an economy can contribute positively to the general economic growth and development. There are several ways that financial markets can promote growth enhancement: i) The accumulation and transmission of invaluable information to investors that in turn can have a beneficial effect on firm financing and performance (Allen and Gale, 1999), ii) The increase of motives to research companies as it is easier to earn profits from this type of information than by having operations in large markets (Holmstrom and Tirole, 1993), iii) The enhancement of corporate governance mechanism by easing acquisitions (Jensen and Murphy, 1990), iv) The facilitation of trading and managing the risk

[1]In some detail, two empirical chapters of this thesis focus exclusively on the US investment banks due to data availability issues.

(Levine, 1991). Based on these and given the fact that most of the functions described above are conducted by investment banks, a well-developed financial market can facilitate investment banking activities that in turn can influence the economic growth. Moreover, as investment banks among other financial institutions carry out such important activities it is natural to expect that when these financial institutions underperform the impact on the real economy can be severely negative as the recent financial crisis has verified. This is evident particularly in the case of Lehman Brothers that filed for bankruptcy in 2008, while a number of firms connected and non-connected to this bank underperformed as well. A study by Chakrabarty and Zhang (2012) shows that the underperformance of investment banking sector can impact negatively the performance of both business related and unrelated companies and consequently this can have a detrimental effect on the entire economy. In particular, Chakrabarty and Zhang (2012) show that firms that had business relationships with Lehman Brothers faced severe consequences as they were exposed *'directly'* to credit losses in line with the *'counterparty risk'* hypothesis. Based on this hypothesis a failure of a company can cause negative effects on the performance of the firms in the same industry through the channel of credit contagion (Davis and Lo, 2001; Jorion and Zhang, 2009). This, in turn, can have detrimental effects on the industry as a whole and can also lead to contagion effects across industries that are connected. Investment banks offer their financial services to a number of companies from different industries. Therefore, consecutive failures of investment banks could, in turn, lead to the underperformance of a number of companies from different industries that would consequently affect negatively the economy as a whole. In support of this argument, Fernando et al. (2012) show that companies that had as their main underwriter Lehman Brothers experienced an important reduction in their returns and, therefore, suffered great output losses. In addition, Chakrabarty and Zhang (2012) show that the poor performance of Lehman Brothers can affect *'indirectly'* companies that do not have business linkages with the failed investment bank and one would expect that are not exposed to thus are less exposed to adverse consequences as they do not have a direct business relationship. However, Chakrabarty and Zhang (2012) found that these companies are also exposed to negative effects of the financial crisis through the large dispersion in views among investors that created abnormal trading behaviour, consistent with the *'information transmission'* hypothesis. The idea that lies behind this concept is that the information of a surprise default of a company is shared across firms and, therefore, this information can lead a number of unrelated companies to the failed firm to behave abnormally with regards to their trading performance (Collin-Dufresne et al., 2010). Another issue that highlights the importance of the investment banking industry is that in the most sophisticated economies including among others, G7 and Switzerland countries, investment banking activities capture a particularly important amount of revenues of the total banking industry profits. These economies have been significantly integrated with global financial markets over the last two decades. There is empirical evidence to support that economies that are more financially integrated suffered extensively over the period of the latest financial crisis (Claessens et al., 2010; Cetorelli and Goldberg, 2011). Hence, it is natural to expect that in countries, such as the G7 and Switzerland, where financial markets have been expanded hugely both in the home country and cross-border level, the performance of investment banking sector has played and continues to play an important role in the general economic growth. Driving forces of the expansion of investment banking activities in the developed countries could be summarized in what it follows as described by Morrison and Wilhelm Jr (2007) and

Liaw (2006): i) The increase of the real per capita income and prosperity has raised the need for higher quality of financial services as being offered by the investment banks, ii) The rise of the number of cross-border mergers and acquisitions in the industrialised countries in which investment banks have played the advisory role, iii) The high level of financial deregulation resulted in a rapid growth of the investment banking industry in the developed countries before the burst of the financial crisis in 2007. Recent regulatory mandates have changed the framework that investment banks operate as banks are not allowed to perform both commercial and investment banking activities.

The choice of developing and focusing this thesis on the factors that affect the performance of the investment banking industry in the G7 and Switzerland countries is thus appropriate. The investment banking industry for these economies is of utmost important as a number of new financial products have become a part of investment banking due to market expansion, financial globalization and environmental conditions, i.e. regulatory and technological framework (Gardener and Molyneux, 1995). The development of investment banking activities in these countries has been encouraged by their well-developed and integrated financial systems that are principally characterised as financial market-based rather than bank-based systems.[2]There is evidence suggesting that not only countries such as the United States (US) and the United Kingdom (UK) have market-based systems but also for European continental countries such as France and Germany the financial market-based system is more relevant than in the past (Allen and Gale, 2000; Hölzl, 2006).

[2]As Demirguc-Kunt and Levine (2001) pg 81 argue the distinction between the bank-based and the market-based systems is described as: *'In bank-based financial systems such as Germany and Japan, banks play a leading role in mobilizing savings, allocating capital, overseeing the investment decisions of corporate managers, and providing risk management vehicles. In market-based financial systems such as England and the US securities markets share centre stage with banks in terms of getting society's savings to firms, exerting corporate control, and easing risk management.'*

Similarly, as claimed by Bruno et al. (2012) pg.1-2: '…*financial structures have converged towards a model which combines elements of the Anglo-Saxon model, where markets and investment banks prevail, with characteristics of the continental European systems, where commercial banks are predominant.'* as argued by Bruno et al. (2012, p.1-2). Secondly, the latest financial crisis has started from the investment banking sector as prominent investment banks filed for bankruptcy, i.e. such as Lehman Brothers, others have asked for financial support to the Federal Deposit Insurance Coverage (FDIC), while others have been acquired or merged with other financial institutions. Since financial crisis has been initiated from the investment banking sector and given that the economic slowdown is still apparent and continues to destabilizes the real economy, the investigation of the determinants of the performance of the investment banking industry is of great importance.

The main focus of this thesis is on the micro-level determinants that affect investment bank performance. We put emphasis on risk, liquidity, fee-based income and corporate governance variables and their impact on investment bank performance. The main reason that drives our interest in these factors is the limited existing literature on the determinants of investment bank performance as well as the lack of any empirical study that includes the financial crisis period. This thesis gives particular attention on factors that can affect significantly the survival and well-functioning of the investment banking industry that is of great importance especially in the wake of the latest financial crisis. Moreover, investment banks are financial institutions that differ fundamentally from other more conventional type of banks, such as commercial and savings. Hence, a comprehensive investigation of the determinants of investment bank performance would give emphasis on the distinctive characteristics of these financial institutions, such as their concentration on fee-based operations that is linked with high earnings volatility (Demirguc-Kunt and Huizinga, 2010; Stiroh, 2004) and the fact that they lack of a deposit base that in turn would increase their risk exposure in case of a financial crisis (Gatev et al., 2009; Gatev and Strahan, 2006). The first contribution of this thesis then is to analyse the impact of various factors on the investment banking performance including a period of a great economic slowdown.

There is also an angle of finance that has not been covered and adequately studied in the extant literature regarding its effect on investment bank performance, named as corporate governance. Due to the financial crisis, the corporate governance of financial institutions has gained much of research attention (Erkens et al., 2012; Beltratti and Stulz, 2012; Pathan and Faff, 2013; Vallascas and Hagendorff, 2013), while there has been a growing view that governance of financial institutions has played a detrimental role in terms of their performance (Kirkpatrick, 2009). Therefore, an investigation of the corporate governance factors that drive the investment bank performance over a period of a huge recession is of utmost importance. Corporate governance and its impact on the investment bank performance has been examined through a number of different measures that capture both board characteristics, executive compensation and ownership variables. We also investigate the impact of the operational environment that is related to the business complexity of the investment banking industry. The second contribution of this thesis then is that it investigates the effect of different types of corporate governance variables on investment bank performance.

Furthermore, monetary policy is critical to central bank’s policy making as the introduction of effective strategies would foster economic growth and affect considerably stability of financial institutions. In response to the financial crisis, the Federal Reserve Bank (Fed) in the US has initiated a number of unconventional monetary policies (UMPs). To this end, it is appropriate to examine if and in which way UMPs could impact the soundness of investment banks. Moreover, while there is a large volume of existing literature that looks at the impact of unconventional monetary policies (UMPs) on the risk-taking of investment banks (Dell'Ariccia et al., 2010, 2012, 2013; Delis et al., 2011; Buch et al., 2014; Fungacova et al., 2014), there is no research paper that focuses on the relationship between UMPs and risk of investment banks. However, according to Adrian and Shin (2009), investment banks' involvement in the US large-scale asset purchases (LSAPs) over the 2008-2013 period as broker-dealers, highlights the importance of these financial institutions when one examines the impact of UMPs on the risk-taking of financial institutions and the economy as a whole. This is particularly apparent in the US, where the position of investment banks has been increased particularly due to the rise of non-traditional banking operations such as securitization and underwriting. Moreover, Maddaloni and Peydro (2010) claim that over prolonged periods of low-interest rates that UMPs might be implemented there is an increase of broker-dealers' activities signifying that monetary policies affect significantly the level of operations of these financial institutions. Thus, an investigation of UMPs on the risk-taking of investment banks is of particular importance and could provide interesting conclusions to both bankers and regulators. We investigate the effect of UMPs on risk taking of the US investment banks through various measures, such as central bank assets and other monetary aggregates that capture expansionary monetary policies. Therefore, the third contribution of this thesis is that explores the impact of UMPs on the risk-taking of the US investment banks.

Also, from a methodological point of view, this thesis opts, among others, for a parametric methodology, the dynamic threshold methodology as recently developed by (Kremer et al., 2013). This methodology enables the data employed in this thesis to show when the financial crisis took place and that is its main advantage in comparison to the other methods used, i.e., a crisis dummy over 2007-2009 or 2008-2010, that attempt to capture arbitrarily the period of the recent economic recession. This econometric technique provides invaluable information with regards to the period prior and during the crisis and investigates the presence of possible threshold-effects of major bank determinants with respect to bank performance. The usage of the dynamic panel threshold methodology is substantial as this thesis covers a wide range of time including both tranquil and turbulent periods. The dynamic threshold analysis enables us to investigate this change of the economic conditions through changes in the number of investment banks that belong to each threshold regime, signifying important changes in the fundamental structure of investment banks before and after the financial turmoil. The fourth contribution of this thesis then is that it examines the determinants of investment bank performance through the application of a quite novel and recent methodology that allows making important implications in terms of key determinants of investment bank performance.

Finally, it is essential to employ the most appropriate measure of bank performance. In this thesis, we use cost efficiency in Chapter 2, profit efficiency and financial indicators in Chapter 3 and technical efficiency in Chapter 4. There has been an extensive amount of banking literature that investigates bank performance by employing the frontier efficiency estimations (Lozano-Vivas and Pasiouras, 2010; Fiordelisi and Molyneux, 2010; Cyree and Spurlin, 2012; Servin et al., 2012; Gaganis and Pasiouras, 2013; Kalyvas and Mamatzakis, 2014; Goddard et al., 2014; Glass et al., 2014). A number of these studies employ cost efficiency (Goddard et al., 2014; Kalyvas and Mamatzakis, 2014), others profit (Cyree and Spurlin, 2012; Gaganis and Pasiouras, 2013) and some of them use as bank performance measure technical efficiency (Servin et al., 2012; Glass et al., 2014). In a nutshell, frontier efficiency estimates evaluate the performance of a decision-making unit (DMU), for example banks, in relative terms with the best performers (DMUs) of a particular industry. The usage of cost efficiency, in Chapter 2, is based on the grounds that risk-related variables are linked particularly with the cost performance of banks and hence would enable us to capture adequately the relationships between the variables of our interest and bank performance measure. With regards to the bank performance measures employed in Chapter 3 of this thesis, we opt for frontier efficiency estimation, as estimated by profit efficiency, so as to investigate the impact of corporate governance-related factors on bank performance. We choose to employ profit efficiency and profitability ratios, instead of cost-function, as corporate governance is a set of internal mechanisms that aim to maximize the value of a bank that is the more accepted economic goal of a firm (Berger and Mester, 1999; Denis et al., 2001). In Chapter 4, we use the enhanced hyperbolic distance function to estimate technical inefficiency as further developed by Cuesta et al. (2009). This efficiency estimation shows if a bank uses the minimum quantity of inputs to produce a given quantity of outputs. The reason that we opt for this methodology is that it allows the inclusion of an undesirable output, as proxied by bank-specific risk, in the translog function. This is of utmost value since investment banks are financial institutions that are involved primarily in highly risky and complex activities (Demirguc-Kunt and Huizinga, 2010).

This thesis is structured into six chapters. The following chapter, Chapter 2, investigates the impact of risk, liquidity and fee-based income on investment bank performance for the G7 and Switzerland countries prior to and during the crisis (1997-2010). Financial data are sourced from IBCA-Bankscope and used in the form of input prices, outputs and netputs to estimate cost efficiency scores employing a stochastic frontier analysis (SFA) that has been broadly used in banking literature (Lozano-Vivas and Pasiouras, 2010; Fiordelisi and Molyneux, 2010; Cyree and Spurlin, 2012; Servin et al., 2012; Gaganis and Pasiouras, 2013; Kalyvas and Mamatzakis, 2014; Goddard et al., 2014; Glass et al., 2014). In a second stage analysis, we use these efficiency scores in fixed panel models, dynamic panel models and dynamic panel threshold analysis to evaluate the impact of risk, liquidity and non-interest income on cost efficiency scores regarding the economies under study. Dynamic threshold methodology enables us to investigate the presence of possible threshold-effects of the three main variables of our interest (risk, liquidity and fee-based income) in terms of cost efficiency during a period that includes the latest financial crisis. Finally, in a further analysis we also split our sample in investment banks that are part of a parent company, from which they can withdraw liquidity in case of a financial shock, and those that are stand-alone investment banks.

The next chapter, Chapter 3, provides a comprehensive empirical analysis of the effect of corporate governance on the performance of the US investment banks over the 2000-2012 period. Financial data for investment banks are derived from Thomson Financial Banker and IBCA-Bankscope, while corporate governance data are obtained from 10-K annual reports of SEC’s filings. These data are then used to estimate profit efficiency as well as accounting-based used that are employed as well as robustness tests. Our corporate governance dataset is unique and it is hand-collected from DEF 14A proxy statements of annual meetings found in the SECs EDGAR filings. In similar lines with Chapter 2, in a second stage analysis we regress profit efficiency scores and financial indicators over a plethora corporate governance variables. The corporate governance dataset could be categorised in five different dimensions; i) board structure ii) CEO power iii) executive compensation iv) ownership of CEO and board members and v) operational complexity. We examine the impact of the above each category on investment bank performance through the usage of dynamic panel models. We also employ dynamic panel threshold methodology that enables us to investigate possible threshold-effects of key corporate governance variable over a period that includes both turbulent and tranquil times. In addition, the advantage of using this methodology in this chapter is to capture possible changes of the number of investment banks that fall within each regime that would imply transformations in the structure of corporate governance mechanisms of investment banks before and after the turmoil.

Chapter 4 focuses on the relationship between M&A advisory fees and bank performance for the G7 and Switzerland for the 1997-2012 period. For this chapter, we obtain financial data from IBCA-Bankscope and we then estimate technical efficiency by using a parametric methodology, named as the enhanced hyperbolic distance function (EHDF). This is a methodology that allows the inclusion of an undesirable output in the estimation of efficiency scores. We employ as the undesirable output bank-specific risk of investment banks in the G7 and Switzerland countries that is of particular importance for these type of institutions that are inherently riskier than the conventional type of institutions. In addition, M&A

advisory fees comprise the main source of income of investment banks and hence it becomes vital to examine their impact on performance as proxied by technical efficiency. We also employ dynamic panel vector autoregression (VAR) models to investigate further endogeneity issues between M&A fees and technical efficiency scores. The high level of financial integration and globalization in the first half of the 2000 decade resulted in a rapid development of the investment banking industry in the G7 and Switzerland (Morana, 2008). In addition, numerous deregulations that have taken place over the last two decades also contributed significantly to this growth of the investment banking industry. This strong growth of investment banking industry came to an abrupt end after the burst of the financial crisis. This economic slowdown had a negative effect on the banking integration process, declining in this way the convergence level among investment banks. Therefore, in a second stage analysis, we examine the level of convergence of investment banks in terms of both M&A advisory fees and technical efficiency in the period before (1997-2007), during (2007-2010) and after the financial crisis (2010-2012).

The following chapter, Chapter 5, provides an empirical investigation on the effect of UMPs on the risk-taking of the US investment banks over the 2007-2014 period. We collect financial data from various sources including primarily 10-K annual reports of SEC's filings and Bankscope database. Note, that we use quarterly data in order to capture the short-term effect of UMPs on investment bank risk-taking. Financial data are used to estimate the individual level of risk, z-score, for each investment bank and regress these scores over various measures of UMPs and other control bank-specific and country level variables using both fixed effect and dynamic panel models. The measures that we employ to capture directly the effect of UMPs are the followings; i) central bank assets over gross domestic product ii) monetary aggregates, i.e., M1 and M2 and iii) Taylor gap. We also use measures that capture indirectly the effect of UMPs, such as the federal fund rate and shadow rate. Over monetary expansionary periods the interest rates, i.e., federal fund rates, are close to zero suggesting that the implementation of UMPs could cause low-interest rates over prolonged periods.

Lastly, in Chapter 6 we provide a summary of the contributions of this thesis and present some final comments and policy implications. We also discuss limitations of this research and thoughts for future research.

Chapter 2: What drives investment bank performance? The role of risk, liquidity and fees prior to and during the crisis

2.1 Introduction

The liberalization and globalization processes resulted in a rapid development of the investment banking industry in all the industrialized countries before the burst of the financial crisis in 2007. Investment banks primarily engage in the issuance of equity or debt securities and in mergers and acquisitions (M&A) advisory services. In addition, investment banks' activities include trading, securities, and merchant banking and investment management services. The wide operational spectrum of the investment banking industry has significantly increased the importance of these financial institutions for the global financial system.

The high level of financial integration in the first half of the 2000 decade has led to a rapid growth of the investment banking sector, particularly in the G7 and Switzerland, (Tomljanovich and Ying 2005; Morana, 2008; Baglioni et al., 2013). Investment bank presence both in terms of a number of institutions and operations is centred in these countries (Kalemli-Ozcan, 2012; Thomson Reuters, 2012). The development of investment banking activities reached its peak in 2006, when the industry's total income in the G7 and Switzerland amounted to 80.67 (US$bn). In particular, investment banking earnings constituted 62% of total bank income in the US and 30% of the gross output of the UK economy in 2006 (Thomson Reuters, 2007; Burgess, 2011). However, this strong growth came to an abrupt end due to the financial crisis in 2007. The investment banking sector in the G7 and Switzerland experienced a considerable deceleration in activity as revenue dropped more than half from its highest point in 2006, reaching a total value of 39.07 (US$bn) in 2008. The industry as a whole has been profoundly reformed by the turmoil.[3] The crisis revealed that investment banking activities are highly complex and interconnected (Demirguc-Kunt and Huizinga, 2010; Adrian and Shin, 2010), particularly between the US and European investment banks (Eichengreen, 2012). As a consequence, the transmission of the US sub-prime mortgage meltdown led to a major recession in the G7 and Switzerland.

In response to the 2007 financial crisis, US regulators passed the Dodd-Frank Act (2010). This Act requires investment banks to have higher capital adequacy ratios as a 'buffer' against credit crunch. Moreover, it includes the 'Volcker Rule' that prohibits *'a banking entity to i) engage in proprietary trading; or ii) acquire or retain any equity, partnership, or other ownership interest in or sponsor a hedge fund or a private equity fund'* (Dodd-Frank Act, 2010). The Rule consequently aims to separate commercial banking from investment banking that is particularly comprised of proprietary trading. Moreover, the impact of the 'Volcker Rule' implementation is not limited within the US as it also applies to the US subsidiaries of foreign banks.[4]

[3]To mention but a few events, JPMorgan acquired Bear Stearns with the financial aid of the Federal Reserve Bank, Bank of America merged with Merrill Lynch, while another prominent investment bank, Lehman Brothers, filed for bankruptcy.

[4]The Rule has given rise to concerns due to its extraterritorial effect on the activity of the non-US banking institutions (Baxter, 2012). Despite the initial opposition of many countries to the formal application of the Rule, countries such as Germany and the UK acknowledge that regulatory amendments should be employed, aiming to rationalize banks' operations in both commercial and investment banking activities. In particular, the UK, France and Germany have been seriously considering the introduction of a regulatory reform similar to the 'Volcker Rule' (Liikanen, 2012; Vickers and Lagarde, 2013; Gambacorta and Van Rixtel, 2013). The widespread criticism of the Rule is further bolstered by the proposition that only US banks should have the right to trade US government bonds. Banks in counties such as Canada, Japan and the UK issue substantial levels of foreign sovereign debt and their exemption from the US government debt market could harm their financial markets.

Despite the importance of the investment banking for the G7 and Switzerland, existing research on investment bank performance determinants is limited, while there is no study that includes the years of the financial crisis. Radic et al. (2012) is the only study to focus exclusively on the performance of investment banks but they cover just the pre-crisis period (2001-2007). The authors estimate profit and cost functions with investment banking fees as output, concluding that insolvency risk has a positive effect on cost inefficiency. Earlier studies, such as those by Allen and Rai (1996) and Vander (2002), examine the performance of universal banks that include investment banking activities. In particular, Allen and Rai (1996) review the efficiency of universal banks compared with conventional banks using both parametric and non-parametric methods. They find that universal banks operate more efficiently than traditional banks. The results of Vander (2002) back this finding of Allen and Rai (1996). A later study by Beccalli (2004) focuses on the performance of non-bank investment firms that engage solely in investment banking activities. Beccalli (2004) performs a comparison study between the UK and Italian investment firms over the 1995 to 1998 period. The author finds that the UK investment firms are more efficient than Italian firms.

Against this background, an examination of the performance determinants of investment banks for a period that includes the financial crisis could be of interest to both bankers and regulators. In this chapter, we focus on fees, risk and liquidity as drivers of the performance of these institutions. We give emphasis to fees because investment banks, as opposed to conventional banks, engage primarily in non-interest income operations (Demirguc-Kunt and Huizinga, 2010). This concentration on fee-based operations could increase the risk of investment banks because of the high volatility of earnings stemming from non-interest income operations (Stiroh, 2004 Demirguc-Kunt and Huizinga, 2010). On the contrary, conventional banks can exploit risk diversification benefits (De-Young and Rice, 2004; Chiorazzo et al., 2008). Thus, investigating the impact of default risk on investment bank performance is of vital importance in the context of this study. In addition, investment banks carry higher liquidity risk than commercial banks, as the latter, in the case of a financial shock, can count on deposits (Gatev and Strahan, 2006; Gatev et al., 2009). Hence, the level of liquid assets availability could form another important contributing factor to the performance of investment banks, particularly at a period of high liquidity constraints.

This chapter contributes to the banking literature in several ways. Firstly, this is the only study on investment bank performance that covers a period (1997-2010) that includes the crisis years. To this end, we employ stochastic frontier analysis (SFA) to estimate cost efficiency as a measure of performance of investment banks in the G7 and Switzerland.[5] The next and main contribution of this study is the application of the dynamic panel threshold model by Kremer et al. (2013) in a second stage analysis. This methodology allows the investigation of the presence of threshold-effects of the variables of our main interest on cost performance, over a period of important structural changes for the investment banking industry. In particular, we investigate the existence of thresholds in three bank-specific variables: a) we use Z-Score to measure default risk, as investment bank activities are related to high-risk b) liquidity as a key factor that affects the performance of financial institutions. We account for

[5]Following previous studies (Hasan and Marton, 2003; Bonin et al., 2005; Pasiouras et al., 2009; Lozano-Vivas and Pasiouras, 2010), we estimate bank performance, as proxied by cost efficiency scores, using the stochastic frontier analysis (SFA). In the efficiency literature, the bank is considered to follow a production function that minimizes expenses given its input prices and output mix (Kumbhakar and Lovell, 2003). SFA is a parametric methodology that developed by Aigner et al. (1977) and suggests that the stochastic frontier constitutes two parts, namely inefficiency and error term.

the distinction between investment banks that are part of larger entities and stand-alone banks, as the former are able to draw liquidity from their group; c) we employ investment banking fees, which is the main income source of investment banks. In the presence of threshold effects, we expect to see shifts of investment banks across different regimes over the crisis period. This would also enable us to investigate which investment banks, i.e., of low or high liquidity (fee-income), are mostly affected in terms of performance during the financial crisis period. Lastly, we extend the literature concerning investment bank performance determinants by including in fixed effects and dynamic panel models crisis related variables that capture the asset bubble burst and policy responses such as the quantitative easing.[6]

Unsurprisingly, we find significant changes in the number of banks that belong to each regime before and during the financial crisis. In particular, more investment banks appear to be of lower liquidity level and higher default risk after the burst of the financial crisis. Z-score exerts a positive effect on cost performance which is pronounced for banks of lower level of default risk. Also, our findings suggest that increases in liquidity for banks that belong to the low liquidity regime result to the huge deterioration of investment banks' cost performance over the years of the crisis. This effect is mainly driven by banks that are not part of a larger banking entity. Moreover, we find that the majority of investment banks fall within the high level of fee income regime. Thus, the positive effect of an increase in investment banking on cost performance is driven principally by banks that belong to the low regime, i.e., banks of the low level of fee income.

[6]The 2007 turmoil led to the implementation of unconventional monetary policies, such as quantitative easing (Q/E), by the central banks of the G7 and Switzerland (Klyuev, 2009; Fratzscher et al., 2013).

The rest of this chapter is structured as follows. Section 2.2 develops our hypotheses. Section 2.3 describes the SFA and the dynamic panel threshold methodology. Section 2.4 discusses the investment banking industry in the G7 and Switzerland and presents our data and variables. Section 2.5 discusses our results and Section 2.6 concludes.

2.2 Hypotheses Development

The operations of investment banks go far beyond the lending activities of traditional banks as they act as direct intermediaries between investors and capital acquirers in the capital markets. Furthermore, they are active participants in the capital markets by trading securities. An important function of investment banks that differentiates them from traditional banks is their advisory role concerning the wealth of acquirers and bidders. Investment banks assess the assets of target companies and advise acquirers to take the most value-enhancing decisions with the aim of creating substantial synergies (Bao and Edmans, 2011). However, the type, the complex nature and the magnitude of investment banking operations carry significant risks that can be transferred to their shareholders and customers. To illustrate this, Fernando et al. (2012) demonstrate that companies with Lehman Brothers as their lead equity underwriter suffered economically, experiencing significant reductions in their returns. Hence, it becomes vital to test the following hypotheses regarding the impact of default risk, liquidity and investment banking fees on the performance of these institutions.

Investment banks are exposed to high risk due to the complexity of their operations. Demirguc-Kunt and Huizinga (2010) argue that higher fee income for investment banks are linked to a higher volatility of earnings and higher risk as a consequence. However, Chiorazzo et al. (2008) find that for German saving banks an increase in their fee income generated from investment banking activity has a positive impact on the efficiency of saving banks. The reason being that these banks benefit from the diversification of their activities as they are involved in both interest and non-interest income operations (De-Young and Rice, 2004). Similarly, Merciera et al. (2007) show that small European banks and US financial holding companies present low revenue volatility due to their focus on deposit-taking activities, while the shift from interest to non-interest income would result in a trade-off between risk and return. Based on previous studies (see Merciera et al., 2007; Chiorazzo et al., 2008; Demirguc-Kunt and Huizinga, 2010) investment banks might carry more risk due to their engagement in non-interest income activities than savings and commercial banks. To this end, it is vital to examine the impact of risk on investment bank performance.

The *'bad luck hypothesis'* states that a negative relationship exists between risk and performance (see Berger and De-Young, 1997). If an unexpected event leads to higher risk, banks react by spending more resources to manage this risk. As a consequence, this procedure can lead to an increase in bank costs. Consistent with the *'bad luck hypothesis'*, Wheelock and Wilson (2000) find that inefficient banks are closer to failure. Similarly, investment banks' performance (measured by cost efficiency) is negatively associated with insolvency risk as defined by the Z-Score (Radic et al., 2012).

Consequently, it would seem that investment banks with lower default risk are more efficient than banks with higher default risk. Interestingly, banks with high default risk aiming to decrease their probability of default, are forced to divert more resources to short-term screening and monitoring operations and could, in fact, become less efficient this way. Thus, our first hypothesis is as follows:

H_1: Lower default risk asserts a positive impact on the performance of investment banks.

Furthermore, investment banks, due to the absence of a deposit base, face higher liquidity risk in comparison with commercial banks (Gatev and Strahan, 2006; Gatev et al., 2009). Brunnermeir (2009) demonstrates that investment banks' reliance on short-term debt, such as repurchase agreements, could escalate their liquidity risk. Similarly, other studies (Adrian and Shin, 2008, 2009; Krishnamurthy, 2009; Brunnermeir and Pederson, 2009) argue that investment banks face more difficulties in raising capital during periods of financial distress than deposit-taking banks. In light of this, an investigation of the relationship between liquidity and investment bank performance would be warranted.

Moreover, banks with higher levels of liquidity might undertake less risk in a case of an unexpected financial shock than banks with lower levels of liquidity. There are numerous studies that examine the impact of liquidity on bank performance (Altunbas et al., 2000; Brissimis et al., 2008; Altunbas and Marques, 2008). Many studies find a direct positive relationship between a bank's liquidity ratio and its performance (Bourke, 1989; Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008). Nonetheless, there are counterarguments: excess liquidity is accompanied by high storage costs (Kwan, 2003; Staikouras et al., 2008) and lower returns (Pasiouras and Kosmidou, 2007), suggesting that while liquid assets could decrease liquidity risk they could carry high costs that negatively affect bank performance.

We assume that banks with higher liquidity perform better than banks with lower levels of liquid assets. By this logic (*'bad luck hypothesis'* by Berger and De-Young, 1997), banks with lower liquidity would underperform banks with more liquid assets while trying to raise their liquidity levels. Hence, our second hypothesis is as follows:

H_2: Higher liquidity asserts a positive impact on the performance of investment banks.

There is a growing discussion in the literature with regards to the risk diversification benefits that stem from the income diversification for banking institutions (Stiroh, 2004; Chiorazzo et al., 2008; Lepetit et al., 2008). Commercial and saving banks' major source of income is interest-based, while for investment banks the main source of income is generated from non-interest based activities. De-Young and Roland (2001) argue that the substitution of traditional operations with fee income activities is related to the instability of earnings, while Acharya et al. (2006) show that banks with higher inclusion of non-interest income activities in their portfolio perform less efficiently than banks with lower involvement in fee-income operations. In the same manner, Stiroh (2004) and Lepetit et al. (2008) find a positive association between fee-based revenue and bank risk. Yet for saving banks an increase in fee income could have a positive impact on performance (Chiorazzo et al., 2008), as these banks engage in both interest and non-interest income operations and thereby could diversify their risk (De-Young and Rice, 2004). Demirguc-Kunt and Huizinga (2010) find that for banks earning high levels of non-interest income, to raise fee income (such as investment banking fees) would induce higher risk. On the contrary, investment banks since they solely focus on investment banking activities could benefit less from risk diversification compared to saving banks. It is clearly of interest to study the impact of fee-income on investment bank performance. Based on the previous empirical studies, we formulate the following hypothesis

H3: Higher level of fee-based income asserts a negative effect on the performance of investment banks.

2.3 Methodology

2.3.1 Measuring Cost Efficiency

In this study, we measure bank performance in terms of cost efficiency by employing Stochastic Frontier Analysis (SFA). The advantage of this parametric methodology is that both random error and inefficiency are combined in a composite error term (Berger and Humphrey, 1997). More specifically, we use the following specification for the cost frontier:

$$TC_{it} = f(P_{it}, Y_{it}, N_{it}, Z_{it}) + v_{it} + u_{it} \quad (1),$$

where TC_{it} is the total cost for bank *i* in year *t*. Total cost is defined as the sum of personnel, interest and non-interest expenses. P_{it} is a vector of input prices, Y_{it} is a vector of outputs, N_{it} is a vector of fixed netputs and Z_{it} is a vector of control variables. We use country dummy variables to control for home country characteristics [7] and a dummy variable for listed banks. The term $v_{i,t}$ stands for the error term, while $u_{i,t}$ denotes bank's inefficiency.

The translog cost function, opted in this study, takes the form:

[7]Structural and macroeconomic conditions might create variances in efficiency from country-to-country and time-to-time. To control for these differences we employ both time effects and country effects in the estimation of the efficiency as in Bonin et al. (2005).

$$lnC_{i,t} = \alpha_0 + \sum_i \alpha_i lnP_{i,t} + \sum_i \beta_i lnY_{i,t} + {}^1\!/_2 \sum_i \sum_j \alpha_{ij} lnP_{i,t} lnP_{j,t} + {}^1\!/_2 \sum_i \sum_j \beta_{ij} lnY_{i,t} lnY_{j,t} + + \sum_i \sum_j \delta_{ij} lnP_{i,t} lnY_{j,t} + \sum_i \zeta_i lnN_{i,t} + {}^1\!/_2 \sum_i \sum_j \zeta_{ij} lnN_{i,t} lnN_{j,t} + {}^1\!/_2 \sum_i \sum_j \theta_{ij} lnP_{i,t} lnN_{j,t} + + \sum_i \sum_j \kappa_{ij} lnY_{i,t} lnN_{j,t} + \mu_1 t + {}^1\!/_2 \mu_2 t^2 + \sum_i \nu_i t lnP_{i,t} + \sum_i \xi_i t lnY_{i,t} + \sum_i \rho_i t lnN_{i,t} + + \sum_\iota \varphi_i Z_{i,t} + u_{i,t} \pm v_{i,t} \quad (2)$$

Standard linear homogeneity and symmetry restrictions are applied. The equation (2) is estimated via a maximum likelihood procedure parameterized in terms of the variance parameters:

$$\sigma_\varepsilon^2 = \sigma_u^2 + \sigma_v^2$$

$$\text{and } \beta = \sigma_u^2/\sigma_\varepsilon^2 \quad (3)$$

We estimate bank-specific efficiency scores using the distribution of the efficiency term conditional to the estimate of the composite error term, as in Jondrow et al. (1982).

2.3.2 Dynamic Panel Threshold Model

We choose to implement this methodology as it enables us to identify regime changes of important determinants of investment bank performance as measured by cost efficiency. Specifically, we employ the model of Kremer et al. (2013), which is an extension of Hansen (1999) model. It is based on the cross-sectional threshold model of Caner and Hansen (2004), where GMM estimators are used allowing for endogeneity issues. However, Kremer et al. (2013) opt for a dynamic unbalanced threshold model, which could identify possible coefficient changes on the independent variables of our interest.

We adopt the dynamic threshold model as further developed by Kremer et al. (2013). This takes the following form:

$$eff_{it} = \mu_i + \lambda_1 m_{it}\, I(q_{it} \le \gamma) + \delta_1 I(q_{it} \le \gamma) + \lambda_2 m_{it}\, I(q_{it} > \gamma) + \varepsilon_{it} \quad (4)$$

where eff_{it} is the dependent variable (efficiency scores derived from SFA), μ_i is the bank-specific fixed effect, while λ_1 and λ_2 are the two reverse regression slopes assuming that there are two regimes. The threshold variable is q_{it}, whereas γ is the threshold value which categorizes the observations above (high regime) and below the threshold value (low regime). ε_{it} is the error term. I is the indicator function signifying the regime indicated by the threshold variable q_{it} and the threshold value γ. This model by Kremer et al. (2013) treats m_{it} as a vector of explanatory variables, which includes one regressor that is correlated with the error term and other regressors, which are not. Moreover, Kremer et al. (2013) extends Hansen's (1999) specification by the regime dependent intercept, δ_1. According to Bick (2007), ignoring the regime intercepts would result in inconsistent estimates for both the threshold value and the coefficient magnitude of the regimes.

In order to circumvent serial correlation in the transformed error terms, Kremer et al. (2013) opt for the GMM estimation method (Arellano and Bover, 1995). To obtain its predicted values, Kremer et al. (2013), like Caner and Hansen (2004), estimate a reduced type regression for the endogenous variable as a function of instruments. In the first step, the predicted values replace the endogenous variable in the equation (4). In step two, equation (4) is estimated via ordinary least squares for a fixed threshold value where the threshold variable is replaced by its predicted values obtained in the first step. The optimal threshold value is derived from the minimization of the concentrated sum of squared errors (Chan, 1993; Hansen, 1997). The 95% confidence interval of the threshold value is given by $\Gamma = \{\gamma: LR(\gamma) \leq C(a)\}$, where $C(a)$ represents the asymptotic distribution of the Likelihood Ratio (LR) statistic at the 95% level (Hansen, 1999; Caner and Hansen, 2004). The above likelihood ratio has been adjusted to control for the number of time periods used for each cross section (Hansen, 1999). After the threshold value has been estimated, the slope coefficients λ_1 and λ_2 could be determined by the GMM estimator (Caner and Hansen, 2004).

2.4 Investment banking in the G7 and Switzerland and Data/Variables

2.4.1 Investment banking in the G7 and Switzerland

Investment banking industry in the G7 and Switzerland demonstrated strong growth for the most part of the last decade and reached its peak in 2006. Due to the financial crisis, investment banking activities were substantially subdued in 2008. This slowdown has been reversed during recent years and the investment banking continues to form an important part of the financial markets in industrialised economies.[8]

In North America, the US investment banks generated 58% of the global investment banking revenues in 2012, while 30% of US banking industry profits were from investment banking operations in the same year (Thomson Reuters, 2013). As a part of North America, Canadian banks facilitated the access of domestic issuers into foreign capital, resulting in a rapid growth of cross-border M&A operations.

In Europe, the UK, as one of the leading financial markets, constitutes an important hub for international investment banking activities carried out by numerous foreign banks from Italy, Germany, the US, Switzerland and Japan (Burgess, 2011). Switzerland is another important financial centre. A large part (13%) of the income of Swiss banks was generated from M&A activity in 2010 (Swiss Bankers Association and Boston Consulting Group, 2011). In the German banking system, universal banks perform both commercial and investment banking operations. International investment banking in Germany, in

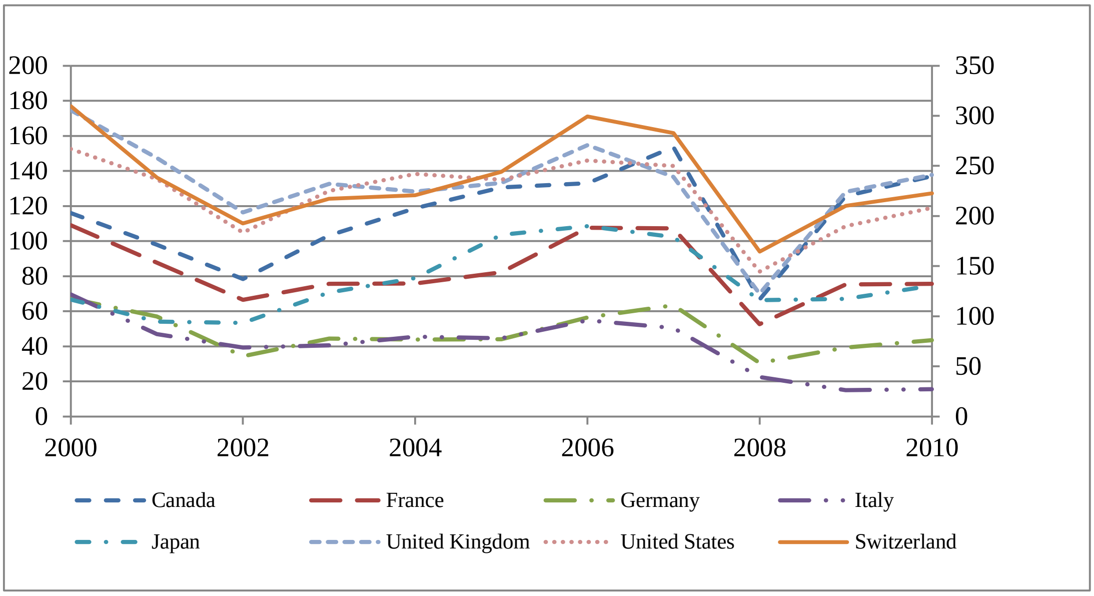
[8]Among the top fee-generating investment banks worldwide are: JPMorgan, Goldman Sachs and Bank of America Merrill Lynch in the US; Barclays in the UK; Deutsche Bank in Germany; BNP Paribas in France; Mediobanca and Banca IMI in Italy; Credit Suisse and UBS in Switzerland; RBC Capital Markets in Canada; and Nomura in Japan (Thomson, 2013).

particular, the M&A, has developed substantially following the Tax Reduction Act in 2000 (Schroder et al., 2012). French investment banks primarily engage in market-based activities, such as trading of securities, and have a relatively lower number of investors than the UK and German banks, which also involve off-balance sheet activities (Vinals and Moghadam, 2012). Banks in Italy play a more predominant role in financing firms than those in Germany, France and the UK (Caselli et al., 2013).

In Japan, which is the only Asian country in the G7, the operational framework of investment banks has been strengthened since 2001. During this period, banks in Japan adopted most of the operations that typical investment banks should cover. Moreover, following the legislation of 2007, foreigners were able to acquire Japanese firms by using their own stock (Stowell, 2012) enabling a higher level of M&A activity.

In all countries considered, the investment banking has largely grown for the greater part of the last decade, as evident in the market capitalization data (see Figure 1). Market capitalization represents the equity aspect of financing and constitutes a major function of investment banks in the primary market. Figure 1 shows the domestic market capitalization in the G7 and Switzerland for the period 2000-2010 (as % of GDP). We observe that market capitalization peaks in 2000 and 2007, which would suggest thriving periods for stock prices before the technology bubble burst in 2001 and the financial crisis in the end of 2007.

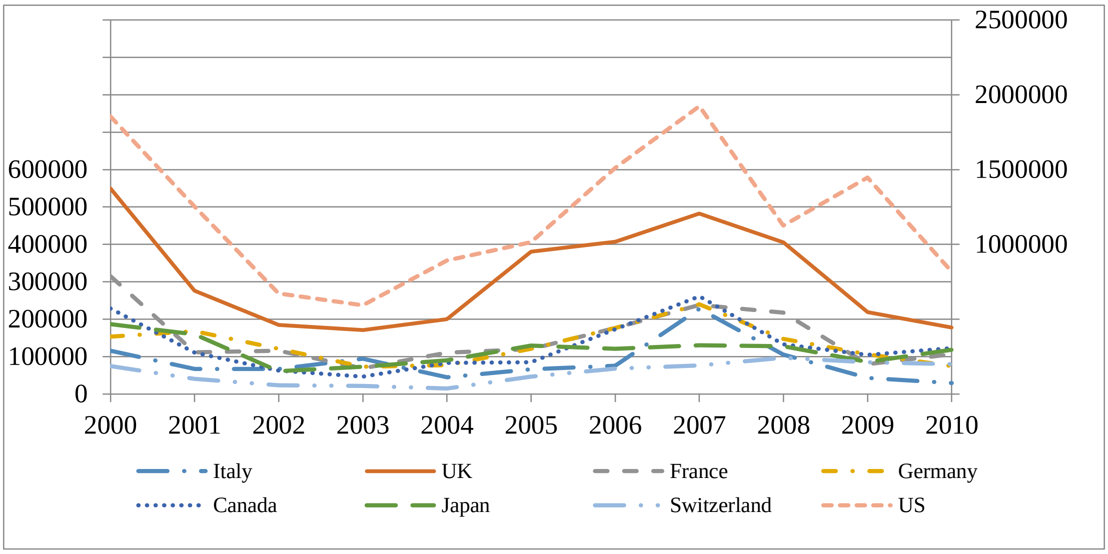
Figure 1.Number of issued shares of domestic companies (Domestic Market Capitalization as % of GDP) across the G7 and Switzerland (2000-2010).



Notes: the Figure shows the Domestic Market Capitalization (as % of GDP) across G7 and Switzerland countries (2000-2010). The left axis includes values that correspond to the US, the UK, France, Italy, Germany, Japan and Canada. The right axis includes only values that correspond to Switzerland. For Domestic Market Capitalization (as % of GDP) data, we use World Development indicators from the World Bank.

Figure 2 shows M&A activity of firms operating in the G7 and Switzerland over 2000-2010. M&A activity constitutes the main source of fee income for investment banks (Kolasinski and Kothari, 2008). It is of note that during periods of financial stability (2004-2007) M&A transactions increased, while they declined during times of economic recession (2001-2003 and 2008-2009). The G7 and Switzerland reached a total transaction value of 3.48 (US$tr) for M&A in 2000, which was to decrease sharply to 1.14 (US$tr) in 2003. From this low level of M&A activity, transaction value grew considerably to a total 3.58 (US$tr) in 2007 while decreased significantly to 1.53(US$tr) in 2010.

Figure 2. M&A activity transaction value across the G7 and Switzerland (2000-2010).



Notes: the Figure shows the M&A transaction value in billion dollars across G7 and Switzerland (2000-2010). The left axis includes M&A transaction values that correspond to the UK, France, Italy, Germany, Switzerland, Japan and Canada. The right axis stands for values that correspond to M&A market in the US. For M&A transaction value we use the Thomson One Banker database.

2.4.2 Data and Variables

We use financial data from the Fitch IBCA's Bankscope database over the period 1997-2010. Our sample includes 97 investment banks and a total of 707 observations for the following countries: the US, the UK, Italy, Germany, Canada, Japan, France and Switzerland. Out of these 97 investment banks, 66 belong to a banking group while the rest (33) are stand-alone investment banks.[9]

We follow Sealey and Lindley (1977) in employing the '*intermediation'* approach identifying bank inputs and outputs. This approach assumes that the core function of banks is to use labour and capital in order to collect funds and transform them into loans and other earning assets. As inputs, we use labour and physical capital. The price of

[9]We thank the anonymous referee for pointing out this distinction. Subsidiary banks as a part of a larger banking entity could benefit from liquidity injections from the parent bank (Mayer and Carlyn, 2008).

labour is measured as the ratio of personnel expenses to total assets while the price of physical capital as the ratio of operating expenses to fixed assets. As output, we employ other earning assets including loans, deposits from banks and credit institutions, government securities, and derivatives among others. Given that we are dealing with investment banks we opt for investment banking fees as an additional output (Radic et al., 2012). Investment banking fees comprise a wide range of operations including trading gains, net commission and other fees. Fixed netputs include the total level of equity and of fixed assets. By including equity we correct for biases in our efficiency scores, as banks with high levels of equity are more likely to adopt risk adverse strategies to protect shareholders' wealth than banks with lower levels of equity (Berger and Mester, 1997). To be consistent with the literature we also include the levels of fixed assets for each bank as a proxy for physical capital (Berger and Mester, 1997). We also include the following control variables: country dummies [10] to count for time-invariant home country characteristics and a dummy for listed banks. Table 1 presents descriptive statistics of cost function variables. The main impression emerging from this table is similar with that which has been previously observed (Radic et al., 2012).

[10] As it is expected one dummy variable (Japan) is dropped from the sample to avoid multicollinearity issues.

Table 1. Descriptive statistics of the variables employed in the cost frontier estimations.

Variable	Description	Mean	Stand. Deviation	Minimum	Maximum
TC	Total Cost	1,688	5,142	0.0019	59,100
Y_1	Total Earnings assets	71,800	224,000	0.0033	2590,000
Y_2	Investment Banking Fees	0.999	2,694	0.0001	23,700
N_1	Equity	1,698	4,354	0.0011	50,100
N_2	Assets	37,700	0,361	0.0033	3,444
P_1	Price of labour	0.776	3.222	0.0002	1.8
P_2	Price of physical capital	27.54	160.82	0.0667	2072.00

Notes: the Table reports the variables used in the cost frontier estimation for the period 1997-2010. Total Cost (TC): personnel, interest and non-interest expenses; Outputs (Y_1 & Y_2)); Total Earning assets (loans, deposits from banks and credit institutions, government securities, derivatives and other earning assets) and 2) Investment Banking Fees (net fees, commission and trading income); Netputs (N_1 & N_2)) Equity and 2) Total Assets; Inputs (P_1 & P_2)) Price of labour (personnel expenses over total assets) and 2) Price of physical capital (total operating expenses over fixed assets). The values of TC, N_1, N_2, Y_1 and Y_2, are in million dollars, while $P_1$and P_2 are ratios.

To test for the '*bad luck hypothesis'* (H1) that a decrease default risk asserts a positive impact on investment banking performance, we employ Z-Score as a measure of risk. We compute Z-Score as in Boyd and Graham (1986) by using the following formula: Z-Score= (1+ ROE)/Standard Deviation of ROE. The Z-Score has been used widely in recent banking studies (Lepetit et al., 2008; Barry et al., 2011; Radic et al., 2012). Banks with lower Z-Score have a higher risk of default than banks with higher Z-Score. We also test the '*bad luck hypothesis'* (H2) whereby an increase in liquidity asserts a positive impact on investment banking performance. Liquidity is defined as each bank as the ratio of liquid assets to total assets. This specification has been employed extensively in the literature (Altunbas et al., 2000; Kwan, 2003; Altunbas and Marques, 2008). Liquid assets include trading assets, loans and advances with less than three months' maturity. Lower values of this ratio suggest that banks face more liquidity risk than banks with higher liquidity ratio. In addition, we use an income-associated ratio to test for the third hypothesis (H3) whereby less reputable investment banks, defined as banks that earn relatively low levels of investment banking fees, would benefit more from an increase in fees than more reputable banks (institutions that earn high levels of fee income). This ratio is defined as the sum of the net commission, fees and net trading income over total assets. The conventional ratio of net income to total assets in the literature (Morgan and Stiroh, 2001; Bonin et al., 2005; Beccalli, 2007; Micco et al., 2007; Lin and Zhang, 2009) is replaced by the ratio of investment banking fees to total assets. This transformation reflects the core revenue of investment banks that stems from non-traditional banking activities.

In terms of bank-specific characteristics, we opt for a number of additional variables such as the ratio of equity to total assets as a proxy for capital (Athanasoglou et al., 2008; Lepetit et al., 2008). We also use the ratio of securities to total assets as in Radic et al. (2012) to account for the varieties of investment banking operations concerning equity issuance and underwriting activities. Finally, we examine the impact of income diversification on bank performance as has been used in recent studies (Laeven and Levine, 2007; Fiordelisi and Molyneux, 2010).[11]

In terms of country macroeconomic variables, we use GDP per capita as a wealth measure (Dietsch and Lozano-Vivas, 2000; Maudos and Guevara, 2007; Maudos and Solis, 2009; Fiordelisi et al., 2011). Empirical evidence and theory point in different directions concerning the impact of GDP per capita on bank performance. An increase of GDP per capita could result in the decline of banking costs as banks in more prosperous countries could benefit from access to new technologies (Lensink et al., 2008). On the other hand, an increase of GDP per capita could increase banking costs due to higher operating expenses to supply a given level of services (Dietsch and Lozano-Vivas, 2000).

To account for financial development, we include domestic credit to the private sector (DCPS) as a percentage of GDP. This is a proxy of banking activity, used in numerous

[11]Income diversification= (1- |Net Interest Income-Other Operating Income|)/Total Operating Income.

studies as an indicator of financial development (Levine, 1997; Beck et al., 2004; Shandre and James, 2004; Abu-Bader and Abu-Qarn, 2008). Financial development could have a positive impact on cost efficiency (Pasiouras, 2008; Lozano-Vivas and Pasiouras, 2010). However, Demirguc-Kunt and Maksimovic (2002) argue that banks with a primary role in financing firms might undertake high loan default risk during a period of financial distress.

Higher FDI inflows may denote a higher presence of foreign investment banks in a country. If foreign banks manage to overcome the cross-border differences, they might increase the efficiency of the investment banking industry of a country (Berger et al., 2000). Higher FDI outflows suggest a high internationalisation of domestic investment banks. Banks that are able to expand globally have superior practices and structures. Consequently, higher FDI outflows can signify that the most efficient banks go abroad to transfer their model. Thus, we expect FDI outflows to have a negative impact on efficiency (Beccalli, 2004).

Moreover, we include the real effective exchange rate to control for exchange rate risk that investment banks could face due to foreign currency activities. The impact of the exchange rate on bank performance is subject to the net asset position of a bank in foreign currencies. A depreciation (appreciation) of the national currency with respect to a specific foreign currency, while the net asset position of a bank denominated in this foreign currency is positive (i.e. assets larger than liabilities), could lead to increased (decreased) gains for this bank (Grammatikos et al., 1986).

We also use the stock and house price index of the countries considered (S&P500, FTSE100, DAX, CAC, FTSEMIB, SMI, SPTSX and NIKKEI), with the aim of capturing the asset price bubble, as in Bordo and Jeanne (2002). A recent study by Adrian and Song

Shin (2010) shows that when the asset and stock prices rise, investment banks' leverage increases as well. Moreover, in order to control for asset bubble bursts, we follow Gerdesmeier et al. (2010) and adopt a composite asset price indicator to construct a dummy, which takes the value of 1 in the case of an asset price burst, and 0 otherwise.[12] In addition, we proxy Q/E by using the reserves held by central banks for the countries considered, following the definition of Kobayashi et al. (2002) who suggests that Q/E stands for the increase in central bank reserves. A number of recent studies look at the impact of Q/E policy on the economies of Japan and UK (Voutsinas and Werner, 2011b; Lyonnet and Werner, 2012) using central bank reserves, among other tools of Q/E, and highlight the positive impact of this non-conventional monetary policy.[13] Hence, we expect the impact of central bank reserves on bank performance to be positive, as in Kobayashi et al. (2006).

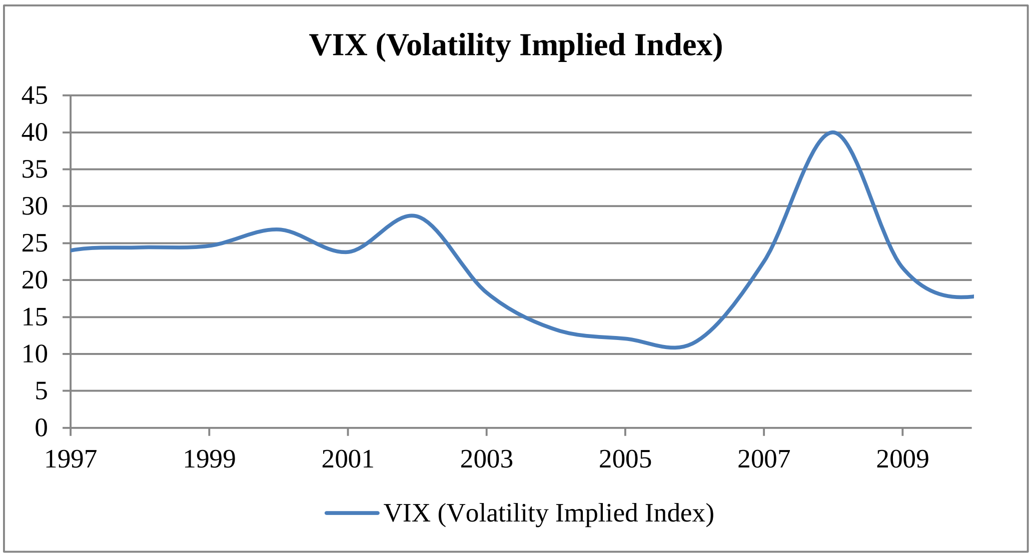
Finally, to account for the market risk we use the Volatility Implied Index (VIX). This financial indicator suggests that higher levels of VIX reflect higher degrees of financial turmoil in the US (Whaley, 2000). It follows that we should expect the VIX impact on investment bank performance to be negative. Over the study period (1997-2010), we

[12]If the composite indicator falls below a critical value the dummy takes the value of 1, and 0 otherwise. For the values of the composite indicator that are below the threshold value a burst exists. The critical value is determined as the mean of the composite indicator minus the standard deviation of the composite indicator times the factor μ. In our study we use μ=0.5, similarly to the study of Gerdesmeir et al. (2010) where μ=0.75. The composite indicator is estimated by the following equation: $CI = \varphi_1 stock\ price\ index + \varphi_2 house\ price\ index$. φ_1 equals to 1, while φ_2 is the ratio of the standard deviation of the stock price index over the standard deviation of the house price index. Alternatively, Voutsinas and Werner (2011a) indicate the boom and the burst phase in their study based on the trend of lending growth rate in Japan over the 1980-1999 periods. The dummy variable equals 1 over the boom period (1980–1989), and 0 during the burst period (1990-1999).

[13]In the study of Voutsinas and Werner (2011b) the case of Japan has been examined, as being the first country to implement the unconventional monetary policy of Q/E. In the early 90s Japan has experienced very low interest rates, triggering the implementation of new monetary policies. Similarly, Lyonnet and Werner (2012) look at the impact of Q/E on the nominal GDP growth for the UK. Only recently (2008), the Bank of England has implemented the relevant monetary policy (Joyce et al., 2011). The studies of Voutsinas and Werner (2011b) and Lyonnet and Werner (2012) investigate the impact of Q/E on the nominal GDP growth of Japan and UK respectively and conclude that credit creation, the original definition of Q/E (Werner, 1995), could form a stable relationship between a lending aggregate for GDP transactions and nominal GDP growth.

observe that volatility increases significantly in two instances: over 2001-2003 and 2008-2009 (see Figure 3). Over 2004-2007 the relative market risk is lower, suggesting a period of financial stability.

Figure 3. Volatility Implied Index (VIX) over the 1997-2010 period.



Notes: the Figure shows the average VIX (Chicago Board Options Exchange Volatility Index) over the period 1990-2012. Source: Bloomberg.

Table 2 shows further descriptive statistics of the bank-specific and country-level variables used in the fixed effect and dynamic panel regressions.

Table 2. Descriptive statistics of the bank-specific and country-level variable.

Country	N	Z-Score	Invest. Banking Fees/ TA	Liquid./TA	E/TA	Income Divers.	Securities /TA	GDP per capita	FDI Inflows	FDI Outflows	House Price Index	Stock Price Index	Reserves
Canada	17	2.0823	0.0342	0.523	0.0547	-0.1807	0.6517	10.1286	3.58	3.914	152.41	155.38	24.2956
France	63	1.2827	0.0556	0.3548	0.1055	0.242	0.2039	10.027	2.733	5.249	196.15	147.60	24.3474
Germany	122	1.9408	0.1702	0.2146	0.2709	0.4383	0.6112	10.0852	1.885	2.864	94.89	134.53	24.666
Italy	23	1.4954	0.0167	0.306	0.0919	-0.384	0.2018	9.8863	1	2.386	194.96	122.82	24.2341
Japan	141	0.6568	0.1131	0.4957	0.2872	0.1012	0.2755	10.5545	0.177	1.096	74.96	83.04	27.272
Switz.	21	1.9423	0.0431	0.6277	0.0606	0.4901	0.2143	10.4944	4.689	10.384	113.66	107.11	24.6329
UK	176	2.346	0.0695	0.3525	0.1576	0.3306	0.2644	10.2306	4.62	5.384	259.73	107.01	24.4951
US	143	2.262	0.1954	0.3908	0.1912	0.207	0.5225	10.5004	1.666	1.867	167.98	135.83	24.964
Total	706												
Mean		1.751	0.0872	0.4081	0.1524	0.1556	0.3682	10.2384	2.544	4.143	156.84	124.16	24.8633

Notes: the Table reports descriptive statistics of bank-specific and most of the country-level variables used to perform fixed effect and dynamic panel regressions. N stands for the number of observations by country. As bank-specific variables we use: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Invest. Banking Fees/TA= net fees, commission and net trading income over total assets; Liquid assets over total assets; E/TA= equity over total assets; Income divers.= (1- |Net Interest Income-Other Operating Income|)/Total Operating Income; Securities/TA= total securities over total assets. Some of the country level independent variables that we use are: GDP per capita (natural logarithm); FDI inflows (natural logarithm); FDI outflows (natural logarithm); House Price Index; Stock Price Index; Reserves (natural logarithm). For bank-specific variables we use FITCH Bankscope database while for most country variables, we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For the Stock Price Index data, we use Bloomberg database.

Note that UK and US investment banks have lower default risk (the highest two Z-Scores of 2.346 and 2.262). French and Japanese investment banks have the highest default risk with Z-Scores of 1.282 and 0.656. US investment banks have the highest level of investment banking fees over total assets. In terms of the liquidity ratio, Switzerland, Canada and Japan have the highest ratios, while Germany and Italy have the lowest.

2.5 Results and Discussion

2.5.1 Cost Efficiency Estimations

Table 3 shows the mean cost efficiency scores. Our mean efficiency scores rank Japan, Switzerland and Germany in the first three places. Our findings are broadly in line with Radic et al. (2012) who find that Japan and Switzerland rank in the second and third place. However, unlike in the present study, they find that US investment banks are the most cost efficient among the considered countries (G7 and Switzerland). Their study focuses on the pre-crisis period (2001-2007) and so misses the post-financial turmoil period where the US investment banking industry confronted severe losses.

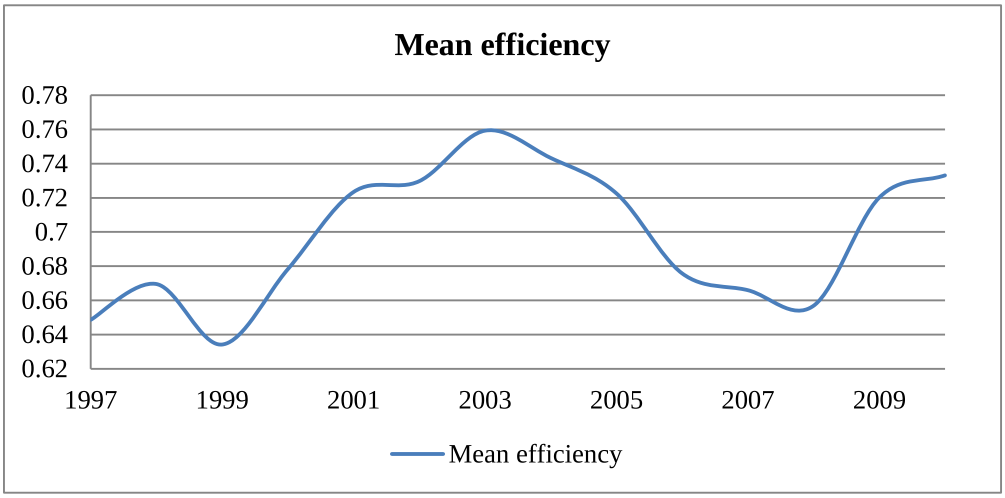
Table 3. Descriptive Statistics of cost efficiency (1997-2010).

Country	Mean	Standard Deviation	Minimum	Maximum
Canada	0.4946	0.1690	0.1848	0.7473
France	0.5859	0.1817	0.1543	0.8582
Germany	0.7769	0.1320	0.1767	0.9170
Italy	0.6547	0.1426	0.4508	0.8812
Japan	0.9197	0.0282	0.7230	0.9559
Switz.	0.8557	0.0893	0.6718	0.9622
UK	0.6029	0.1658	0.2099	0.9451
US	0.6319	0.1484	0.2247	0.8373
Mean	**0.6903**	**0.1321**	**0.1767**	**0.9621**

Notes: the Table reports the mean efficiencies for the G7 and Switzerland over the period 1997-2010. Efficiencies are derived from the Stochastic Frontier Analysis (SFA).

In Figure 4, we report changes in the mean efficiency score over time. We observe a downward trend from 2004 to 2008. In 2003, the average efficiency score is 75.93%. It decreases to 72.26% in 2005, 66.60% in 2007 and 65.68% in 2008. It would appear that performance was affected adversely by the financial crisis of the 2007-2009 period.

Figure 4. Mean efficiency score of investment banks over the 1997-2010 period.



Notes: the Figure shows the average efficiency score of investment banks derived from Stochastic Frontier Analysis (SFA).

2.5.2 Panel Estimations

2.5.2.1 The Impact of the Z-core, Liquidity and Investment banking fees

Tables 4 and 5 present the results for the fixed effect and dynamic panel regressions, where bank performance is a function of bank-specific and country-level variables. In the dynamic panel analysis, we employ the two-step system GMM estimator of Arellano and Bover (1995) and Blundell and Bond (1998) with Windmeijer (2005) corrected (robust) standard errors. The two main characteristics of this estimator are that it follows the moments conditions on the level equations and uses the orthogonality conditions introduced by the Arellano and Bond (1991) model. This method serves as a control for possible biases brought by country-specific effects and endogeneity issues. Here, we employ as endogenous explanatory variables the lagged efficiency score, Z-Score, liquidity and fee-income ratios. According to Athanasoglou et al. (2008) in order to test the endogeneity of the variables we run the model twice. The first time we treated the three variables, Z-Score, liquidity and fee-income ratios, as investment banks' endogenous variables, while all the other determinants as strictly exogenous. The second model treated all the variables as exogenous. The results support the hypothesis that bank-specific variables are better modeled as endogenous and country-level as exogenous (in accordance with Delis, 2012) because the Sargan test has 1.00 p-value. This suggests that the instruments are acceptable. On the other hand, in the case where all variables are treated as exogenous the p-value of the Sargan test is 0.003. For the GMM estimation, we use Roodman (2006) 'xtabond 2' specification in Stata.

Table 4. Fixed effects results for Z-Score, liquidity and investment banking fees as bank cost efficiency determinants in the G7 and Switzerland (1997-2010).

Variables	Model(1)	Model(2)	Model(3)	Model(4)
Z-Score	0.008**			0.009**
	(0.0039)			(0.0038)
Investment Banking Fees/TA		0.128		0.144*
		(0.0885)		(0.0852)
Liquid assets/TA			0.048	0.069**
			(0.0327)	(0.0307)
E/TA	0.119**	0.106*	0.108*	0.111*
	(0.0586)	(0.0590)	(0.0595)	(0.0611)
Securities/TA	0.172***	0.182***	0.170***	0.204***
	(0.0418)	(0.0447)	(0.0407)	(0.0420)
Income diversification	-0.016***	-0.015***	-0.015***	-0.016***
	(0.0018)	(0.0018)	(0.0018)	(0.0019)
GDP per capita	-0.032	-0.039	0.001	-0.058
	(0.156)	(0.154)	(0.155)	(0.152)
FDI inflows	-0.008***	-0.008***	-0.008***	-0.008***
	(0.0027)	(0.0027)	(0.0026)	(0.0026)
FDI outflows	-0.002	-0.002	-0.002	-0.003*
	(0.0019)	(0.0019)	(0.0019)	(0.0018)
DCPS/GDP	-0.013	-0.012	-0.010	-0.010
	(0.0315)	(0.0315)	(0.0311)	(0.0319)
Real effective exchange rate	-0.000	-0.000	4.14e-05	-5.74e-05
	(0.0006)	(0.0006)	(0.0007)	(0.0006)
House Price Index	-0.0003	-0.0003	-0.0003	-0.0005*
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Stock Price Index	-0.0007**	-0.0006**	-0.0006*	-0.0006**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Burst of the asset bubble (dummy)	-0.0252**	-0.0239**	-0.0225**	-0.0245**
	(0.0103)	(0.0101)	(0.0104)	(0.0101)
Reserves	0.046**	0.048**	0.044**	0.045**
	(0.0193)	(0.0189)	(0.0187)	(0.0183)
Volatility Implied Index	-0.002***	-0.002***	-0.002***	-0.002***
	(0.0005)	(0.0005)	(0.0006)	(0.0005)
Constant	0.0343	0.0293	-0.303	0.238
	(1.529)	(1.508)	(1.500)	(1.477)
F-test	11.68***	10.46***	11.75***	11.31***
Observations	706	706	706	706
R-squared	0.185	0.190	0.183	0.206
Number of banks	97	97	97	97

Notes: the Table reports the regression results based on a fixed effect model over the period 1997 to 2010. The dependent variable is cost efficiency derived using a SFA methodology. As bank-specific independent variables we employ: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Investment Banking Fees= net fees, commission and trading income over total assets; Liquid assets over total assets; E/TA= equity over total assets; Income diversification= 1- |Net Interest Income-Other Operating Income|/Total Operating Income; Securities/TA= total securities over total assets. As country variables we employ: GDP per capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Burst of the asset bubble (dummy); Reserves (natural logarithm); Volatility Implied Index. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (VIX-*Chicago* Board Options *Exchange* Volatility Index) and Stock Price Index we use Bloomberg database. To avoid collinearity problems with the selected variables, we first analyze correlations of all the selected variables. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively. Robust Standard errors are in parentheses.

Table 5. Dynamic panel results for Z-Score, liquidity and investment banking fees as bank cost efficiency determinants in the G7 and Switzerland (1997-2010).

Variables	Model(1)	Model(2)	Model(3)	Model(4)
Lag efficiency	0.371***	0.459***	0.425***	0.278***
	(0.116)	(0.105)	(0.104)	(0.0874)
Z-Score	0.013**			0.0152**
	(0.0056)			(0.0069)
Investment Banking Fees/TA		0.128**		0.116**
		(0.0541)		(0.0489)
Liquid assets/TA			0.0679	0.0813
			(0.0553)	(0.0605)
E/TA	-0.0765	-0.138*	-0.037	0.018
	(0.0786)	(0.0714)	(0.0988)	(0.0807)
Securities/TA	0.164***	0.153***	0.190***	0.228***
	(0.0536)	(0.0406)	(0.0650)	(0.0585)
Income diversification	-0.023***	-0.022***	-0.024***	-0.025***
	(0.0026)	(0.0024)	(0.0041)	(0.0041)
GDP per capita	-0.211	-0.175	-0.240*	-0.262
	(0.180)	(0.145)	(0.140)	(0.200)
FDI inflows	-0.006**	-0.007**	-0.006**	-0.006**
	(0.002)	(0.0024)	(0.0025)	(0.0023)
FDI outflows	0.000	-0.000	-0.002	-0.001
	(0.00192)	(0.00164)	(0.00160)	(0.00201)
DCPS/GDP	-0.103**	-0.0732*	-0.0629	-0.0828*
	(0.0435)	(0.0418)	(0.0524)	(0.0464)
Real effective exchange rate	4.63e-05	0.000276	0.000547	2.90e-05
	(0.0008)	(0.0007)	(0.0008)	(0.0009)
House Price Index	-0.0006**	-0.0006***	-0.0005**	-0.0005*
	(0.0002)	(0.0002)	(0.0002)	(0.0003)
Stock Price Index	-0.001**	-0.001**	-0.000	-0.001**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Burst of the asset bubble (dummy)	-0.016	-0.015	-0.005	-0.016
	(0.0119)	(0.0105)	(0.0140)	(0.0175)
Reserves	0.042**	0.0453**	0.063***	0.062***
	(0.0196)	(0.0183)	(0.0209)	(0.0183)
Volatility Implied Index	-0.001	-0.000	-0.000	-0.001
	(0.0006)	(0.0006)	(0.0007)	(0.0006)
Constant	1.859	1.272	1.387	1.796
	(2.034)	(1.700)	(1.514)	(1.978)
Wald test	230.17***	354.73***	317.36***	203.56***
Sargan (p-value)	43.5(0.19)	39.22(0.29)	38.89(0.31)	73.78(0.45)
AR(1)	-2.4202**	-2.773***	-2.9819***	2.4062***
AR(2)	-0.9097	-1.0944	-1.044	0.9080
Observations	609	609	609	609
Number of instruments	45	45	45	89
Number of banks	97	97	97	97

Notes: the Table reports the dynamic panel regression results for the period 1997 to 2010. As bank-specific independent variables we employ: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Investment Banking Fees=Net fees, commission and trading income over total assets; Liquid assets over total assets; E/TA: equity over total assets; Income diversification=1- |Net Interest Income-Other Operating Income|/Total Operating Income; Securities /TA=total securities over total assets. As country variables, we employ: GDP per capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Burst of the asset bubble (dummy); Reserves (natural logarithm); Volatility Implied Index. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (*Chicago* Board Options *Exchange* Volatility Index) and Stock Price Index, we use Bloomberg database. To avoid collinearity problems with the selected variables, we first analyze correlations of all the selected variables. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively. Windmeijer (2005) corrected (robust) standard errors are in parentheses.

Consistent with Radic et al. (2012) and Berger and De-Young (1997), the fixed effect results reveal a positive relationship between the Z-Score and bank performance at the 5% level of significance (Model 1 in Table 4). This finding remains robust when we control for the rest variables of our main interest (Model 4 in Table 4), which are the liquidity ratio and investment banking fees. Similarly, the dynamic panel analysis shows that the Z-Score exerts a positive impact at the 5% level of significance on cost efficiency (Model 1 and 2 in Table 5). These results lend support to our first hypothesis (H_1), the '*bad luck hypothesis'*. Moreover, the fixed-effect regressions indicate a positive effect of investment banking fees over total assets ratio on cost efficiency at the 10% level of significance (Model 4 in Table 4). Dynamic panel results provide additional evidence of the positive relationship between fee-based income and cost performance (Model 2 and 4 in Table 5). This implies that banks with higher amounts of net income are more efficient (Bonin et al., 2005; Beccalli, 2007; Micco et al., 2007; Lin and Yzhang, 2009). We also find a positive association between the liquidity ratio and cost performance at the 5% level of significance (Model 4 in Table 4) in the fixed effect model. While the dynamic panel analysis indicates that the liquidity ratio has a positive impact on bank performance, the result is not robust (Model 3 and 4 in Table 5). It appears that the results would confirm our second hypothesis (H_2) and previous empirical work suggesting a positive relationship between liquidity and bank performance (Bourke, 1989; Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008).

The findings above show that risk, estimated as the Z-Score, liquidity, and fee-income ratios are significant determinants of investment banking performance over the 1997-2010 period. We go a step further in the next section (5.3) and employ the flexible approach of the dynamic panel threshold model (Kremer et al., 2013) to identify thresholds in these three variables with respect to cost efficiency and different underlying regimes over the crisis period. This is essential due to both the inherent volatility of non-interest income (De-Young and Roland, 2001) which can rise in crisis periods and also because of the importance of default risk and the low availability of liquidity during recessions.

2.5.2.2 Impact of the Control Variables

Concerning other bank-specific variables, we find that the ratio of equity to total assets has a significantly positive impact on cost efficiency at the 5% level in the fixed effect model (Model 1 in Table 4) and at the 10% level of significance in the dynamic specifications (Models 2, 3 and 4 in Table 4). These results indicate that more capitalized banks are more cost efficient as in Athanasoglou et al. (2008) and Lepetit et al. (2008). The securities to total assets ratio has a positive effect on performance at the 1% level of significance both in the fixed and dynamic panel regressions (all Models in Table 4 and 5). This finding suggests that off-balance sheet activities may induce a higher risk of bank losses (Radic et al., 2012). Finally, results from fixed and dynamic panel regressions reveal that the income diversification variable asserts a negative impact on cost efficiency at the 1% level of significance (all Models in Table 4 and 5).

Next we turn to the impact of the country-level control variables on cost efficiency. An important finding relates to the policy measure of Q/E that has been implemented by many countries in order to weather the financial crisis. In particular, we find central bank reserves, a proxy of Q/E, to have a positive and significant relationship with cost efficiency in both fixed effect and dynamic panel regressions (all Models in Table 4 and 5). This result would suggest that in countries where the Q/E has been broadly implemented, investment banks perform better than in countries where the Q/E has been applied at a lower level. This finding is consistent with recent studies that provide evidence of a positive impact of Q/E on economic outcomes (Voutsinas and Werner, 2011b; Lyonnet and Werner, 2012) and justifies, from an investment banking perspective, the use of such unconventional monetary policies. The countries of our sample that have implemented Q/E on a large scale are Japan, the UK, and the US. The Bank of Japan is the first to follow this policy (Lyonnet and Werner, 2012). Furthermore, in response to the intensification of the financial crisis, the Bank of England implemented Q/E in the form of asset purchases backed by the central bank (Joyce et al., 2011). Similarly, the Federal Reserve launched a new set of non-conventional monetary ‘tools’, termed as ‘crediting easing’, in order to rise the liquidity of the markets after the collapse of Lehman Brothers. The rest of the economies in our sample, the ones belonging to the Eurozone area, also engaged in Q/E but at a lower extent in comparison with the large asset purchases in the US and the UK (Martin and Milas, 2012; Reichlin, 2013).

Our fixed and dynamic panel analysis reveals that both the house price and the stock price index have a negative and significant impact on cost efficiency.[14] As expected, a bubble burst has a negative impact on investment bank performance due to decreased investment activity (Allen and Carletti, 2010).[15] We also find a strong negative effect of the VIX indicator on bank performance at the 1% level of significance (all Models in Table 4) in line with previous studies (Bourke 1989; Miller and Noulas, 1997). Moreover, GDP per capita has a negative impact on cost efficiency, suggesting the higher operating and

[14]These results show that during boom periods, where a rise of asset and stock prices takes place, there exists a deterioration of investment bank performance. A recent study by Adrian and Song Shin (2010) shows that when the asset and stock prices rise, investment banks’ leverage increases as well in a pro-cyclical manner. At low levels of leverage, any increase in leverage might moderate the conflicts between shareholders and managers regarding the choice of investment and the underlying risk (Myers, 1977). This is so because managers would need cash to service the debt rather than take excessively risky investments (Jensen and Meckling, 1976). However, when leverage becomes relatively high, any increase in leverage might raise conflicts between debt holders and shareholders, mainly due to the higher risk of default or liquidation (Jensen and Meckling, 1976). These conflicts would escalate agency costs between debt holders and shareholders and this would result in higher interest expenditures to pay debt holders for their estimated losses.

[15]The bubble-burst indicator shows that there are two major bursts that concern the majority of the sample, these occur in the 2001-2003 and 2008-2010 periods. For all countries in the sample we identify the 2001-2003 burst. The latter result corresponds to the technology bubble burst in 2001, while the second burst (2008-2010) coincides with the recent financial flood of 2007 (Lin, 2009).

financial costs for supplying a particular level of service (Dietsch and Lozano-Vivas, 2000). FDI inflows have a negative impact on cost performance, in line with Berger et al. (2000). Similarly, FDI outflows have a negative impact on bank performance, suggesting that most efficient banks go abroad to export their model (Beccalli, 2004). As for the financial development indicator, we find that the DCPS/GDP ratio has a statistically significant negative effect on cost efficiency, consistent with Demirgunt-Kunt and Maksimovic (2002).

2.5.3 Threshold Estimations

2.5.3.1 Z-Score Threshold

Our empirical estimations for threshold effects are based on an unbalanced dataset of 707 observations including 97 banks for the period 1997-2010. Table 6 presents the dynamic panel threshold model with the Z-Score as threshold variable.[16]

[16]We perform a general to the specific sensitivity analysis. In the first stage, we employ a wide range of instruments while in the second stage we include only one instrument. We find no significant difference in our results. We follow the same procedure for the liquidity and investment banking fees threshold analysis. The results are available on request.

Table 6.Results of dynamic panel threshold estimation with Z-Score as threshold variable.

Investment banks		
Threshold estimate		
Z-Score		1.516866
95% confidence interval		(1.318830-2.165600)
Impact of Z-Score		S.E
λ1	0.012**	0.0058
λ2	0.044**	0.0180
Impact of covariates		S.E
Investment Banking Fees/TA	0.056	0.0861
Liquid Assets/TA	0.056	0.0372
E/TA	0.108**	0.0403
Securities/TA	0.190***	0.0370
Income diversification	-0.016***	0.0040
GDP per capita	-0.015	0.1274
FDI inflows	-0.008***	0.0025
FDI outflows	-0.003	0.0018
DCPS/GDP	-0.001	0.0284
Real Effective Exchange Rate	0.000	0.0006
House Price Index	-0.000**	0.0002
Stock Price Index	-0.001**	0.0002
Burst of the asset bubble (dummy)	-0.024**	0.0103
Reserves	0.041***	0.0132
Volatility Implied Index	-0.002***	0.0005
δ	0.018***	0.0055
Observations	609	
Low regime	372	
High regime	237	

Notes: the Table reports the estimations for the dynamic panel threshold model. Each regime has at least 5% of the observations (Hansen, 1999). The threshold value of Z-Score variable for banks range between 1.31883 and 2.1656.We denote as dependent variable banks' efficiency scores (eff_{it}), while as the threshold and the regime dependent variable we impose the $(Z - Score_{it})$ which represents banks' default risk. Following Bick (2007), the model accounts for regime dependent intercepts (δ). We assume m_{it} includes bank-specific and country explanatory variables. For bank-specific variables we use: Investment Banking Fees= net fees, commission and trading income over total assets; Liquid assets over total assets; Securities/TA= total securities over total assets; Income diversification= 1- |Net Interest Income-Other Operating Income|/Total Operating Income; E/TA= equity over total assets. As country variables we employ: GDP per capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Burst of the asset bubble (dummy); Reserves (natural logarithm); Volatility Implied Index. For bank-specific variable we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (*Chicago* Board Options *Exchange* Volatility Index) we use Bloomberg database. Also as endogenous variable for the model we impose the Investment Banking Fees, where $Investment\ Banking\ Fees = eff_{it-1}$. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

We find that the threshold value for the Z-Score variable is 1.516 (see Table 6). This value splits the sample into two regimes: the first regime consists of banks with a relatively high risk of default; the second consists of banks with lower risk. The coefficient $\lambda_2 = 0.044$ for banks within the high regime is positive and significant at the 5% level. This implies that a 1% decrease in Z-Score would benefit efficiency by 4.4%. This result is consistent with our first hypothesis (H_1). A decrease in default risk for banks with low Z-Score, below the threshold value, is also significant at the 5% level and positively related to cost efficiency ($\lambda_1 = 0.012$), although here at a lower magnitude than the one of the high regime.

In Table 7, the percentage of investment banks classified as low-regime is consistently above the percentage of banks classified as high-regime with respect to the Z-Score. Note between 2000 and 2003 there is a clear negative trend in the number of investment banks with low exposure to risk (46 investment banks in 2000 decreases to 18 in 2003). The composite indicator of asset prices reveals the burst during 2001-2003 while the VIX indicator shows higher levels of risk during the same period (Figure 3). Between 2004 and 2007, we observe a decreasing trend in the percentage of investment banks that have high-risk exposure, when according to the VIX indicator there should be lower market volatility. Finally, the percentage of investment banks with low-risk exposure (the high regime) has decreased significantly since 2008 due to the crisis. This result is supported by the identification of the 2008-2010 burst when again the associated risk (VIX) increases considerably (Figure 3).

Table 7. Dynamic Threshold Analysis: classification of investment banks into the two identified regimes based on threshold value of Z-Score.

Threshold: Z-Score													
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Low regime	64%	47%	53%	75%	78%	82%	62%	49%	52%	52%	54%	65%	67%
High regime	36%	53%	47%	25%	22%	18%	38%	51%	48%	48%	46%	35%	33%

Notes: the Table shows the classification of the investment banks based on the Z-Score threshold value that we obtained following Kremer's et al. (2013) threshold model for the dynamic panel. As threshold variable, we use: Z-Score= (1+ROE)/ (Standard Deviation of ROE).

Concerning the other bank-specific variables, we find that the equity and securities to total assets ratios have a positive and significant relationship with cost efficiency. On the other hand, income diversification has a negative effect on performance. In terms of country-level determinants, we find that FDI inflows, house price and stock price index, bubble bursts and VIX indicator have a negative and significant impact on efficiency. Moreover, central bank reserves have a positive effect on efficiency. Overall, our results are similar to the fixed effect and the dynamic panel regressions.

2.5.3.2 Liquidity Threshold

Table 8 presents the threshold effects due to liquidity measured as the ratio of liquid assets to total assets.

Table 8. Results of dynamic panel threshold estimation with liquidity as threshold variable.

Investment banks		
Threshold estimate		
Liquidity		0.229967
95% confidence interval		(0.02045-0.59454)
Impact of Liquid Assets/TA		S.E
λ1	-0.202**	0.0907
λ2	0.017	0.0313
Impact of covariates		S.E
Z-Score	0.005	0.0053
Investment Banking Fees/TA	0.141***	0.0676
E/TA	0.113**	0.0405
Securities/TA	0.199***	0.0377
Income diversification	-0.017***	0.0043
GDP per capita	-0.047	0.1237
FDI inflows	-0.008***	0.0025
FDI outflows	-0.003*	0.0018
DCPS/GDP	-0.004	0.0290
Real Effective Exchange Rate	0.000	0.0006
House Price Index	-0.000*	0.0002
Stock Price Index	-0.001**	0.0002
Burst of the asset bubble (dummy)	-0.024**	0.0099
Reserves	0.045***	0.0131
Volatility Implied Index	-0.002***	0.0005
δ	0.049	0.0514
Observations	609	
Low regime	195	
High regime	414	

Notes: the Table reports the estimations for the dynamic panel threshold model. Each regime has at least 5% of the observations (Hansen, 1999). The liquidity threshold value ranges between 0.02045 and 0.59454. We denote as dependent variable banks' efficiency scores(eff_{it}), while as the threshold and the regime dependent variable we impose the liquidity $(liquidity_{it})$, which represents bank's liquid assets over total assets. Following Bick (2007), the model accounts for regime dependent intercepts (δ).We assume m_{it} includes bank-specific and country explanatory variables. For bank-specific variables we use: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Investment Banking Fees= net fees, commission and trading income over total assets; Securities/TA= total securities over total assets; Income diversification= 1- |Net Interest Income-Other Operating Income|/Total Operating Income; E/TA= equity over total assets. As country variables we employ: GDP per, capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Reserves (natural logarithm); Burst of the asset bubble (dummy); Volatility Implied Index . For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (VIX-*Chicago* Board Options *Exchange* Volatility Index) and Stock Price Index we use Bloomberg database. Also as endogenous variable for the model we impose Z-Score, where $Z - Score = eff_{it-1}$. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Again we find evidence of two regimes. A liquidity threshold value of around 0.230 splits the sample into (i) banks with low liquidity ratios (higher liquidity risk) and (ii) banks with high liquidity ratios (lower liquidity risk). We find a negative and significant (at the 5% level) relationship between liquidity and performance for banks within the low regime (high liquidity risk) as λ_1 = -0.202. This result is consistent with the findings of Kwan

(2003) and Staikouras et al. (2008). On the other hand, the impact of liquidity on bank performance for the banks in the high regime is rather inconclusive as it is not significant, yet it takes a positive sign as in Athanasoglou et al. (2008).

Table 9 shows the classification of banks over time based on the liquidity threshold value (0.23). This classification implies that there are more banks classified in the high liquidity regime as opposed to the low one over the whole period. This also indicates that the majority of investment banks fall into the category of high liquidity and hence carry less liquidity risk in the event of a financial shock. Nonetheless, the number of banks within the low regime increases from 28% in 2007 to 37% in 2009.

Table 9. Dynamic Threshold Analysis: classification of investment banks into the two identified regimes based on threshold value of Liquidity.

Threshold: Liquidity													
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Low regime	45%	41%	31%	21%	22%	32%	29%	38%	32%	28%	36%	37%	30%
High regime	55%	59%	69%	79%	78%	68%	71%	63%	68%	72%	64%	63%	70%

Notes: the Table shows the classification of the investment banks based on the liquidity threshold value that we obtained following Kremer's et al. (2013) threshold model for the dynamic panel. As threshold variable we use the ratio of liquid assets to total assets.

For the remaining bank-specific determinants, we find that investment banking fees, equity, and securities to total assets ratios have a highly significant and positive impact on cost performance (see Table 8) while the income diversification variable has a negative impact on efficiency at the 1% level of significance. For the country-level variables, we find that FDI inflows, stock price index, bubble burst and VIX indicator have a strong negative impact on cost performance. Additionally, central bank reserves continue to have a strong positive effect on cost performance at the 1% level of significance.

2.5.3.3 Investment Banking Fees Threshold

In this section, we use the ratio of investment banking fees to total assets as the threshold variable to test the effect of investment banking fees on cost efficiency performance. We present our findings in Table 10.

Table 10. Results of dynamic panel threshold estimation with investment banking fees as threshold variable.

Investment banks		
Threshold estimate		
Investment banking fees		0.009322
95% confidence interval		(0.008271-0.009322)
Impact of investment banking fees/TA		S.E
λ1	0.216**	0.0941
λ2	-0.005	0.0633
Impact of covariates		S.E
Z-Score	0.007	0.0052
Liquid Assets/TA	0.059	0.0366
E/TA	0.117**	0.0414
Securities/TA	0.020	0.0352
Income diversification	-0.016***	0.0040
GDP per capita	-0.113	0.1261
FDI inflows	-0.009***	0.0026
FDI outflows	-0.003	0.0017
DCPS/GDP	-0.027	0.0286
Real Effective Exchange Rate	0.000	0.0006
House Price Index	0.000	0.0002
Stock Price Index	-0.001**	0.0002
Burst of the asset bubble (dummy)	-0.026**	0.0097
Reserves	0.046***	0.0134
Volatility Implied Index	-0.002***	0.0005
δ	0.146**	0.0672
Observations	609	
Low regime	73	
High regime	533	

Notes: the Table reports the estimations for the dynamic panel threshold model. Each regime has at least 5% of the observations (Hansen, 1999). The threshold value of Investment Banking Fees variable for banks range between 0.008271 and 0.009322. We denote as dependent variable banks' efficiency scores(eff_{it}), while as the threshold and the regime dependent variable we impose the Investment Banking Fees ($Investment\ Banking\ Fees_{\ it}$), which represents banks' net fees commission and trading income over total assets. Following Bick (2007), the model accounts for regime dependent intercepts (δ). We assume m_{it} includes bank-specific and country explanatory variables. For bank-specific variables we use: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Liquid assets over total assets; Securities/TA= total securities over total assets; Income diversification= 1- |Net Interest Income-Other Operating Income|/Total Operating Income; E/TA= equity over total assets. As country variables we employ: GDP per capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Burst of the asset bubble (dummy); Reserves (natural logarithm) ; Volatility Implied Index. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (VIX-*Chicago* Board Options *Exchange* Volatility Index) and Stock Price Index we use Bloomberg database.. Also as endogenous variable for the model we impose Z-Score, where $Z - Score = eff_{it-1}$. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

The threshold value of fee-income is around 0.009. The variable splits the sample into two regimes. In line with Demirguc-Kunt and Huizinga (2010) we find that for banks with low levels of investment fees (for banks in the low regime) an increase in fees asserts a positive and significant (at the 5% level) impact on performance as λ_2 = 0.216. This finding supports our third hypothesis (H3). Nonetheless, banks within the high regime exhibit a decrease in performance when fees increase, but in this case, this effect is not statistically significant.

Between 1998-2007 we observe a stable increase in the percentage of investment banks that belong to the low fee regime that peaks in 2008, while in 2009 and 2010 there is a decrease in banks that fall within this regime (see Table 11).

Table 11. Dynamic Threshold Analysis: classification of investment banks into the two identified two regimes based on Investment Banking Fees.

Threshold: Investment Banking Fees													
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Low regime	5%	6%	6%	6%	6%	11%	10%	13%	12%	15%	19%	15%	14%
High regime	95%	94%	94%	94%	94%	89%	90%	88%	88%	85%	81%	85%	86%

Notes: the Table shows the classification of the investment banks based on the investment banking fees threshold value that we obtained following Kremer's et al. (2013) threshold model for the dynamic panel. As threshold variable we use: Investment Banking Fees= net fees, commission and net trading income over total assets.

Regarding the other cost efficiency correlates, we find equity to total assets to have a strong positive impact on cost performance. As in with our previous findings, income diversification has a strong negative effect on investment banking performance at the 1% level of significance. The relationship between FDI inflows, stock price index, the bubble burst and VIX indicator and efficiency remains negative and significant, in line with our previous results. Lastly, central bank reserves stimulate the cost efficiency of investment banks.

2.5.3.4 Does the impact of liquidity differ for investment banks as subsidiaries of banking groups?

Subsidiary banks as a part of a larger banking entity can benefit from liquidity injections as these banks have ready access to liquidity from the parent bank (Mayer and Carlyn, 2008). Banks that are members of a banking group can draw liquidity from the parent company in case of a financial shock (De Haas and van Lelyveld, 2010). We split the sample between banks that are part of a banking group and those which are not for this reason. Our findings are available in Tables 12 and 13.

Table 12. Sensitivity analysis with liquidity as bank cost efficiency determinant.

Variables	Model(1)	Model(2)	Model(3)	Model(4)
Lag efficiency	0.434***	0.491***	0.355***	0.223*
	(0.0993)	(0.119)	(0.172)	(0.176)
Liquid assets/TA	0.105*	0.147**	-0.103*	-0.087**
	(0.0645)	(0.0707)	(0.0652)	(0.0430)
Z-Score		0.015*		0.081**
		(0.0076)		(0.0036)
Investment banking fees/TA		0.388***		0.096
		(0.145)		(0.091)
E/TA	-0.136	-0.179	0.043	-0.002
	(0.120)	(0.132)	(0.079)	(0.011)
Securities/TA	0.244***	0.272***	0.079*	0.211**
	(0.0629)	(0.0592)	(0.0472)	(0.0831)
Income diversification	-0.021***	-0.023***	-0.102***	-0.102***
	(0.0022)	(0.0019)	(0.0333)	(0.0394)
GDP per capita	-0.290	-0.473***	-0.006	-0.008
	(0.178)	(0.172)	(0.0319)	(0.295)
FDI inflows	-0.009**	-0.008***	-0.004	-0.006**
	(0.0038)	(0.0029)	(0.0049)	(0.003)
FDI outflows	0.001	0.002	-0.002	-0.002
	(0.0019)	(0.00241)	(0.0025)	(0.0015)
DCPS/GDP	-0.086**	-0.067	-0.093	-0.190
	(0.041)	(0.0444)	(0.107)	(0.11)
Real effective exchange rate	0.001	0.001	-1.39e-06	0.001
	(0.0012)	(0.0011)	(0.0018)	(0.0013)
House Price Index	-0.001**	-0.001*	-0.000	-0.001
	(0.0002)	(0.0002)	(0.0004)	(0.0005)
Stock Price Index	-0.0006	-0.0005	-0.0075*	-0.0006**
	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Burst of the asset bubble (dummy)	-0.023	-0.020	0.019	0.009
	(0.0159)	(0.0194)	(0.0139)	(0.017)
Reserves	0.084***	0.051*	0.067*	0.061**
	(0.0283)	(0.0280)	(0.0367)	(0.0308)
Volatility Implied Index	-0.001	0.001	-7.19e-05	0.000347
	(0.001)	(0.0012)	(0.0007)	(0.0008)
Constant	1.471	4.003**	-0.187	-1.001
	(1.958)	(1.700)	(3.938)	(3.005)
Wald test	365.63***	1058.80***	110.82***	194.33***
Sargan (p-value)	36.98(0.35)	21.25(0.45)	18.65(0.52)	18.73(0.56)
AR(1)	-2.42**	-2.13**	-2.12**	-2.22**
AR(2)	-1.156	-0.81851	1.1053	1.13
Observations	390	390	219	219
Number of instruments	23	23	23	23
Number of banks	64	64	33	33

Notes: Models 1&2 refer to dynamic panel results for banks that belong to a group and Models 3&4 for stand-alone investment banks. The Table reports the regression results based on a fixed effect model over the period 1997 to 2010. The dependent variable is cost efficiency derived using a SFA methodology. As bank-specific independent variables we employ: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Investment Banking Fees= net fees, commission and trading income over total assets; Liquid assets over total assets; E/TA= equity over total assets; Income diversification= 1- |Net Interest Income-Other Operating Income|/Total Operating Income; Securities/TA= total securities over total assets. As country variables we employ: GDP per capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Burst of the asset bubble (dummy); Reserves (natural logarithm); Volatility Implied Index. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (VIX-*Chicago* Board Options *Exchange* Volatility Index) and Stock Price Index, we use Bloomberg database. Windmeijer (2005) corrected (robust) standard errors are in parentheses.

Table 13. Sensitivity analysis with liquidity as threshold variable.

Investment banks		
Threshold estimate	Model (1)	Model (2)
Liquidity	0.525295	0.314819
95% confidence interval	(0.289233-0.557692)	(0.02081-0.541402)
Impact of Liquid Assets/TA		
λ1	-0.086**	-0.105
λ2	-0.008	-0.032
Impact of covariates		
Z-Score	0.004*	0.0068
Investment Banking Fees/TA	0.018	0.1040
E/TA	0.106***	0.0630
Securities/TA	0.041	0.0420***
Income diversification	-0.099***	-0.0155***
GDP per capita	-0.448***	0.1523
FDI inflows	-0.001	-0.0150**
FDI outflows	-0.001	-0.0013
DCPS/GDP	-0.014	-0.0071
Real Effective Exchange Rate	0.000	0.0003
House Price Index	-0.001*	-0.0006**
Stock Price Index	-0.000	-0.0008**
Burst of the asset bubble(dummy)	-0.011	-0.0331**
Reserves	0.068	0.0400**
Volatility Implied Index	-0.000	-0.0025***
δ	0.005	0.0022
Observations	219	390
Low regime	160	137
High regime	59	253

Notes: Model 1 refers to dynamic panel threshold results for stand-alone banks and Model 2 for investment banks that belong to a group. The Table reports the estimations for the dynamic panel threshold model. Each regime has at least 5% of the observations (Hansen, 1999). The liquidity threshold value for non-banking group ranges between 0.289233 and 0.557693 while for banking group banks between 0.02081 and 0.541402. We denote as dependent variable banks' efficiency scores(eff_{it}), while as the threshold and the regime dependent variable we impose the liquidity ($liquidity_{it}$), which represents bank's liquid assets over total assets. Following Bick (2007), the model accounts for regime dependent intercepts (δ). We assume m_{it} includes bank-specific and country explanatory variables. For bank-specific variables we use: Z-Score= (1+ROE)/ (Standard Deviation of ROE); Investment Banking Fees= net fees, commission and trading income over total assets; Securities/TA= total securities over total assets; Income diversification= 1- |Net Interest Income-Other Operating Income|/Total Operating Income; E/TA= equity over total assets. As country variables we employ: GDP per capita; DCPS/GDP; FDI inflows; FDI outflows; Real Effective Exchange Rate; House price Index; Stock Price Index; Burst of the asset bubble (dummy); Reserves (natural logarithm); Volatility Implied Index. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank. As House Price Index we use the index constructed by the Economist Intelligence Unit using as the base year the 1997. For Volatility Implied Index (VIX-*Chicago* Board Options *Exchange* Volatility Index) and Stock Price Index we use Bloomberg database. Also as endogenous variable for the model we impose Z-Score, where $Z - Score = eff_{it-1}$. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

A number of previous studies have found a positive relationship between liquidity and bank performance (Bourke, 1989; Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008). Our results show that for banks as part of a banking group, an increase in liquidity has a positive effect on efficiency at the 10% and 5% levels of significance

(Model 1 and 2 in Table 12). Yet an increase in liquidity for stand-alone banks has a negative impact on efficiency at the 10% and 5% levels of significance (Model 3 and 4 in Table 12). The negative relationship between liquidity and bank performance is supported by empirical evidence (Kwan, 2003; Staikouras et al., 2008; Pasiouras and Kosmidou, 2007). The first result supports the '*bad luck hypothesis'* (H_2) concerning the positive impact of liquidity on cost efficiency. However, our findings imply that the impact of liquidity on performance varies and depends on whether investment bank could draw liquidity from a larger banking entity. Table 13 presents threshold estimations for stand-alone banks, revealing that an increase in liquidity for the low liquidity regime banks has a negative effect on investment bank performance at the 5% level of significance as λ= -0.086 (Model 1 in Table 13). Moreover, threshold estimation for subsidiary banks shows that for both the low and high regime investment banks there exists a negative relationship between efficiency and liquidity but the coefficients are not statistically different from zero (Model 2 in Table 13). The results for both banking groups may indicate that our significant threshold liquidity effects for the whole sample are driven by banks with low liquidity that are mainly banks that do not belong to a larger banking entity.

Table 14 shows that the majority of stand-alone investment banks fall within the low liquidity regime. Lastly, the number of banks in the low liquidity regime decreases markedly (20%) from 2007 to 2008 with the burst of the financial crisis (Panel A in Table 14).

Table 14. Dynamic Threshold Analysis: classification of investment banks into the two identified regimes based on liquidity (stand-alone and group-banks).

Panel A: Liquidity (stand-alone banks)													
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Low regime	73%	77%	79%	74%	62%	80%	71%	77%	77%	80%	60%	67%	63%
High regime	27%	23%	21%	26%	38%	20%	29%	23%	23%	20%	40%	33%	37%
Panel B: Liquidity (group-banks)													
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Low regime	55%	47%	32%	28%	28%	38%	33%	44%	43%	36%	44%	41%	37%
High regime	45%	53%	68%	72%	72%	62%	67%	56%	57%	64%	56%	59%	63%

Notes: the Table shows the classification of the investment banks (stand-alone and group-banks) based on the threshold values that we obtained following Kremer's et al. (2013) threshold model for the dynamic panel. As threshold variable we use the ratio of liquid assets to total assets. The low regime stands for the percentage of banks that have bank-specific values for the liquidity measure below the threshold, while the high regime stands for the percentages of banks that have bank-specific values above the liquidity threshold value.

2.6 Conclusions

In this chapter, we employ the dynamic panel threshold methodology introduced by Kremer et al. (2013) and find that the positive impact of Z-Score on investment bank performance, as measured by cost efficiency, is more pronounced for banks with lower risk. This result is important in the context of the investment banks whose operations are inherently riskier than those of conventional banks (Bertay et al., 2013). Furthermore, we find that liquidity has a negative impact on cost efficiency for banks that belong to the low liquidity regime. This effect is driven for the most part by stand-alone banks that could neither draw liquidity from a larger banking entity nor rely on deposits as commercial banks (Gatev and Strahan, 2006; Gatev et al., 2009). The analysis also reveals that the fee income ratio has a positive impact on cost efficiency only for banks belonging to the low fee-income regime. This suggests that an increase in investment banking fees comes at the expense of increased risk for investment banks in the high fee-income regime. This is a major difference between investment banks and conventional, as for the latter a rise of the fee-income could bring diversification benefits (De-Young and Rice, 2004; Chiorazzo et al., 2008).

Notably, we find important changes in the percentages of banks that fall within each threshold regime before and during the financial crisis. In particular, the percentage of banks in the regime of high default risk (low Z-Score), increases considerably in the 2008-2010 period. This indicates that investment banks underwent a period of substantial financial distress. Moreover, the number of banks belonging to the low liquidity regime increases in the years of the crisis. This, in combination with the negative impact of liquidity on cost efficiency for stand-alone investment banks in the low liquidity regime could denote the high costs of drawing liquidity during financial turmoil (Brunnermeier and Pedersen, 2009). Finally, there is a slight increase in the number of banks belonging to the low fee-income regime over the crisis period. The positive impact of fee-income on the performance of banks in the low regime could suggest the importance of income generation capability in order to weather the financial crisis.

Measures to strengthen bank stability are warranted. One of the regulatory gaps revealed by the credit crunch was the absence of strict capital adequacy ratios for investment banks. This became evident during the crisis period as the intensification of investment banking risk led to significant losses both for the financial institutions and the entire economy. More stringent legislation related to capital requirements such as the Dodd-Frank Act (2010) in the US and the Capital Requirements Directive 4 (CRD 4) in Europe could act as a defence mechanism against default risk and thus improve investment bank performance. In terms of liquidity, the liquidity coverage ratio (LCR) proposed in Basel III and in CRD 4 could ensure sufficient short-term liquidity and thus diminish the need for banks to seek external funding during periods of financial turmoil. The LCR measure could be of particular importance for stand-alone investment banks who cannot rely on deposit funding.

Chapter 3: The effect of corporate governance on the performance of US investment banks

3.1 Introduction

The liberalization and the globalization of financial services in combination with rapid advances in the financial innovation have broadened significantly the variety of operations in which investment banks engage in over the last two decades. Such operations are the issuance of debt or equity securities in the primary market, while they also include the financial advisory services and the trading of securities in the secondary market. As a result, the performance of investment banking industry, through complex and far-reaching operations, is of utmost importance for the well-functioning of global financial markets. Yet, few studies (Brunnermeier and Pederson, 2009; Adrian and Shin, 2010; Radic et al., 2012) appear to examine the underlying determinants of the performance of investment banks. This chapter bridges this gap in the literature and further reveals a crucial link between corporate governance and the performance of these financial institutions.

Investment banking activities have been particularly important in the US economy as they captured more than half (58%) of the global investment banking revenues in 2012, while the US investment banking accounted for 30% of the total US banking industry profits during the same year. However, the investment banking industry has also been held accountable for the credit crunch in 2008 that hit the US and then was transmitted globally. In fact, the turmoil reveals the possible detrimental impact of the investment banking on the financial market (Brunnermeier and Pederson, 2009; Demirguc-Kunt and Huizinga; 2010). Moreover, the US financial market towards the end of the last decade entered a period of unprecedented instability where the estimated losses due to subprime mortgages were between 400 (US$bn) and 500 (US$bn). Consequently, investment banks went through some very dramatic changes. Bear Stearns was acquired by JP Morgan with the financial support of the Federal Reserve Bank, Merrill Lynch had to raise a substantial volume of capital to cover high realised losses on assets, whereas Lehman Brothers filed for bankruptcy. Demirguc-Kunt and Huizinga (2010) and Acharya and Richardson (2009) argue that part of the causes of the crisis should be attributed to the considerably complex activities of investment banks. The shift of financial institutions from deposit-taking activities into highly complex operations might have contributed to the crisis resulting in the underperformance of investment banks and the financial system as a whole (Demirguc-Kunt and Huizinga, 2010).[17] The degree of complexity of the investment banking is related closely to the underlying corporate governance. To this end, an inquest into the operations of investment banks necessitates a detailed study of their corporate governance.

In this chapter, we focus on the impact of the corporate governance on investment bank performance. Due to the crisis of 2007, the governance of financial institutions has been into the spotlight (Fahlenbrach and Stulz, 2011; Erkens et al., 2012; Beltratti and Stulz, 2012; Pathan and Faff, 2013; Vallascas and Hagendorff, 2013), whilst a growing perception about the destructive role of corporate governance has gained support (Kirkpatrick, 2009). Coming up with a definition of corporate governance is not an easy task. Gillan and Starks (1998) define corporate governance as an internal mechanism that is linked closely to the system of acts, laws, and dynamics that control the operations of a firm. Therefore, corporate governance is very complex particularly for banks which are

[17] Fernando et al. (2012) demonstrate that firms that had as their main equity underwriter Lehman Brothers suffered economically and their earnings experienced a substantial fall.

unique and differ fundamentally from non-banking institutions. This, in turn, implies that corporate governance in banks has an important role because of the specialness of these institutions. Banks have three main characteristics that motivate a separate examination of the corporate governance in banking. Firstly, according to the banking theory, the nature of financial intermediation makes banks more opaque compared to other institutions due to the difficulty of outsiders to monitor bank assets (Diamond and Rajan, 2001; Levine, 2004). Moreover, the special nature of banks is reflected on the complexity of the bank business model (Furfine, 2001). In the case of investment banks, the high level of operational complexity is of utmost importance because it distinguishes the business model of these financial institutions from that of other types of banking and non-banking institutions (Acharya and Richardson, 2009; Demirguc-Kunt and Huizinga, 2010). Therefore, the issue of bank opacity in combination with the complexity of the bank business model makes it difficult for the outside shareholders to monitor bank operations raising in this way information asymmetries (Andres and Vallelado, 2008).

Secondly, banks are heavily leveraged institutions and this can have implications in terms of corporate governance (Hagendorff, 2014). Banks' equity is relatively low compared to the standards of other institutions. However, shareholders in banks appear to control the main mechanisms of corporate governance such as the executive compensation and the board of directors. Hence, despite the fact that creditors are more important than equity investors for the wealth of banks, the shareholders of banks have a predominant role in the governance of banks and thus can take decisions intended to maximize their own wealth. This is particularly important as shareholders are risk-neutral while creditors risk-averse and thus, they have different risk preferences. (Hagendorff, 2014). This, in turn, implies that under a high level of leverage the power of shareholder rises as they have a key role in the decision-making process of banks (Jensen and Meckling, 1976; Hagendorff, 2014). In this case, shareholders hold large claims on bank's assets and hence they are encouraged to raise risk aiming to increase their equity value. However, an increase of bank risk would bear losses for creditors and thus, this would decrease their wealth.

Thirdly, regulation plays a crucial role for banking institutions due to the importance of banks in the economy and the opacity of bank activities (Hagendorff, 2014). This special monitoring of regulators for banks is a supplementary governance, as for example in the US regulators have imposed restrictions on the executive compensation (Board of Governors et al., 2010). Moreover, with regards to the banking industry, the government can also own banks and thus act in its own interests (Santomero, 1997). Previous studies show that state-owned banks underperform compared to private banks (Iannotta et al., 2007; Lin and Zhang, 2009). This is due to the fact that state-owned banks have to provide primarily funding for governmental projects that might dampen bank performance (Altunbas et al., 2001).

Investment banks focus primarily on non-interest income activities and thus they differ principally from other types of banks, such as commercial banks, that concentrate on interest income operations (Demirguc-Kunt and Huizinga, 2010). In addition, after the hit of the financial crisis of 2007, the government intervention in the investment banking is particularly evident as many US investment banks had to convert their status into Bank Holding Companies (BHCs) in order to gain access to the Federal Deposit Insurance (FDIC) support (Volcker, 2010) and other funding programs such as the Troubled Asset Relief Program (TARP). The status of investment banks as part of BHCs implies that the main stakeholders have become other banks in the group and the government. These structural changes could lead to a rise in moral hazard of investment banks because it enables them to rely on the funds of the other banking institutions that belong to the BHC (Mayer and Carlyn, 2008) and on the 'implicit government guarantee' that the access to FDIC support implies (Sironi, 2003; Gropp et al., 2006; Gropp et al., 2013). Therefore, examining the impact of corporate governance on the performance of investments banks is important for both bank managers and regulators. Furthermore, an advantage of our analysis is that it tests for threshold-effects of important corporate governance variables with respect to bank performance over a period that covers the financial crisis and the immediate period after. Possible changes in the percentage of banks that belong to threshold regimes would imply transformations in the structure of corporate governance mechanism of investment banks before and after the turmoil. Thus, this study could also shed light on the effect of corporate governance changes on investment bank performance since the period that investment banks have been converted to BHCs.

The current banking literature focuses on various dimensions of corporate governance. Table 1 presents an overview of the recent studies that examine the impact of corporate governance on bank performance. A number of papers put emphasis on board structure (Andres and Vallelado, 2008; Tanna et al., 2011; Adams and Mehran, 2012; Pathan and Faff, 2013; Liang et al., 2013), i.e., board size, board composition and gender diversity, and its impact on bank performance. Other studies look at the impact of executive compensation and managerial incentives on performance (Pi and Timme, 1993; Fahlenbrach and Stulz, 2011; Beltratti and Stulz, 2012; Erkens et al., 2012) and bank risk (Vallascas and Hagendorff, 2013; Berger et al., 2014). A smaller amount of studies examines the relationship between CEO power and bank performance (Mishra and Nielsen, 2000) and risk (Pathan, 2009). Lastly, there is also empirical evidence of the effect of operational complexity on bank performance (Adams and Mehran, 2012). Hence, according to the literature, there are five broad mechanisms of corporate governance: board structure, executive compensation, managerial incentives, CEO power, and operational complexity.

Table1. Recent studies on the relationship between corporate governance and bank performance.

References	Countries in Sample	Years in sample	Specialisation of banks	Measure of performance	Methodology
Andres and Vallelado (2008)	Spain, Italy, France, Canada, United States, and the United Kingdom	1995-2005	Commercial banks	Tobin's Q, ROA and annual returns of bank shareholders	Two-step 'system' GMM estimator
Tanna et al. (2011)	United Kingdom	2001-2006	Commercial, saving and investment banks*	Efficiency (Data Envelopment Analysis-DEA)	OLS
Beltratti and Stulz (2012)	United States	2007-2008	Commercial banks	Buy-and-hold returns	Cross-sectional regressions
Fahlenbrach and Stulz(2011)	United States	2007-2008	Commercial banks	Buy-and-hold returns	Cross-sectional regressions
Erkens et al. (2012)	Australia, Austria, Belgium, Bermuda, Brazil, Canada, China, Cyprus,Denmark,Finland,France,Germany,Greece,Iceland,India ,Ireland,Italy,Liechtenstein, Luxembourg, Morocco, Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, United Kingdom and the United States	2007-2008	Commercial banks, brokerages, and insurance companies	Buy-and-hold returns	OLS and Tobit regressions
Pathan and Faff (2013)		1997-2011	Bank Holding Companies (BHCs)	Tobin's Q, ROA, ROE,POI ratios	Two-step 'system' GMM estimator
Liang et al. (2013)	China	2003-2010	Commercial	ROA and ROE	Two-step 'system' GMM estimator
Adams and Mehran (2012)	United States	1965-1999	Bank Holding Companies (BHCs)	Tobin's Q and ROA.	Fixed-effect estimator
Aebi et al. (2012)	United States	2007-2009	Commercial and Saving banks	Buy-and-hold returns, ROA, and ROE	Time-series regressions
Mishra and Nielsen (2000)	United States	1975-1989	Bank Holding Companies (BHCs)	ROA and ROE	OLS and 2SLS
Choi and Hasan (2005)	Korea	1998-2002	Commercial banks	ROA, ROE, and Efficiency	OLS
Pi and Timme (1993)	United States	1987-1990	Bank Holding Companies (BHCs)	ROA and Efficiency	OLS and Tobit regressions

*The list of the Bank of England's (2006) Institutions included within the United Kingdom banking sector –nationality analysis.

Some of the above studies (Andres and Vallelado, 2008; Pathan and Faff, 2013; Liang et al., 2013) use a dynamic panel regression framework (two-step 'system' GMM estimator) for their analysis, while others (Fahlenbrach and Stulz, 2011; Beltratti and Stulz, 2012) employ cross-sectional type of estimations as they examine only a short period of time (2007-2008). However, the usage of a dynamic panel is relevant in the context of this study as it accounts for endogeneity issues that arise from the examination of the relationship between corporate governance and bank performance. Additionally, the well-known persistence in bank profits (Berger et al., 2000) could be treated by the usage of the lagged dependent variable among the regressors (Athanasoglou et al., 2008). With regards to the methods employed for the estimation of bank performance most of the studies use accounting-based indicators (Andres and Vallelado, 2008; Pathan and Faff, 2013; Liang et al., 2013; Adams and Mehran, 2012; Aebi et al., 2012; Mishra and Nielsen, 2000), neglecting in that way the importance of using also a structural approach of measuring performance, i.e. the Stochastic Frontier Analysis (SFA). The SFA approach of measuring bank performance has the advantage of accommodating a full set of information from bank balance sheets, and not just a single ratio as simple accounting indicators, whilst it is based on the fundamental notion of microeconomic theory of optimising when it comes to performance. In addition, according to Hughes and Mester (2010) using SFA for measuring bank performance reveals bank managers' decisions regarding both expected revenues, costs, and the related risk. In this study, we opt for both the SFA approach and accounting-based indicators. In addition, the majority of existing studies examines the impact of corporate governance on bank performance of commercial or BHCs banks (Mishra and Nielsen, 2000; Andres and Vallelado, 2008; Pathan and Faff, 2013; Liang et al., 2013; Adams and Mehran, 2012; Aebi et al., 2012; Fahlenbrach and Stulz, 2011; Beltratti and Stulz, 2012). However, none of these studies focuses exclusively on the examination of the underlying relationship between corporate governance and the performance of investment banks.

This chapter contributes to the existing literature in several ways. It is the first study to examine the impact of corporate governance on investment bank performance during both the pre-crisis and post-crisis period. Secondly, we employ a comprehensive set of corporate governance measures which includes board structure, compensation, managerial ownership, CEO power and operational complexity. Thirdly, we use both simple accounting-based financial indicators and the SFA approach to proxy for bank performance, providing in that way additional evidence for the validity of our findings. Finally, we opt for a dynamic threshold model (Kremer et al., 2013) to investigate possible threshold-effects of some key corporate governance determinants of investment bank performance under a period of financial distress. The main advantage of this analysis is that different regimes could be identified endogenously from the underlying data generating process.

Our results show that the board size asserts a negative effect on performance consistent with the *'agency cost hypothesis'*, particularly for banks with board size higher than ten members. The threshold analysis reveals that in the post-crisis period most of the investment banks opt for boards with less than ten members, aiming to decrease the agency conflicts endemic in large boards. We also find evidence of a negative association between operational complexity and performance. Moreover, CEO power asserts a positive effect on performance in line with the *'stewardship hypothesis'*. In addition, an increase in the share ownership of board members has a negative impact on performance for banks below an identified threshold. On the other hand, for banks with share ownership of board members above the threshold value, this effect turns positive, indicating an alignment between shareholders' and managers' incentives.

The rest of this chapter is structured as follows. Section 3.2 presents the hypotheses development and discusses further the related literature review. Section 3.3 introduces the data while Section 3.4 discusses the methodology. Section 3.5 provides the empirical findings and Section 3.6 concludes.

3.2 Related literature and hypotheses development

3.2.1 Board size and bank performance

Agency theory posits that a large board can be less efficient than a small board due to a rise in agency conflicts because of inefficient communication and cooperation costs (Jensen, 1993; Lipton and Lorsch, 1992). Turning now to the empirical research that focuses on the banking industry, Pathan and Faff (2013) study the impact of board size on bank performance for a sample of US BHCs over the 1997-2011 periods. In support of the agency cost theory, the authors observe a negative relationship between board size and performance as estimated by Tobin's Q, return on assets (ROA), return on equity (ROE) and pre-tax operating income (POI) ratios. In an earlier study, Andres and Vallelado (2008) show that there exists an inverted U-shaped association between board size and bank performance for 69 commercial banks from six European countries over 1995-2005 periods. This indicates that an increase in the number of board members to a certain extent enhances the performance of banks, as large financial institutions benefit from more board members who can legitimate the company to its external environment (Pfeffer, 1972). However, when the board size becomes very large this, in turn, can have the adverse effect on performance due to high information asymmetries between the board members. Based on the above theoretical framework and previous empirical findings, the first hypothesis, H1, can be defined as:

H1: An increase in the number of board members has a negative effect on the performance of investment banks.

3.2.2 Board composition and bank performance

Jensen and Meckling (1976) argue that more independent oriented boards are positively related to firm performance. Dalton et al. (1998) suggest that independent directors minimize managerial entrenchment risk through their expertise and objectivity in the decision-making process. However, recent empirical evidence that focuses on the banking industry suggests that there exists a negative relationship between bank performance and board independence. In particular, Pathan and Faff (2013) find a negative association between bank performance, estimated by various financial indicators, and board independence for the 1997-2011 periods. This study lends support to the 'stewardship theory' (Donaldson, 1990), that an increase in the proportion of non-independent directors (insiders) could positively contribute to firm performance as insiders have more experience and better firm-specific knowledge (Gomez-Mejia and Wiseman, 1997). Also, a higher level of independence may result in infertile political activity by non-independent members that could lessen the productivity of the outsiders and decrease the cooperation among the board members (Westphal, 1998, 1999). In support of this argument, Erkens et al. (2012) find that board independence dampens the performance, as estimated by buy-and-hold stock returns, of 296 banks across 30 countries over the financial crisis period (2007-2008). Therefore, based on the above discussion our second hypothesis can be formulated as:

H2: An increase in the proportion of independent directors has a negative impact on the performance of investment banks.

3.2.3 Gender diversity and bank performance

Robinson and Dechant (1997) suggest that female directors are likely to be more committed to their duties and communicate better with the other board directors. In support of the view that women are more productive at this level of hierarchy, Eagly and Carli (2003) argue that the 'glass ceiling' effect motivates females to be even more proficient in order to reach these kind of positions in a firm. The 'glass ceiling hypothesis' describes the gender discrimination in a firm. Under this hypothesis, there is a misperception that women have inferior skills than men and, therefore, they face additional hurdles entering the market and hold a directorship (Martell, 1999; Baxter and Wright, 2000). Even though, the existing findings are contradictory on the relationship between gender diversity and performance, most studies support that more women in the boardroom increase the firm performance. In particular, Pathan and Faff (2013) find that gender diversity, estimated as the percentage of female directors on the board, has a positive impact on bank performance proxied by Tobin's Q, ROA, ROE and POI ratios. Additionally, García-Meca et al. (2015) find that an increase in the proportion of women in the board exerts a positive effect on performance, as estimated by ROA, for a sample of 159 banks in nine countries over the 2004-2010 period. Thus, following the preceding discussion, our third hypothesis is formulated as:

H3: An increase in the proportion of female board members has a positive impact on the performance of investment banks.

3.2.4 CEO power and bank performance

According to the 'stewardship hypothesis' (Donaldson, 1990; Barney, 1990), CEO duality could enhance firm performance. This theory suggests that a CEO who is also the chairman of the board (COB), would act as a good agent of company's assets and a firm would take advantage of the unity of direction, strong command, and control that the powerful CEO would offer. Therefore, the agency conflicts would rather be moderated when the positions of the CEO and COB in a company are occupied by the same individual. Similarly, Finkelstein and D'Aveni (1994) suggest that the unity of control, as expressed by the CEO duality, encourages CEOs to make decisions determinedly. This unity of command can prove to be beneficial particularly in terms of firm performance in the event of an outside thread, such as a hostile acquisition, which requires concentration of the control and stringent monitoring (Alvarez and Svejenova, 2005). Turning to the empirical evidence, an early study by Donaldson and Davis (1991) finds that the CEO duality improves performance, lending support to the stewardship theory. Moreover, Lin (2005) finds that the CEO duality exerts a positive effect on the financial performance of Taiwan companies between 1997-1999 period. Additionally, Pathan (2009) finds that the CEO duality decreases risk-taking that in turn could improve bank performance for a sample of US BHCs over the 1997-2004 periods. Drawing from these arguments, our fourth hypothesis can be stated as:

H4: Higher CEO power has a positive impact on the performance of investment banks.

3.2.5 Executive compensation and bank performance

Executive compensation has attracted the interest of researchers as it could be perilous to the corporate governance of firms (Barro and Barro, 1990; Zajac and Westphal, 1994; Hubbard and Palia, 1995; Crawford et al., 1995; Bedchuk et al., 2009). Compensation is typically categorized into two forms: 1) cash that includes base salary and bonus 2) and equity-based compensation that includes stock options and restricted stock grants and constitutes a form of long-term compensation. Agency theorists argue that a long-term form of compensation better aligns managers' and shareholders' incentives (Jensen and Murphy, 1990), as long-term pay normally reward managers when they meet firms' performance goals (Baysinger and Hoskisson, 1990). Fahlenbrach and Stulz (2011) examine the impact of executive compensation on the performance of 77 banks for the 2007-2008 crisis period. Their results show a positive association between equity-based compensation and performance, estimated as buy-and-hold returns, during the turmoil. Another study by Vallascas and Hagendorff (2013) looks at the impact of compensation on bank risk focusing on the cash bonus payment of CEOs. They conclude CEO cash bonus has a negative effect on bank default risk, implying a positive impact on the former on bank performance. Apart from the compensation of CEO and its impact on bank performance, the compensation of top executives (top management team, TMT) has received very little empirical attention due to the assumption that the compensation schemes of TMT are 'isomorphic' with those of CEO (Carpenter and Sanders, 2002). However, Finkelstein and Hambrick, (1996) and Henderson and Fredrickson (2001) argue that there is no evidence to support the convergence in the compensation of CEO and TMT, while Hambrick (1995) shows that there is large gap between them. Therefore, it is important to control for the effect of TMT compensation when one examines the relationship between CEO compensation and bank performance. Overall, the above theoretical and empirical analysis shows that the association between the CEO equity-based compensation and performance could be positive, thus:

H5: An increase in the CEO equity-based compensation has a positive impact on the performance of investment banks, after controlling for the TMT compensation.

3.2.6 Ownership and bank performance

Following Jensen and Meckling (1976) and Eisenhardt (1989), the distinction of the ownership and managerial control leads to the misalignment of shareholders' and board's interests. Corporate governance analysts claim generally that managers' interest are in line with shareholders' when the former have partial ownership of the company (Murphy, 1999). In support of this perception, Pi and Timme (1993) find that for banks with non-chairman CEO there is a positive relationship between ownership and performance, estimated by ROA and efficiency, for a sample of US banks over the 1987-1990 periods. Lately, the financial crisis has motivated researchers to examine the corporate governance of banking entities in terms of managers' incentives over the period of the financial crisis. However, Fahlenbrach and Stulz (2011) find that there is no statistical evidence to show that the CEO incentives were not aligned with the shareholders' interests during the period of the turmoil. Similarly, Beltratti and Stulz (2012) stress that banks with a higher proportion of board ownership operate worse than banks with less board ownership for a sample of US banks over the 2007-2008 period. The reason being that banks with high ownership boards have been positioned in ways that managers assumed that would maximize shareholder wealth. However, this policy left banks exposed to high risk and had a negative effect on bank performance. Therefore, our sixth hypothesis H6.A and the competing hypothesis H6.7 is specified as follows:

H6: An increase in managerial ownership has a positive impact on the performance of investment banks.

3.2.7 Operational complexity and bank performance

Operational complexity denotes the variety of activities which are related to a firm's operations (Child, 1972). The higher the level of complexity is, the more apparent becomes the need of higher expertise and knowledge specific to the environment. This implies that co-ordination problems between specialists rise and can correspondingly increase communication costs of the firm (Lawrence and Lorch, 1967). Adams and Mehran (2012) observe a negative impact of complexity on bank performance which is consistent with the theoretical argument by Lawrence and Lorch (1967). In addition, authors find that his negative effect turns to be positive when banks have more lead directors that sit on subsidiary boards. These directors are capable of managing effectively the bank and hence can deal with increased complexity. This also implies that banks might need more independent members in their boards so as to improve the expertise and knowledge to the banks. However, as director independency increases, the level of the attendance and effort of independent members on board and committee meeting decreases, resulting in the rise of free-riding problems that large banks suffer from (Jensen, 1993). The above discussion shows that the association between operational complexity and performance could be negative after controlling for committee and board related variables, thus:

H7: An increase in operational complexity has a negative impact on the performance of investment banks, after controlling for board and committee related variables.

3.3 Data and preliminary analysis

Our sample consists of the major 23 listed investment banks headquartered in the US with standard industry classification (SIC) of 6211 and 6282. Our unbalanced panel dataset includes 203 observations over the period 2000-2012. The data are collected from DEF 14A proxy statements, 10-K annual reports, Bankscope and Thomson Financial's Banker.

The corporate governance data are hand collected from DEF 14A proxy statements of annual meetings found in the SECs EDGAR filings. Following previous studies (Pathan, 2009; Adams and Mehran, 2012; Pathan and Faff, 2013) governance data are measured from the date of the proxy statement. Financial information on investment banks is firstly sourced from Thomson Financial's Banker and secondly from 10-K annual reports of SEC'S filings and Bankscope. We include only listed investment banks as information on corporate governance data are standardized through the SEC Edgar platform. Our main inclusion criterion is that we include in the sample only financial institutions that their main source of income consists of fees, commission and trading revenues reflecting in that way their distinctive operational nature.

Table 2. Definitions of variables used in the fixed effect and dynamic panel estimations.

Variables	Measures
Corporate governance (explanatory variables)	
Board size (BS)	The number of members in the board (we use the natural logarithm in the fixed effect and dynamic panel estimations)
Board composition % (IND)	The percentage of independent directors
Gender diversity(GD)	The percentage of female directors
CEO 'internally' hired (CEOIN)	A dummy that takes the value of 1 if the CEO is the founder or has a long-term relationship with the bank, and 0 otherwise
CEO duality (CEODUAL)	A dummy that takes the value of 1 if the CEO chairs the board as well, and 0 otherwise
CEO tenure (CEOTEN)	The number of years that the CEO has served in the position (we use the natural logarithm in the fixed and dynamic panel estimations)
CEO age (CEOAGE)	The age of the CEO (we use the natural logarithm, in the fixed and dynamic panel estimations)
Executives' Compensation (bonus &base salary) (EXECASH)	The cash compensation of the top management team which includes base salary and bonus (we use the natural logarithm in the fixed and dynamic panel estimations)
Executives' Compensation (equity) (EXEEQ)	The equity compensation of the top management team which includes restricted stock and stock options (we use the natural logarithm in the fixed and dynamic panel estimations)
CEO Compensation (bonus &base salary) (CEOCASH)	The cash compensation of the CEO which includes base salary and bonus (we use the natural logarithm in the fixed and dynamic panel estimations)
CEO Compensation (equity) (CEOEQ)	The equity compensation of the CEO which includes restricted stock and stock options (we use the natural logarithm in the fixed and dynamic panel)
Executives' bonus incentive(EXEBON)	The ratio of bonus over executives' total cash compensation
CEO's bonus incentive (CEOBON)	The ratio of bonus over CEOs' total cash compensation
Board ownership % (BOARDOWN)	The percentage shares that the directors hold
CEO ownership % (CEOOWN)	The percentage shares that the CEO holds
Number of board committees (NBCOM)	The number of board committees (we use the natural logarithm in the fixed and dynamic panel estimations)
Fees paid for board meetings (FBCOM)	Fees paid to directors for attending the board committees (we use the natural logarithm in the fixed and dynamic panel estimations)
Number of audit committee meetings(NMAUD)	Number of meetings of audit committee (we use the natural logarithm in the fixed and dynamic panel estimations)
Number of Segments (SEG)	Number of different business segments (we use the natural logarithm in the fixed and dynamic panel estimations)
Number of Subsidiaries (SUBS)	Number of subsidiaries (we use the natural logarithm in the fixed and dynamic panel estimations)
Performance measures (dependent variables)	
1. Return on average assets (ROAA)	The net income before interest and taxes as a proportion of the average book value of total assets.
2. Return on average equity (ROAE)	The net income after tax as a percentage of the average book value of total equity
3. Pre-tax operating income (POI)	The pre-tax operating income as a percentage of the average total assets
4. Profit efficiency (EFF)	Efficiency scores obtained from the SFA
Other control variables	
Equity over total assets (E/TA)	The ratio of equity over total asset
Investment banking fees (FEES)	The ratio of net fees, commission and net trading income over total assets
Other earnings assets (EARN)	The ratio of trading securities, derivatives, treasury bills and bonds over total assets
Risk to default (RISK)	Z-score= (1+ ROE)/Standard Deviation of ROE
Volatility Implied Index (VIX)	Chicago Board Options Exchange Volatility Index
Post Sarbanes-Oxley Act period (PSOX)	A dummy which takes the value of 0 if year is 2000-2001 and the value of 1 otherwise.
Crisis period (CRS)	A dummy which takes the value of 1 if year is 2007-2010.

Our corporate governance data comprise five general dimensions; board structure, CEO power, compensation of the CEO and TMT, ownership of CEO and board members and operational complexity measures. In particular, we account for three board characteristics, namely board size, board composition and gender diversity. The first two variables have been used extensively in the corporate governance literature (Adams and Mehran, 2008; Andres and Vallelado, 2008; Staikouras et al., 2007; Busta, 2007; Tanna et al., 2011). Board size is the number of members that constitute the board, while board composition refers to the proportion of independent members in the board. Gender diversity is the percentage of females in the boardroom (Shrader et al., 1997; Campel and Minguez-Vera, 2008; Francoeur et al., 2008).

We employ two measures of the CEO power; CEO duality and 'internally' hired CEO. CEO duality is a dummy that takes the value of 1 if the CEO chairs the board as well, and 0 otherwise (Rechner and Dalton, 1989, 1991; Donaldson and Davis, 1991; Daily and Dalton, 1992, 1993; Daily, 1995; Boyd, 1995; Baliga et al., 1996; Dalton et al., 1998; Ballinger and Marcel, 2010). CEO 'internally' hired is a dummy variable which takes the value of one 1 if the CEO is either the founder or has been member of the board before being moved to the CEO position, while otherwise it takes the value of zero (Adams et al., 2005; Pathan, 2009; Fahlenbrach 2009). As additional CEO characteristics, we control for the CEO tenure and the CEO age. The CEO tenure is the natural logarithm of the years that the CEO has served in the same position (Mishra and Nielsen, 2000; Cornett et al., 2008; Pathan and Faff, 2013). Finally, the CEO age is the natural logarithm of the age that the CEO has (Mishra and Nielsen, 2000; Cornett et al., 2008).

In order to examine the impact of ownership on bank performance we use the number of shares hold by the CEO and TMT as the percentage of the total outstanding number of bank's shares (Beltratti and Stulz, 2012; Aebi et al., 2012). We also control for the cash short-term incentives by employing the ratio of bonus to total cash compensation of the CEO and the TMT (Fahlenbrach and Stulz, 2011). Moreover, we examine the impact of cash and equity compensation of CEO and TMT on investment bank performance. The natural logarithm of cash-based compensation includes the base salary and bonus, while the natural logarithm of equity-based compensation includes restricted stock and stock options. Decomposition of the compensation has been used in a number of different studies that investigate differences on the impact of cash and equity-based compensation on performance (Baysinger and Hoskisson, 1990; Frye, 2004; Carpenter and Sanders, 2002). We also examine the impact of operational complexity on bank performance. Operational complexity is proxied by the number of different business segments (Booth and Deli, 1999; Bushman et al., 2004; Linck et al., 2007) and subsidiaries (Adams and Mehran, 2012). Moreover, we control for the total outstanding number of board committees (Vafeas, 1999), the fees paid to the board committees and the number of audit committee meetings (Xie et al., 2003; Goodwin-Stewart and Kent, 2006).

Turning to the bank-specific control variables that are not related to corporate governance, we opt for the ratio of equity to total assets as a proxy of leverage (Berger and Bonaccorsi di Patti, 2006). We also use the ratio of other earning assets over total assets in line with Beltratti and Stulz (2012), so as to capture the different nature of investment banks centered on equity issuance and underwriting activities. We further employ the ratio of investment banking fees over total assets as non-interest income reflects the main activity of investment banks (Radic et al., 2012). Lastly, we control for the insolvency risk estimated by z-score, as in Boyd's and Graham (1986).[18]

[18]Z-score= (1+ ROE)/Standard Deviation of ROE. The z-score has been used in recent banking studies (Lepetit et al., 2008; Radic et al., 2012).

In addition, in our analysis, we account for the regulatory mandates with the introduction of the Sarbanes-Oxley Act (SOX) in 2002 as a dummy, which takes the value of 0 if the year is 2000-2001 and the value of 1 otherwise consistent with Pathan and Faff (2009).[19] We also impose a crisis dummy which takes the value of 1 if the year is 2007-2010 and zero otherwise in order to account for the financial crisis period (Pathan and Faff, 2009; De Jonghe et al., 2012). Finally, in order to capture the market risk, we use the Volatility Implied Index indicator (VIX).[20] This financial indicator suggests that higher levels of VIX reflect higher degrees of financial turmoil in the US (Whaley, 2000).

[19] In particular, Section 301 of SOX Act obligates the audit committee to be comprised solely by independent members.

[20] VIX is the volatility implied index for *Chicago* Board Options *Exchange* Volatility Index. For the data collection we use Bloomberg database.

3.3.1 Descriptive Statistics

The descriptive statistics for the corporate governance variables are provided in Table 3.

Table 3. Descriptive statistics of the variables employed in the fixed effect and dynamic panel regressions.

Variables	Mean	SD	MIN	MAX	Median
Panel A: Corporate governance variables					
BS	8.3	3.5	5	16	9
IND	0.66	0.25	0.4	0.92	0.71
GD	0.11	0.1	0	0.44	0.11
CEOIN	0.65	0.48	0	1	1
CEODUAL	0.72	0.49	0	1	1
CEOTEN	7.74	8.25	0	41	5
CEOAGE	55.35	8.18	39	72	56
BOARDOWN	12.27	15.43	0	67.21	6.68
CEOOWN	6.08	8.59	0.01	55.71	1.83
NBCOM	3.32	1.20	0	6	3
FBCOM	0.31	1.031	0	1,25	0
NMAUD	8.01	4.04	0	18	8
SEG	3.04	1.76	0	8	3
SUB	114.6	236.4	0	1255	15
EXECASH	16,500	20,700	0	139,000	7,897
EXEEQ	20,100	30,300	0	209,000	7,234
CEOCASH	4,303	6,063	0	41,200	1,950
CEOEQ	5,720	8,219	0	42,400	1,356
Panel B: Bank-specific and country level variables					
E/TA	0.2324	0.2456	0.0105	0.97	0.1022
FEES	0.4703	0.8905	0.0004	5.21	0.0676
EARN	0.6094	0.3765	0.0001	3.756	0.6638
RISK	3.0961	6.3524	-42.59	52.82	2.1066
VIX	20.97	7.5946	11.56	40	21.68
Panel C: Bank performance measures					
ROAE	8.02	29.77	-305.05	122.82	8.97
ROAA	1.96	11.73	-50.6	72.97	0.74
POI	3.32	14.99	-63.15	91.17	0.99
EFF	0.65	0.39	0.12	0.97	0.78

Panel D: Year by year corporate governance variables					
Year	**BS**	**IND**	**CEODUAL**	**CEOOWN**	**BOARDOWN**
2000	8.7	0.66	0.80	6.78	10.40
2001	8.2	0.65	0.92	5.68	9.75
2002	7.8	0.60	0.87	6.92	9.89
2003	7.4	0.60	0.80	6.91	11.11
2004	8.9	0.69	0.87	7.97	9.23
2005	8.5	0.68	0.81	7.45	9.64
2006	9.0	0.69	0.83	7.30	13.57
2007	8.5	0.66	0.82	6.39	14.20
2008	8.1	0.64	0.60	2.84	13.05
2009	8.4	0.66	0.59	7.35	14.84
2010	8.1	0.66	0.56	5.27	12.91
2011	8.0	0.66	0.47	4.08	14.57
2012	8.4	0.67	0.46	3.73	14.05

Notes: the Table reports the descriptive statistics of the variables employed in the fixed effect and dynamic panel regressions All the variables are in absolute values except the compensation determinants (EXECASH,EXEEQ,CEOCASH and CEOEQ) which are in million dollars. BS: the number of members in the board; IND: the percentage of independent directors; GD: the percentage of female directors; CEOIN: a dummy that takes the value of 1 if the CEO is the founder or has a long-term relationship with the bank, and 0 otherwise; CEODUAL :a dummy that takes the value of 1 if the CEO chairs the board as well, and 0 otherwise; CEOTEN: the number of years that the CEO has served in the position; CEOAGE: the age of the CEO; BOARDOWN: the percentage shares that the directors hold; CEOOWN: the percentage shares that the CEO holds; NBCOM: the number of board committees; NMAUD: number of meetings of audit committee; FBCOM: fees paid to directors for attending the board committees; SEG: the number of different business segments; SUBS: Number of subsidiaries; EXECASH: the cash compensation of the top management team which includes base salary and bonus; EXEEQ: the equity compensation of the top management team which includes restricted stock and stock options; CEOCASH: the cash compensation of the CEO which includes base salary and bonus; CEOEQ: the equity compensation of the CEO which includes restricted stock and stock options; E/TA: equity over total assets; FEES: of net fees, commission and net trading income over total assets; EARN: ratio of trading securities, derivatives, treasury bills and bonds over total assets; RISK: Z-score= (1+ROE)/Standard Deviation of ROE; VIX: Volatility Implied Index (Chicago Board Options Exchange Volatility Index); ROAE: net income after tax as a percentage of the average book value of total equity; ROAA: net income before interest and taxes as a proportion of the average book value of total assets; POI: pre-tax operating income as a percentage of the average total assets; EFF: efficiency scores obtained from the SFA.

The sample mean of board size in Panel A of Table 3 is 8.30, which is similar to that of 10 in Coles et al. (2008) and 9 in Francis et al. (2012). Moreover, our sample mean of gender diversity of 0.11 is comparable to that of 0.076 in Pathan and Faff (2013). Turning to the CEO characteristics, the sample mean of CEO duality is 0.72, while that of CEO 'internally' hired is 0.65 which is similar to that of 0.58 in Pathan and Skully (2010). The CEO age sample mean is 55.35 (years), which is comparable to that of 56.26 in Cornett et al. (2009). Also, the mean tenure of the CEO is 7.74 (years) and is similar to that of 8.85 in Pathan and Skully (2010). With regards to the ownership, the sample mean of board ownership is 12.27 %, which is comparable to that of 10.25% in Pathan and Skully (2010) and to that of 9.63% in Andershon and Fraser (2000). Our CEO ownership sample mean is 6.08% which is consistent to that reported (4.41%) by Pathan and Skully (2010). The sample mean of the number of board committees is 3.32, and is in line to that found (4.9) by Adams and Mehran (2003). Lastly, the sample mean of the total outstanding number of business segment is 3.04, which is also comparable to that of 2.6 in Coles et al. (2008).

In Panel B of Table 3 we present some descriptive statistics of control variables, namely E/TA, FEES, EARN, Z-SCORE and the VIX financial indicator. The sample mean of return on average equity, ROAE, in Panel C of Table 2 is 8.02%, which is similar to the sample mean of 9.92% in Pathan and Faff (2013). Moreover, our mean efficiency score for US investment banks is 0.65, which is similar to the sample mean of 0.66 in Radic et al. (2012).

Panel D shows an upward trend in the average percentage of independent members of the board over time, with a notable increase from 60% in 2003 to 69% in 2006. This increase is attributed to the independent board requirements imposed by SOX. Lastly, we also observe that the mean of CEO ownership was sharply reduced from 6.39% in 2007 to 2.84% in 2008.

3.4 Methodology

3.4.1 Bank Performance measures

There are two broad approaches to evaluate bank performance; 1) the structural method that is based on the economics of profit maximization or cost minimization under which bank performance is estimated as a function (profit or cost) by employing either a parametric (Stochastic Frontier Analysis-SFA) or a non-parametric methodology (Data Envelopment Analysis-DEA) and 2) the non-structural method that refers to the accounting-based performance indicators such as are return on average assets (ROAA), return on average equity (ROAE) and pre-tax operating income (POI) as a percentage of the average total assets (Hughes and Mester, 2010).

There are numerous empirical studies (Hasan and Marton, 2003; Bonin et al., 2005; Pasiouras et al., 2009; Lozano-Vivas and Pasiouras, 2010; Casu and Girardone, 2010; Sun and Chang, 2011; Barth et al., 2013) that employ structural methods (SFA or DEA) to evaluate bank performance, while others use accounting-based financial ratios (Klapper and Love, 2004; Athanasoglou et al., 2008; Lin and Zhang, 2009; Aebi et al., 2012). In our study, we employ the SFA approach as estimated by a profit function and three accounting-based ratios, namely ROAA, ROAE and POI. The reason that we employ a profit function, instead of a cost-function, is because corporate governance can be seen as a set of internal mechanisms aiming to maximize the value of a bank (Denis et al., 2001). Besides, investment banks are revenue-motivated institutions and hence the profit function is appropriate when one estimates the efficiency of these financial institutions consistent with Radic et al. (2012). In addition, *'profit maximization is* *superior to cost minimization for most purposes because it is the more accepted economic goal of firm's owners'* as argued by Berger and Mester (1999, pg. 3).

By employing both the profit function and accounting ratios we rely on two different approaches, strengthening in that way the robustness of our results. One might argue that because SFA's efficiency scores and accounting-based performance indicators might be highly correlated that in turn would lead both estimation approaches to give similar results. The SFA approach of measuring bank performance has the advantage of accommodating a full set of information from bank balance sheets, and not just a single ratio as in accounting indicators, whilst it is based on the fundamental notion of microeconomic theory of optimising when it comes to performance. In addition, according to Hughes and Mester (2010) using SFA for measuring bank performance reveals bank managers' decisions regarding both expected revenues, costs, and the related risk. Furthermore, Beccalli (2007) argue that accounting-based ratios do not count for changes in the production process and input and output mix. Therefore, these two performance measures might reflect different type of information and thus, the correlation between them might be fairly low. Indeed, our findings show that the correlation between profit efficiency scores (EFF) and the three accounting based ratios (ROAA, ROAE and POI) is positive but is relatively low (see Table 4), as in Bauer et al. (1998) and Koetter (2006).

Table 4. Correlation of efficiency and accounting-based ratios.

	EFF	ROAE	ROAA	POI
EFF	1			
ROAE	0.0952	1		
ROAA	0.0889	0.6915	1	
POI	0.1107	0.6701	0.7913	1

Notes: the Table shows the correlation of efficiency and accounting-based ratios for a sample of the US investment banks over 2000-2012 periods. EFF denotes the profit efficiency scores obtained from the SFA, ROAE is the return on equity , ROAA is the return on assets and POI denotes the pre-tax operating income.

We opt for the SFA, as introduced by Aigner et al. (1977), to estimate profit efficiency scores. The advantage of this parametric methodology relative to the non-parametric (DEA) approach is that both the random error and inefficiency are combined in a composite error term (Berger and Humphrey, 1997). To do so we use a fixed-effect specification where efficiency scores are independently and identically distributed (Greene, 2002).

In particular, we use the following specification for the profit frontier:

$$TP_{it} = f(P_{it}, Y_{it}, N_{it}) + v_{it} + u_{it} \quad (1),$$

where TP_{it} is pre-tax profits for bank i in year t.[21] P_{it} is a vector of input prices, Y_{it} is a vector of outputs, N_{it} is a fixed net-put. The term v_{it} stands for the error term, while u_{it} denotes bank inefficiency.

Moreover the translog profit function, opted in the study, takes the form:

$$lnP_{i,t} = \alpha_0 + \sum_i \alpha_i lnP_{i,t} + \sum_i \beta_i lnY_{i,t} + {}^1/_2 \sum_i \sum_j \alpha_{ij} lnP_{i,t} lnP_{j,t} + {}^1/_2 \sum_i \sum_j \beta_{ij} lnY_{i,t} lnY_{j,t} +$$
$$+ \sum_i \sum_j \delta_{ij} lnP_{i,t} lnY_{j,t} + \sum_i \zeta_i lnN_{i,t} + {}^1/_2 \sum_i \sum_j \zeta_{ij} lnN_{i,t} lnN_{j,t} + {}^1/_2 \sum_i \sum_j \theta_{ij} lnP_{i,t} lnN_{j,t} +$$
$$+ \sum_i \sum_j \kappa_{ij} lnY_{i,t} lnN_{j,t} + \mu_1 t + {}^1/_2 \mu_2 t^2 + \sum_i \nu_i t lnP_{i,t} + \sum_i \xi_i t lnY_{i,t} + \sum_i \rho_i t lnN_{i,t} +$$
$$+ u_{i,t} \pm v_{i,t} \quad (2)$$

Ordinary linear homogeneity and symmetry limitations are employed. We estimate equation (2) with a maximum likelihood method parameterized based on the variance parameters: [22]

[21]In order to deal with negative values of profits we follow the approach suggested by Bos and Koetter (2011). In particular, negative values of profits are replaced by the value of 1 in the left had side, while simultaneously we use a new variable, namely negative profit indicator at the right hand side. This indicator in case of losses takes the absolute value of negative profits while in case of positive profits takes the value of 1.

[22]We estimate bank-specific efficiency scores using the distribution of efficiency term conditional to the estimate of the composite error term as in Jondrow et al. (1982).

$$\sigma_\varepsilon^2 = \sigma_u^2 + \sigma_v^2$$

$$\text{and } \beta = \sigma_u^2 / \sigma_\varepsilon^2$$

(3)

Following Sealey and Lindley (1977) we employ the ‘intermediation’ approach in order to define bank inputs and outputs. This approach assumes that banks use labour and capital in order to collect funds and transform them into loans and other earning assets. We follow this approach which is used widely in numerous previous studies (Altunbas et al., 2001; Isik and Hasan, 2002, 2003; Fries and Taci, 2005; Casu and Girardone, 2006; Gaganis and Pasiouras; 2013) that estimate efficiency and which is also employed by Radic et al. (2012) that is the only study to this date that examines the performance of investment banks in terms of profit efficiency. Hence, with regards to inputs used we also employ the price of labour and physical capital, which is the norm in the banking literature (Berger and Mester, 1997). The price of labour is measured as the ratio of personnel expenses to total assets, while the price of physical capital is measured as the ratio of operating expenses to fixed assets. The selection of outputs for investment banks should reflect their operational nature and hence we could not use loans because this is the standard output used for the efficiency estimation of commercial banks. Investment banks differ fundamentally from commercial banks, as the former engage primarily in non-interest operations and hence they lack the deposit base that conventional banks have. Therefore, for the selection of the outputs we follow Radic et al. (2012) and employ two outputs that are associated closely with the operational nature of investment banks; 1) we use the sum of other earning assets that include trading securities, derivatives, treasury bills and bonds 2) and the total level of investment banking fees that include net commission, fees and trading gains and comprises the main source of income of investment banks. Lastly, as fixed netput, we employ the total level of fixed assets that is also standard in the literature related to efficiency estimation (Berger and Mester, 1997; Berger and Mester, 2003).

3.4.2 Second-stage regressions

3.4.2.1 Dynamic Panel Analysis

For the second stage regressions, we opt for the two-step 'system' GMM estimator (Arrelano and Bover, 1995; Blundell and Bond, 1998), as used in previous papers to examine the relationship between corporate governance and bank performance (Andres and Vallelado, 2008; Liang et al., 2013; Pathan and Faff, 2013), aiming to account for endogeneity issues. In their early study, Jensen and Warner (1988), claim that managerial ownership could be influenced by firm characteristics, such as the size and performance. Moreover, recent studies suggest that corporate governance characteristics, such as the board size, compensation, board ownership and performance might be interrelated and this, in turn, causes endogeneity problems (Wintoki et al, 2012; Aebi et al., 2012). With regards to the instruments used in the dynamic panel specifications, the only instrument used is the lagged dependent variable. The reason is that the sample size is fairly small (184 observations), suggesting that the usage of many instruments would result in estimation bias.[23] In addition to this, the documented persistence in bank profits (Berger et al., 2000; Goddard et al., 2004) is treated by the inclusion of the lagged dependent variable among the regressors, according to Athanasoglou et al. (2008). Therefore, the use of the dynamic panel two-step 'system' GMM estimator is relevant to the context of this study. The two-step estimates of standard errors are likely to be downward biased (Blundell and Bond, 1998) and thus, we follow a finite sample correction introduced by Windmeijer (2005). The estimates are also tested via Hansen's diagnostic test for

[23]As robustness test we use panel-VAR methodology and we find that indeed the relationship runs from corporate governance characteristics to bank performance.

instrument validity and the test for second-order autocorrelation of error terms introduced by Arellano and Bond (1991).The dynamic panel model that we use takes the following form:

$$(Perform)_{i,t} = \left[a_0 + \varphi(Perform)_{i,t-1} + a_1(PSOX)_t + a_2(CRS)_t + \beta_j \sum_{j=1}^{n}(Corpor - Govern)_{i,t} + \gamma_j \sum_{j=1}^{1}(Control)_{i,t} + e_{i,t}\right] \quad (4),$$

where i signifies individual investment bank (i = 1,2,...,23) and t is the period that we cover (t = 2000,2001,. . .,2012). α, β, γ are parameters to be estimated. $(Perform)_{i,t}$ is the dependent variable and stands for the performance of investment banks estimated by ROAA, ROAE, POI and EFF while $(Perform)_{i,t-1}$ stands for the lagged performance independent variable. $(PSOX)_t$ is a dummy variable that takes the value of 0 in the post SOX period (2000-2001) and 1 otherwise. $(CRS)_t$ is a crisis dummy that takes the value of 1 if year is 2007-2010, and 0 otherwise. $(Corpor - Govern)_{i,t}$ consists of five different dimensions of corporate governance variables: 1) board size, board composition and gender diversity 2) CEO 'internally' hired, CEO duality, CEO age and CEO tenure 3) cash and equity compensation of TMT and CEO 4) CEO/board ownership and CEO/TMT bonus as a percentage of total cash compensation and 5) number of business segments, number of subsidiaries, number of board committees, fees paid for the attendance of members in board committees and number of audit committee meetings. $(Control)_{i,t}$ comprises a number of bank-specific and country-level control variables while $e_{i,t}$ denotes the error term.[24]

[24]For estimations that we employ EFF as a measure of bank performance, we exclude from the regression models two bank-specific control variables, FEES and EARN, which are used as outputs in the estimation of profit efficiency using SFA.

3.4.2.2 Threshold Dynamic Panel Analysis

As a further step, we employ the dynamic panel threshold methodology (Kremer et al., 2013) to identify threshold-effects in important corporate governance determinants of the performance of investment banks.[25] The main advantage of this econometric technique is that identifies threshold values of key corporate governance variables and could observe any change on the impact of these threshold variables on bank performance during the examined period. This is important particularly as our study covers the period of financial crisis where major changes in the number of banks that belong to each threshold regime might be identified, suggesting important changes in the structure of corporate governance mechanism of investment banks before and after the turmoil. Note that we use this methodology for two of the corporate governance variables found, in the initial dynamic panel regressions, to be negatively associated with the performance of investment banks. These are the board size and the board ownership.

Therefore, our equation takes the following specification:

$$perform_{it} = \mu + \lambda_1 m_{it}\, I(q_{it} \leq \gamma) + \delta_1 I(q_{it} \leq \gamma) + \lambda_2 m_{it}\, I(q_{it} > \gamma) + \varepsilon_{it}$$

(5),

where $perform_{it}$ is the dependent variable (ROAE) and μ is the bank-specific fixed effect parameter. The two reverse regression slopes are λ_1 and λ_2 and are defined based on the assumption that there exist two regimes. q_{it} stands for the threshold variable (board size and board ownership), γ is the threshold value which splits the observations into two

[25]In this study, we use the model proposed by Kremer et al. (2013). That is an extension of the threshold methodology introduced by Hansen (1999). The extended method of Kremer et al. (2013) is built on the cross sectional technique of Caner and Hansen (2004), where GMM estimators are employed to account for endogeneity. As an extension to Caner and Hansen (2004) model, Kremer et al (2013) opt for a dynamic threshold methodology.

regimes: 1) above the threshold value (high regime), and 2) below the threshold value (low regime). ε_{it} stands for the residual. I is the indicator term that signifies the regime specified by the threshold variable q_{it} and the threshold value γ. As in Kremer et al. (2013), we use m_{it} as a vector of independent variables.[26] Moreover, Kremer et al. (2013) extends the Hansen's (1999) model by including the regime dependent intercept, δ_1. Bick (2007) suggests that ignoring the regime intercepts would cause biased estimation of threshold value and the the scale of the regimes' coefficients.[27]

3.5 Empirical Results

3.5.1 Dynamic Panel Analysis

Tables 5, 6 and 7 present the results of the dynamic panel analysis. The appropriateness of the two-step 'system' GMM estimator is held by the significant lagged performance variable in all the corresponding models of Tables 5, 6 and 7. Moreover, regarding basic diagnostics the tests (AR (2)) for second-order autocorrelation in second differences and the Hansen J-statistics of over-identifying restrictions are insignificant (see Tables 5, 6 and 7).

[26]We include all the explanatory variables of dynamic panel estimations apart from the crisis (CRS) dummy variable. The reason being that we opt for the threshold methodology to allow our data to determine this period of the turmoil through the identification of changes in the number of investment banks that belong to each regime based on threshold values of important corporate governance determinants of investment bank performance.

[27]Kremer et al. (2013) employ the GMM estimator (Arellano and Bover, 1995) so as to avoid serial correlation in the residuals. Then, they measure a short type regression to obtain the predicted values of the endogenous variables using a function of instruments (Caner and Hansen, 2004). As a first step, the endogenous variable is replaced with the predicted values in equation (5). As a second step, threshold value is obtained via OLS method where the threshold variable has been replaced by its predicted values estimated in the first step. The threshold value is obtained so as to minimize the concentrated sum of squared errors (Chan, 1993; Hansen, 1997). Once threshold value has been determined, the regression slopes, λ_1 and λ_2 can be estimated by employing the GMM estimator (Caner and Hansen, 2004).

Table 5. Dynamic panel regressions over the period 2000 to 2012 for US investment bank performance (board structure and CEO characteristics).

	Board Structure				CEO Characteristics			
VARIABLES	ROAE(1)	ROAA(2)	POI(3)	EFF(4)	ROAE(5)	ROAA(6)	POI(7)	EFF(8)
Lag performance	0.3539**	0.3405**	0.3612***	0.986***	0.2088**	0.1874**	0.4721**	0.976***
	(0.1426)	(0.1664)	(0.1207)	(0.142)	(0.0906)	(0.087)	(0.1974)	(0.178)
E/TA	0.3842	-0.5491**	-0.1291	-0.00016	-1.412***	-0.5543**	-0.6541**	0.00143
	(0.4728)	(0.2332)	(0.0916)	(0.00052)	(0.268)	(0.2681)	(0.2962)	(0.00119)
EARN	-0.0312	-0.0595***	0.0470	-	0.0319	-0.0317**	-0.0115	
	(0.0406)	(0.0205)	(0.0387)		(0.0420)	(0.0178)	(0.0207)	-
FEES	-0.0515	0.0240	0.0611**	-	0.5491***	0.3566	-0.0019	
	(0.0674)	(0.0486)	(0.0287)		(0.131)	(0.297)	(0.0415)	-
RISK	0.0007	-0.0007	0.0024	-3.15e-06	-0.0003	0.0004	0.0056	
	(0.0097)	(0.004)	(0.0037)	(9.49e-06)	(0.0047)	(0.0034)	(0.0035)	0.0005
PSOX	-0.0959**	-0.0397***	0.0398	0.00016	-0.0564***	-0.0981***	-0.0460	(0.0013)
	(0.0477)	(0.0151)	(0.0347)	(0.0001)	(0.0161)	(0.0272)	0.0750	-0.000135**
VIX	-0.0079**	-0.0043***	-0.0066**	-0.0000*	-0.0063**	-0.0067**	8.38e-06	(0.00059)
	(0.0031)	(0.0011)	0.0033	(9.77e-06)	(0.0027)	(0.0032)	(0.00590)	-0.00008*
CRS	-0.0906*	-0.0647**	-0.0942*	-0.0001**	0.0320	0.0431	-0.1286***	(0.00004)
	(0.0498)	(0.0329)	(0.0562)	(0.00005)	(0.0136)	(0.3281)	(0.0429)	0.00092
BS	0.01922	-0.0316***	-0.5018***	-0.00017*	-	-	-	-
	(0.0351)	(0.0096)	(0.1815)	(0.0001)				
IND	0.2335	-0.0468	-0.2072	-0.00033	-	-	-	-
	(0.3347)	(0.1247)	(0.2235)	(0.00051)				
GD	0.1131	0.0031	0.0855	0.0000	-	-	-	-
	(0.7499)	(0.0513)	(0.3851)	(0.00006)				
CEODUAL	-	-	-	-	0.2512**	0.2218	0.0035	0.00573*
					(0.1165)	(0.7688)	(0.0918)	(0.00294)
CEOAGE					0.3077	-0.1195	-0.0342	0.00315
	-	-	-	-	(0.2703)	(0.3716)	(0.2737)	(0.0105)
CEOTEN					-0.1493	0.3609	-0.0030	0.00015
	-	-	-	-	(0.0705)	(0.3522)	(0.0267)	(0.00012)
CEOIN	-	-	-	-	0.3960**	0.1759***	0.183**	0.0012
					(0.1875)	(0.0635)	(0.079)	(0.0019)
Constant	-0.1441	0.3732***	1.195***	-0.0011	-0.1271	0.5608	0.2348	0.00749
	(0.3266)	(0.0830)	(0.3613)	(0.0007)	(1.465)	(1.545)	(1.141)	(0.0404)
Wald chi2	216.22***	94.41***	335.68***	479.25***	133478.85***	73.56***	68.30***	145.39***
AR(1) test stat	-2.10**	1.69*	-1.69*	-2.27**	-1.96*	2.03**	-1.72*	-2.18**
AR(2) test stat	0.95	0.35	-0.32	-0.15	0.26	0.63	-1.03	-0.23
Hansen J-stat	1	0.675	0.907	0.482	0.674	0.984	0.889	0.897
Instruments	23	23	23	23	23	23	23	23
Observations	184	184	184	184	184	184	184	184
Number of banks	23	23	23	23	23	23	23	23

Notes: the Table reports the dynamic panel regression results for the period 2000 to 2012. The dependent variable is the performance of investment banks 1) ROAE: net income after tax as a percentage of the average book value of total equity; 2)ROAA: net income before interest and taxes as a proportion of the average book value of total assets; 3)POI: pre-tax operating income as a percentage of the average total assets; 4)EFF: efficiency scores obtained from the SFA. As independent variables we employ BS: the number of members in the board; IND: the percentage of independent directors; GD: the percentage of female directors; CEOIN: a dummy that takes the value of 1 if the CEO is the founder or has a long-term relationship with the bank, and 0 otherwise; CEODUAL :a dummy that takes the value of 1 if the CEO chairs the board as well, and 0 otherwise; CEOTEN: the number of years that the CEO has served in the position; CEOAGE: the age of the CEO; E/TA: equity over total assets; FEES: of net fees, commission and net trading income over total assets; EARN: ratio of trading securities, derivatives, treasury bills and bonds over total assets; RISK: Z-score= (1+ROE)/Standard Deviation of ROE; PSOX: dummy which takes the value of 0 if year is 2000-2001 and the value of 1 otherwise; CRS: a dummy which takes the value of 1 if year is 2007-2010; VIX: Volatility Implied Index (Chicago Board Options Exchange Volatility Index). For Volatility Implied Index data (VIX-Chicago Board Options Exchange Volatility Index) we use Bloomberg database. To avoid collinearity problems with the selected variables, we first analyze correlations of all the selected variables.

With regards to the board size, we find a strong negative impact of the board size on bank performance. The result remains robust at the 1% level (Table 5, Models 2 and 3) and at the 10% (Table 5, Models 4 and 4) level of significance. This finding supports the 'agency cost hypothesis' by Jensen and Meckling (1976), suggesting that an increase in the members of the board could result in higher information asymmetry and communication costs. We also find that CEO duality has a positive impact on bank performance at the 5% (Table 5 Model 5) and 10% significance level (Table 5 Model 8), which is consistent with the *'stewardship hypothesis'* (Donaldson, 1990; Barney, 1990). Under this hypothesis, the CEO who chairs the board would act as a good agent of the firm and would offer a unity of direction and strong control resulting in the improvement of performance. Our finding is consistent with a number of previous studies (Donaldson and Davis, 1991; Boyd, 1995; He and Wang, 2009). Although there is robust evidence to support that the CEO duality has a positive impact on bank performance, there is no empirical study to examine the relationship between the 'internally' hired CEO and bank performance. Our results also lend support to the 'stewardship hypothesis' as there exists a positive relationship between 'internally' hired CEO and bank performance (at the 1% level of significance, Table 5 Model 6; at the 5% level of significance, Table 5 Model 5 and 7).

Table 6. Dynamic panel regressions over the period 2000 to 2012 for US investment bank performance (compensation and ownership).

	Compensation				Ownership			
VARIABLES	ROAE(1)	ROAA(2)	POI(3)	EFF(4)	ROAE(5)	ROAA(6)	POI(7)	EFF(8)
Lag Performance	0.3789**	0.4266*	0.3098***	0..954***	0.2074*	0.4392***	0.2592**	0.972***
	(0.1919)	(0.2245)	(0.0779)	(0.153)	(0.1142)	(0.0955)	(.1090)	(0.148)
E/TA	-1.956***	-0.3703*	0.0988	0.0007	-0.0118	-0.1747***	-0.4124**	-0.000693*
	(0.750)	(0.2125)	(0.0607)	(0.0010)	(0.2461)	(0.0642)	(0.2001)	(0.000413)
EARN	-0.0377	-0.0117	-0.0555	-	-0.0446***	-0.0255****	-0.0616***	-
	(0.084)	(0.0242)	(0.0926)		(0.0169)	(0.0086)	(0.0138)	
FEES	-0.0225	0.0079	-0.0059	-	0.0554*	0.0262*	0.0924***	-
	(0.0505)	(0.0440)	(0.0200)		(0.0278)	(0.0152)	(0.0175)	
RISK	0.0102*	0.0023	0.0018	0.00078	0.0088	0.0028	-0.0041	0.00006
	(0.0058)	(0.00256)	(0.0014)	(0.0011)	(0.0117)	(0.0019)	(0.0119)	(0.0005)
PSOX	0.0296	-0.0455	-0.035**	0.00092	-0.0952	-0.0538	-0.1125	0.00011
	(0.0435)	(0.1178)	(0.015)	(0.0022)	(0.1036)	(0.0766)	(0.1306)	(0.0003)
VIX	-0.0045*	-0.0026	0.0010	0.00040	-0.0066	-0.0107***	-0.0122***	-0.0000***
	(0.0024)	(0.00225)	(0.0031)	(0.00027)	(0.0058)	(0.0025)	(0.0037)	(0.0000)
CRS	-0.1245**	0.0534	-0.064*	-0.00066***	-0.1408***	-0.1020***	0.0500	-0.0001***
	(0.0624)	(0.0543)	(0.0362)	(0.00002)	(0.0360)	(0.0313)	(0.1102)	(0.0000)
EXECASH	-0.0483*	-0.1121*	0.0215	-0.00016	-	-	-	-
	(0.0265)	(0.0629)	(0.07055)	(0.0003)				
EXEEQ	-0.01853	0.0072***	-0.0089	0.000278	-	-	-	-
	(0.0117)	(0.00270)	(0.0146)	(0.0005)				
CEOCASH	0.0282***	-0.0730	0.00618***	0.000145	-	-	-	-
	(0.0089)	(0.0750)	(0.00115)	(0.000178)				
CEOEQ	0.0069**	0.0117**	0.00238	0.000327*	-	-	-	
	(0.0031)	(0.0052)	(0.0029)	(0.000184)				-
BOARDOWN	-	-	-	-	-0.0092***	-0.0042***	-0.0081**	0.00002
					(0.0022)	(0.0014)	(0.0040)	(0.00003)
CEOOWN	-	-	-	-	0.0118**	0.0021	0.0100*	0.00005*
					(0.0055)	(.0021)	(0.0056)	(0.00003)
EXEBON	-	-	-	-	-0.0060	-0.0182	0.0464*	0.00001***
					(0.0331)	(0.0146)	(0.0277)	(0.0000)
CEOBON	-	-	-	-	-0.0053	0.0024	0.0132	0.00001**
					(0.0441)	(0.0096)	(0.0181)	(0.0000)
Constant	0.8893	0.2944	0.129	1.72***	0.2622	0.4694***	0.3653	-2.80***
	(0.6705)	(0.2165)	(0.796)	(0.335)	(0.3894)	(0.1559)	(0.3599)	(0.0981)
Wald chi2	324.86***	52.12***	424.60***	412.24***	464.92***	253.27***	2979.09***	470.30***
AR(1) test stat	-1.72*	-1.86*	-2.04*	-2.20**	-2.16**	-1.97***	-2.32**	2.08**
AR(2) test stat	-0.06	0.26	-0.52	-0.73	-0.21	0.06	-1.44	0.14
Hansen J-stat	0.829	0.595	0.252	0.286	0.522	1	0.516	0.961
Instruments	23	23	23	23	23	23	23	23
Observations	184	184	184	184	184	184	184	184
Number of banks	23	23	23	23	23	23	23	23

Notes: the Table reports the dynamic panel regression results for the period 2000 to 2012. The dependent variable is the performance of investment banks 1) ROAE: net income after tax as a percentage of the average book value of total equity; 2) ROAA: net income before interest and taxes as a proportion of the average book value of total assets; 3) POI: pre-tax operating income as a percentage of the average total assets; 4) EFF: efficiency scores obtained from the SFA. As independent variables we employ EXECASH: the cash compensation of the top management team which includes base salary and bonus; EXEEQ: the equity compensation of the top management team which includes restricted stock and stock options; CEOCASH: the cash compensation of the CEO which includes base salary and bonus; CEOEQ: the equity compensation of the CEO which includes restricted stock and stock options; BOARDOWN: the percentage shares that the directors hold; CEOOWN: the percentage shares that the CEO holds; EXEBON: bonus over executives' total cash compensation; CEOBON: bonus over CEOs' total cash compensation; E/TA: equity over total assets; FEES: of net fees, commission and net trading income over total assets; EARN: ratio of trading securities, derivatives, treasury bills and bonds over total assets; RISK: Z-score= (1+ROE)/Standard Deviation of ROE; PSOX: dummy which takes the value of 0 if year is 2000-2001 and the value of 1 otherwise; CRS: a dummy which takes the value of 1 if year is 2007-2010; VIX: Volatility Implied Index (Chicago Board Options Exchange Volatility Index). For Volatility Implied Index data (VIX-Chicago Board Options Exchange Volatility Index) we use Bloomberg database. To avoid collinearity problems with the selected variables, we first analyze correlations of all the selected variables.

Concerning the impact of CEO and TMT compensation on performance, the results show some variation depending on the different kinds of compensation, i.e., cash or equity-based compensation. Specifically, we find a negative impact of cash-based compensation of TMT on bank performance at the 10% level of significance (Table 6 Model 1 and 2), while there exists a positive impact of equity compensation of TMT on bank performance at the 1% level of significance (Table 6, Model 2). These findings are not surprising since cash compensation does not create sufficient incentives to executives to increase corporate value, while equity compensation constitutes a form of long-term pay and could align better incentives between executives and shareholders (Jensen and Murphy, 1998). Regarding CEO compensation, we find that CEO cash compensation asserts a positive effect on investment bank performance at the 1% level of significance (Table 8, Model 1 and 3) as in the previous studies of Harris and Raviv (1979) and Grossman and Hart (1983). Similarly, we find that CEO equity-based compensation has a positive impact on bank performance. The result remains robust at the 5% (Table 6 Model 1 and 2) and 10% (Table 6 Model 4) significance level.

Board ownership asserts a negative impact on bank performance at the 1% (Table 6 Model 5 and 6) and 5% (Table 6 Model 7). This finding is consistent with earlier studies (Beltratti and Stulz, 2012; Laeven and Levine, 2009) which document that banks with boards of higher bank ownership perform worse compared to banks with lower board ownership. This is because board members of high bank ownership position banks in a way that maximizes shareholder value. This behaviour of board members can worsen the performance as banks are exposed to high risk. On the other hand, CEO ownership has a positive impact on performance at the 5% (Table 6 Model 5) and 10% (Table 6 Model 7 and 8) significance level. Our finding supports the idea that the partial ownership of CEO reduces the agency costs and aligns better shareholders' and managers' incentives resulting in a positive impact on bank performance (Murphy, 1999). Also, we find evidence of a positive impact of CEO and TMT bonus as a percentage of total cash compensation on bank performance. This result is comparable with that of Fahlenbrach and Stulz (2011), as they find that banks that pay higher cash bonuses as a proportion of total compensation to their executives perform better that those that pay a lower level of bonuses over total compensation over the crisis period.

Table 7. Dynamic panel regressions over the period 2000 to 2012 for the US investment bank performance (governance complexity).

	Other Governance characteristics			
VARIABLES	ROAE(1)	ROAA(2)	POI(3)	EFF(4)
Lag performance	0.1844***	0.2800***	0.2229*	0.9762***
	(0.0676)	(0.1077)	(0.1180)	(0.119)
E/TA	0.2205	-0.4860**	-0.8901**	-0.0026*
	(0.4529)	(0.2027)	(0.3852)	(0.0014)
EARN	0.0114	0.0162	-0.0444	-
	(0.0104)	(0.0377)	(0.066)	
FEES	0.0178	-0.0369	0.0172	-
	(0.0208)	(0.0237)	(0.0624)	
RISK	0.0192***	0.0040	0.0019	0.0000*
	(0.0069)	(0.0028)	(0.0023)	(0.00001)
VIX	-0.0028	-0.0008	-0.0072***	-0.00003***
	(0.0022)	(0.0016)	(0.0024)	(0.00001)
CRS	-0.1503***	-0.0555**	-0.1187**	-0.00019***
	(0.0425)	(0.0263)	(0.0517)	(0.00006)
PSOX	-0.0914***	-0.0337	-0.0213	-0.00024*
	(0.0275)	(0.033)	(0.0481)	(00014)
NBCOM	-0.2694*	-0.2261*	-0.1477**	-0.00061*
	(0.1571)	0.1296	(0.0714)	(0.00036)
NMAUD	0.1732***	0.0405	-0.0102	0.00010
	(0.0553)	(0.0492)	(0.0495)	(0.00009)
FBCOM	0.00039	-0.0011	-0.7538*	0.00021
	(0.00565)	(0.0128)	(0.444)	(0.0015)
SEG	0.0312	-0.1873***	-0.2296***	-0.0003
	(0.0859)	(0.0491)	(0.0872)	(0.00025)
SUB	-0.0460	-0.02873**	0.0653	0.00011
	(0.0344)	(0.0137)	(0.0412)	(0.00008)
	-0.3371	-0.0025	0.7851***	-0.002**
Constant	(0.3374)	(0.1744)	(0.2867)	(0.0009)
Wald chi2	83.71***	554.62***	218.11***	479.23***
AR(1) test stat	-2.27**	-1.67*	-1.91*	-2.03**
AR(2) test stat	-0.37	-0.45	-0.14	0.51
Hansen J-stat	0.747	0.517	0.738	0.744
Instruments	23	23	23	23
Observations	184	184	184	184
Number of banks	23	23	23	23

Notes: the Table reports the dynamic panel regression results for the period 2000 to 2012. The dependent variable is the performance of investment banks 1) ROAE: net income after tax as a percentage of the average book value of total equity; 2)ROAA: net income before interest and taxes as a proportion of the average book value of total assets; 3)POI: pre-tax operating income as a percentage of the average total assets; 4)EFF: efficiency scores obtained from the SFA. As independent variables we employ NBCOM: the number of board committees; NMAUD: number of meetings of audit committee; FBCOM: fees paid to directors for attending the board committees; SEG: the number of different business segments; SUBS: Number of subsidiaries; E/TA: equity over total assets; FEES: of net fees, commission and net trading income over total assets; EARN: ratio of trading securities, derivatives, treasury bills and bonds over total assets; RISK: Z-score= (1+ROE)/Standard Deviation of ROE; PSOX: dummy which takes the value of 0 if year is 2000-2001 and the value of 1 otherwise; CRS: a dummy which takes the value of 1 if year is 2007-2010; VIX: Volatility Implied Index (Chicago Board Options Exchange Volatility Index). For Volatility Implied Index data (VIX-Chicago Board Options Exchange Volatility Index) we use Bloomberg database. To avoid collinearity problems with the selected variables, we first analyze correlations of all the selected variables.

In addition, the dynamic panel estimations reveal a negative impact of operational complexity on bank performance. We find that an increase in both the number of different business segments and the total outstanding number of subsidiaries reduces bank performance. The results are robust at the 1% (Table 7, Model 2 and 3) and 5% (Table 7, Model 2) level of significance respectively. These findings imply that banks that have high operational complexity operate less efficiently because co-ordination problems between specialists rise and this can increase correspondingly communication costs of the bank (Lawrence and Lorch, 1967). Also, we find evidence that an increase in the number of committees reduces performance at the 10% (Table 7, Model 1,2 and 4) and 5% (Table 7, Model 3) significance level. This implies that although an increase in the amount of task's delegation from board to committees might reduce the time and effort that boards devote as a group of directors, this could rise the amount of the resources that the board should divert for the supervision of the increased number of outstanding committees (Vafeas, 1999). Lastly, we also find that fees paid to the board committees are associated negatively with performance at the 1% significance level (Table 7, Model 2 and 3).

In terms of the rest of the bank-specific control variables, we find that an increase in leverage (decrease in the equity over total assets ratio) has a positive impact on performance. The reason being that higher leverage mitigates the agency costs from the outside equity that arises from the choice of investment (Myers, 1977), the risk of bank liquidation (Harris and Raviv, 1990) and the undertaken risk (Jensen and Meckling, 1976). We also report a positive impact of investment banking fees over total assets ratio on bank performance. Fees constitute the main source of income for investment banks, hence, an increase in net income improves bank profitability (Beccalli, 2007; Micco et al., 2007; Lin and Zhang, 2009). Also, the risk, proxied by z-score, asserts a negative impact on bank performance consistent with the *'bad luck hypothesis'* by Berger and De-Young (1997).[28] The dynamic panel analysis provides also evidence of the negative and significant impact of other earning assets over total assets ratio on performance. The negative coefficient suggests that activities such as trading securities may induce high risk of bank losses (Demirguc-Kunt and Huizinga, 2010).

We also find that the VIX indicator has a negative effect on bank performance, signifying that higher market volatility decreases bank performance consistent with previous studies (Bourke 1989; Miller and Noulas, 1997). Also, as it is expected, there is a negative impact of the financial crisis on bank performance (Pathan and Faff, 2013). Lastly, we find a strong negative impact of the PSOX period on performance, indicating that more board independency reduces the level of meeting attendance of the independent board members (Adams and Ferreira, 2007), resulting in the increase in the free-riding problems that large banks suffer from (Jensen, 1993).

3.5.2 Dynamic Threshold Analysis

In this section, we opt for the dynamic threshold methodology (Kremer et al., 2013) and investigate threshold-effects of important corporate governance variables with respect to investment bank performance. We employ this econometric technique for two of the key variables in our previous analysis (5.1). These are the board size and board ownership that we find them to be associated negatively with investment bank performance.

According to Andres and Vallelado (2008), there is a non-linear relationship between the board size and bank performance for a sample of commercial banks in Europe over the 1995-2005 period. This, in turn, suggests that increases in the number of board members

---

[28]Under the 'bad luck hypothesis' if an unexpected event increases the risk of a bank, the bank would start to spend more resources in risk-monitoring operations increasing in this way its costs and consequently decreasing its net profits and performance (Berger and De-Young, 1997) .

to a certain extent would improve bank performance as large boards would increase the monitoring and the expertise to deal with problems of the bank-specific environment. However, when the board size rises above a certain degree, thereby increasing information costs considerably, this, in turn, would affect negatively the performance of banking institutions. Furthermore, agency theory underlies that an increase in the board ownership better aligns incentives between the managers and shareholders (Jensen and Meckling, 1976; Eisenhardt, 1989; Murphy, 1999). Therefore, boards that hold higher ownership are more likely to take decisions to increase the corporate value. However, our findings in the dynamic panel estimations (5.1) indicate that an increase in board ownership decreases bank performance, as in Beltrazzi and Stulz (2011). To this end, the threshold analysis enables us to investigate, if and at which level, the board ownership asserts a positive impact on investment bank performance.

Table 8. Results of dynamic panel threshold estimation with board size as threshold variable.

Investment banks		
Threshold estimate		
BS		2.30259
95% confidence interval		(2.197220 -2.397900)
Impact of board size		S.E
λ1	-0.0524	0.046
λ2	-1.3778***	0.416
Impact of covariates		S.E
E/TA	-0.538	0.505
RISK	0.0017	0.002
EARN	-0.0302**	0.013
FEES	0.0459*	0.025
IND	0.1314	0.105
GD	-0.0951	0.157
PSOX	-0.0741**	0.034
VIX	-0.0042***	0.001
δ	-0.5948***	0.164
Observations	184	
Low regime	117	
High regime	67	

Notes: the Table reports the estimations for the dynamic panel threshold model. Each regime has at least 5% of the observations (Hansen, 1999). The threshold value of Board size variable for banks range between 2.1972 and 2.3973. We denote as dependent variable banks' ROAE ($perform_{it}$), while as the threshold and the regime dependent variable we impose the BS ($BS_{\ it}$), which represents the natural logarithm of banks' board size. We assume m_{it} includes a number of explanatory variables. IND: the percentage of independent directors; GD: the percentage of female directors; E/TA: equity over total assets; FEES: of net fees, commission and net trading income over total assets; EARN: ratio of trading securities, derivatives, treasury bills and bonds over total assets; RISK: Z-score= (1+ROE)/Standard Deviation of ROE; PSOX: dummy which takes the value of 0 if year is 2000-2001 and the value of 1 otherwise; VIX: Volatility Implied Index (Chicago Board Options Exchange Volatility Index). Following Bick (2007), the model accounts for regime dependent intercepts (δ).

Our analysis finds a threshold value of the board size around ten.[29] This threshold value splits the sample into two regimes. The low regime with banks that have board size lower than ten members and the high regime with banks of more than ten members in their boards. The results indicate that there is a highly negative impact at the 1% level of the board size on investment bank performance for the high regime banks, as λ_2=-1.3778 (see Table 8). This finding is consistent with the *'agency cost hypothesis'* by Jensen and Meckling (1976). Moreover, the threshold value indicates that the board size of the investment banks should be less than ten members, which is similar to the argument of

[29]We use the natural logarithm of the board size to perform our estimation. The threshold value that is equal to 10 members (exponential value of 2.30259)

Lipton and Lorsch (1992) who suggest the restraining of the membership of boards to ten people, with the desired size of eight or nine members. Regarding the impact of the board size on bank performance for the low regime banks, we still find a negative coefficient but the result is not statistically significant.

Table 9. Dynamic Threshold Analysis: classification of investment banks into the two identified regimes based on a threshold value of Board size.

Threshold: Board size													
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2010**	**2011**
Low regime	70%	62%	64%	64%	67%	56%	56%	47%	73%	65%	75%	73%	62%
High regime	30%	38%	36%	36%	33%	44%	44%	53%	27%	35%	25%	27%	38%

Notes: Table shows the classification of the investment banks based on the Board size (natural logarithm) threshold value that we obtained following Kremer's et al. (2013) threshold model for the dynamic panel.

Moreover, Table 9 shows that the percentage of banks with large boards constantly increases and reaches the highest level (53%) in 2007. This implies that the majority of US investment banks underperformed with an increase in their board size above the threshold value of 10 board members. After the burst of the financial crisis, we observe a sharp decrease (from 53% to 27%) in the proportion of investment banks that had large boards, suggesting the need for these financial institutions to reduce agency costs from the high information asymmetry that large boards caused in the period of the turmoil.

Table 10. Results of dynamic panel threshold estimation with board ownership as threshold variable.

Investment banks		
Threshold estimate		
BOARDOWN		8.54313
95% confidence interval		(0.276317-23.428200)
Impact of Board ownership		S.E
λ1	-0.026***	0.008
λ2	0.116**	0.053
Impact of covariates		S.E
E/TA	-0.4462	0.380
RISK	0.0022*	0.001
EARN	-0.0163	0.011
FEES	0.0423**	0.021
CEOOWN	0.0055**	0.002
EXEBON	0.0069***	0.001
CEOBON	-0.0017***	0.000
PSOX	-0.0716**	0.031
VIX	-0.0021*	0.001
δ	-0.0006	0.001
Observations	184	
Low regime	94	
High regime	90	

Notes: the Table reports the estimations for the dynamic panel threshold model. Each regime has at least 5% of the observations (Hansen, 1999). The threshold value of Board ownership variable for banks range between 0.276317 and 23.4282. We denote as dependent variable banks' ROAE ($perform_{it}$), while as the threshold and the regime dependent variable we impose the BOARDOWN ($BOARDOWN_{it}$), which represents the percentage of bank's shares hold by the board members. We assume m_{it} includes a number of explanatory variables. Following Bick (2007), the model accounts for regime dependent intercepts (δ). CEOOWN: the percentage shares that the CEO holds; EXEBON: bonus over executives' total cash compensation; CEOBON: bonus over CEOs' total cash compensation; E/TA: equity over total assets; FEES: of net fees, commission and net trading income over total assets; EARN: ratio of trading securities, derivatives, treasury bills and bonds over total assets; RISK: Z-score= (1+ROE)/Standard Deviation of ROE; PSOX: dummy which takes the value of 0 if year is 2000-2001 and the value of 1 otherwise; VIX: Volatility Implied Index (Chicago Board Options Exchange Volatility Index).

Regarding the board ownership threshold analysis, we find a threshold value of 8.54% (see Table 10). This value splits the sample into investment banks with boards that hold higher ownership (high regime) and those with boards that hold lower ownership (low regime). We find that for the banks in the low regime, an increase in the board ownership has a negative impact on performance at the 1% level of significance (λ_1=-0.026). This result is similar to that in the previous section (5.1). However, it further reveals that the negative impact of board ownership refers explicitly to banks that have lower levels of board ownership, that is below the threshold value. Turning to the high regime, which denotes banks of higher board ownership level, we find that there is a positive relationship between the board ownership and performance at the 5% level of significance (λ_2=0.116). This result is confirmed by the agency theory (Jensen and Meckling, 1976;

Eisenhardt,1989) and a number of previous studies that indicate a positive impact of the managerial ownership on firm performance (Kosnik, 1990; Malatesta et al., 1988; Pi and Timme,1993).

Table 11. Dynamic Threshold Analysis: classification of investment banks into the two identified regimes based on a threshold value of Board ownership.

Threshold: Board ownership													
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2010**	**2011**
Low regime	70%	69%	50%	57%	53%	50%	44%	47%	53%	35%	50%	53%	46%
High regime	30%	31%	50%	43%	47%	50%	56%	53%	47%	65%	50%	47%	54%

Notes: Table shows the classification of the investment banks based on the Board ownership threshold value that we obtained following Kremer's et al. (2013) threshold model for the dynamic panel.

Lastly, Table 11 shows that there is a constant increase over time in the percentage of banks that belong to the low regime which includes banks with boards that hold lower levels of ownership. In the 2005-2007 period, we also observe that the majority of investment banks is classified in the high regime, indicating that during the financial crisis investment banks opt for a high level of board ownership.

3.6 Conclusion

In this chapter, we investigate the impact of corporate governance on the performance of the US investment banks between 2000 and 2012. We find that there is a negative relationship between board size and performance. The threshold analysis reveals that this negative impact is enhanced when board size increases above the critical value of around ten board members. This implies that above a threshold value the rising costs of monitoring and communication deteriorates the performance of investment banks, consistent with the *'agency cost hypothesis'* (Jensen, 1993). Adams and Mehran (2008) and Andres and Vallelado (2008) show that the impact of the board size on the performance of commercial banks is positive. Hence, investment banks appear to react differently compare to other banks with respect to the effect of board size on performance. Threshold analysis also reveals that most of the investment banks scaled down their boards, aiming to reduce agency conflicts that banks with large boards suffer from since the crisis of 2007. Also, we find evidence that the CEO power exerts a positive impact on bank performance consistent with the *'stewardship hypothesis'* (Donaldson, 1990; Barney, 1990). This indicates that investment banks perform better when the CEO chairs the board as well or has a long-term relationship with the bank, 'internally' hired CEO. Thus, investment banks could benefit from the unity of control that the powerful CEO would offer. Our result sheds new light and provide an alternative view to Mishra and Nielsen (2000) who argue that the CEO power could have a negative impact on the performance of commercial banks. With regards to the ownership held by the board, we find, similarly to Beltratti and Stulz (2012), that it has a negative impact on performance. This effect is present predominantly in banks with board ownership below a threshold value. On the contrary, the impact of board ownership on investment bank performance turns to positive above a threshold value. Additionally, we find evidence of a negative association between operational complexity and bank performance.

Our results, also in the light of the financial crisis, are of importance for both policy makers and market participants. In response to the severe financial crisis, regulators in the US passed the Dodd-Frank Act (2010), a major financial reform that has a significant impact on bank corporate governance along with other aspects of the financial markets. The transformation of investment banks into BHCs and their subsequent access to the Federal Deposit Insurance (FDIC) support (Volcker, 2010) and other subsidy programs such as the Troubled Asset Relief Program (TARP) could lead to a rise in moral hazard problems for investment banks. Therefore, policy makers should ensure that the corporate governance of investment banks is geared towards structures that are beneficial to the performance of these institutions. To this end, the identification of threshold-effects in this study could be of assistance to future regulatory mandates. Regulators could look for example at the evidence where investment bank performance declines with board's size more than ten members, while enhances with boards' ownership above a threshold value.

Chapter 4: The impact of M&A fees on investment bank performance. Is there convergence during crisis?

4.1 Introduction

The number of mergers and acquisitions (M&As) increased (Berger, 2003; Humphrey et al., 2006; Evanoff and Ors, 2008), reaching a transaction value of $3.5 US trillion the years before the crisis.This upward trend of the M&A activity led to the rise of the importance of the M&A advisory role of investment banks worldwide. [30] Investment banks, as financial advisors for the acquirers and targets wealth, evaluate the assets of the bidder companies and advise acquirers to take value-enhancing decisions with the scope to create substantial synergies (Bao and Edmans, 2011). As this particular function of investment banks was developed substantially (Walter et al., 2008; Kolasinski and Kothari, 2008), this resulted in a considerable rise in the level of fees received from advisors offering M&A services. In fact, the total value of M&A fees generated by investment banks in G7 and Switzerland grew significantly from 38,00 (US$bn) in 2000 to 75,98 (US$bn) in 2007. Despite the importance of M&A fees for investment banks, there is no study to this date, to the best of our knowledge, that looks into the impact of M&A fees on investment banks' performance. This study fills this gap in the existing literature regarding the underlying relationship between M&A fees and investment bank performance for a sample of such institutions in the G7 and Switzerland.

The high level of financial integration in the first half of the 2000 decade resulted in a rapid growth of the investment banking industry in the G7 and Switzerland (Morana, 2008). Some of the deregulations that have taken place the last two decades have also

[30] The terms 'investment banks' and 'advisors' are used interchangeably in this study.

contributed to this upward trend of the investment banking industry. In particular, the Glass-Steagall Act (1999) imposed in the US allowed commercial and investment banks to merge and operate together. Also, international investment banking in Germany has demonstrated substantial improvement in the Tax Reduction Act (2000) that has made Germany an attractive financial market for investment via M&A activity. However, the strong growth of investment banking industry significantly subdued due to the recent financial crisis. Investment banks' total income from M&A advisory operations in G7 and Switzerland reached a total value of 52.06 (US$bn) in 2008. Overall, the performance of investment banking industry faced an extraordinary decline that also led to the collapse of many financial institutions. Moreover, this deterioration of investment banks has significantly affected a large number of their shareholders (individuals, companies, and governments). To demonstrate this, a recent study by Fernando et al. (2012) reveals that companies that had as a lead equity underwriter Lehman Brothers faced substantial losses after the collapse of the investment bank in 2008. Hence, the examination of investment bank performance is of utmost importance not only for the industry but also for the economy as a whole.

The literature to this date focuses on the estimation of bank performance, in terms of inefficiency, by employing parametric and nonparametric econometric techniques. A number of studies (Bonin et al., 2005; Bos et al., 2007; Pasiouras et al., 2009; Fiordelisi et al., 2011; Casu and Girardone, 2010) use the stochastic frontier analysis (SFA) while others (Pasiouras et al., 2009; Tanna et al., 2011; Paradi and Zhu, 2013) employ the data envelopment analysis (DEA) to estimate the inefficiency of banks. Regarding the performance of investment banking industry, there is only one study (Radic et al., 2012) that estimates the inefficiency of investment banks in the pre-crisis period (2001-2007).

The study, however, by focusing only on the 2001-2007 period, lacks important information concerning the performance of the investment banking industry under high levels of financial distress. Investment banks have higher exposure to risk compared to commercial, saving and co-operative banks due to the complexity of the operations that engage (Demirguc-Kunt and Huizinga, 2010). De-Young and Rice (2004) argue that investment banks could not exploit risk diversification benefits as their income, such as M&A fees, stems primarily from non-interest income operations which are considered to be more volatile. Investment banks also face more liquidity constraints during economic recessions than deposit-taking banks (Brunnermeir and Pederson, 2009; Adrian and Shin, 2008, 2009), as the latter could count on deposits (Gatev and Strahan 2006; Gatev et al. 2009). In order to account for the risks associated with investment banking activities, we opt for the enhanced hyperbolic distance function (EHDF) as introduced by Cuesta et al. (2009) that allows the inclusion of the risk as an undesirable output in the translog function.

The financial crisis of 2007 has posed serious challenges to the performance of investment banks. This turmoil also had a detrimental effect on the banking integration process (Rughoo and Sarantis, 2014), decreasing in this way the level of convergence among the investment banks. Based on this effect, we examine the level of convergence of investment banks with respect to the technical inefficiency and M&A fees variables. We focus our convergence analysis on technical inefficiency, that captures the performance of investment banks, and the level of M&A fees, that constitutes the main source of income of these financial institutions. We test for convergence in these two variables because these factors have been affected considerably by the turmoil and hence they could illustrate the level of financial integration in the investment banking industry before

(1997-2007), during (2007-2010) and after the financial crisis (2010-2012). The existing literature focuses on the convergence in the efficiency of commercial, co-operative and saving banks. In particular, Casu and Girardone (2010) examine the presence of convergence in technical efficiency for commercial banks in EU-15 markets. They estimate bank efficiency by employing DEA (Charnes, 1978), while for the convergence test they use the concepts of β-convergence and σ-convergence to test also for the speed of convergence among banks (Barro and Sala-I-Martin, 1991). The authors find evidence of convergence towards the European average. In similar lines, Weill (2009) studies if financial integration has taken place in the EU-10 member countries by investigating the convergence in banking cost efficiency for commercial, cooperative and saving banks over the 1994-2005. They estimate cost efficiency by using a SFA while they also opt for the concepts of β-convergence and σ-convergence to perform the convergence test. They conclude that there is convergence in terms of cost efficiency for the banks in their sample.

An earlier study by Mamatzakis et al. (2008) performs a cross-country analysis for commercial banks of the EU-10 member countries to examine the presence of convergence in efficiency over the 1998-2003 period. The authors opt for a SFA methodology and estimate both profit and cost efficiency and similarly to previous studies they employ the beta and sigma convergence tests. Their results show that while there is an indication of convergence in cost efficiency there is no robust indication of convergence in profit efficiency among the EU members. Similarly, Fung (2006) examines whether there is convergence in productivity, estimated as technical efficiency, among US bank holding companies (BHC). They estimate technical efficiency based on DEA methodology and find some evidence of *'conditional'* convergence which suggests that the steady-state efficiency to which a BHC is converging depends on the BHCs individual level of efficiency. Lastly, Tortosa-Ausina (2002) shows that there is convergence in cost efficiency, estimated by the DEA methodology, for a sample of Spanish banks between 1985-1999. Against this background, in our study, we test for convergence in the investment banking industry under a period of a serious downturn. In order to do so, we opt for the Phillip and Sul's (2007) convergence methodology that enables us to identify the presence of convergence clubs in technical inefficiency and M&A fees variables among investment banks in G7 and Switzerland.

Our study contributes to the existing literature in several ways. This is the first study to examine the impact of M&A fees on investment banks performance for the 1997-2012 period. Our analysis also employs a dynamic panel vector autoregression (VAR) methodology to support the validity of our findings. Moreover, for the first time, the performance of investment banks in G7 and Switzerland is estimated by employing the enhanced hyperbolic distance function (Cuesta et al., 2009). The advantage of this methodology is that it allows the inclusion of an undesirable output in the translog function. In this study, we employ as an undesirable output the level of risk exposure of investment banks. This is of major importance for the estimation of the technical inefficiency of investment banks as these financial institutions engage primarily in highly complex and risky operations (Demirguc-Kunt and Huizinga, 2010). Lastly, we also test for the presence of convergence in inefficiency and the level of M&A fees for investment banks over the pre-crisis (2004-2007), during the crisis (2007-2010) and post-crisis (2010-2012) period. To do so, we opt for the Phillip and Sul's (2007) convergence methodology that enables us to identify if there are convergence clubs of investment banks within our sample.

Our results show that M&A advisory is an important determinant of investment bank performance, as we find that there is a strong negative relationship between M&A fees and technical inefficiency. Moreover, we provide evidence of convergence in inefficiency over the pre-crisis period (2004-2007), while also there is a divergent club in the 2007-2010 period. Interestingly, we find presence of convergence in M&A fees over both the pre-crisis and during crisis period. Lastly, we find no indication of convergence in both inefficiency and M&A fees over the post-crisis period (2010-2012).

The rest of the study is structured as follows. Section 4.2 presents our hypotheses development. Section 4.3 describes the hyperbolic distance function. Section 4.4 presents our data and variables. Section 4.5 describes the convergence methodology and discusses our results. Section 4.6 develops our sensitivity analysis while Section 4.7 concludes.

4.2 Hypothesis Development

One of the main functions of investment banks is to offer their M&A advisory services to acquirer and bidder companies in order to form valuable collaborations. M&A advisory fees is the source of income that investment banks gain as a result of these activities. Investment banks' M&A advisory role requires particular skills to be implemented (Bao and Edmans, 2011), thereby, in this section, we develop our main hypothesis with regards to the impact of M&A advisory fees on the investment bank performance.

In a recent study by Bao and Edmans (2011) establish the 'skilled-advice hypothesis' which indicates that investments banks are capable of identifying higher gains in targets companies. Capable investment banks could improve the quality of matches between acquirer and target companies and consequently facilitate the merging procedure (Diamond and Maskin, 1979; Mortensen, 1982). Moreover, under this hypothesis investment banks could demonstrate specialized knowledge and ability in negotiating in transactions. Also, it could be argued that skillful investment banks, in cases of substantial synergies that could not be easily executed due to increased information asymmetry, are able to employ the required skills so as to successfully complete the deal (Chahine and Ismail, 2009). For instance, investment banks might have specific knowledge with regard to the characteristics of specific sectors and companies, such as financial and product market potential, that could help to reduce information asymmetry for both parties (Servaes & Zenner, 1996). Therefore, under the 'skilled-advice hypothesis' investment banks are able to identify quality matches between acquirer and targets companies, based on specialized knowledge and ability in negotiating in transactions. Moreover, it is well-established in the literature that there is a positive association between the ability and expertise of investment banks to allocate efficiently their resources and the level of M&A advisory fees that gain (Bowers and Miller, 1990). Thus, these institutions would not need to waste resources into monitoring M&A deals, thereby increasing the net benefits arising from their advisory role. Therefore, an increase in M&A fees under the skilled-advice hypothesis might not lead to an increase of the inputs (resources) used for the increase of output. Along these lines, there is empirical evidence to suggest that top-tier investment banks could successfully identify and negotiate the profitable opportunities (Golubov et al., 2012).

Based on the above discussion, we formulate our main hypothesis as:

H.1: An increase of M&A fees has a positive impact on the investment bank performance

4.3 Methodology

4.3.1 Estimation of inefficiency

In this chapter we opt for the enhanced hyperbolic distance function (Cuesta et al. 2009), an extension of Fare's and Primont (1995) production technology technique, to estimate the performance of investment banks. This is expressed by the following specification:

$D_E(x, y, b) = \inf\{\theta > 0: (x\theta, y/\theta, b\theta) \epsilon\, T\}$ (1),

where D_E stands for the hyperbolic distance function of a bank i= $(1, \dots, N)$from the frontier. $x_i = (x_{1i}, \dots, x_{Ki}) \epsilon\, R_+^K$ stands for a vector of input vectors that a bank *i* could transform into vectors of desirable $y_i = (y_{1i}, \dots, y_{Ki}) \epsilon\, R_+^K$ and undesirable outputs $b_i = (b_{1i}, \dots, b_{Ki}) \epsilon\, R_+^K$. Following Cuesta et al. (2009), the production technology is expressed by the enhanced hyperbolic distance function (EHDF) that requires the simultaneous and equiproportionate expansion of the desirable output and contractions of the inputs and the undesirable output proportionally by θ. Under the EHDF, a bank i is considered to be an efficient bank when $D_E(x, y, b) = 1$. On the contrary, if $D_E(x, y, b) < 1$ the bank could improve its technical efficiency by increasing its production of desirable outputs and proportionately decreasing the production of inputs and undesirable outputs. The incorporation of undesirable outputs in the EHDF assures the following criteria: 1) it is almost homogeneous $D_E(x, \mu y, \mu^{-1} b) = \mu D_E(x, y, b)$, 2) it is non-decreasing in desirable outputs with $D_E(x, \lambda y, b) \leq D_E(x, y, b)$, $\lambda \epsilon [0,1]$, 3) it is non-increasing in undesirable outputs with $D_E(x, y, \lambda b) \leq D_E(x, y, b)$, $\lambda \geq 1$ and 4) it is non-increasing in inputs with $D_E(\lambda x, y, b) \leq D_E(x, y, b)$, $\lambda \geq 1$.

The stochastic frontier analysis (SFA) using the EHDF incorporates both the random error and the inefficiency in a composite error term. More specifically, we use the following specification for the frontier:

$ln\left(\frac{D_{Ei,t}}{y_{Mi,t}}\right) = f\left(x_{i,t}, y_{i,t}, b_{i,t}, N_{i,t}, D_{i,t}\right) + v_{i,t}$ (2),

where the $ln\left(\frac{D_{Ei,t}}{y_{Mi,t}}\right)$ is the distance from the frontier of bank *i* in year *t* as a proportion of its production of the desirable output, y_{Mit}, which is estimated as the sum of earning assets and net trading income. $x_{i,t}$ is a vector of input prices,$y_{i,t}$ is a vector of desirable outputs, $b_{i,t}$ is vector of undesirable outputs, $N_{i,t}$ is a vector of fixed netputs and $D_{i,t}$ is a vector of bank specific and country-level variables. Lastly, the term $v_{i,t}$ stands for the error term.

Since inefficiency, or the distance from the frontier $ln\, D_{Ei,t}$, is captured by $u_{i,t}$ the translog function opted in the study is:

$$
\begin{aligned}
-lny_{Mit} = {} & \alpha_0 + \sum_{k=1}^{K} \alpha_k lnx_{kit} + {}^1/_2 \sum_{k=1}^{K}\sum_{j=1}^{K} \alpha_{kj} lnx_{kit} lnx_{jit} + \sum_{m=1}^{M-1} \beta_m lny_{mit} + {}^1/_2 \sum_{m=1}^{M-1}\sum_{n=1}^{M-1} \beta_m lny_{mit}\, lny_{nit} \\
& + \sum_{r=1}^{R} \gamma_r lnb_{rit} + {}^1/_2 \sum_{r=1}^{R}\sum_{s=1}^{R} \gamma_{rs} lnb_{kit} lnb_{sit} + \sum_{k=1}^{K}\sum_{n=1}^{M-1} \rho_{km} lnx_{kit} lny_{mit} \\
& + \sum_{k=1}^{K}\sum_{r=1}^{R=1} \delta_{ij} lnx_{kit} lnb_{rit} + \sum_{\varphi=1}^{\Phi} \zeta_\varphi lnN_{\varphi it} + {}^1/_2 \sum_{\varphi=1}^{\Phi}\sum_{l=1}^{\Phi} \zeta_{\varphi l} lnN_{\varphi it} lnN_{lit} \\
& + {}^1/_2 \sum_{k=1}^{K}\sum_{\varphi=1}^{\Phi} \theta_{\kappa\varphi} lnx_{kit} lnN_{\varphi it} + {}^1/_2 \sum_{M=1}^{M-1}\sum_{\varphi=1}^{\Phi} \eta_{m\varphi} lny_{mit} lnN_{\varphi it} + \sum_{r=1}^{R}\sum_{\varphi=1}^{\Phi} \kappa_{r\varphi} lnb_{rit} lnN_{\varphi it} \\
& + \sum_{n=1}^{N} \mu_{ni} D_{nit} + v_{it} - u_{it}
\end{aligned}
\tag{3}
$$

For the estimation of the EHDF the regressors x_{kit}, y_{mit} and b_{rit} have to enter the model in a product form where $x_{kit} = x_{kit} * y_{Mit}$, $y_{mit} = y_{mit}/y_{Mit}$ and $b_{rit} = b_{rit} * y_{Mit}$. In our model, we employ the desirable output of net trading income , y_{Mit}, to impose the almost homogeneity property on the translog function. Note that when in equation (3) when $y_{mit} = y_{Mit}$ we have $y_{mit} = y_{mit}/y_{Mit}$=1 and hence the logarithm of y_{mit} equals zero. Therefore, the summations regarding y_{mit} in equation (3) are over $M-1$. Moreover, since the technical inefficiency is directly influenced by a number of bank-specific and country level variables, $D_{i,t}$, that are included in the translog function, we follow a single-step methodology (Battese and Coelli, 1995). The term v_{it} stands for the error term which is identically and independently distributed (i.i.d) and has $N(O, \sigma_V^2)$. The technical inefficiency term, u_{it} , is assumed to be independently but not identically distributed, such that u_{it} is estimated as truncations (at zero) of the $N(m_{i,t}, \sigma_{i,t}^2)$ distribution where the mean is calculated by the following form:

$$m_{i,t} = z_{i,t}\delta \qquad (4),$$

where $z_{i,t}$ is a vector of explanatory variables that could influence the level of technical inefficiency for bank i and time t and δ is a vector of coefficients to be calculated. Moreover, the parameters of the model are measured via a maximum likelihood procedure, while the technical inefficiency is estimated based in Battese and Coelli (1988) as $E[\exp(u_{it}) \mid v_{i,t}]$.

4.4 Data and Variables of the EHDF

Our analysis includes data from the Fitch IBCA's Bankscope database for the 1997-2012 periods. For the M&A fees data, we use both Bankscope and SDC platinum of Thomson Banker One database. Our final sample includes 100 investment banks and 767 observations for the G7 and Switzerland.

For the identification of bank inputs and outputs, we follow the *'intermediation'* approach (Sealey and Lindley, 1977) that assumes that banks are financial intermediaries that use capital and labour in order to collect funds and transform them into other earning assets and loans. Based on this approach, we employ as inputs labour and physical capital. Labour is estimated as the outstanding amount of personnel expenses while physical capital is the sum of interest and non-interest expenses that stand for the operating costs of banks. Moreover, following Cuesta et al. (2009), we use in the EHDF two desirable and one undesirable output. As desirable outputs, we employ the sum of other earning assets including loans, deposits from banks and credit institutions, government securities, derivatives among others and the net trading gains stemming from associated activities.

As an undesirable output, we employ bank default risk that reflects the risk that investment banks carry due to the level of complexity and the kind of the operations that engage (Demirguc-Kunt and Huizinga, 2010). We measure bank default risk by using the z-score index, employing the following formula: Z-score= (1+ROE)/Standard Deviation of ROE (Boyd and Graham, 1986). This indicator of bank default risk has been broadly used in the banking literature (Lepetit et al., 2008; Barry et al., 2011; Radic et al., 2012). Higher values of the index show lower risk of bank default. Moreover, as fixed netput we use the total level of fixed assets.[31] Table 1 shows some of the descriptive statistics of the variables employed for the estimation of the EHDF.

Table 1: Descriptive statistics of the variables employed in the technical inefficiency estimation

Variable	Description	Mean	Stand. Deviation	Minimum	Maximum
P_1	Physical capital	0,4687	1,1695	0,0008	13,100
P_2	Labour	0,7952	2,1054	0,0007	17,000
N_2	Fixed Assets	0,1584	0,4235	0,0010	3,444
Y_1	Trading gains	0,4599	0,1778	-23,500	12,400
Y2	Earnings assets	91,400	0,2270	0,4147	2,080,000
Y_3	Z-score	1.784	2.843	-4.944	21.494

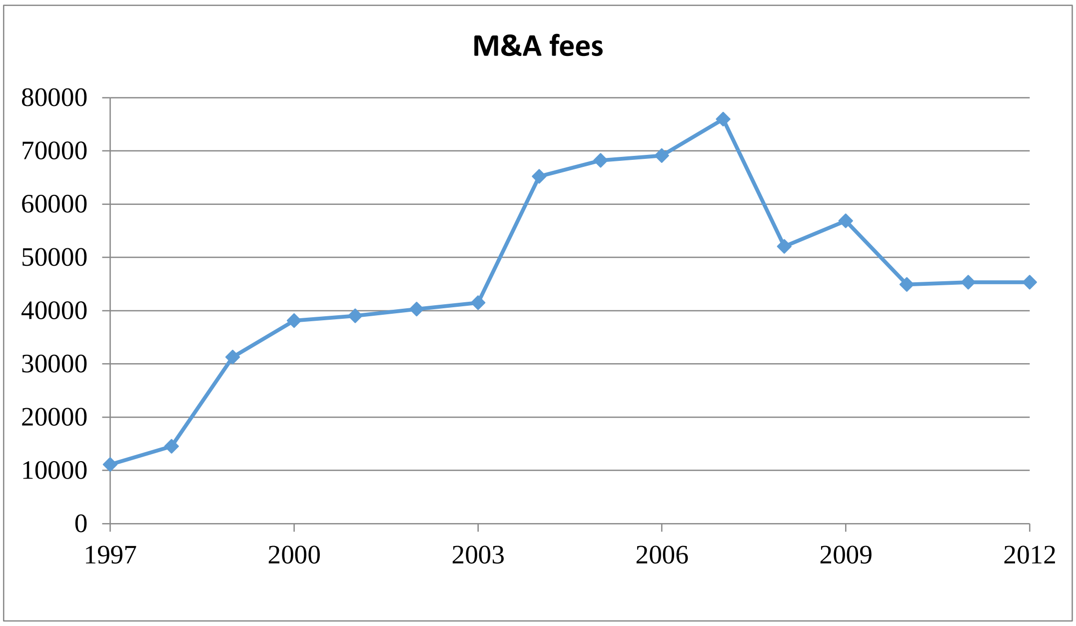
Notes: the Table reports the variables used in the EHDF for the period 1997-2010. Inputs (P_1 & P_2)); 1) Physical capital (total operating expenses) and 2) Labour (personnel expenses); Netput (N_1)) 1) Fixed Assets; Outputs (Y_1, Y_2 & Y_3));1) Trading gains that stand for the first desirable output 2) Total Earning assets which stands for the second desirable output (loans, deposits from banks and credit institutions, government securities, derivatives and other earning assets) and 2) Z-score that stands for the undesirable output (Z-score= (1+ ROE)/Standard Deviation of ROE). The values are of P_1, P_2, N_1, Y_1 and Y_2 in million dollars, while Y_3 is an index.

In order to control for bank individual characteristics, we opt for a number of bank-specific variables. The main variable of our interest is M&A fees estimated as the sum of net fees and commissions, that are principally generated from M&A activities. The conventional ratio of net income to total assets in the literature (Morgan and Stiroh, 2001; Bonin et al., 2005; Beccalli, 2007; Micco et al., 2007; Lin and Zhang, 2009) is replaced by the ratio of M&A fees to total assets. This ratio represents the main source of revenue of investment banks that stems from M&A advisory services. Figure 1 depicts the upward

[31] We use the level of fixed assets as a fixed netput so as to account for the level of physical capital for each bank (Berger and Mester, 1997).

trend of M&A fees in G7 and Switzerland the period under examination. In particular, the total value of M&A fees increased from 31,80 (US$bn) in 2000 to 75,98 (US$bn) in 2007. However, this growth of investment banking industry was significantly subdued due to the financial turmoil as M&A fees dropped, reaching a total value of 45,30 (US$bn) in 2012.

Figure 1. M&A fees across the G7 and Switzerland (1997-2012).



Notes: the Figure shows the M&A fees value in million dollars across the G7 and Switzerland countries (1997-2012).The data are obtained from the Bankscope and SDC platinum of Thomson Banker One database.

We also include the ratio of equity to total assets in order to proxy of capital (Athanasoglou et al., 2008; Lepetit et al., 2008) and the natural logarithm of banks' total assets that captures banks' size (Fries and Taci 2005; Pasiouras, 2008*; Mamatzakis et al., 2013).* We also account for liquidity estimated as the ratio of liquid assets to total assets for each bank. A bank with a lower level of liquidity might face increased risk in case of a financial crisis compared to a bank with a higher level of liquid assets. Based on the *'bad luck hypothesis'* (see Berger and De-Young, 1997), an increase of liquidity risk would prompt the bank to spend more resources in managing the risk that could increase banks' costs and which would have as a result the decline bank performance. Similarly, a number of studies have found a positive impact of liquidity on bank performance (Bourke, 1989; Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008). On the other hand, numerous studies indicate that there exists a negative impact of liquidity on performance due to increased storage costs (Kwan, 2003; Staikouras et al., 2008) and low returns (Pasiouras and Kosmidou, 2007). Also, we employ a dummy variable for listed banks as in Beccalli et al. (2006) and Fiordelisi and Molyneux (2010) in order to account for the diversification of the information supplied by the market to the customers of investment banks. The dummy takes the value of 1 if the investment bank is a listed company in the stock exchange, otherwise, it takes the value of 0. Based on the empirical evidence, we expect to find a negative relationship between listed banks and inefficiency (Beccalli et al., 2006).

Turning to the country-level control variables, we employ GDP per capita as an indicator of wealth (Maudos and Guevara, 2007; Brissimis et al. 2008; Maudos and Solís, 2009; Fiordelisi et al., 2011). The empirical evidence with regard to the impact of GDP per capita on bank performance points in different ways. Banks in countries with higher GDP per capita could benefit from lower banks' costs as they might have easier access to new technologies compared to banks in countries with lower GDP per capita (Lensink et al., 2008). However, high GDP per capita might imply an increase in bank's costs because of high operating expenses for supplying a given amount of services to customers (Dietsch and Lozano-Vivas, 2000).

In addition, we use the consumer price index inflation so as to capture the monetary stance (Albertazzi and Gambacorta, 2009). Revell (1979) suggests that the impact of inflation on bank performance is conditional on whether bank's salaries and other operating costs could rise at a faster degree than the inflation rate. Hence, the impact of the inflation on bank performance depends on how successfully a bank could predict the rate of inflation and therefore accordingly manage its operating costs. In particular, if a bank's management could accurately forecast the inflation rate, a bank could adjust interest rates so as to rise earnings faster than expenses and thus increase bank efficiency. On the other hand, if a bank's management could not precisely predict the inflation rate this, in turn, would lead to inappropriate adjustment of interest rates and, therefore, might increase faster costs than revenues of a bank that would consequently decrease bank efficiency. However, most studies find a positive association between inflation and bank performance (Bourke 1989; Molyneux and Thornton 1992).

We also employ a stock price index with the scope to account for the asset price bubble similar to Bordo and Jeanne (2002).[32] Investment banks' leverage increases when the asset and stock prices rise as well. An increase of leverage, at low levels of leverage, might mitigate the conflicts between shareholders and managers regarding the choice of investment (Myers, 1977). The reason being that managers would require cash to service the debt rather than take considerably risky investments (Jensen and Meckling, 1976). When leverage becomes relatively high, a rise of leverage could increase conflicts between debt holders and shareholders, mainly because of the high risk of liquidation (Jensen and Meckling, 1976). These conflicts would intensify agency costs among debt holders and shareholders and this could lead to higher interest expenses to pay debt holders for their estimated losses. In addition, in order to account for asset bubble bursts, we employ a composite asset price indicator as in Gerdesmeir et al. (2010) proxied by a

[32] The stock market indexes that we use are: S&P500, FTSE100, DAX, CAC, FTSEMIB, SMI, SPTSX and NIKKEI.

dummy variable that takes the value of 1 when there exists an asset price burst among the countries in our sample, and 0 otherwise.[33] We expect the impact of asset bubble burst to be negative on bank efficiency, as a burst is accompanied by reduced investment activity and could have as a result of a banking crisis (Allen and Carletti, 2010). Finally, we include the following control variables: country [34] and time dummies to count for time-invariant home country characteristics and neutral technical change respectively.

Table 2 reports some further descriptive statistics of the bank-specific and some of the country-level variables used as determinants of technical bank inefficiency in the translog function.

Table 2. Descriptive Statistics of bank-specific and country-level variables.

Country	N	Size	E/TA	Liquidity	M&A fees	GDP per capita	Consumer Price Index	Stock price index
Canada	18	16.251	0.044	0.659	0.031	10.453	100.340	160.611
France	71	14.371	0.135	0.452	0.051	10.447	107.879	133.407
Germany	132	12.813	0.365	0.458	0.117	10.335	99.803	133.081
Italy	23	15.934	0.099	0.293	0.012	10.364	107.559	108.348
Japan	143	15.344	0.277	0.502	0.082	10.303	100.597	82.112
Switz.	24	14.673	0.117	0.602	0.067	10.583	99.946	107.320
UK	208	15.740	0.142	0.342	0.043	10.388	104.270	107.437
US	148	16.137	0.157	0.404	0.169	10.620	97.260	134.866
Total	767							
Mean		15.158	0.167	0.464	0.063	10.437	102.207	120.897

Notes: the Table reports descriptive statistics of bank-specific and most of country-level variables used to perform fixed effect and dynamic panel regressions. N stands for the number of observations by country. As bank-specific variables we use: size= natural logarithm of total assets; E/TA= equity over total assets; Liquidity= liquid assets over total assets; M&A fees = net fees and commission stemming from M&A advisory services. Some of the country level independent variables that we use are: GDP per capita (natural logarithm); Population Density; Consumer Price Index and Stock Price Index. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank.

[33] If the composite indicator falls under a critical value the dummy takes the value of 1, and 0 otherwise. For the values of the composite indicator that are below the threshold value a burst takes place. The critical value is determined as the mean of the composite indicator minus the standard deviation of the composite indicator times the factor μ. In our study, we employ μ= 0.5, consistent with the study of Gerdesmeir et al. (2010). The composite indicator is calculated by the following specification: $CI = \varphi_1 stock\ price\ index + \varphi_2 house\ price\ index$. φ_1 equals to 1, while φ_2 is the ratio of the standard deviation of the stock price index over the standard deviation of the house price index.

[34] For multicollinearity issues we dropped from the sample one dummy variable (Japan).

We observe that US investment banks have the highest amount of total assets and M&A fees across the G7 and Switzerland. Moreover, in terms of the level of capitalization, Germany and Japan and appear to have the most capitalized investment banks, while Canada and Italy have the less capitalized banks within the sample.

4.5 Results and Discussion

4.5.1 Inputs' and undesirable's output elasticities of the EHDF

Table 3 shows the parameter estimates of the EHDF. The input elasticities of operating expenses (α_1) and personnel expenses (α_2) with respect to the distance of the frontier have a negative sign and are significantly different from zero at the 10% level.

Table 3. Estimates of parameters and bank technical inefficiency determinants

Parameter	Estimate	t-Statistic
A_0	25.741***	10.81
α_1	-0.282*	-1.690
α_2	-0.329*	-1.730
α_{11}	-0.008*	-1.790
α_{22}	-0.011**	-2.040
α_{12}	0.003	0.650
β_1	0.869***	4.320
β_2	3.861***	-18.72
β_{11}	-0.019**	-2.450
β_{22}	-0.011**	-2.040
β_{12}	-0.072***	-8.910
γ_1	-0.307**	-2.070
γ_{11}	-0.004	-1.320
ρ_{11}	-0.009	-1.630
ρ_{21}	0.015***	2.460
ρ_{12}	0.016*	1.950
ρ_{22}	0.004	0.540
φ_{11}	0.011***	2.720
φ_{12}	0.028***	3.730
η_{11}	0.003	0.850
η_{12}	-0.006**	-2.050
Size	0.017***	2.780
E/TA	0.070***	3.130
M&A fees	0.041**	2.290
Liquidity	-0.001	-0.170
Listed banks	0.015**	2.140
Consumer Price Index	0.001**	2.090
GDP per capita	-0.010**	-2.070
Stock price index	-0.000**	-2.030
Burst	-0.002	-0.680
Year dummies	Yes	Yes
Country dummies	Yes	Yes
Wald chi2	24731.47	
Prob > chi2	0.000	
Number of banks	**100**	
Observations	**767**	

Notes: the α_k stand for the coefficients of the input variables; β_k stand for the coefficients of the outputs variable; the γ_k stand for the coefficients of the net-put variable; and ρ_k, η_k and φ_k stand for the cross-term coefficients. The table reports information on the influence of the z variables employed in the estimation technical inefficiency scores of investment banks in the G7 and Switzerland countries. The dependent variable is technical efficiency derived using an EHDF methodology. As bank-specific variables we use: size= natural logarithm of total assets; E/TA= equity over total assets; Liquidity= liquid assets over total assets; M&A fees = net fees and commission stemming from M&A advisory services; Listed banks= dummy of listed banks and T-dummy=time dummy. Country level independent variables that we use are: GDP per capita; Consumer Price Index; Stock Price Index; Burst of the asset bubble (dummy) and Country dummy. For bank-specific variables we use FITCH Bankscope database while for most country variables we use World Development indicators from World Bank.

This implies that an increase in the amount of inputs used would result in a greater distance from the frontier. Also, the magnitude of operating expenses (α_1=-0.282) as an input elasticity compared to that of personnel expenditures (α_2=-0.329) indicates that the latter plays a more important role in the production process of investment banks in G7 and Switzerland. In addition, the elasticity of the desirable output of other earning assets (β_1=0.869) has a positive sign suggesting that an increase in the amount of the desirable output for an investment bank would cause a decrease in the distance from the frontier. On the other hand, the undesirable output parameter β_2, that is significant at the 1% significance level, has also the expected positive sign (β_1=3.861). This finding indicates that any increase of z-score, a decrease of the banks' default risk, would reduce the distance from the frontier. When compared to the magnitudes of the input and desirable output elasticities estimates, the undesirable output's elasticity value has a relatively higher level of impact on the production function, suggesting the appropriateness of employing the bank's default risk for the estimation of investment banks' inefficiency.

Table 4 shows the mean technical inefficiency scores across the G7 and Switzerland. As the mean technical inefficiency for the estimated translog hyperbolic distance function is 21.43%, this implies that investment banks in these countries could improve technical efficiency by increasing desirable output by 27,3% (1/0.7857=1.2727) and simultaneously decrease undesirable output and inputs by 21.43% (1-0.7857=0.2143). Our estimations rank banks in Switzerland, the US and Japan as the most technical efficient among the banks in our sample. These findings are widely similar to Radic et al. (2012) that also find that Switzerland and Japan rank among the most efficient in the G7 and Switzerland. However, unlike us, they estimate bank performance by using cost and profit inefficiencies.

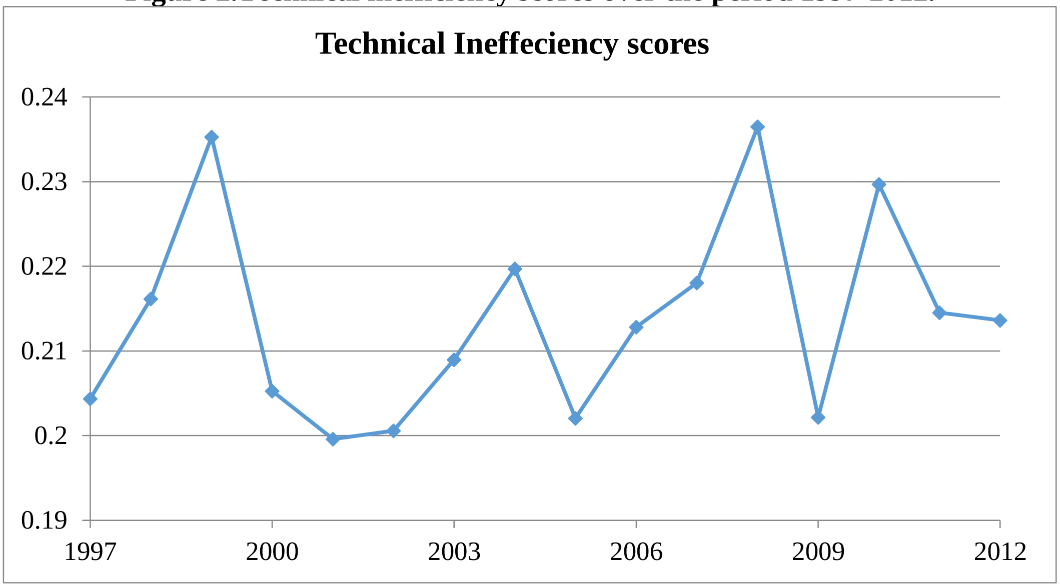
Table 4. Descriptive Statistics of technical inefficiencies -investment banking industry (1997-2012).

Country	Mean	Standard Deviation	Minimum	Maximum
Canada	0.2168	0.0063	0.2079	0.2292
France	0.2144	0.0228	0.1706	0.2721
Germany	0.2187	0.0523	0.0175	0.2718
Italy	0.2215	0.0659	0.1216	0.3183
Japan	0.2100	0.0249	0.1517	0.2748
Switz.	0.2082	0.0441	0.1538	0.2674
UK	0.2151	0.0284	0.1566	0.3205
US	0.2098	0.0308	0.1060	0.2742
Mean	0.2143	0.0344	0.0175	0.3205

Notes: the Table reports the mean inefficiencies for the G7 and Switzerland over the period 1997-2012. Inefficiencies are derived from the EHDF.

Changes in the mean technical inefficiency over time are reported in Figure 2. We observe that there is a growing trend from 1999 to 2008. In particular, the average technical inefficiency score increases from 19.95% in 1999 to 23.65% in 2008. Hence, our estimations illustrate the negative impact of the late 2007 financial crisis on the performance of investment banks. Lastly, the technical inefficiency of investment banks decreases from 23.65% in 2008 to 21.39% in 2012.

Figure 2.Technical inefficiency scores over the period 1997-2012.



Notes: the Figure shows is the average technical inefficiency scores derived from the EHDF (Cuesta et al., 2009).

4.5.2 Determinants of Technical Inefficiency

Also, Table 3 shows the results of the impact of bank-specific and country-level variables on the technical inefficiency of investment banks in G7 and Switzerland.

Our finding shows that M&A fees have a negative impact on technical inefficiency at the 5% level of significance (see Table 3). This finding confirms the *'skilled-advice hypothesis'* proposed by (Bao and Edmans, 2011), implying that an increase in M&A fees, which suggests the higher involvement of investment banks in M&A transactions in terms of the magnitude and the value of operations, could have a positive impact on the performance of investment banks. This is so as capable investment banks could better deal with complex processes of completing M&A contracts and negotiating their terms without increasing their resources and costs towards these activities.

Moreover, there is a negative relationship between bank size and technical inefficiency at the 1% level of significance (Table 3). This result might suggest that large banks tend to raise less expensive capital and, therefore, this could decrease their inefficiency (Bikker and Hu, 2002; Goddard et al., 2004). We also find a negative relationship between equity over total assets and technical inefficiency (at the 1% significance level), suggesting that less capitalized investment banks are more technical inefficient compared to investment banks that hold a higher level of capital (Athanasoglou et al., 2008; Lepetit et al., 2008). In addition, listed banks perform better, in terms of technical inefficiency, than non-listed financial institutions. The result is significant at the 5% level and is similar to that in Radic et al. (2012) and Beccalli et al. (2006). Also, we find some evidence of a positive association between liquidity and technical inefficiency, which is consistent with numerous previous studies (Kwan, 2003; Staikouras et al., 2008). However, the result is not statistically significant.

Turning to the country-level variables, there is a positive and significant at the 5% level impact of GDP per capita on bank technical inefficiency (see Table 4).This result suggests that banks in countries of higher GDP per capita might have increased operating expenditures for a given level of services that offer to customers (Dietsch and Lozano-Vivas, 2000). The second country-level control variable, that appears to be an important determinant of bank technical efficiency, is the inflation rate. We find a strong negative relationship between the inflation rate and technical inefficiency (see Table 4) at the 1% level of significance, which is consistent with previous studies (Bourke, 1989; Molyneux and Thornton 1992). This finding suggests that investment banks' management might accurately predict the inflation rate and hence they are able to adjust interest rates accordingly so as to increase revenues faster than costs and consequently this would decrease bank inefficiency (Revell, 1979). We also find that the stock price index has a positive impact on technical inefficiency at the 5% significance level. This result suggests that an increase in stock prices, which could be observed during prosperous times, could rise the level of leverage that investment banks hold (Adrian and Song Shin, 2010). High leverage during periods of financial distress could increase the inefficiency of investment banks mainly due to the higher risk of liquidation (Jensen and Meckling, 1976). Lastly, as it is expected, we find that burst of an asset bubble exerts a negative impact on technical efficiency of investment banks but the result is not statistically different from zero.

4.6 Testing for convergence

Due to the variability that we observed in the technical inefficiency over time we opt for convergence in inefficiency and M&A fees for investment banks over the pre-crisis (2004-2007), the crisis (2007-2010) and the post-crisis (2010-2012) period. We determine the crisis period as the 2007-2010 period following previous studies in the banking literature (Dietrich et al., 2014; Al-Najjar, 2014; Caporale et al., 2014). We employ Phillip and Sul's (2007) convergence methodology that enables us to identify if there are convergence clubs among investment banks over time.

4.6.1 Phillip and Sul's (2007) convergence test

We follow Phillips and Sul (2007) model that allows us to identify convergence clubs with respect to the technical inefficiency and M&A fees variables. This analysis requires a balanced dataset, hence during 2004-2007, 2007-2010 and 2010-2012 periods we remained with 50, 48 and 28 investment banks respectively. This methodology employs a non-linear time-varying factor model that includes the possibility of transitional divergence.

In more detail, we consider a set of observable series X_{it} of bank *i* such that:

$$X_{it} = g_{it} + a_{it} \qquad (5),$$

where X_{it} is the panel data for technical inefficiency and M&A fees variables. Based on Phillips and Sul (2007), we decompose X_{it} into two parts, the g_{it} that is the systematic and the a_{it} which stands for the transitory component. The equation (5) takes the following specification:

$$X_{it} = \left(\frac{g_{it}+a_{it}}{\mu_t}\right)\mu_t = \delta_{it}\mu_t \qquad \text{for all } i \text{ and } t, \qquad (6),$$

where μ_t is the common element while δ_{it} is the idiosyncratic component. To this end, testing for convergence is equivalent of examining whether the δ_{it} components converge. In order to estimate δ_{it}, Phillips and Sul (2007) eliminate the common element μ_t by rescaling using the panel average as follows:

$$h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}\mu_t}{\frac{1}{N}\sum_{i=1}^{N}\delta_{it}\mu_t} = \frac{\delta_{it}}{\frac{1}{N}\sum_{i=1}^{N}\delta_{it}} \qquad (7),$$

the h_{it} captures the transition path of a bank i compare to the panel average. A formal econometric technique of convergence and an empirical algorithm to define convergence requires the loading coefficients δ_{it} that are defined as follows:

$$\delta_{it}=\delta_i+\sigma_{it}\xi_{it} \quad (8),$$

where $\sigma_{it}=\frac{\sigma_i}{L(t)t^a}$, $\sigma_i>0$, $t\geq 1$ for all i. ξ_{it} is weakly dependent over t and identically and independently distributed (0,1) over i. $L(t)$ is a slowly varying function , which is equal to the log_t, and a stands for the speed of convergence. Based on the above transformation of δ_{it} , the null hypothesis of relative convergence is as follows:

$H_0 : \delta_i = \delta$ and $a\geq 0$

While the alternative of non-convergence is:

$H_A : \delta_i \neq \delta$ for all 1, or $a<0$

Step one: The cross-sectional variance $\frac{H_1}{H_t}$ is estimated as follows:

$$H_t = \frac{1}{N}\sum_{i=1}^{N}(\hat{h}_{it}-1)^2$$

(9)

Step two: Following Phillips and Sul (2007), we test the null hypothesis using the subsequent log_t specification:

$$log\left(\frac{H_1}{H_t}\right)-2logL(t)=\hat{c}+\hat{b}log_t+u_t \quad (10),$$

where $L(t)$=log$(t+1)$. The fitted coefficient of log_t is $\hat{b}=2\hat{a}$, where $\hat{a}$ is the estimate of a in H_0 .

Step three: Phillips and Sul (2007) use a one side t-test of null hypothesis H_0 and a Heteroscedasticity and Autocorrelation Consistent estimator to estimate the residual. The t-statistic is normally distributed and therefore at the 5% significance level, the null hypothesis is not upheld when $t_b \leq -1.65$.

However, following Phillips and Sul (2007) the rejection of the null convergence hypothesis does not necessarily imply that there are not sub-group convergence within the panel. Hence, Phillips and Sul (2007) in order to investigate the existence of sub-group convergence develop an empirical algorithm based on a three-step procedure. As a first step, we order the banks of out panel according to the last observation. Secondly, we organize core groups of banks by estimating the convergence *t*-statistics, t_k , for sequential log_t regression based on the k highest members with 2≤ k ≤ N. The group of banks with the maximum t_k , with t_k >- 1.65, is the core group. As a third step, we include new members in the group when the associated t_k > 0. Lastly, we run the log_t regression for the set of banks in the club which constitute a cluster. In case this cluster converges, there are two subgroups in the panel. If not, we should repeat the three previous steps to investigate if there is a smaller convergent club in the panel. If there is no core group in our panel data, we conclude that banks display non-converge behaviour.

4.6.2 Convergence in technical inefficiency

Panel A of Table 5 indicates that the period before the financial crisis (2004-2007) three convergence clubs are identified. The existence of convergence clubs before the turmoil suggests the high level of financial integration in the investment banking industry. The core group comprises of six investments from Japan, France, Germany and the UK. The second group includes eight investments of which five are German. Hence, German investment banks are more present in the first and the second convergence club. The third convergence club includes the majority of investment banks (36 out of 48) the period under examination. Investment banks in this convergence club are mostly from Japan, the US and the UK and less from the rest countries within the sample. Moreover, it could be observed that the speed of convergence is faster for the second convergence (b-coef=0.364) club compared to that of the core (b-coef= -0.224) and the third convergence club (b-coef= -0.386).

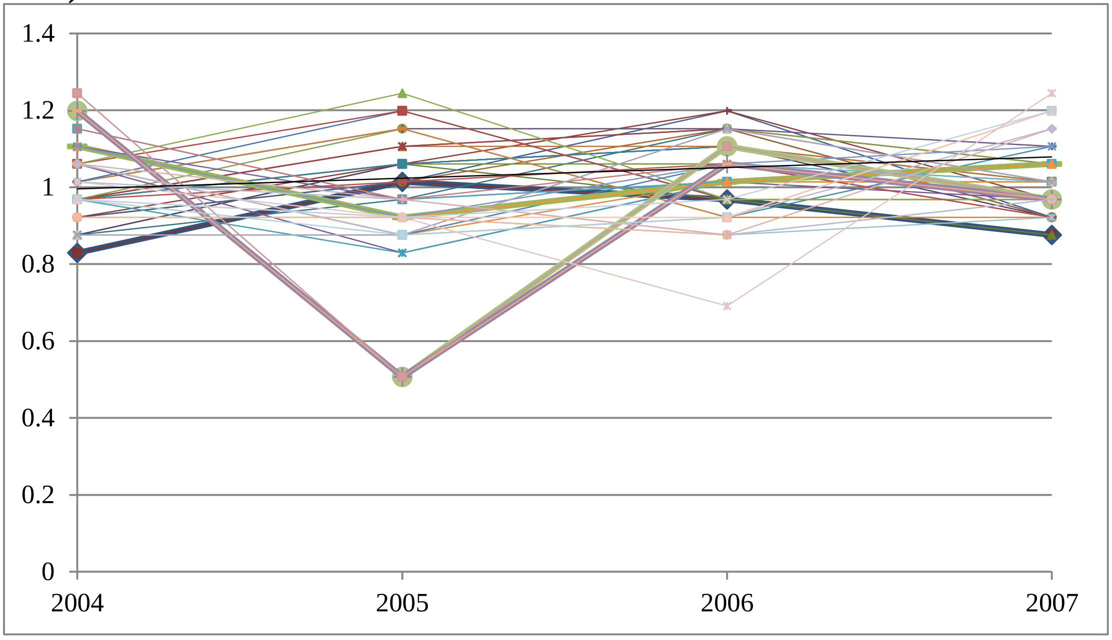
Table 5. Convergence in technical inefficiency for investment banks in G7 and Switzerland.

Period	Convergence club classification Group membership	b-coef	(t-stat)
Panel A: Technical Inefficiency before crisis			
2004-2007	**Core Group:** 4 investment banks	-0.224	(-1.559)
	2nd Group: 8 investment banks	0.364	(-0.822)
	3rd Group: 36 investment banks	-0.386	(-1.503)
Panel B: Technical Inefficiency during crisis			
2007-2010	**Core Group:** 6 investment banks	0.028	(-0.183)
	Divergent banks: 44 investment banks	-3.261	(-38.167)
Panel C: Technical Inefficiency after crisis			
2010-2012	**Core Group:** 4 investment banks	3.177	(4.135)
	Divergent banks: 24 investment banks	-2.821	(-33.216)

Notes: the Table shows the results of the Phillip and Sul's (2007) convergence test in technical efficiency for investment banks in G7 and Switzerland across three different periods:1) 2004-2007 (pre-crisis) 2) 2007-2010 (during the crisis) and 3) 2010-2012 (after the crisis). b-coef stands for the speed of convergence among the investment banks within a club and the t-stat tests for the existence of convergence club. When t-stat>-1.65 there is convergence within the club of investment banks formed.

Figure 3 shows the relative transition curves for the investment banks in G7 and Switzerland and indicates that during the pre-crisis period the majority of investment banks follow almost parallel paths. These curves depict the behaviour of the technical inefficiency of an investment bank relative to the panel average of all banks included in the sample. For investment banks of the second convergence club that is comprised mainly of German banks, their curves are above 1, while for the rest investment banks, that comprises the third convergence club and are located in the UK, the US, Japan, France, Switzerland , Canada and Italy their curves are below 1.

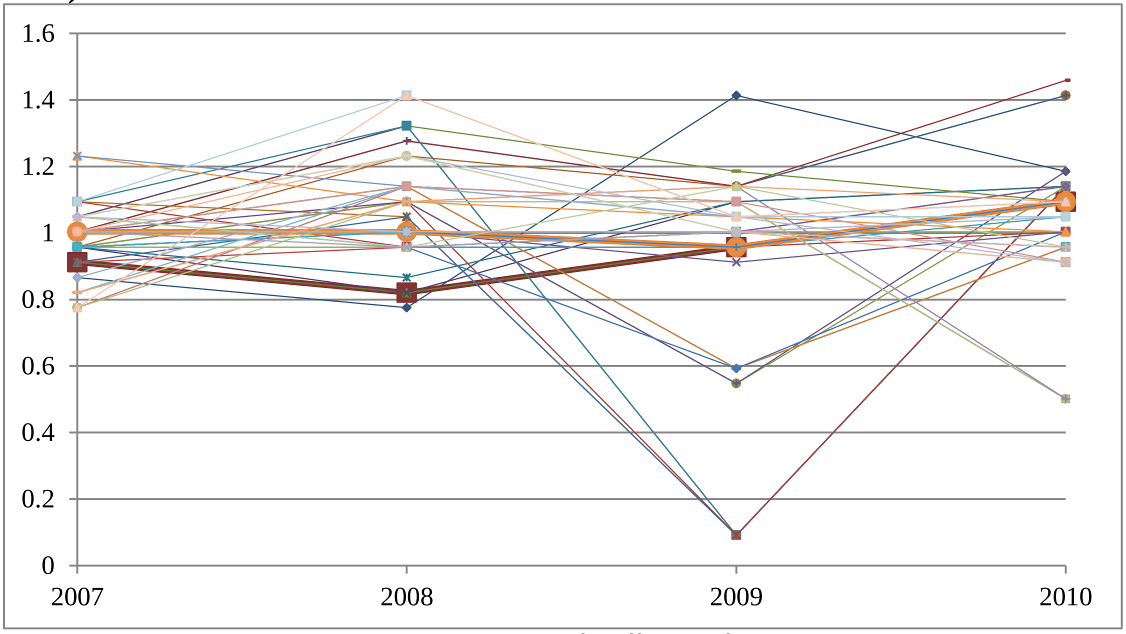
Figure 3. Relative Transition Curves of Inefficiency for G7 and Switzerland (2004-2007).



Notes: the Figure shows the relative transition curves of inefficiency for each investment bank in the G7 and Switzerland (2004-2007).

In addition, Panel B shows that evidence during the financial crisis (2007-2010) there exists one core group that includes five investment banks while the rest of the investment banks within the sample diverge (t-statistic: -38.167). This result suggests that investment banks during the crisis period show a diverge behaviour with respect to the technical inefficiency contrary to the high convergence identified in the pre-crisis period. A similar picture emerges from Figure 4 that indicates a low level of convergence especially for the 2008-2010 period when most of the investment banks diverge. The core convergence club includes five investment banks that diverge during almost the whole 2008-2010 period and appear to converge at the end of the period under examination.

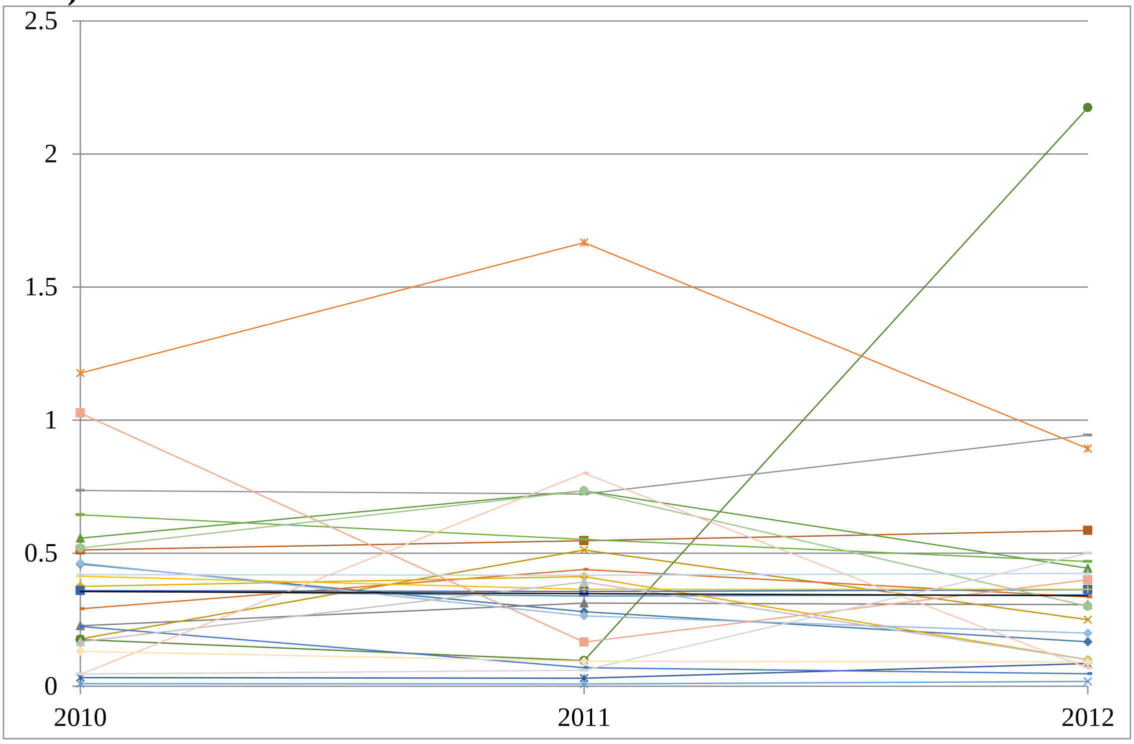
Figure 4. Relative Transition Curves of Inefficiency for G7 and Switzerland (2007-2010).



Notes: the Figure shows the relative transition curves of inefficiency for each investment bank in the G7 and Switzerland (2007-2010).

Lastly, Panel C indicates that during 2010-2012 the investment banks form one core convergence group that includes four investment banks from the UK and Italy. The rest of investment banks within the sample diverge (t-statistic: -33.216). The same conclusion arises from Figure 5 where investment banks curves based on technical inefficiency scores follow diverge.

Figure 5. Relative Transition Curves of Inefficiency for G7 and Switzerland (2010-2012).



Notes: the Figure shows the relative transition curves of inefficiency for each investment bank in the G7 and Switzerland (2007-2010).

4.6.3 Convergence in M&A fees

Table 6 shows the presence of convergence clubs for investment banks with the respect to the level of M&A fees the pre-crisis period (2004-2007), over the crisis (2007-2010) and after the crisis period (2010-2012). Crisis period (2007-2010) is determined based on previous empirical studies in the banking literature (Dietrich et al., 2014; Al-Najjar, 2014; Caporale et al., 2014).

Table 6. Convergence in M&A fees for investment banks in G7 and Switzerland.

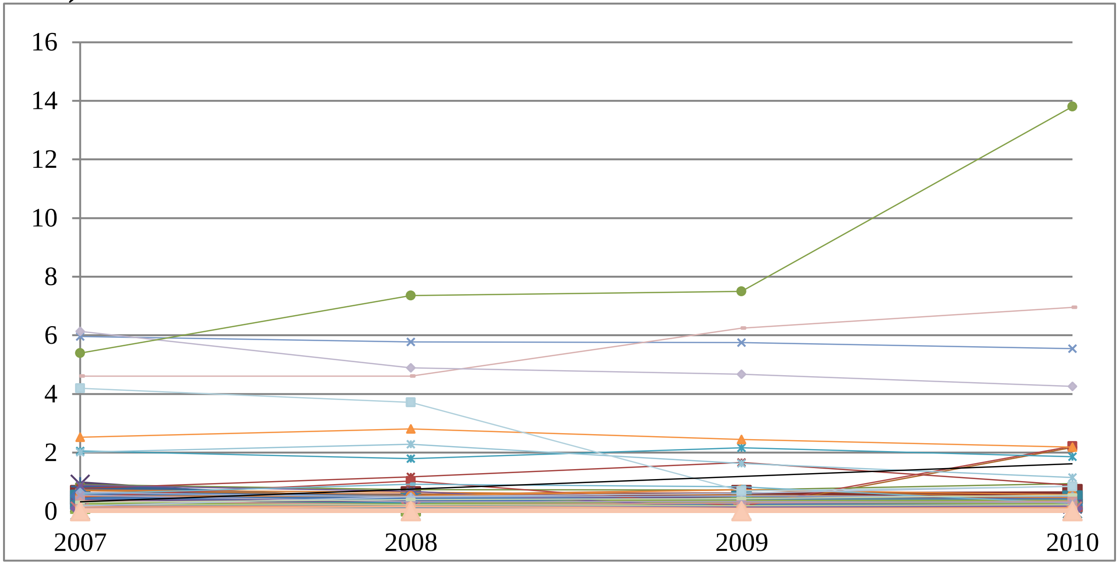
Period	Convergence club classification Group membership	b-coef	(t-stat)
Panel A: M&A fees before crisis			
2004-2007	**Core Group:** 13 investment banks	-0.012	(-0.437)
	2nd Group: 35 investment banks	-0.267	(-0.200)
Panel B: M&A fees during crisis			
2007-2010	**Core Group:** 13 investment banks	0.387	(-5.016)
	2nd Group: 37 investment banks	4.512	(7.236)
Panel C: M&A fees after crisis			
2010-2012	**Core Group:**3 investment banks	-1.327	(-0.214)
	Divergent banks: 25 investment banks	-2.791	(-32.768)

Notes: the Table shows the results of the Phillip and Sul's (2007) convergence test in M&A fees for investment banks in G7 and Switzerland across three different periods:1)2004-2007 (pre-crisis) 2) 2007-2010 (during the crisis) and 3) 2010-2012 (after the crisis). b-coef stands for the speed of convergence among the investment banks within a club and the t-stat tests for the existence of convergence club. When t-stat>-1.65 there is convergence within the club of investment banks formed.

Panel A of Table 6 reports the identification of two convergence clubs among the investment banks over the pre-crisis period. The core convergence club includes 13 investment banks the majority of whom are from the UK, the US and Japan. The second convergence club consists 35 out of 48 investment banks. In addition, Figure 7 illustrates that the relative transition curves for the investment banks in G7 and Switzerland are homogeneous and follow parallel paths. The transition curves of the core group are those that follow a downward trend while the relative curves of the second convergence group diverge.

Similarly, Panel B of Table 6 shows the existence of two convergence clubs during the crisis period (2007-2010). The core convergence club includes 19 investment banks the majority of which are German banks while the second club 31 banks mostly from the US, the UK, and the Japan. In addition, it could be noted that the speed of convergence is faster for the second convergence club (b-coef=4.512) compared to that of the core group (b-coef= -0.267). The identification of investment bank clubs with respect to the M&A fees in both the pre-crisis and during crisis period indicates the high level of financial integration in the investment banking industry. Similarly, Figure 6 shows that investment banks follow parallel paths during the whole period under study. Moreover, investment banks in the core group have transition curves that follow a decreasing trend while investment banks that form the second convergence club follow an increasing path.

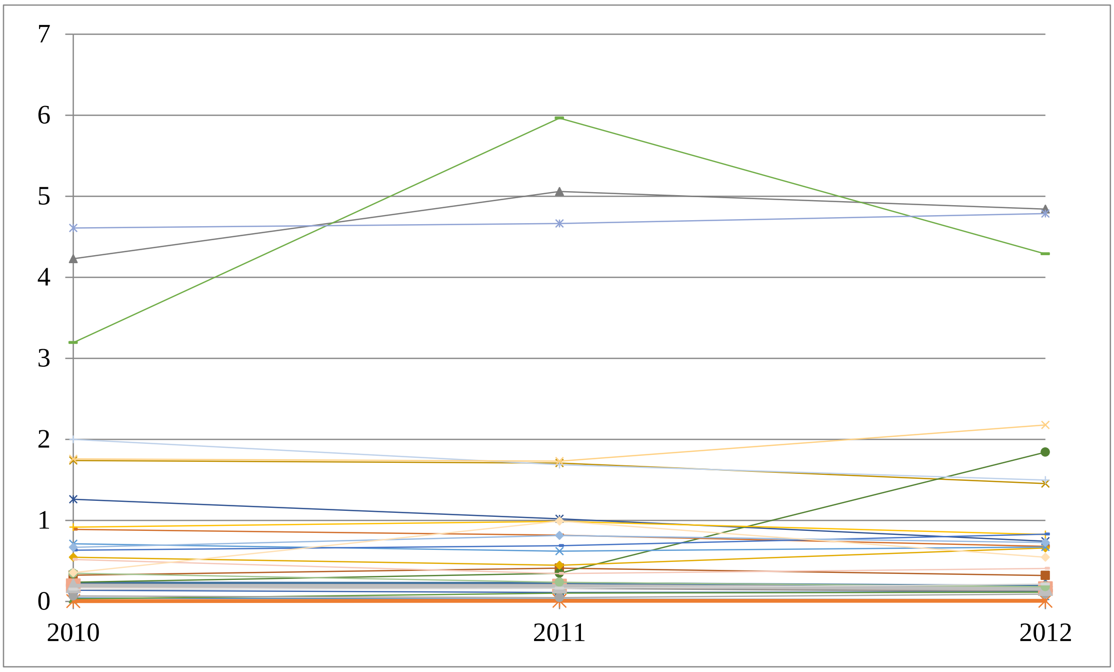
Figure 6. Relative Transition Curves of M&A fees for G7 and Switzerland (2007-2010).



Notes: the Figure shows the relative transition curves of M&A fees for each investment bank in the G7 and Switzerland (2007-2010).

Finally, Panel C of Table 6 shows the existence of a low level of convergence of investment banks with regard to the M&A fees over the 20010-2012 period. In particular, we identify one core convergence group that includes 3 investment banks from the UK. The rest investment banks that are mostly from Italy, France, and the Japan do not appear to form a convergence club (t-statistic: -32.768). Similarly, Figure 7 depicts that the majority of investment banks curves based on M&A fees diverge.

Figure 7. Relative Transition Curves of M&A fees for G7 and Switzerland (2010-2012).



Notes: the Figure shows the relative transition curves of M&A fees for each investment bank in the G7 and Switzerland (2010-2012).

4.7 Testing for endogeneity – Panel-Vector Autoregressive (VAR) estimation

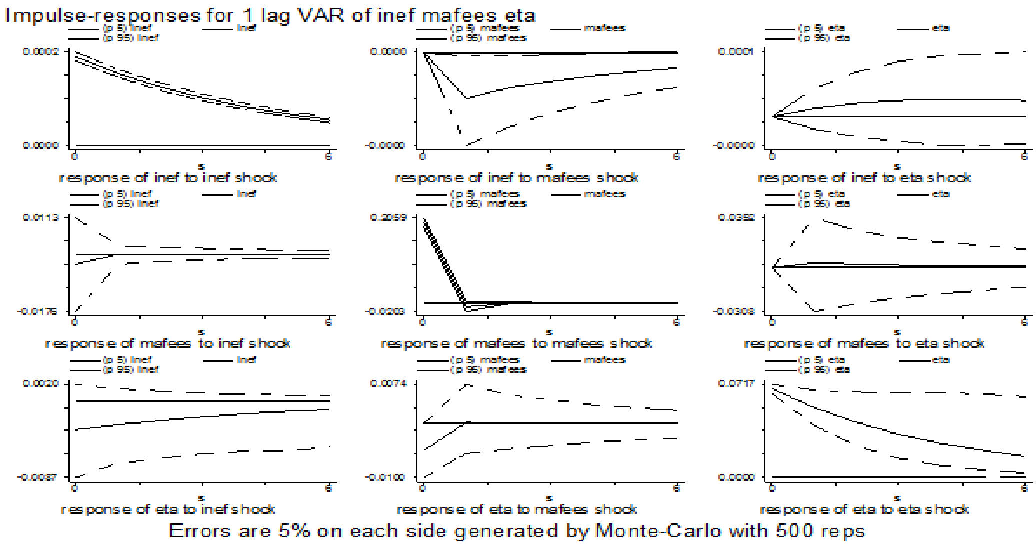
The usage of the Panel-Vector Autoregressive methodology (Panel-VAR) is appropriate in the context of our study as this econometric technique allows all variables to enter as endogenous in a system of equations, whereby the underlying relationships between the variables could be identified (Lütkepohl, 2005). Regarding the estimation, we employ the STATA software with the code written by Love and Zicchino (2006). The authors follow Arellano and Bover (1995) to estimate each equation included in the system of equations. Once the system of equations is estimated, it is then used to perform dynamic simulations. This analysis offers the estimation of variance decompositions (VDC) and impulse response functions (IRF) and suggests addressing a common identification problem. We deal with this issue by using a preference ordering suggesting that more exogenous variables affect on the more endogenous based on a sequential order according to the identification strategy as developed by Choleski (1924). In order to proceed with the estimation of the panel-VAR, we should first choose the optimum lag order j of the right-hand variables in the system of equations (Lutkepohl, 2006). Hence, we employ the Arellano-Bond GMM estimator for the for the lags of j=1,2 and 3. Following the Akaike Information Criterion (AIC), we find that the optimal lag order is one. This is also confirmed by the Arellano- Bond AR tests. In addition, to test for autocorrelation we add more lags. The Sargan tests suggest evidence of optimal lag order one.[35]

The panel-VAR analysis allows the investigation of the impact of M&A fees and the equity over total assets (E/TA) variables on technical inefficiency (Inef). The impulse response function (IRFs) obtained from the panel-VAR methodology are reported in

[35] For a formal exposition of the panel-VAR econometric technique see Appendix.

Figure 9. The first row depicts the response of inefficiency (Inef) to a one standard deviation shock in the M&A fees and ETA variables.

Figure 8. Impulse response functions (IFRs) for technical inefficiency (Inef), M&A fees (M&Afees) and equity over total assets (E/TA).



It is apparent that the impact of M&A fees on Inef is negative, while this effect becomes less pronounced after the second year. This result confirms again the *'skilled-advice hypothesis'* (Bao and Edmans, 2011). In the case of M&A fees, the panel-VAR methodology appears to confirm the findings of the preceding single-step analysis. Moreover, Figure 9 shows that the impact of ETA on technical inefficiency is positive in the period under study, which comes in contrast with our previous results. However, we observe that the standard errors of the corresponding impact are relatively large and hence this raises concerns regarding the validity of this finding.

Table 7 suggests further evidence of the impact of M&A fees and E/TA on technical Inef as presented by the variances decompositions (VDCs) estimations. These results are consistent with the IRFs and suggest that the two bank-specific variables are important in explaining the variation in technical inefficiency. Equity over total assets (E/TA) is confirmed to be an important determinant of technical inefficiency (Inef) as 2.02% of the forecast error of technical inefficiency after ten years is explained by shocks in the E/TA variable. Also, around 0.46% of forecast error variance of technical inefficiency after 10 years is captured by M&A fees disturbances. On the other hand, a small part, less than 0.02%, of the variation of M&A fees is explained by technical inefficiency. This result suggests that the causality would run from M&A fees to technical inefficiency.

Table 7. Variance decompositions (VDCs) for technical inefficiency (Inef), bank M&A fees (M&A fees) and the level of equity over total assets (E/TA).

Variance Decompositions (VDCs) for M&A fees (M&A fees), the ratio of equity to total assets (E/TA) and the bank technical inefficiency (Inef)

	s	Inef	M&A fees	E/TA
Inef	10	0.97527	0.00454	0.02020
M&A fees	10	0.00024	0.99892	0.00084
E/TA	10	0.00255	0.00203	0.99542
Inef	20	0.97070	0.00455	0.02475
M&A fees	20	0.00024	0.99891	0.00085
E/TA	20	0.00257	0.00202	0.99542
Inef	30	0.97051	0.00455	0.02494
M&A fees	30	0.00024	0.99891	0.00085
E/TA	30	0.00257	0.00202	0.99542

Notes: the Table shows the Variance Decompositions for investment banks' M&A fees (M&A fees), the ratio of equity to total assets (E/TA) and the technical inefficiency (INEF).

4.8 Conclusion

In this chapter, we estimate technical inefficiency scores for investment banks in G7 and Switzerland by employing the enhanced hyperbolic distance function (Cuesta et al., 2009). We further examine the impact of M&A fees on bank performance. Our results show a positive association between M&A fees and performance of investment banks consistent with the *'skilled-advice hypothesis'* (Bao and Edmans, 2011). The dynamic panel-VAR results using impulse response functions and variance decomposition further support this finding. Also, as the investment banking industry has become increasingly global in its operations we examine the presence of investment bank convergence clubs with respect to technical inefficiency and M&A fees by employing Phillip and Sul's (2007) methodology. Our results show evidence of convergence in inefficiency over the pre-crisis period (2004-2007), while also there is a divergent club in the 2007-2010 period. Interestingly, we also find the presence of convergence in M&A fees over both the pre-crisis and during the crisis period. Lastly, we find no indication of convergence for both inefficiency and M&A fees for the post-crisis period (2010-2012).

The results could be of interest for bankers and regulators alike. With regard to the relationship between M&A fees and investment bank performance, the latter could benefit from an increase of fees when the investment bank has specialized knowledge and experience in completing M&A transactions. Moreover, the presence of convergence clubs with respect to the M&A fees shows the high level of financial integration in the investment banking industry both the pre-crisis and during the crisis period. This, in turn, implies that investment banks despite that they operate in different countries when they follow analogous strategies, i.e., raise their M&A fees, they get exposed to the same risk. Hence, this suggests that regulators should promote regulatory harmonization policies, such as similar capital adequacy and liquidity requirements, that would improve the financial stability of investment banks in the G7 and Switzerland.

Appendix to Chapter 4

Appendix

Panel VAR Methodology

We use a panel-data vector autoregression methodology and study the causality associations between technical inefficiency (Inef), M&A fees (M&Afees), and the ratio of equity to total assets (E/TA) by using a first order 3x3 panel-VAR model following Love and Zicchino (2006):

$$X_{it} = \mu_i + \Phi X_{it-1} + e_{i,t}, \quad i = 1, \ldots, N, \; t = 1, \ldots, T. \qquad (1),$$

where X_{it} is a vector of three bank-specific variables; the technical inefficiency ($Inef_{it}$), the ratio of M&A fees over total assets ($M\&Afees_{it}$) and the ratio of equity to total assets (ETA_{it}). Thus, Φ is a 3x3 matrix of coefficients, μ_i is a vector of m individual effects and $e_{i,t}$ are the errors which are iid. For the estimation purposes, following Love and Zicchino (2006) we use a system-based GMM as developed by Arellano and Bover (1995), thereby the panel-VAR takes the following specification:

$$Inef_{it} = \beta_{10} + \sum_{j=1}^{J} \beta_{11} Inef_{1it-j} + \sum_{j=1}^{J} \beta_{12} M\&Afees_{1it-j} + \sum_{j=1}^{J} \beta_{13} ETA_{1it-j} + e_{1i,t}$$
$$M\&Afees_{it} = \beta_{20} + \sum_{j=1}^{J} \beta_{21} Inef_{1it-j} + \sum_{j=1}^{J} \beta_{22} M\&Afees_{1it-j} + \sum_{j=1}^{J} \beta_{23} ETA_{1it-j} + e_{2i,t}$$
$$ETA_{it} = \beta_{30} + \sum_{j=1}^{J} \beta_{31} Inef_{1it-j} + \sum_{j=1}^{J} \beta_{32} M\&Afees_{1it-j} + \sum_{j=1}^{J} \beta_{33} ETA_{1it-j} + e_{3i,t}$$

(2)

Following Arrelano and Bover (1995), the moving averages (MA) specification of the model sets $Inef_{it}$, $M\&Afees_{it}$, and ETA_{it} equal to a set of present and past errors e_1, e_2 and e_3:

$$Inef_{it} = \mu_{10} + \sum_{j=1}^{J} b_{11} e_{1it-j} + \sum_{j=1}^{J} b_{12} e_{2it-j} + \sum_{j=1}^{J} b_{13} e_{3it-j}$$
$$M \& Afees_{it} = \mu_{20} + \sum_{j=1}^{J} b_{21} e_{1it-j} + \sum_{j=1}^{J} b_{22} e_{2it-j} + \sum_{j=1}^{J} b_{23} e_{3it-j}$$
$$ETA_{it} = \mu_{30} + \sum_{j=1}^{J} b_{31} e_{1it-j} + \sum_{j=1}^{J} b_{32} e_{2it-j} + \sum_{j=1}^{J} b_{33} e_{3it-j}$$

(3)

Based on the endogeneity assumption the errors would be correlated and hence the coefficients of the MA representation could not be interpreted. Hence, the residuals should be orthogonal. We achieve this by multiplying the MA representation with the Cholesky decomposition of the covariance matrix of the errors. The orthogonalized representation according to Love and Zicchino (2006) is as follows:

$$Inef_{it} = \mu_{10} + \sum_{j=1}^{J} b_{11} \varepsilon_{1it-j} + \sum_{j=1}^{J} b_{12} \varepsilon_{2it-j} + \sum_{j=1}^{J} b_{13} \varepsilon_{3it-j}$$
$$M \& Afees_{it} = \mu_{20} + \sum_{j=1}^{J} b_{21} \varepsilon_{1it-j} + \sum_{j=1}^{J} b_{22} \varepsilon_{2it-j} + \sum_{j=1}^{J} b_{23} \varepsilon_{3it-j}$$
$$ETA_{it} = \mu_{30} + \sum_{j=1}^{J} b_{31} \varepsilon_{1it-j} + \sum_{j=1}^{J} b_{32} \varepsilon_{2it-j} + \sum_{j=1}^{J} b_{33} \varepsilon_{3it-j}$$

(4)

and

$$\begin{pmatrix} \beta_{11j}\beta_{12j}\beta_{13j} \\ \beta_{21j}\beta_{22j}\beta_{23j} \\ \beta_{31j}\beta_{32j}\beta_{33j} \end{pmatrix} = \begin{pmatrix} b_{11j}b_{12j}b_{13j} \\ b_{21j}b_{22j}b_{23j} \\ b_{31j}b_{32j}b_{23j} \end{pmatrix} P \begin{pmatrix} \varepsilon_{1it} \\ \varepsilon_{2ij} \\ \varepsilon_{31j} \end{pmatrix} = P^{-1} \begin{pmatrix} e_{1it} \\ e_{2it} \\ e_{3it} \end{pmatrix}$$

(5)

where P is the Cholesky decomposition of the covariance matrix of the errors as developed by Cholesky (1924):

$$\begin{pmatrix} Cov(e_{1it}, e_{1it}) & Cov(e_{1it}, e_{2it}) & Cov(e_{1it}, e_{3it}) \\ Cov(e_{2it}, e_{1it}) & Cov(e_{2it}, e_{2it}) & Cov(e_{2it}, e_{3it}) \\ Cov(e_{3it}, e_{1it}) & Cov(e_{3it}, e_{2it}) & Cov(e_{3it}, e_{3it}) \end{pmatrix} = PP^{-1} \quad (6)$$

We employ fixed effects in the panel-VAR estimation to ensure heterogeneity in the levels, represented by μ_i. Moreover, similar to Love and Zicchino (2006) we are forward mean-differenced the data based on the Helmert process (Arellano and Bover, 1995). Lastly, we opt for Monte Carlo simulations to compute standard errors for the impulse response functions (IRFs). Note that for simplicity reasons and in order to facilitate the exposition of the vectors and matrixes of panel-VAR model (1) we restrict our analysis to two bank-specific variables (M&A fees and E/TA).

Chapter 5: The impact of unconventional monetary policy on risk-taking of the US investment banks

5.1 Introduction and Related Literature

This chapter places emphasis on the effect of unconventional monetary policies (UMPs) on risk-taking of the US investment banks. Our focus on this topic is driven by the importance of monetary policy for central bank's policy making as the initiation of suitable strategies would foster economic growth and affect significantly the stability of financial institutions. In particular, as a response to the recent financial crisis, the Federal Reserve Bank (Fed) in the US has been engaged in unconventional monetary policies such as large-scale asset purchases (LSAPs). Fed's transaction included purchases of trillions of the US long-term Treasury bonds and mortgage-backed securities (MBS) over the 2008-2013 period suggesting a large expansion of its balance sheet assets. The existing literature has examined extensively the relationship between monetary easing and risk-taking of the US commercial banks (Dell'Ariccia et al., 2010, 2012, 2013; Delis et al., 2011; Buch et al., 2014; Fungacova et al., 2014). However, to the best of our knowledge, the effect of UMPs on the risk-taking of investment banks has not been investigated yet thoroughly in the extant literature. To this end, we try to fill a gap by investigating the impact of UMP on bank risk-taking focusing exclusively on the US investment banks.

Our focus in the US is motivated by the importance of the investment banking industry for the US economy both in terms of size and also in terms of its contribution to the recent financial crisis. Furthermore, the US is one of the countries that have used in unparalleled levels UMP tools to wither the recent financial crisis. Before the advent of the economic crisis in 2007, the US investment banking industry had experienced strong growth. Over a period of continuous economic prosperity, investment banking revenues increased considerably and constituted more than the half of total US bank income in the US (Burgess, 2011). Since the 2007 crisis, the investment banking industry has been transformed significantly as a number of prominent US investment banks have collapsed while others were acquired by other banking entities or transformed into bank holding companies (BHCs) to wither the severe consequences of the crisis. In some detail, the industry's revenues dropped by 30% between 2009-2012 period. There is also evidence that the profitability, as estimated by return on equity (ROE), of the top US 15 investment banks decreased by 35% in 2014 compared to the average profitability in the years before the crisis (Oliver Wyman, 2015). This underperformance of the US investment banking industry has led to a series of regulatory changes that in turn have transformed fundamentally the way investment banks operate. In particular, the Dodd-Frank Act (2010) included a number of restrictions on major specific business areas of US investment banks. A key legislative rule is known as 'Volcker rule', requires investment banks to separate commercial banking from investment banking activities (Dodd-Frank Act, 2010). This, in turn, suggests a major transformation of the operational framework of the US investment banks since the 2007 crisis. In addition, government intervention in the US industry is considerably apparent, as a number of US investment banks have been converted into BHCs so as to have access to government funding such as the Federal Deposit Insurance (FDIC) support and the Troubled Asset Relief Program (TARP). Although these stringent rules are imposed by the US regulators aiming to enhance the stability of investment banks, there is evidence that the 'implicit government guarantee', which stems from access to capital provided by the government, could result in an increase of moral hazard of financial institutions (Gropp et al., 2006, 2013).

The Fed in the US, after the collapse of Lehman Brothers, has implemented a series of unconventional monetary tools aiming to ensure the well-functioning of deposit-taking institutions and primary dealers that include, among others, prominent US investment banks (Gagnon et al., 2011). A major UMP tool implemented by the Fed, the large-scale asset purchases (LSAPs), has resulted in significant expansion of central bank's assets.[36] Note, that these programmes involve primarily transactions between the Fed and major investment banks that have primary dealer status such as Goldman Sachs and Morgan Stanley (Gagnon et al., 2011).[37] Therefore, UMPs, as explained by LSAPs, has a direct impact on the stability of these financial institutions and hence it is of importance to further investigate the relationship between UMPs and investment banks' risk-taking. In addition, primary dealers' expectations as trading counterparties of the Fed in the implementation of UMP is critical. This is so as the Fed compiled the Survey of Primary Dealers where primary dealers develop their projections with regards to the impact of the Fed's LSAP program.[38]

Given the extensive usage of UMP tools by the Fed, there has been a growing research interest that sheds light on the effect of monetary easing, through low-interest rates over a prolonged period of time, on the level of bank risk-taking. This is well-documented in the literature as the *'risk-taking transmission channel'* (Altunbas et al., 2010, 2012; Fungáčová et al., 2014; Buch et al., 2014). The *'risk-taking transmission'* hypothesis suggests that low-interest rates rise the risk-taking of commercial banks through the

[36] To illustrate this, in 2008 the Fed announced asset purchases of agency mortgage-backed securities (MBS) of up to $600 billion, while the federal open market committee (FOMC) expanded significantly its purchases of MBS reaching a total value of up to $1.25 trillion. These transactions involve the first phase of UMP and include also LSAPs of longer Treasury securities and agency debt of up to $300 and $175 billion respectively. In a second phase of the LSAP program, Fed expanded its balance sheet assets' with an additional purchase of longer-term Treasury securities of up to $600 billion.

[37] The Federal Reserve Bank of New York provides a detailed list of the primary dealers in the US: http://www.newyorkfed.org/markets/pridealers_current.html

[38] Information on the questions asked in the Survey of Primary Dealer is available on the Federal Reserve Bank of New York: http://www.newyorkfed.org/markets/primarydealer_survey_questions.html

decrease in the difference between the lending and the deposit rate, which is known as the *'intermediation spread'*. Lower intermediation spreads rise incentives of commercial banks to invest in riskier assets, rather than safer assets such as Treasury-bills and government bonds, so as to increase their return. In support of this argument, Borio and Zhu (2008) show that low-interest rates decrease asset price movement. This, in turn, reduces the probability of a bank to default and encourage managers to undertake risk positions. Managers are also motivated to follow this search-for-yield mechanism as higher returns lead to higher level of executive compensation (Borio and Zhu, 2008).

Departing from the existing literature, there is a rather limited discussion with regards to the effect of UMP on risk-taking of investment banks. However, there has been a growing research interest in the relationship between UMP and risk of commercial banks. Thereafter, we provide a brief overview of the existing literature on this topic. Table 1 summarises the empirical studies that are relevant to the focus of our study and in terms of the period of examination and the sample employed. Note, that all these studies report evidence of positive relationship between UMP and risk of commercial banks (Altunbas et al., 2010, 2012; De-Nicolo et al., 2010; Delis et al., 2011; Dell'Ariccia et al., 2013; Buch et al., 2014; Fungacova et al., 2014) consistent with the *'risk-taking transmission'* hypothesis. From Table 1 it is obvious that, among the studies reviewed, there exists a clear concentration in terms of the country coverages in the euro area (Altunbas et al., 2010, 2012; Fungacova et al., 2014) and the US (Altunbas et al., 2010, 2012; De-Nicolo et al., 2010; Delis et al., 2011; Dell'Ariccia et al., 2013; Buch et al., 2014; Fungacova et al., 2014), suggesting that UMP has been extensively employed by European central bank (ECB) and Fed as a tool to wither the financial crisis in these economies. In terms of the measures employed to proxy for UMP, most of the studies use the US federal fund rate (De-Nicolo et al., 2010; Buch et al., 2014; Dell'Ariccia et al., 2013), while others employ as a measure of UMP the Taylor gap (Altunbas et al., 2010; Fungacova et al., 2014) as introduced by Taylor (1993). However, there is a stand of literature (Altunbas et al., 2010; De-Nicolo et al., 2010; Buch et al., 2014) that highlights the ineffectiveness of US federal fund rate as a proxy of UMP due to its close to zero values over a prolonged period of time. In addition, Table 1 shows the variety of risk measures employed such as the expected default frequency (Altunbas et al., 2010,2012), insolvency risk as estimated by Z-score (Delis et al., 2011), risk-weighted assets (De-Nicolo et al., 2010) and loan supply (Fungacova et al., 2014; Buch et al., 2014). Furthermore, studies vary with respect to the periods employed as some of them cover a period that ends at 2009 (Altunbas et al., 2010, 2012; De-Nicolo et al., 2010; Buch et al., 2014), while others include the following years of 2010 (Delis et al., 2010; Fungacova et al., 2014) and 2011 (Dell'Ariccia et al., 2013) as well. Finally, the vast majority of these studies (Altunbas et al., 2010, 2012; De-Nicolo et al., 2010; Delis et al., 2011; Dell'Ariccia et al., 2013; Buch et al., 2014) use quarterly data as high-frequency data are appropriate in the context of these studies that aim to examine the short-term effect of UMP on bank risk-taking.

Table 1. Summary of relevant studies

A/A	References	Title	Monetary policy variable	Risk Indicators	Years in Sample	Country sample
1	Altunbas, Y., Gambacorta, L., & Marques-Ibanez, D. (2012).	Do bank characteristics influence the effect of monetary policy on bank risk?	The number of consecutive quarters that the real monetary interest rate is below the natural rate.	Expected default frequency (EDF)	2002q2-2009q4	Austria, Belgium, Denmark, Germany, Greece, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom and the United States
2	Fungáčová, Z., Solanko, L., & Weill, L. (2014).	Does competition influence the bank lending channel in the euro area?	Taylor Gap	Loan supply	2002-2010	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain and the United States
3	Altunbas, Y., Gambacorta, L., & Marqués-Ibáñez, D. (2010). Does monetary policy affect bank risk-taking?.	Does monetary policy affect bank risk-taking?	Use three alternative measures of Taylor gap.	Expected default frequency (EDF)	1999q1-2008q3	Austria, Belgium, Denmark, Germany, Greece, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom and the United States
4	Manthos Delis and Iftekhar Hasan and Nikolaos Mylonidis (2011)	The risk-taking channel of monetary policy in the USA: Evidence from micro-level data.	Quarterly change in the real federal fund rate as the difference between the nominal funds rate and the CPI.	1) Z-score 2)Syndicated loans	1985q1-2010q2	United States
5	Claudia M.Buch, Sandra Eickmeier, Esteban Prieto (2014)	In search for yield? Survey-based evidence on bank risk-taking	The US Federal fund rate	1) Ex-ante loans and 2) New loans.	1997q2-2008q2	United States
6	Giovanni Dell'Ariccia, Luc Laeven, and Gustavo Suarez (2013)	Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States	The US Federal fund rate	The ex-ante internal risk rating assigned by the bank to a given new loan	1997q1-2011q3	United States
7	De Nicolò, G., G. Dell'Ariccia, L. Laeven, and F. Valencia (2010)	Policy at the Zero Lower Bound: A Cross-Country	The US Federal fund rate	Risk-weighted assets over total assets	1997q1–2008q2	United States

Based on the above review of the existing literature, while there is growing volume of research papers that investigate the impact of monetary policy on the risk-taking of commercial banks, there is no empirical study, to the best of our knowledge, that explicitly focuses on the investigation of the effect of UMP on the risk-taking of investment banks. However, recently researchers highlight the importance of broker-dealers, also known as primary dealers, as main financial intermediaries regarding the LSAPs programmes (Carpenter et al., 2015). The list of the US primary dealers consists of prominent bank holding companies (BHCs), such as Morgan Stanley and J.P. Morgan, that before the Dodd-Frank (2010) and their transformation into BHCs used to operate as investment banks. Adrian and Shin (2009) claim that broker-dealers, also known as investment banks, are a better barometer of the general funding conditions compared to commercial banks. This is particularly the case in financial systems, such as the US and the UK, where the importance of broker-dealers' activities has been increased due to the securitisation (Stiroh, 2004; Yin and Yang, 2013). Since the importance of investment banks has been neglected by researchers for some time now, the existing research on the effect of unconventional monetary policy on the risk of these financial institutions is rather limited. However, there are some studies to justify the presence of a theoretical link on the relationship between unconventional monetary policies and investment banks' risk.

Based on the 'risk-taking transmission' hypothesis, low-interest rates rise the risk-taking of commercial banks through the decrease in the difference between the lending and the deposit rate. Thus, it is natural to expect that investment banks are less exposed to unconventional monetary shocks compared to commercial banks. However, empirical evidence shows that low-interest rates increase significantly securitization and underwriting operations of banking institutions (Maddaloni and Peydro, 2010). Therefore, as investment banks are involved primarily in non-banking activities such as insurance, underwriting, and securitization operations it is expected that UMP would affect considerably investment banks. Moreover, reality has shown that prominent investment banks, such as Bear Stearns, Lehman Brothers, and Merrill Lynch proved to be significantly affected by monetary policy changes. In addition, investment banks are financial institutions that differ fundamentally from commercial banks. This is so as investment banks' main source of income comes from non-interest based activities, while commercial banks focus mainly in interest-based operations (Demirguç-Kunt and Huizinga, 2010). Furthermore, Stiroh (2004) highlights that there exists a high positive correlation between fee-based and interest based income. This is due to increased level of reliance on loan substitutes that shows that different business segments are exposed to same economic fluctuations and that in turn reduces diversification benefits as product lines become considerably blurred (Stiroh, 2004, Yin and Yang, 2013). This suggests that unconventional monetary tools, through lower interest rates, would consequently affect to a similar extent banks relying on fee-based operations, such as investment banks, and these financial institutions that focus on interest-based income activities, such as commercial banks. Also, previous studies show that banks that focus primarily on non-interest operations are more exposed to monetary policy shocks (Fraser et al., 2002; Stiroh, 2004).

Moreover, Adrian and Shin (2009) highlight the importance of investment banks for the well- functioning of financial markets and their response to monetary policy changes. Initially, they report that asset growth of investment banks provide a better prediction of general funding conditions compared to the balance sheet growth of commercial bank asset growth. Moreover, in an earlier study, Adrian and Shin (2008) find that the leverage of investment banks has a procyclical behaviour and thus when the balance sheets of these financial institutions become large their leverage increases, while smaller balance sheets have as a result the reduction in leverage. The authors also document that lower short-term interest rate is associated with higher balance sheet asset growth of investment banks (Adrian and Shin, 2008). In particular, it is documented that monetary easing boosts asset prices. Gambacorta et al. (2014) perform a cross-country analysis, including the US, the UK, and Japan, and investigate the impact of unconventional monetary policy on output and consumer prices. They measure unconventional monetary policy by employing central bank assets as a percentage of GDP and they conclude that the latter increases output and consumer prices suggesting that unconventional monetary tools are effective in boosting asset prices. This increase of asset prices would cause a rise in bank equity while leverage would fall. Investment banks would respond to this reduction of the leverage by increasing their borrowing and consequently the demand of assets that would, in turn, increase further the price of assets resulting in higher balance sheet asset growth of these financial institutions (Adrian and Shin, 2008). This finding suggests that investment banks are exposed particularly to monetary policy shocks. Therefore, the above studies signify that it is important to put emphasis on the effect of UMP on investment bank risk.

In support of the above theoretical prediction, the most relevant empirical study is that by Gilchrist and Zakrajsek (2013). The authors investigate the impact of unconventional monetary policy, through low-interest rates for a prolonged period of time, on the credit risk of the financial sector using daily data over the 2008-2011 period. They use 5-year CDS contracts to construct indexes that incorporate the credit risk of two types of financial intermediaries, i.e., commercial banks and broker-dealers. To create these credit risk indicators, they use daily data for a sample of 9 US investment banks and 26 US commercial banks. They also perform a case study analysis where they measure the impact of unconventional monetary policy tools on the credit risk of the five most prominent US investment banks: Morgan Stanley, Goldman Sachs Group, Bank of America, Citigroup and J.P. Morgan. Overall, they find that lower interest rate over the crisis period, raises the credit risk of these financial institutions due to the increased cost of insurance.

From a methodological point of view, we employ both fixed effect and dynamic panel specifications to further boost the validity of our results. The usage of the dynamic panel analysis allow us to encounter two major econometric issues that our study faces: i) the well documented in the literature persistence of bank risk-taking (Keeley, 1990; Cordella and Yeyati, 2002), ii) and the endogeneity issues with regards to the relationship between the monetary policy stance and bank risk-taking (Jimenez et al., 2008; Ioannidou et al., 2015; Maddaloni and Peydro, 2011).

Based on the above discussion, the examination of the impact of UMP on the risk taking of the US investment banks is of importance both in terms of academic interest and policy implications. Thus, this study contributes to the existing literature in various ways. Firstly, it is the only study that investigates the underlying relationship between UMPs and bank risk-taking of investment banks. By contrast, the vast majority of the academic research has been focused on the effect of UMP on bank risk-taking of commercial and saving banks (Dell'Ariccia et al., 2010, 2012, 2013; Delis et al., 2011; Buch et al., 2014; Fungacova et al., 2014). Secondly, our analysis is based on quarterly based data as high-frequency information can gauge effectively the short term effect of UMPs on the US investment banks' risk (Altunbas et al., 2010). Thirdly, we use a number of alternative measures of UMP including both indicators that are standard in the relevant literature, such as central bank's assets, as well as variables that has been recently in the research spotlight as effective proxies of UMP, such as the shadow short rate (Kim and Singleton, 2012; Bullard, 2012; Bauer and Rudebusch, 2013; Krippner, 2013; Wu and Xia, 2014).

Fourthly, the usage of dynamic panel regressions enables us to deal with banks' risk persistence and endogeneity issues that arise from the effect of UMPs on risk, thus increasing the validity of our findings.

Overall our findings suggest a positive association between UMP and bank risk-taking, across a number of specifications where we employ a plethora of measures to capture the monetary policy stance. Our findings are broadly in line with the existing literature that also confirms the presence of a transmission risk channel on commercial and saving banking institutions under prolonged periods of low-interest rates. However, this is the first study that finds a strong relationship between UMPs and risk taking of the US investment banks, suggesting that these institutions are particularly affected by changes in the monetary policy.

The remainder of this chapter is organized as follows. Section 5.2 presents the hypothesis development. Section 5.3 describes our sample, data, and variables. Section 5.4 explains the methodology employed in our study. Section 5.5 discusses our results and Section 5.6 concludes with a brief summary of our key findings and policy implications.

5.2 Hypothesis development

There has been an extensive research that focuses on establishing a theoretical and empirical linkage between UMP and the risk of deposit-taking institutions (Delis et al., 2011; Altunbas et al., 2012; Fungáčová et al., 2014; Buch et al., 2014). However, there is rather limited research that bridges a conceptual framework on the effect of monetary expansionary policies on other financial intermediaries, such as investment banks. Subsequently, we develop our main hypothesis with regards to the association of UMP and the risk-taking of investment banks based on established literature (Adrian and Shin, 2009,2008; Yin and Yang, 2013).

5.2.1 Unconventional monetary easing and risk-taking of investment banks

There is a large body of literature that investigates the relationship between low-interest rates and risk-taking of commercial banks and confirms the presence of risk-taking channel (Delis et al., 2011; Altunbas et al., 2012; Fungáčová et al., 2014; Buch et al., 2014). The risk transmission channel might also be present in the case of investment banks since these financial institutions are exposed particularly to monetary policy shocks and could be a better barometer of general funding conditions compared to commercial banks (Yin and Yang, 2013; Adrian and Shin, 2009,2008; Stiroh, 2004). In the case of LSAPs, in which investment banks are largely involved, the "portfolio balance" channel as originally developed by Tobin (1963,1969) and Brunner and Meltzer (1973) is a key mechanism that could explain how UMP is able to affect financial institutions and the wider economy (Steeley and Matyushkin, 2015). They suggest that central banks, by shifting the relative supplies of assets with different maturities and liquidity, can have an impact on the relative returns on these assets owing to imperfect substitutability. Therefore, in the long term, an asset supply increase would result in adjustments of prices and returns aiming to restore equilibrium. In some detail, when central bank purchases assets from primary dealers such as investment banks, the cash holdings of sellers is increased. As money is not a perfect substitute for assets sold by primary dealers, sellers might put an emphasis in rebalancing their portfolios by buying other assets that are better substitutes (Joyce et al., 2012; Kapetanios et al., 2012). These purchases could involve riskier assets than cash, such as corporate bonds and equities, that would, in turn, increase risk-taking of these financial institutions (Fisher, 2010; Fratzscher et al., 2013). Moreover, the bid-ask spread of safe assets is reduced because of lower interest rates imposed by UMPs (Steely et al., 2015; Wu, 2014; Fratzscher et al., 2013).[39] Given that investment

[39] This resembles the intermediation spread explained by the risk-transmission channel for commercial banks.

banks are engaged in trading operations, they would shift towards riskier assets aiming to increase their return. This could consequently increase the risk-taking of investment banks.

In addition, following the literature (Adrian and Shin, 2008), monetary easing results in higher balance sheet asset growth of investment banks due to the procyclical behaviour of leverage. In particular, monetary easing boost asset prices (Gambacorta et al., 2014) that in turn rises the value of equity while decreases the level of leverage. Investment banks would restore the level of leverage by increasing their borrowing and the demand of assets (Adrian and Shin, 2008). This rise in the demand of assets would further increase the asset prices that would again result in the increase of leverage. High leveraged institutions, such as investment banks, entail a higher risk of default especially under high financial distressed conditions (Adrian and Shin, 2008). On the other hand, low leveraged banks are considered to be safer by investors and less sensitive to interest rate fluctuations (Madura and Schnusenberg, 2000).

Finally, in support of the risk transmission channel, Bekaert et al. (2010) find that investors are less risk-averse over monetary expansionary periods because UMP reduces market uncertainty and thus they are more confident in undertaking riskier positions. Similarly, Roache and Rousset (2014) observe that UMP, over the crisis and post-crisis period, reduces the probability of extreme movements of asset prices that in turn rises the risk-taking of financial institutions. Given that investment banks' operational framework involves, among others, trading activities this moderation effect of UMP on extreme asset price movements could reduce the level of risk-aversion that would lead to an increase of risk-taking of these financial institutions. Also, there is empirical evidence that confirms the positive relationship between monetary easing and the risk-taking of investment banks. In particular, Gilchrist and Zakrajšek (2013) suggest that low-interest rates increase credit risk of the US BHCs (previously known as investment banks). Based on the above theoretical predictions and empirical evidence, we conclude that UMP would increase the risk-taking of investment banks and thus our first hypothesis is defined as:

H1. : The effect of unconventional monetary easing on the investment bank risk-taking is positive.

5.3 Data and Variables

5.3.1 Sample

We hand-collect quarterly financial data from 10-Q fillings form SEC Edgar platform over a period that includes the financial crisis (2007Q1-2014Q4). The usage of quarterly data is particularly appropriate for examining the short-term effect of monetary policy stance on bank risk-taking (Altunbas et al., 2010). In addition, our analysis covers a period that includes not only the financial crisis of 2007 but also major UMPs. Our final sample consists of 20 investment banks with standard industry classification (SIC) of 6211 and 6282 and a total of 540 observations, after removing discrepancies and errors. Table 2 defines all variables, explanatory and dependent, employed to identify the underlying relationship between unconventional monetary policy and investment bank risk-taking.

Table 2. Variable definitions and sources

Notation	Measure	Data source
A. Dependent variables		
Z-SCORE	(1+ROE)/SDROE where ROE is the return on equity and sdROE is the standard deviation of return on equity	Authors' estimation
SDROE	Standard deviation of ROE	Authors' estimation
B. Independent Variables of our main interest		
CBA/GDP	Central bank assets over GDP ratio	International Financial Statistics (IFS), International Monetary Fund (IMF).
M1	Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions	Federal Reserve Bank of St. Louis
M2	Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares.	Federal Reserve Bank of St. Louis
TAYL.GAP-NCORE	The difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993), using the non-core inflation rate.	Authors' estimation
TAYL.GAP-CORE	The difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993), using the core inflation rate.	Authors' estimation
SHADOW-RATE	Shadow short rate is the monetary policy rate estimated at the Zero Lower Bound	Monthly Shadow short rate data as estimated by Wu and Xia (2014) are available at the Federal Reserve Bank of Atlanta.
FED-RATE	Federal Fund rate	Federal Reserve Bank of St. Louis
C. Other bank-specific and state-level explanatory variables		
SIZE	Natural logarithm of total assets	Authors' estimation-financial data resourced from 10-Q
E/TA	Equity/total assets	Authors' estimation-financial data resourced from 10-Q
ROAE	Net income/average total assets	Authors' estimation-financial data resourced from 10-Q
LIQUID_ASSETS/TA	Liquid assets/total assets	Authors' estimation-financial data resourced from 10-Q
FEES/TA	Investment banking fees/total assets	Authors' estimation-financial data resourced from 10-Q
VIX	Volatility Implied Index	Chicago Board Options Exchange Volatility Index
SP&500	Stock Price Index	Bloomberg database

5.3.2 Bank risk indicators

We proxy risk-taking of banks by two alternative measures that are standard in the banking literature; i) Z-score index and ii) SDROE. Z-score is calculated as follows:

$$Z - score = \frac{1+ROE}{\sigma(ROE)} \quad (1),$$

where ROE is return on equity, and $\sigma(ROE)$ is the standard deviation of ROE (Boyd and Graham, 1986). Z-score has been widely used in commercial and investment banking studies (Lepetit et al., 2008; Barry, et al., 2011; Radic et al., 2012) as it an intuitive and easily implementable measure. Following this equation (1), Z-score reduces when earnings' volatility increases. Thus, there is a negative relationship between Z-score and bank's default risk, and hence Z-score can be considered as an inverse proxy of bank's default risk. Therefore, higher values of Z-score denote lower default risk, while lower Z-score values suggest increased default risk. Table 3 shows that the mean value of Z-score is 0.587, while it ranges from -4.913 to 6.650.

Table 3. Descriptive statistics of the variables used in the empirical analysis with respect to bank performance.

Variable	Obs.	Mean	Std. dv.	Min.	Max.
A. Dependent Variables					
Z-SCORE	540	0.587	1.315	-4.913	6.482
SDROE	540	1.423	1.446	0.000	6.650
B. Independent Variables of our main interest					
CBA/GDP	540	56.27	21.68	20.890	90.766
M1	540	7.56	0.250	7.221	7.966
M2	540	9.11	0.147	8.868	9.356
TAYL.GAP-NCORE	540	-4.15	1.923	-8.822	0.095
TAYL.GAP-CORE	540	-3.81	0.801	-4.946	-1.903
SHADOW-RATE	540	0.58	1.886	-0.996	5.340
FED-RATE	540	0.94	1.658	0.060	5.340
C. Other bank-specific and country-level explanatory variables					
SIZE	540	16.112	2.878	10.233	21.668
E/TA	540	26.708	25.755	-8.810	92.856
ROAE	540	2.030	34.394	-362.129	546.191
LIQUID_ASSETS/TA	540	39.789	22.411	0.005	106.295
FEES/TA	540	15.487	38.226	-10.104	409.227
VIX	540	21.859	8.851	11.570	44.140
S&P500	540	7.210	0.223	6.667	7.625

Notes: the Table shows the basic descriptive statistics (mean, std.dv., min., max.) of all our dependent and independent variables. Our dependent variables are: Z-score=(1+ROE)/sdROE where ROE is the return on equity and sdROE is the standard deviation of return on assets; and SDROE is the standard deviation of return on equity as estimated based on twelve quarters. Our independent variables are: CBA/GDP= central bank's assets to gross domestic product ratio; M1= Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions; M2= Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares. TAYL.GAP-NCORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the non-core CPI; TAYL.GAP-CORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the core CPI; SHADOW-RATE= shadow short rate; FED-RATE= federal fund rate; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. Taylor gap=Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993); Shadow short rate;

Figure 1 demonstrates the trend of Z-score index over the 2007Q1-2014Q4 and reveals that investment banks face particularly high-risk exposure over the last quarter of 2008 reaching the lowest mean Z-score value of -0.2859. In particular, a number of investment banks underwent through an unprecedented financial crisis that had led to severe and adverse consequences to the survival of these financial institutions. Note that investment banks appear to have lower default risk between 2009 and 2010, reaching a lower bank exposure in the last quarter of 2010 (1.1262). Lastly, from 2011Q1 and onwards we observe a mean Z-score around 0.5539, suggesting a comparable stable risk-taking behavior of investment banks.

Figure 1. Mean values Z-score index across the 2007Q1-2014Q4 period.

Notes: the Figure 1 shows the trend of mean Z-score index over the 2007Q1-2014Q4.

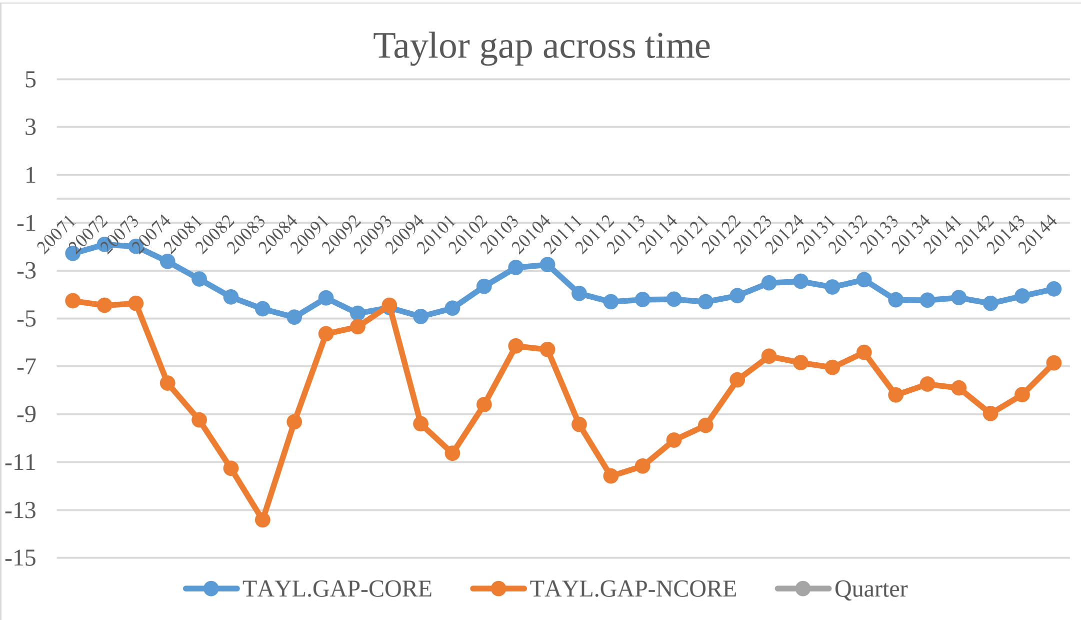
As a secondary variable we use SDROE that is the standard deviation of ROE calculated on values of ROE over the last twelve quarters. SDROE denotes income volatility and has been used by previous banking studies as a measure of bank risk (Jensen and Mester, 2003; Stiroh, 2004; Lepetit et al., 2008). Thus, higher values of SDROE increase earnings' variability and investment bank's risk, while lower values reduce banks' risk-taking. The mean value of SDROE is 1.423, while SDROE ranges between -2.279 and 6.650.

5.3.3 Unconventional monetary policy indicators

Unconventional monetary policy is proxied by a number of alternative variables that used in previous studies. As the first proxy of unconventional monetary policy, we use central bank assets over gross domestic product (CBA/GDP) that has been used in previous studies (Lambert and Ueda, 2014; Meaning and Zhu, 2012). This ratio shows the growth of central bank's balance sheets by buying government bonds and less safe assets by initiated unconventional monetary schemes that can increase bank lending. In addition, early academic literature (Friedman and Schwartz, 1986; Cagan, 1972) stresses the usefulness of monetary aggregates, i.e., M1 and M2, to gauge the monetary stance. We also use the Taylor gap to estimate the impact of unconventional monetary policy on investment bank risk that is used in previous studies (Altunbas et al., 2010; Lambert and Ueda, 2014). The Taylor gap is expressed as the difference between the federal fund rate and the interest rate as estimated by the Taylor rule (Taylor, 1993). Taylor rule interest rate is estimated as: Real Interest Rate +Inflation Target+0.5*Inflation Deviation+0.5*Output Gap. Inflation deviation is the difference between the current inflation and the target inflation rate as aimed by the Federal Open Market Committee (FOMC). The Output gap is estimated as the percentage change between the real and potential gross domestic product. We estimated the output gap based on the official data released by the FED. We employ two different measures of Taylor rule rate, based on 1) the non-core consumer price index CPI (TAYL.GAP-NCORE) and 2) the core CPI (TAYL.GAP-CORE) that excludes energy and food prices. For consistency reasons, we also use different sets of weights on the estimation of the Taylor rule rate i) 0.5 and 1.0 and ii) 0.5 and 1.5. Table 3 demonstrates that the mean values of TAYL.GAP-NCORE and TAYL.GAP-CORE are -4.149 and -3.808 respectively, suggesting that core inflation rate provides lower (negative) values. Moreover, negative Taylor gap values suggest that interest rates are below the benchmark rate (Taylor rule rate) and that in turn show increased monetary easing over the examination period (2007Q1-2014Q4).

Figure 2 shows that both TAYL.GAP-NCORE and TAYL.GAP-CORE fall below zero over the 2007Q1-2014Q4 period. This reveals that mean interest rates are lower compared to interest rates as estimated by the Taylor rule (Taylor, 1993). This, in turn, suggests a prolonged period of low-interest rates due to the implementation of UMP. Interestingly, we observe that both these two indicators reach their lowest value in the late 2008, when investment banks experience particularly high-risk exposure. Moreover, we can observe that TAYL.GAP-NCORE takes consistently lower values compared to the TAYL.GAP-CORE, as the latter is estimated based on the core CPI from which volatile prices, such as food and gas prices, are removed and thus the TAYL.GAP-CORE appear to be steadier than the TAYL.GAP-NCORE.

Figure 2. Mean values of TAYL.GAP-CORE and TAYL.GAP-NCORE variables the 2007Q1-2014Q4 period.



Notes: the Figure 2 shows the trend of mean TAYL.GAP-CORE and TAYL.GAP-NCORE variables over the 2007Q1-2014Q4.

We also employ federal fund rate (FED-RATE) as it is considered very informative in explaining movements of macroeconomic and microeconomic variables (Bernanke and Blinder, 1992) and has been broadly used in previous studies to examine the relationship between bank risk-taking and monetary stance (Buch et al., 2014; Ioannidou et al., 2015; Dell'Ariccia et al., 2013; De Nicolò et al., 2010). Table 3 displays that FED-RATE ranges between 0.060-5.340, while the mean value is equal to 0.937. In addition, there has been an increased research interest in the estimation of the shadow short rate (Kim and Singleton, 2012; Bullard, 2012; Bauer and Rudebusch, 2013; Krippner, 2013), while there are studies that examine the suitability of these rates on investigating the impact of unconventional monetary policies on asset prices (Francis et al., 2014; Claus et al., 2014). Therefore, we also use shadow short rate (SHADOW-RATE) measured by Wu and Xia (2014) as an additional proxy of UMP. The shadow short rate is constructed to replace the federal fund rate as a more effective measure to identify the impact of unconventional monetary policies on general economic and business conditions. The reason being that federal fund rate has been targeted at zero lower bounds after the initiation of unconventional monetary policies (2008Q1) and, in turn, is considered to be a less effective proxy of monetary policy between the 2008Q1-2014Q4 (Bruno and Shin, 2015). The Shadow short rate could be a better proxy compared to federal fund rate as it takes negative values and thus could capture the effects of monetary shocks on both the macro and micro-economic economic environment. The mean value of SHADOW-RATE is 0.575 and is almost half the mean value of FED-RATE (0.937). This is so as SHADOW-RATE takes both positive and negative values with a minimum value of -0.996.

5.3.4 Control Variables

We use numerous bank-specific and country-level control variables in our specifications following previous research papers. We control for the size (SIZE) of banks as estimated by using the natural logarithm of total assets. The impact of size on bank risk is mixed (Altunbas et al., 2001; DeGuevara and Maudos, 2007), as there are studies to find that size exerts a positive impact on bank risk-taking (Berger et al., 1987; Black and Hazelwood, 2013), while others observe a negative relationship between size and investment bank's risk (Athanasoglou et al., 2008; Black and Hazelwood, 2013). Increases of bank size might result in decreases in bank risk as increased size denotes higher level and mix of operations and thus, might result in higher risk diversification benefits (Mester, 1993). By contrast, the negative impact of bank size on bank risk-taking suggests that economies of scope and scale are not realized (Berger et al., 1987). In addition, we control for the equity to total assets ratio (E/TA) to proxy for bank risk-taking preferences (Athanasoglou et al., 2008; Lepetit et al., 2008). Similarly to SIZE, the impact of E/TA on bank risk could be either negative or positive. In particular, increases of E/TA suggest a higher level of capital at risk and therefore bank managers undertake less risky positions (Gorton and Rosen, 1995; Athanasoglou et al., 2008; Lepetit et al., 2008). However, increases of E/TA (decreases of leverage) could result in a higher risk, as lower leverage reduces the priority of managers to secure funding to pay back the debt and thus are eager to undertake riskier projects (Myers, 1977). Furthermore, we investigate the effect of liquidity, as estimated by the liquid asset over total assets (LIQUID_ASSETS/TA), on investment bank risk-taking. Empirical studies suggest that the impact of LIQUID_ASSETS/TA on bank risk-taking could be negative as liquidity risk is decreased (Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008), while LIQUID_ASSETS/TA could also affect bank risk-taking positively as they are associated with lower returns and thus manager might try to undertake more risky positions in their effort to increase their revenues (Maddaloni and Peydró, 2011). In addition, we control for the ROAE aiming to test whether banks that have higher levels of profits accumulate increased risks (Altunbas et al., 2011; Black and Hazelwood, 2013).

In addition, the main source of income for investment banks is related to non-interest based activities, such as trading securities, underwriting, and M&A advisory services. Therefore, it is essential in the context of this study to include investment banking fees, proxied by the ratio of net fees, commission and net trading income over total assets (FEES/TA), as an additional bank-specific control variable. Based on previous empirical evidence (Demirguç-Kunt and Huizinga, 2010), we expect the impact of FEES/TA on bank risk to be positive, as non-interest income is found to be more volatile compared to interest income, such as deposits (Stiroh, 2004). The mean value of FEES/TA is 15.487 and the standard deviation is equal to 38.226 (see Table 2).

With regards to the impact of asset prices on bank risk taking, we include the stock price index, as estimated by S&P500, following a study by Adrian and Song Shin (2010) that investment banks' balance sheet expansion is positively influenced by the rise of asset and stock prices. We observe that the mean value of S&P500 is 7.210 while the standard deviation is relatively low (see Table 2). Finally, we control for the market risk by using the Volatility Implied Index (VIX) consistent with numerous previous studies aiming to examine the impact of monetary stance on macroeconomic and microeconomic variables (Adrian and Shin, 2009; Bekaert et al., 2013; Bruno and Shin, 2015; Gambacorta et al., 2014). Higher values of VIX indicator reflect higher degrees of financial distress in the US economy (Whaley, 2000). Therefore, we expect that the effect of VIX index on investment bank risk to be positive. The mean value of VIX indicator is 21.859 while the variable ranges from 11.570 to 44.140.

5.4 Methodology

5.4.1 Fixed effect estimator

We provide results from both fixed and dynamic panel specifications. The fixed effect estimator takes the following general model:

$$(RISK)_{i,t} = \left[a_0 + \beta_1 \sum_{j=1}^{n} (Control)_{i,t} + \beta_2 (UMP)_{i,t} + e_{i,t}\right] \qquad (2)$$

where $RISK_{i,t}$ is the vector of bank-specific measure of US investment bank risk as estimated by two different proxies; i) insolvency risk as estimated by the Z-SCORE= (1+ROE)/σROE, where σROE is the estimate of standard deviation of ROE. Z-SCORE is an indicator of bank stability and has been used in the banking literature (Lepetit et al., 2008; Barry et al., 2011; Radic et al., 2012). Higher values of Z-SCORE suggest higher distance of bank default. ii) SROE standard deviation of ROE (3 years window) , that also captures risk as it estimates income volatility (Jensen and Mester, 2003). $UMP_{i,t}$ stands for the vector of UMP measures i) central bank assets over GDP ratio (CBA/GDP) ii) money supply (M1 & M2) iii) Taylor gap (non-core and core inflation) iv) Shadow short rate v) Federal fund rate. $Control_{i,t}$ includes a number of bank-specific (SIZE, E/TA, ROAE, FEES/TA, LIQUID_ASSETS/TA) and country-level (VIX, S&P500) control variables, while $e_{i,t}$ denotes the error term.

5.4.2 System GMM estimator

We further opt for a dynamic panel analysis as it is essential in the context of our study for two main reasons. Firstly, our study encounters an identification problem in the relationship between the monetary policy stance and bank risk-taking, as there is a perception in the existing literature that bank risk could influence monetary policy stance (Jimenez et al., 2008; Ioannidou et al., 2015; Maddaloni and Peydro, 2011). Therefore, by employing dynamic analysis and setting UMP variables as endogenous in our panel regression we are able to adequately control for this endogeneity issue. Secondly, the well-documented in the literature persistence of bank risk necessitates the usage of the dynamic panel (Delis and Kouretas, 2011). This behaviour of bank risk-taking could be explained by the increased competition among financial institutions that further ease the risk-taking of banks (Keeley, 1990; Cordella and Yeyati, 2002). Moreover, the regulation framework, such as deposit insurance coverages might enhance moral hazard and this, in turn, may lead to risky positions over a prolonged period of time (Delis and Kouretas, 2011).[40] Therefore, in our dynamic panel analysis, risk persistence is treated with the inclusion of the lagged dependent variable.

For the dynamic panels, we use the two-step system generalised method of moments estimator (GMM) as advanced by Arellano and Bover (1995) and Blundell and Bond (1998), using the corrected robust standard errors (Windmeijer, 2005). The model includes among others explanatory variables, one lag of the bank risk indicator, and, therefore, equation (2) takes the following form:

$$(RISK)_{i,t} = \left[a_0 + \beta_1 (RISK)_{i,t-1} + \beta_2 \sum_{j=1}^{n} (Control)_{i,t} + \beta_3 (UMP)_{i,t} + e_{i,t}\right] \quad (3)$$

In particular, besides the UMP measures, we treat as endogenous variables the bank-specific control variables (SIZE, ETA, ROAE, FEES/TA, LIQUID_ASSETS/TA) following the literature (Dietrich and Wanzenried, 2011; Delis, 2012). Our results of the two-step GMM estimator are also verified by Hansen's J test for instrument validity and the second-order autocorrelation of the error terms test, AR2, as introduced by Arellano and Bond (1991).

[40] Following the Dodd-Frank Act (2010), investment banks have been obliged to be transformed into bank holding companies (BHCs) in order to have access to the governmental deposit insurance coverage.

5.5 Discussion of the Results

5.5.1 Fixed effect panel results

Our fixed effect estimations suggest that unconventional monetary policy exerts a positive impact on bank risk, i.e. a negative effect on Z-score. In particular, unconventional monetary policy, as estimated by the CBA/GDP ratio, reduces Z-score and thus increases investment banks risk. This effect is significant at the 1% level (see Table 3, Model 2). Our finding is in line with previous studies (Lambert and Ueda, 2014; Meaning and Zhu, 2012) that focus on the impact of central bank's assets on bank risk-taking of commercial banks. We also observe the impact of the combined money supply indicator, M1, and M2, on Z-score and conclude that there exists also a negative and significant relationship at the 1% level (see Table 4, Model 5). We further decomposed the combined indicators into M1 and M2 to test for the individual impact of each of these variable on bank risk-taking. Similarly, we find that both indicators, M1, and M2, have a negative effect on the Z-score at the 1% level of significance (see Table 4, Model 3 and 4 respectively). However, we observe that the impact of M2 indicator on risk is somewhat stronger than the impact of M1. In some detail, the coefficient of M1 (0.122) is almost the half of the coefficient of M2 (0.205). The reason could be that M2 indicator includes among others, overnight repos and money market funds, that involve major sources of lending to broker-dealers (Duygan-Bump et al. 2010; Rosengren, 2014). Overall, our findings lend support to our hypothesis (H1) that there exists a positive association between the UMP and investment bank's risk-taking.

Table 4. Fixed effect results for unconventional monetary policies measures as bank risk (Z-score) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
SIZE	0.036	0.054	0.056	0.055	0.057
	(0.089)	(0.052)	(0.090)	(0.091)	(0.089)
ROAE	0.002***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
E/TA	0.005*	0.000	0.001	0.000	0.000
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
FEES/TA	-0.001***	-0.001*	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LIQUID_ASSETS/TA	0.065**	0.074***	0.075**	0.075**	0.076**
	(0.031)	(0.013)	(0.030)	(0.030)	(0.030)
VIX	-0.001*	-0.001***	-0.002**	-0.002*	-0.002*
	(0.0009)	(0.000)	(0.000)	(0.001)	(0.001)
S&P500	-0.0405	-0.0312	0.064**	0.063**	0.053**
	(0.210)	(0.0253)	(0.031)	(0.031)	(0.020)
CBA/GDP	-	-0.120***	-	-	-
		(0.030)			
M1	-	-	-0.122***		
			(0.034)	-	-
M2	-	-	-	-0.205***	
				(0.055)	-
M1&M2	-	-			-0.195***
			-	-	(0.050)
Constant	1.307***	1.317***	1.762***	2.715***	3.042***
	(0.303)	(0.274)	(0.341)	(0.416)	(0.489)
F-test	13.96***	37.05***	15.97***	16.59***	16.74***
Observations	540	540	540	540	540
R-squared	0.265	0.204	0.189	0.226	0.198
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a fixed effect model over the period 2007Q1 to 2014Q4. Our dependent variable is: Z-score=(1+ROE)/sdROE where ROE is the return on equity and sdROE is the standard deviation of return on assets. Our independent variables are: CBA/GDP= central bank's assets to gross domestic product ratio; M1= Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions; M2= Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Turning to the impact of UMP on SDROE, our findings are similar to those specifications where we employed Z-score as the bank risk indicator. In some detail, CBA/GDP exerts a positive impact on SDROE suggesting that increases of central bank's assets increases the instability of bank's net earnings and thus rises investment bank's risk-taking. The effect of CBA/GDP on SDROE is significant at the 1% level (see Table 5, Model 2), signaling a strong positive association between UMP and risk-taking. Moreover, M1&M2 combined money supply indicator exerts a positive and significant impact on SDROE at the 1% level of significance (see Table 5, Model 5). We also test for any differences in the impact of M1 and M2 on risk-taking and conclude that both have a significant at the 1 % (see Table 5, Model 3 and 4) and positive relationship with SDROE. In line with the Z-score's specifications, the effect of M2 on bank risk is stronger than that of M1 as the coefficient of the former (0.236) is larger than that of the latter (0.139). These results show that M2 is a more effective indicator compared to M1 to gauge the effect of UMP on risk-taking of investment banks.

Table 5. Fixed effect results for unconventional monetary policies measures as bank risk (SDROE) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
SIZE	0.268	-1.422*	-1.518*	-1.504*	-1.510*
	(0.341)	(0.798)	(0.815)	(0.811)	(0.812)
E/TA	0.000	-0.003**	-0.004**	-0.004**	-0.004***
	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)
FEES/TA	0.003**	-0.002	-0.003	-0.002	-0.003
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
LIQUID_ASSETS/TA	-0.306***	0.208	0.240	0.235	0.237
	(0.101)	(0.211)	(0.220)	(0.218)	(0.218)
VIX	0.004	0.013**	0.009	0.010	0.010
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
S&P500	0.001***	0.000*	0.331	0.354	0.342
	(0.001)	(0.000)	(0.326)	(0.325)	(0.326)
Central bank assets/GDP	-	0.148***	-	-	-
		(0.046)			
M1	-	-	0.139**	-	
			(0.051)		
M2	-	-	-	0.236**	-
				(0.084)	
M1&M2	-	-	-	-	0.211**
					(0.076)
Constant	5.93**	9.244**	21.024***	32.143***	30.186***
	(2.926)	(3.628)	(4.283)	(7.158)	(6.608)
F-test	46.79***	9.06***	10.91***	11.09***	11.07***
Observations	540	540	540	540	540
R-squared	0.122	0.186	0.1796	0.1814	0.181
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a fixed effect model over the period 2007Q1 to 2014Q4. Our dependent variable is: SDROE is the standard deviation of return on equity as estimated based on twelve quarters. Our independent variables are: CBA/GDP= central bank's assets to gross domestic product ratio; M1= Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions; M2= Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

In addition, we find that the TAYL.GAP-NCORE, as estimated by the non-core CPI, exerts a positive impact at the 10% significance level on Z-score (see Table 6, Model 2), suggesting that higher negative values that stand for increased monetary easing, enhances investment banks' default risk. In other words, if interest rates are below the benchmark rate, investment banks undertake more risks (lower Z-score). We also find a significant at the 1% level and positive relationship between TAYL.GAP-CORE, as measured by the core CPI (see Table 6, Model 3). Overall, our findings are consistent with previous studies that find a negative relationship between Taylor gap and bank risk (Altunbas et al., 2010; Lambert and Ueda, 2014). Furthermore, we find a negative and significant at the 1% level (see Table 6, Model 3) relationship between SHADOW-RATE and Z-score, suggesting that lower values of the shadow short rate increase investment banks' risk taking. Similarly, we observe that the FED-RATE exerts a positive and significant effect at the 1% level (see Table 6, Model 4) on Z-score, signifying that values of FED-RATE that are close to zero-bounds increase investment banks' risk-taking. Our finding is further confirmed by previous relevant studies that observe the impact of FED-RATE on the risk-taking of commercial banks (Buch et al., 2014; Ioannidou et al., 2015; Dell'Ariccia et al., 2013; De Nicolò et al., 2010). Overall, our evidence lends support to our hypothesis and the presence of a risk-taking channel for investment banks following the US implementation of unconventional monetary policies.

Table 6. Fixed effect results for unconventional monetary policies measures as bank risk (Z-score) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
SIZE	0.036	0.036	0.039	0.055	0.054
	(0.089)	(0.088)	(0.090)	(0.091)	(0.091)
ROAE	0.002***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
E/TA	0.005*	0.000	0.001**	0.001*	0.001*
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
FEES/TA	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LIQUID_ASSETS/TA	0.065**	0.067**	0.068**	0.068**	0.076**
	(0.031)	(0.031)	(0.032)	(0.032)	(0.030)
VIX	-0.001*	-0.001*	-0.001	-0.001	-0.001
	(0.0009)	(0.0009)	(0.001)	(0.001)	(0.001)
S&P500	-0.0405	0.016	-0.023	-0.001	-0.001
	(0.210)	(0.029)	(0.310)	(0.031)	(0.022)
TAYL.GAP-NCORE	-	0.005*	-	-	-
		(0.002)			
TAYL.GAP-CORE	-	-	0.028***		
			(0.009)	-	-
SHADOW-RATE	-	-	-	0.013***	-
				(0.003)	
FED-RATE					0.016***
	-	-	-	-	(0.003)
Constant	1.307***	1.170***	1.542***	1.261***	1.268***
	(0.303)	(0.324)	(0.315)	(0.324)	(0.323)
F-test	13.96***	14.59***	13.58***	16.04***	16.12***
Observations	540	540	540	540	540
R-squared	0.265	0.212	0.251	0.158	0.178
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a fixed effect model over the period 2007Q1 to 2014Q4. Our dependent variable is Z-score=(1+ROE)/sdROE where ROE is the return on equity and sdROE is the standard deviation of return on assets. Our independent variables are: TAYL.GAP-NCORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the non-core CPI; TAYL.GAP-CORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the core CPI; SHADOW-RATE= shadow short rate; FED-RATE= federal fund rate; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Turning to the effect of Taylor gap on SDROE, TAYL.GAP-NCORE enters the regression negative, suggesting that lower (negative) values increase bank risk-taking of investment banks (see Table 7, Model 2). Regarding the impact of TAYL.GAP-CORE on SDROE, we also observe that the Taylor gap, as estimated by the core CPI, exerts a positive effect on risk-taking (see Table 7, Model 3). However, in both the above specifications the relationship between Taylor gap, as proxied by TAYL.GAP-NCORE and TAYL.GAP-CORE, and bank risk-taking is not statistically significant. To gauge the impact of interest rates on SDROE, we also examine the effect of shadow short rate and the federal fund rate on bank risk-taking. In particular, SHADOW-RATE has a negative and significant at the 1% level on SDROE (see Table 7, Model 4), signalling that lower rates increases earning's volatility and hence rise bank risk. Similarly with the SHADOW-RATE, the FED-RATE exerts a negative and significant effect at the 1% level on SDROE (see Table 7, Model 5) and conclude that UMP, as captured by FED-RATE values close to zero-bounds, enhances investment bank's risk-taking.

Table 7. Fixed effect results for unconventional monetary policies measures as bank risk (SDROE) determinants of the US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
SIZE	-0.268	-1.304	-1.324	-1.508*	-1.491*
	(0.341)	(0.913)	(0.890)	(0.789)	(0.794)
E/TA	0.000	-0.005**	-0.005**	-0.004**	-0.004**
	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)
FEES/TA	0.003**	0.003*	0.003*	0.003	0.003
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
LIQUID_ ASSETS/ TA	-0.306***	0.601	0.091	0.255	0.241
	(0.101)	(0.253)	(0.242)	(0.195)	(0.199)
VIX	0.004	0.151**	0.023***	0.018**	0.0196**
	(0.005)	(0.006)	(0.008)	(0.007)	(0.007)
S&P500	0.001***	1.113***	1.041***	0.966***	1.210***
	(0.001)	(0.336)	(0.345)	(0.330)	(0.364)
TAYL.GAP-NCORE	-	-0.038	-	-	-
		(0.042)			
TAYL.GAP-CORE	-	-	-0.125	-	-
			(0.380)		
SHADOW-RATE	-	-	-	-0.160***	-
				(0.050)	
FED-RATE	-	-	-		-0.180***
					(0.057)
Constant	5.93**	17.062***	16.65***	14.498***	16.216***
	(2.926)	(4.228)	(3.695)	(3.609)	(3.572)
F-test	46.79***	15.68***	17.35***	8.85***	9.18***
Observations	540	540	540	540	540
Rsquared	0.122	0.1235	0.1281	0.1837	0.1812
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a fixed effect model over the period 2007Q1 to 2014Q4. Our dependent variable is: SDROE is the standard deviation of return on equity as estimated based on twelve quarters. Our independent variables are: TAYL.GAP-NCORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the non-core CPI; TAYL.GAP-CORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the core CPI; SHADOW-RATE= shadow short rate; FED-RATE= federal fund rate; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Given the above findings, there is clear evidence that UMP, as proxied by a plethora measures, increase bank risk-taking of investment banks. One channel through which UMP could rise the risk of investment banks is via the “portfolio balance” effect. The “portfolio balance” theory in the investment banking context would suggest that investment banks could be motivated to gear their trading efforts toward riskier assets due to the reduction of bid-ask spread of safer assets (Steely et al., 2015; Wu, 2014; Fratzscher et al., 2013). Moreover, primary dealers such as investment banks could shift towards riskier assets due to low returns of increased cash holdings stemming from the sale of safe assets to central banks’ (Joyce et al., 2012; Kapetanios et al., 2012). In this way, the “portfolio balance” channel resembles the “risk taking” channel of monetary policy in commercial banking which posits that lower intermediation spreads rise incentives of commercial banks to invest in riskier assets. Previous, empirical evidence also confirms our results as Gilchrist and Zakrajšek (2013) find that low-interest rates increase credit risk of the US BHCs (previously known as investment banks). Another channel through which UMP could increase the risk-taking of investment banks is through limiting extreme movements in asset prices. Based on previous empirical evidence (Bekaert et al., 2010; Roache and Rousset, 2014), monetary expansionary policies reduce volatility in asset prices and consequently reduce market uncertainty. In some detail, Roache and Rousset (2014) find that UMP during the crisis and post-crisis period declines extreme changes in asset prices that in turn increase increases confidence and risk-taking of financial institutions. There is evidence to support that low asset price volatility decreases investors’ risk aversion (Lansing and LeRoy, 2014; Lansing, 2015). This is important in the case of investment banks as these financial institutions rely heavily on trading operations.

With regards to the impact of the bank-specific control variables, we find a positive association between SIZE and Z-score (Table 4 and 5, all Models), indicating that larger banks undertake lower risks compared to smaller banks. The reason is that larger banks could benefit from increased risk diversification due to the mixture of banking operations, i.e., interest and non-interest activities (Mester, 1993). Similarly, we find a negative relationship between SIZE and risk as proxied by SROE. Our results are statistically significant in most of our specifications (see Table 5, Model 2,3 and 5; see Table 7, Model 4 and 6), confirming the presence of risk diversification benefits. Turning to the impact of capital on investment banks' risk-taking, we observe a positive and significant effect of E/TA on Z-score at the 10 % (see Table 4, Model 1; see Table 5, Model 1, 4 and 5) and 5% level of significance (see Table 5, Model 3), suggesting that managers undertake less risky positions under higher levels of capital at risk (Gorton and Rosen, 1995; Athanasoglou et al., 2008; Lepetit et al., 2008). We also observe that E/TA exerts a negative and significant effect at the 5% (see Table 5 and 7, Model 2,3 and 4) and 1% level on SDROE (see Table 5, Model 5) in the relevant fixed effect regressions. Concerning the impact of ROAE on Z-score, we observe that increases of ROAE decrease the bank risk-taking (see Table 4 and 5, all Models), suggesting that the net income of investment banks, that include both net interest and non-interest income, is not associated with higher default risk.[41] Our finding is consistent with previous studies (Altunbas et al., 2011; Lamont and Hazelwood, 2013).

We also observe that FEES/TA exerts a negative and significant effect at the 1% level (Table 4 and 5, all Models) on Z-score, suggesting that fee-income is a more volatile source of income compared to interest based and that in turn can increase bank risk-taking

[41]With regards to the impact of ROAE on the SDROE, we omit the former from these regression specifications due to multicollinearity reasons.

(Stiroh, 2004; Dermiguc-Kunt and Huizinga, 2010). In the case of investment banks, the effect of FEE/TA on bank risk-taking is of utmost importance, as the main source of income of these financial institutions is derived from non-interest based activities. In the same way, we observe a positive association between FEES/TA and SDROE. Our findings are significant at the 5% (see Table 5 and 7, Model 1) and 10% (see Table 7, Model 2 and 3) significance level and thus confirms that FEE/TA increases bank risk-taking due to the highly risky and complex operations that investment banks' operations involve.

With regards to the impact of LIQUID_ASSETS/TA on bank risk, we observe a positive and significant effect at the 5% (see Table 4, Model 1,3,4 and 5; see Table 5, all Models) and 1% significance level on Z-score (see Table 4, Model 2). This result indicates that increases in investment banks' liquidity reduce liquidity risk (Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008). We also test the effect of LIQUID_ASSETS/TA on SDROE and our findings suggest that there is a negative and significant at the 1% impact (see Table 5 and 7, Model 1) of liquidity on risk-taking in line with the previous empirical evidence.

Turning to the VIX indicator, we find that there is a positive association between VIX and bank default risk. Our finding is significant at the 5% (see Table 4, Model 1; see Table 5, Model 2,4 and 5) and 1% significance level (Table 5, Model 3). This relationship could be attributed to the fact that market uncertainty is related positively with bank risk-taking (Bourke 1989; Miller and Noulas, 1997). Likewise, we observe that there is a positive association between the VIX indicator and SDROE that in turn confirms our previous findings. Our results are robust in most of our specifications at the 5% (see Table 5, Model 2; see Table 7, Model 2,4 and 5) and 1% (see Table 7, Model 3) level of significance. Also, S&P500 has a negative association with default risk, suggesting that stock prices are associated positively with investment banks' balance sheet assets growth and consequently rise of leverage (Adrian and Song Shin, 2010). High level of leverage is related positively with bank risk-taking due to a higher risk of default and liquidation (Jensen and Meckling, 1976). Finally, we observe that S&P500 has a positive relationship with SDROE at the 1% significance level (see Table 5, Model 1; see Table 7, all Models), confirming in that way our previous results.

5.5.2 Dynamic panel results

Tables (8, 9, 10 and 11) show the regression results of the dynamic panel analysis with the alternative measures of UMP and the two proxies of bank risk-taking, Z-score, and SDROE. We choose to perform dynamic panel analysis to account for endogeneity issues that are very relevant in the context of our study (Jimenez et al., 2008; Ioannidou et al., 2015; Maddaloni and Peydro, 2011) and further confirm the validity of the fixed effect panel results. Based on the dynamic panel results, we identify that the usage of the of the two-step 'system' GMM estimator is appropriate as the coefficients in all the corresponding models on the lagged dependent variables, i.e., Z-score and SDROE, shows that bank risk-taking is highly persistent (see Tables 8, 9, 10 and 11). Moreover, all the observed statistical diagnostics suggest there is no second-order autocorrelation in second differences as Hansen test for overidentification remains insignificant in all our specifications (see Tables 8, 9, 10 and 11).

Our dynamic panel estimations show that UMP increases bank risk-taking as proxied by Z-score. In some detail, central bank's assets to GDP (CBA/GDP) ratio enters the regression negative and significant at the 5% level (see Table 8, Model 2), supporting our main hypothesis (H1). In some detail, one of the reasons could be that UMP encourages investment banks to undertake riskier positions through the rise of leverage under periods of high financial distress (Adrian and Shin, 2008). Our results are also in line with those of previous studies (Delis et al., 2011; Altunbas et al., 2012; Fungáčová et al., 2014; Buch et al., 2014; Lambert and Ueda, 2014; Meaning and Zhu, 2012) that focus exclusively on commercial banks. In similar lines with the fixed effect specification, we also observe that the combined money supply indicator, M1&M2, exerts a negative and significant impact at the 5% level on Z-score (see Table 8, Model 5). This, in turn, denotes that UMP increases bank risk-taking consistent with our findings in the fixed effect regressions. Similarly, we decompose M1&M2 combined indicator into M1 and M2, and we further find that the individual impact of each of the two proxies of UMP remains negative and significant at the 5% level (see Table 8, Model 3 and 4).

Table 8. Dynamic results for unconventional monetary policies measures as bank risk (Z-score) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
Lagged Z-SCORE	0.457***	0.428**	0.411**	0.406**	0.407**
	(0.164)	(0.180)	(0.178)	(0.171)	(0.172)
SIZE	0.194*	0.212**	0.233	0.234*	0.234*
	(0.104)	(0.105)	(0.125)	(0.123)	(0.124)
ROAE	0.004***	0.005***	0.005***	0.004***	0.004***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
E/TA	0.007	0.009	0.007	0.008	0.007
	(0.013)	(0.022)	(0.015)	(0.015)	(0.015)
FEES/TA	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
LIQUID_ASSETS/TA	0.004*	0.003	0.004	0.004	0.004
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
VIX	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
S&P500	-0.161***	-0.160	-0.192**	-0.187**	0.187**
	(0.051)	(0.100)	(0.083)	(0.086)	(0.086)
CBA/GDP		-0.060**	-	-	-
	-	(0.028)			
M1			-0.061**		
			(0.028)	-	-
M2	-	-		-0.022**	-
				(0.009)	
M1&M2	-	-	-	-	-0.017**
					(0.007)
Constant	-1.62***	-1.35***	-1.954**	-1.830**	-1.86**
	(0.452)	(0.225)	(0.612)	(0.521)	(0.598)
Wald test	136.19***	89.82***	162.73***	164.15***	164.08***
Hansen (p-value)	0.065	0.074	0.064	0.063	0.063
AR(1)	-3.43***	-4.187**	-2.517**	-2.425**	-3.218***
AR(2)	0.954	0.998	0.925	0.815	0.889
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a dynamic panel model over the period 2007Q1 to 2014Q4. Our dependent variable is: Z-score=(1+ROE)/sdROE where ROE is the return on equity and sdROE is the standard deviation of return on assets. Our independent variables are: CBA/GDP= central bank's assets to gross domestic product ratio; M1= Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions; M2= Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

With regards to the effect of UMP on bank risk-taking, as proxied by SDROE, our conclusions are similar to the Z-score's specifications. In particular, we observe that CBA/GDP ratio enters the regression positive and significant at the 5% level (see Table 9, Model 2) and hence we conclude that increases in central bank's assets rise investment bank's risk-taking. In addition, we find that there exists a positive and significant relationship at the 5% (see Table 9, Model 5) level between the combined money supply indicator, M1&M2, and bank risk-taking as estimated by SDROE that in turn further confirms the fixed effect specifications. As above, we also examine the individual impact of the M1 and M2 money supply proxies on SDROE and we conclude that they both have a positive and significant (see Table 9, Model 3 and 4 respectively) impact on risk taking, also confirming our previous findings. Furthermore, we observe that M2 indicator has a stronger effect on bank risk compared to M1 variable, suggesting that the former is a better barometer of UMP for investment banks in order to gauge the impact of monetary expansionary policies on risk-taking.

Table 9. Dynamic results for unconventional monetary policies measures as bank risk (SDROE) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
Lagged SDROE	0.371**	0.366**	0.473***	0.608***	0.600***
	(0.174)	(0.170)	(0.094)	(0.192)	(0.200)
SIZE	-0.451	-1.452	-1.713	-0.372	-0.325
	(0.358)	(1.693)	(2.091)	(0.900)	(0.879)
E/TA	-0.012	0.020	-0.025*	0.009	0.006
	(0.015)	(0.020)	(0.014)	(0.011)	(0.011)
FEES/TA	0.008*	0.009*	0.013**	0.013**	0.012**
	(0.004)	(0.005)	(0.006)	(0.005)	(0.006)
LIQUID_ASSETS/TA	-0.006	-0.015	-0.004	-0.002	-0.002
	(0.010)	(0.012)	(0.013)	(0.010)	(0.010)
VIX	0.008	0.016	0.031***	0.033***	0.034***
	(0.010)	(0.014)	(0.011)	(0.010)	(0.010)
S&P500	0.267	0.202	1.060	1.044*	1.024
	(0.643)	(0.752)	(0.669)	(0.601)	(0.627)
CBA/GDP		0.427**	-	-	-
		(0.117)			
M1	-	-	0.100*	-	-
			(0.056)		
M2	-	-	-	0.497**	-
				(0.227)	
M1&M2	-	-	-	-	0.441**
					(0.220)
Constant	5.976	13.921	13.30***	56.25***	51.548**
	5.182	13.03	2.700	24.67	25.03
Wald test	76.75***	22.01***	162.24***	67.90***	54.22***
Hansen (p-value)	0.124	0.185	0.145	0.137	0.128
AR(1)	-2.28**	-2.48**	-2.60***	-2.47**	-2.44**
AR(2)	0.975	0.885	0.995	0.834	0.956
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a dynamic panel model over the period 2007Q1 to 2014Q4. Our dependent variable is: SDROE is the standard deviation of return on equity as estimated based on twelve quarters. Our independent variables are: CBA/GDP= central bank's assets to gross domestic product ratio; M1= Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions; M2= Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

In addition, we observe the effect of Taylor gap, as another measure of UMP, on Z-score using a dynamic panel model. In particular, TAYL.GAP-NCORE, as estimated by the non-core CPI, enters the regression positive and significant at the 5% level (see Table 10, Model 2). This result further boosts our findings that when interest rates fall below the benchmark rate banks raise their risk taking. Moreover, we estimate Taylor gap using non-core CPI in order to examine in more detail the effect of Taylor gap under different inflation rates. Similarly, to our fixed effect estimations, we observe that TAYL.GAP-CORE exerts a positive and significant at the 5% level effect on Z-score (see Table 10, Model 3), confirming in that way our previous findings. These results further confirm that Taylor gap increases bank risk-taking consistent with existing empirical evidence that concentrates on the effect of Taylor gap on risk-taking of commercial banks (Altunbas et al., 2010; Lambert and Ueda, 2014). Turning to the impact of interest rates on Z-score using dynamic panel estimations, we also observe a positive association between SHADOW-RATE and FED-RATE and Z-score but these findings are not statistically significant (see Table 10, Model 4 and 5). The positive relationship of federal fund rate and bank risk-taking is consistent with previous empirical research (Buch et al., 2014; Ioannidou et al., 2015; Dell'Ariccia et al., 2013; De Nicolò et al., 2010).

Table 10. Dynamic results for unconventional monetary policies measures as bank risk (Z-score) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
Lagged Z-SCORE	0.457***	0.352**	0.329**	0.409**	0.445**
	(0.164)	(0.149)	(0.152)	(0.195)	(0.202)
SIZE	0.194*	0.262	0.260	0.219*	0.052
	(0.104)	(0.180)	(0.181)	(0.117)	(0.057)
ROAE	0.004***	0.004***	0.004***	0.006***	0.003***
	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)
E/TA	0.007	0.000	0.000	0.000	0.007
	(0.013)	(0.001)	(0.001)	(0.001)	(0.023)
FEES/TA	-0.000	-0.001	-0.001	-0.001	-0.001**
	(0.000)	(0.001)	(0.010)	(0.002)	(0.000)
LIQUID_ASSETS/TA	0.004*	0.002*	0.004	0.006	-0.000
	(0.002)	(0.001)	(0.003)	(0.006)	(0.001)
VIX	-0.002**	-0.003**	-0.003**	-0.001*	-0.001
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
S&P500	-0.161***	-0.152***	-0.159***	-0.210*	-0.077
	(0.051)	(0.064)	(0.066)	(0.125)	(0.140)
TAYL.GAP-NCORE	-	0.019**			
		(0.008)	-	-	-
TAYL.GAP-CORE	-	-	0.026**		
			(0.012)	-	-
SHADOW-RATE	-	-		0.003	
			-	(0.004)	-
FED-RATE	-	-			0.006
			-	-	(0.005)
Constant	-1.62***	-1.75***	-1.77***	-2.13***	-1.87***
	(0.452)	(0.487)	(0.554)	(0.548)	(0.513)
Wald test	136.19***	55.39***	284.34***	76.01***	238.37***
Hansen (p-value)	0.065	0.125	0.137	0.158	0.125
AR(1)	-3.43***	-2.78***	-2.565**	-2.470**	-2.857***
AR(2)	0.954	0.754	0.885	0.998	0.991
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a dynamic panel model over the period 2007Q1 to 2014Q4. Our dependent variable is: Z-score=(1+ROE)/sdROE where ROE is the return on equity and sdROE is the standard deviation of return on assets. Our independent variables are: TAYL.GAP-NCORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the non-core CPI; TAYL.GAP-CORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the core CPI; SHADOW-RATE= shadow short rate; FED-RATE= federal fund rate; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Our findings concerning the effect of Taylor gap on SDROE are similar to the fixed-effect specifications. With regards to the impact of TAYL.GAP-NCORE on SDROE, TAYL.GAP-NCORE enters the regression negative and significant at the 1% level (see Table 11, Model 2), suggesting that lower (negative) values increase bank risk-taking of investment banks. Turning now to the impact of Taylor gap, as estimated by core CPI, on SDROE, we observe that TAYL.GAP-CORE also exerts a negative effect on bank risk-taking confirming in that way our previous findings (see Table 11, Model 3). Regarding the impact of interest rates on SDROE using a dynamic panel analysis, we observe that increases of SHADOW-RATE and FED-RATE decrease bank risk-taking. In some detail, both SHADOW-RATE and FED-RATE have a negative and significant at the 5% level on SDROE (see Table 11, Model 4 and 5). This, in turn, suggests that lower values of interest rates particularly close to zero increase bank risk-taking in line with existing empirical evidence (Buch et al., 2014; Ioannidou et al., 2015; Dell’Ariccia et al., 2013).

Table 11. Dynamic results for unconventional monetary policies measures as bank risk (SDROE) determinants of US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
Lagged SDROE	0.371**	0.401***	0.423***	0.369**	0.335**
	(0.174)	(0.136)	(0.132)	(0.160)	(0.144)
SIZE	-0.451	-0.271	-0.514**	-0.243	-0.166
	(0.358)	(0.912)	(0.254)	(1.749)	(0.263)
E/TA	-0.012	-0.029	-0.021	-0.017	-0.029**
	(0.015)	(0.071)	(0.078)	(0.018)	(0.013)
FEES/TA	0.008*	0.015	0.007**	0.009*	0.112**
	(0.004)	(0.013)	(0.003)	(0.005)	(0.005)
LIQUID_ASSETS/TA	-0.006	-0.006	-0.009	-0.023*	0.007
	(0.010)	(0.013)	(0.012)	(0.013)	(0.016)
VIX	0.008	0.023**	0.019**	0.011	0.018
	(0.010)	(0.009)	(0.009)	(0.013)	(0.012)
S&P500	0.267	2.370***	1.911*	0.001	1.522**
	(0.643)	(0.899)	(1.129)	(0.001)	(0.610)
TAYL.GAP-NCORE	-	-0.101***			
		(0.036)			
TAYL.GAP-CORE		-	-0.166		
			(0.153)		
SHADOW-RATE		-	-	-0.111**	
				(0.047)	
FED-RATE	-	-	-	-	-0.131**
					(0.051)
Constant	5.976	15.34***	16.70	16.69	17.45***
	(5.182)	(5.181)	(11.136)	(11.135)	(5.243)
Wald test	76.75***	179.18***	24.35***	24.35***	32.14***
Hansen (p-value)	0.124	0.053	0.078	0.178	0.248
AR(1)	-2.28**	-1.93**	-2.67***	-2.67***	-2.28**
AR(2)	0.975	0.810	0.924	0.971	0.962
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a dynamic panel model over the period 2007Q1 to 2014Q4. Our dependent variable is: SDROE is the standard deviation of return on equity as estimated based on twelve quarters. Our independent variables are: TAYL.GAP-NCORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the non-core CPI; TAYL.GAP-CORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the core CPI; SHADOW-RATE= shadow short rate; FED-RATE= federal fund rate; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

In support of our findings in the fixed effect specifications, we also observe that expansionary monetary policy asserts a positive effect on risk-taking of investment banks. Another channel through which UMP could rise the risk-taking of investment banks is through the procyclical behaviour of leverage (Adrian and Shin, 2008). The procyclicality of investment banks' leverage suggests that during periods of monetary expansionary policies the level of leverage of these financial institutions rises. The reason is that UMP boosts asset prices (Gambacorta et al., 2014) and this, in turn, could raise the level of equity of investment banks and reduce their debt. As a response to this capital structure change, investment banks increase their borrowing that consequently raises the demand of assets (Adrian and Shin, 2008). This rise in asset demand could further increase asset prices and result in an increase of investment banks' leverage (Adrian and Shin, 2008). High leveraged institutions are considered as riskier compared to low leveraged particularly under periods of high financial distress when high leveraged banks face increased default risk.

Regarding the effect of the bank-specific control variables, our findings are consistent with those of fixed effect specifications. In particular, SIZE exerts a positive and significant at the 5% (see Table 8, Model 2) and 10% level impact (see Table 8, Model 1,4 and 5; see Table 10, Model 1 and 4), suggesting that large banks could take advantage of risk diversification benefits. Similarly, we find that increases in SIZE decrease SDROE that in turn displays that larger investment banks income's volatility reduces compared to smaller banks due to increased diversification benefits. The negative impact of SIZE on SDROE is apparent in all our specifications, although the effect is not statistically significant across all the regression models (see Table 9 and 11, all Models). We also observe, a positive association between E/TA and Z-score, signaling that increases in capital reduce investment banks' default risk as managers would be more risk-averse due to increased capital at risk (Athanasoglou et al., 2008; Lepetit et al., 2008). This association is also apparent in the specifications where we use SDROE as a risk indicator. In particular, we find that E/TA exerts a negative impact at the 10% (see Table 9, Model 3) and 5% (see Table 11, Model 5) significance level on SDROE, signifying that increases of equity reduce risk-taking of investment banks. With regards to the impact of ROAE on Z-score, we find similar results to those of fixed effect models. In particular, ROAE exerts a positive and significant at the 1% level on Z-score (see Table 8 and 10, all Models) that in turn shows that the net income of investment banks is associated with income diversification benefits as these financial institutions include both non-interest and interest-based income (Altunbas et al., 2011; Lamont and Hazelwood, 2013).

In addition, we find that FEES/TA exerts a positive and significant impact at the 10% (see Table 9, Model 1 and 2; Table 11, Model 1 and 4) and 5% significance level on SDROE (see Table 9, Model 3,4 and 5; Table 11, Model 3 and 5), confirming in that way that non-interest based income rises bank-risk (Stiroh, 2004; Dermiguc-Kunt and Huizinga, 2010). As in the fixed effect specifications, we also find that of LIQUID_ASSETS/TA have a positive impact on Z-score (see Table 8 and 10), while exerts a negative effect on SDROE (see Table 9 and 11). These findings show that liquidity reduces bank risk-taking and are consistent with the previous empirical evidence (Demirguc-Kunt and Huizinga, 1999; Athanasoglou et al., 2008). Finally, we also observe a negative and significant impact of VIX and S&P500 indexes on Z-SCORE, whereas both these indicators have a positive and significant effect on SDROE. Our findings are also consistent with existing empirical evidence (Bourke 1989; Miller and Noulas, 1997; Adrian and Shin, 2010).

Turning to the impact of the VIX indicator on bank risk, we find that higher values of VIX increase bank default risk. Our finding is significant at the 5% (see Table 4, Model

1; see Table 5, Model 2,4 and 5) and 1% (Table 5, Model 3) level and is consistent with previous empirical evidence (Bourke 1989; Miller and Noulas, 1997), suggesting that higher market uncertainty increases bank's risk default. Likewise, we observe that higher values of VIX increase SDROE that in turn confirms our findings. Our results are robust in most of our specifications at the 5% (see Table 5, Model 2; see Table 7, Model 2,4 and 5) and 1% (see Table 7, Model 3) level of significance. Also, S&P500 exerts a negative effect on default risk, suggesting an increase of stock prices result in expansion of investment banks' assets growth and consequently rise of leverage (Adrian and Song Shin, 2010). This, in turn, could increase bank risk-taking due to a higher risk of default and liquidation (Jensen and Meckling, 1976). Finally, we observe that S&P500 exerts a positive and significant effect on SDROE at the 1% level (see Table 5, Model 1; see Table 7, all Models), confirming in that way the positive association between stock price index and bank risk-taking.

5.5.3 Sensitivity Analysis

In this section, we present additional estimates to examine the robustness of our findings. These include fixed effect and dynamic panel specifications using as an alternative indicator of bank risk that encompasses earnings' volatility is the standard deviation of return on assets (SDROA) (Kwan, 2004; Lepetit et al.,2008; Barry et al.,2011).

We re-estimate the impact of UMP on bank risk as estimated by SDROA. Our fixed effect results show that expansionary monetary policies increase bank risk. In some detail, we observe that CBA/GDP ratio increases SDROA, suggesting that central bank's asset growth through LSAPs rises risk-taking of investment banks. Thus, the effect of CBA/GDP on SDROA is positive and significant at the 1% level (see Table 12, Model 2). Moreover, we also find that both M1 and M2 indicators enter the regressions positive and significant at the 5% level (see Table 12, Model 3 and 4 respectively). Similarly to our previous findings, we observe that the effect of M2 indicator (0.634) on SDROA is fairly stronger than the impact of M1 indicator (0.388). As mentioned before, this is due to the fact that the M2 indicator comprises among others, overnight repos and money market funds, which encompasses main sources of lending to investment banks (Duygan-Bump et al. 2010; Rosengren, 2014).

Table 12. Robustness check- Fixed effect results for unconventional monetary policies measures as bank risk (SDROA) determinants of the US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
SIZE	-1.685***	-0.829***	-0.813***	-0.821***	-0.819***
	(0.332)	(0.244)	(0.242)	(0.244)	(0.243)
E/TA	0.002	-0.024***	-0.025***	-0.025***	-0.025***
	(0.002)	(0.004)	(0.004)	(0.005)	(0.005)
FEES/TA	0.001	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
LIQUID_ASSETS/TA	0.119**	0.075**	0.075**	0.076**	0.075**
	(0.061)	(0.030)	(0.031)	(0.031)	(0.031)
VIX	0.059	0.020**	0.049	0.064**	0.061**
	(0.050)	(0.010)	(0.029)	(0.028)	(0.030)
S&P500	0.117	0.100	0.156*	0.147	0.150
	(0.093)	(0.078)	(0.083)	(0.081)	(0.081)
Central bank assets/GDP	-	0.423***			
		(0.137)	-	-	-
M1	-	-	0.388**		
			(0.147)	-	
M2	-	-	-	0.634**	-
				(0.225)	
M1&M2	-				0.571**
		-	-	-	(0.207)
Constant	12.377***	6.882***	5.189***	2.371	2.837
	(2.233)	(1.477)	(1.469)	(1.889)	(1.812)
F-test	9.75***	22.16***	21.51***	22.17***	22.01***
Observations	540	540	540	540	540
R-squared	0.230	0.134	0.179	0.191	0.149
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a fixed effect panel model over the period 2007Q1 to 2014Q4. Our dependent variable is: SDROA is the standard deviation of return on assets as estimated based on twelve quarters. Our independent variables are: CBA/GDP= central bank's assets to gross domestic product ratio; M1= Money supply that is defined as the sum of currency held by the public and transaction deposits at depository institutions; M2= Money supply that is defined as M1 plus savings deposits, small-denomination time deposits, and retail money market mutual fund shares; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index. We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Table 13 shows results of dynamic specifications with regards to the impact of Taylor gap on SDROA. It is worth mentioning that the impact of TAYL.GAP-CORE on bank risk-taking is more robust compared to that of TAYL.GAP-NCORE on SDROA. In particular, TAYL.GAP-CORE exerts a negative and significant effect on SDROA at the 10%, signifying that monetary easing increases bank risk-taking of investment banks (see

Table 13, Model 3). Concerning the effect of TAYL.GAP-NCORE on SDROA, we observe that remains negative but not statistically significant (see Table 13, Model 2). Furthermore, we find that both FED-RATE and SHADOW-RATE have a negative and significant effect at the 10% level on bank risk-taking (see Table 13, Model 4 and 5). These results suggest that UMP increases SDROA. Overall, our findings lend support to our main hypothesis H1 that UMP increases bank risk-taking of investment banks.

Table 13. Robustness check- Dynamic results for unconventional monetary policies measures as bank risk (SDROA) determinants of the US investment banks (2007Q1-2014Q4).

Variables	Model(1)	Model(2)	Model(3)	Model(4)	Model(5)
Lagged SDROA	0.682***	0.502***	0.370**	0.421***	0.420***
	(0.064)	(0.136)	(0.158)	(0.137)	(0.139)
SIZE	-0.055	-0.150	-0.188	-0.064	-0.061
	(0.060)	(0.153)	(0.156)	(0.045)	(0.041)
E/TA	-0.012***	-0.025***	-0.026***	-0.026***	-0.026***
	(0.002)	(0.005)	(0.005)	(0.005)	(0.005)
FEES/TA	0.019	0.041	-0.067**	-0.070**	-0.069**
	(0.017)	(0.028)	(0.033)	(0.032)	(0.032)
LIQUID_ASSETS/TA	0.005***	0.004**	0.003	0.003	0.003
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
VIX	0.002	0.002**	0.002**	0.001**	0.001**
	(0.002)	(0.001)	(0.001)	(0.000)	(0.000)
S&P500	0.086	0.027*	0.029*	0.019	0.020*
	(0.072)	(0.015)	(0.017)	(0.013)	(0.0011)
TAYL.GAP-NCORE-		-0.010			
		(0.010)			
TAYL.GAP-CORE		-	-0.160*		
			(0.083)		
SHADOW-RATE		-	-	-0.071*	
				(0.036)	
FED-RATE	-	-	-	-	-0.079*
					(0.045)
Constant	1.628**	3.35**	2.378*	3.598***	2.941**
	(0.684)	(1.410)	(1.378)	(1.325)	(1.286)
Wald test	36.75***	50.66***	52.85***	61.73***	59.85***
Hansen (p-value)	0.078	0.096	0.117	0.120	0.117
AR(1)	-3.90***	-5.94***	-4.67***	-3.67***	-3.28***
AR(2)	0.678	0.814	0.874	0.751	0.956
Number of banks	20	20	20	20	20

Notes: the Table shows the regression results based on a dynamic panel model over the period 2007Q1 to 2014Q4. Our dependent variable is: SDROA is the standard deviation of return on assets as estimated based on twelve quarters. Our independent variables are: TAYL.GAP-NCORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the non-core CPI; TAYL.GAP-CORE= Difference between the federal fund rate and the Taylor rate estimated by the Taylor rule (Taylor, 1993) and the core CPI; SHADOW-RATE= shadow short rate; FED-RATE= federal fund rate; SIZE= natural logarithm of total assets; E/TA= equity over total assets ratio ; Return on average equity ROAE= Net income/ total assets; LIQUID_ASSETS/TA= liquid assets over total assets ratio; FEES/TA= investment banking fees over total assets ratio; VIX= volatility implied index; S&P500= stock price index We check that there is not a high level of correlation between the variables used in the models. ***, ** and * indicate 1%, 5% and 10% significance levels respectively.

Regarding the other risk indicator correlates, we find SIZE to have a strong negative effect on bank risk. As in with our previous findings, E/TA, and LIQUID_ASSETS/TA ratios have a negative effect on risk-taking while FEES/TA increases bank risk. Lastly, the relationship between VIX and S&P500 and SDROA remains positive and significant, in line with our previous results.

5.6 Conclusion

In this chapter, we investigate the impact of unconventional monetary policy on the risk-taking of the US investment banks for the 2007Q1-2014Q4. We find that there is a strong positive association between UMP and bank risk-taking of investment banks. In some detail, we find that central banks' assets to gross domestic product ratio exerts a positive effect on investment bank risk-taking as estimated by both Z-score and SDROE. Furthermore, we observe that the effect of the M2 indicator on the risk-taking of investment banks is positive and larger in magnitude than that of M1. This is so as M2 indicator covers among others, overnight repos and money market funds, which involve primary sources of lending to investment banks (Duygan-Bump et al. 2010; Rosengren, 2014). Moreover, we observe that the shadow short rate introduced by (Wu and Hia, 2014) increases the risk-taking of investment banks, confirming in that way both our results and the appropriateness of this measure in gauging the impact of UMP on bank risk-taking. Overall, our results lend support to a risk transmission channel of monetary expansionary policies.

Our results, also in consideration of the financial crisis, are of importance in terms of both policy and managerial implications. In response to the latest crisis, the central bank of the US, Fed, has initiated a number of monetary expansion policies to boost the economy and increase investment spending. The transformation of investment banks into BHCs and their access into the Federal Deposit Insurance Coverage (FDIC) (Volcker, 2010) suggests that they could represent potentially cost for the taxpayer. This, in turn, denotes that regulators should put emphasis on ensuring the stability of investment banks as part of BHCs. Moreover, investment banks being part of BHCs can have access to deposit insurance coverage and hence they can rely on governmental support that might rise the undertaken risk of these financial institutions due to increased moral hazard. Therefore, managers and policy makers should ensure that investment banks are geared toward strategies that could reduce the disproportionate risk of their portfolio. Moreover, as investment banking operations still occur within BHCs, regulation of higher minimum capital requirements and lower leverage is important particularly for these type of financial institutions.

Chapter 6: Conclusion

This thesis provides a comprehensive analysis of the impact of bank-specific variables on the bank performance of the investment banking industry in the G7 and Switzerland countries including the period of the financial crisis.[42] Moreover, we look at the impact of UMPs on the risk-taking of investment banks. This topic is a novel contribution to the banking literature that investigates the determinants of bank performance and risk and has substantial policy implications. The contribution initiated by examining the effect of risk, liquidity and non-interest income on the performance, as estimated by cost efficiency scores, of investment banks in the G7 and Switzerland countries (Chapter 2). During the last decade the investment banking industry in the industrialized countries, which considered being the G7 and Switzerland, has changed dramatically due to the latest financial crisis that was initiated by investment banks making the investigation of the effect of risk related factors on investment bank performance a timely topic. In more detail, we have measured cost efficiency scores using a parametric methodology (SFA) for investment banks in the G7 and Switzerland over the 1997-2010 period. As a second stage, we have regressed these efficiency scores by employing fixed effects, dynamic panel and dynamic threshold analysis for the main three variables, i.e., risk, liquidity and fee-based income, of our main interest. An important result that threshold analysis reveals is that the positive effect of Z-Score, as a measure of bank stability, on investment bank performance is more pronounced for banks of lower risk. This finding is important in the context of investment banks whose activities are fundamentally different and inherently riskier than those of more conventional type of banks such as commercial or savings. We also find that higher liquidity exerts a negative impact on cost efficiency banks for banks

[42] Two empirical chapters, the effect of UMPs on risk-taking and the impact of corporate governance on bank performance, focuses exclusively on the US investment banks' due to data availability issues.

that fall below a threshold liquidity value. A further analysis shows that this effect is driven particularly by investment banks that neither can draw funding from a larger banking entity nor depend on bank deposits as conventional banks, in case of credit constraints. We also find that the fee income ratio has a positive effect on cost efficiency for investment banks that belong to the low fee-income regime. This shows that a rise in fee income causes increased risk for investment banks that belong to the high fee-income regime. This finding is particularly important and highlights the special nature of investment banks compared to conventional banks, as the latter can benefit from an increase of the fee-based in terms of risk diversification. The public policy implications that arise from this chapter are clear and point out more stringent legislation linked with capital requirements. Moreover, with regards to liquidity, the liquidity coverage ratio (LCR) as suggested in Basel III in the US and the Capital Requirements Directive 4 (CRD 4) in Europe could act as defence mechanism in terms of liquidity sufficiency and therefore decrease the need for investment banks to seek for external financial aid under turbulent economically periods.

In Chapter 3, we have investigated the effect of the plethora of corporate governance measures on bank performance, as estimated by both a structural (profit efficiency) and non-structural measures (financial indicators), in the US investment banks over the 2000-2012 period. Specifically, we examine the effect of five different categories of corporate governance on investment bank performance: i) board structure ii) CEO power iii) executive compensation iv) ownership of CEO and board members and v) operational complexity. We put particular emphasis on these five different categories of corporate governance since there is no clear evidence or conclusion of whether and to such extent the governance has contributed to the underperformance of the investment banking sector. To this end, we regress profit efficiency scores and financial indicators, for a sample of

US investment banks over the 2000-2012 period, in dynamic panel models over a number of corporate governance variables hand-collected from DEF 14A proxy statements of annual meetings found in the SECs EDGAR filings. The findings of this research are important since for the first time in the literature is examined the impact of corporate governance, as proxied by a number of different measures, on the performance of investment banks solely. The motivation for a separate examination of the corporate governance in banking is driven mainly by two factors. Firstly, based on the banking theory the nature of financial intermediaries makes those institutions less transparent compared to another type of organizations owing to the difficulty of regulators and shareholders to screen bank assets (Diamond and Rajan, 2001; Levine, 2004). In addition, the special nature of banks is mirrored in the complexity of these financial institutions' business model (Furfine, 2001). This is particularly apparent in investment banks as their operational framework distinguishes them from other types of financial and non-financial institutions (Acharya and Richardson, 2009; Demirguc-Kunt and Huizinga, 2010). Hence, the low level of bank opacity in combination with the high level of business complexity of investment banks cause difficulty to outsiders in monitoring bank operations increasing in that way information asymmetries (Andres and Vallelado, 2008). Secondly, regulation plays an important part for financial institutions due to the significant role of banks in the well-functioning of the entire economy (Hagendorff, 2014). This monitoring of regulators towards banks is a form of additional governance. For example, the Dodd-Frank restrictions imposed by US regulators on the remuneration of executives. Therefore, the special operational framework and nature of investment banks raise the need for a separate investigation of the relationship between corporate governance on investment bank performance. As far as concerns the board structure, we find that there is a negative effect of the board size on performance. A further analysis shows that this negative impact is pronounced if board size raises above the threshold value of approximately ten members. This suggests that above this critical value screening and monitoring costs reduce the performance of investment banks. In addition, we find evidence that the CEO power has a positive effect on bank performance, suggesting that investment banks increase their performance when the CEO is the chairman of the board or has a long-term association with the bank. Moreover, we observe that the board ownership exerts a negative impact on performance. In a further analysis, we show that this impact occurs solely for banks of board ownership below a critical value. On the contrary, the effect of board ownership is positive on investment bank performance above this threshold value. These findings are of utmost importance for both regulators and market participants. After the burst of the latest financial crisis, investment bank operations, and governance have been put into the spotlight of US regulators (Dodd-Frank Act (2010)). Also, the compulsory transformation of investment banks into BHCs and their following access into the Federal Deposit Insurance (FDIC) support (Volcker, 2010) might increase moral hazard for these financial institutions. Hence, regulators should examine ways of ensuring that the governance of these financial institutions is linked towards structures that would prove to have a positive impact on the performance of investment banks.

Chapter 4 investigates the relationship between M&A advisory fees and bank performance, as estimated by technical inefficiency for G7 and Switzerland over the 1997-2012. M&A revenues comprise the main source of income for investment banks and, therefore, it is essential to examine the underlying association between this type of fee-based income and bank performance. In addition, a number of deregulation processes in G7 and Switzerland countries resulted in the rise of M&A activities both domestically and internationally which in turn raised the importance of the role that investment banks play as advisors to investors that seek to successfully complete M&A deals. In this chapter,

Chapter 4, we estimate technical inefficiency scores by using SFA methodology that can take into account undesirable outputs. By doing so, we are able to include bank-specific risk in the production function, as the undesirable output of investment banks. The reason that this methodology is appropriate in this analysis is because investment banks are financial institutions that differ principally from other types of banks, as the former engage primarily in activities, such as M&A, riskier and highly complex compared to those of saving and commercial banks. Indeed, our results show that bank-specific risk increases significantly technical inefficiency of investment banks. We also find that M&A fees exert a positive impact on bank performance, as a rise in M&A fees reduce technical inefficiency. We further employ panel VAR methodology to further examine the robustness of our results and to account for endogeneity issues. In this research, we also test for the level of convergence, in terms of technical inefficiency and M&A advisory fees, of investment banks before (2004-2007), during (2007-2010) and after (2007-2010) the financial crisis. The reason being that the strong performance of investment banks and M&A activity has been decelerated significantly by the latest crisis, causing a negative impact on the banking integration process. Based on the above, we investigate the level of convergence in inefficiency and M&A advisory fees of investment banks in the G7 and Switzerland in terms of both their technical inefficiency scores and their income as estimated by M&A fees. We find that there is convergence in technical inefficiency and M&A fees of investment banks before the crisis (2004-2007), while there is no convergence in technical inefficiency during the crisis (2007-2010). By contrast, we find evidence of convergence in M&A fees of investment banks over the financial crisis period (2007-2010). Therefore, the documented convergence of investment banks in G7 and Switzerland countries would encourage regulators to impose harmonization policies, for example, similar capital and liquidity requirements, aiming to enhance the stability of the investment banking industry in these countries.

Chapter 5 explores the impact of UMPs on risk-taking of investment banks, as measured by z-score and income volatility (standard deviation of ROE) for the US over the 2007-2014 period. Expansionary monetary policies, such as LSAPs, have been widely used in the US aiming to ensure the stability of financial institutions and boost the economy as a whole. Moreover, researchers highlight the key role of investment banks in explaining the effects of UMPs on the general funding conditions in a country (Adrian and Shin, 2008). Also, empirical evidence suggests that UMPs could affect directly the level of operations of investment banks, as low-interest rates over an extended period could result in the increase of securitisation and underwriting activities. Since these operations consist major sources of revenues for investment banks, risky strategies promoted by low-interest rates could lead to important destabization effects for these institutions. Hence, the investigation of UMPs on the risk-taking of investment banks becomes predominantly relevant in the context of this thesis. In Chapter 5, we have regressed the individual level of risk of each investment bank with a plethora of variables that capture UMPs both in a direct, i.e., central banks' assets over GDP, monetary aggregates (M1 and M2), taylor gap, and an indirect way, i.e., federal fund rate and shadow short rate. We also perform sensitivity analysis, where we employ as an alternative measure of risk the standard deviation of ROA and examine the impact of UMPs on bank risk-taking through fixed and dynamic panel specifications. Overall, we find that UMPs exert a positive and significant impact on risk-taking of investment banks across a number of alternative regression models, dependent and independent variables employed. An interesting finding, that both our main and sensitivity analysis reveals, is that M2 indicator proves to be a more appropriate measure compared to M1, as the former includes among others, overnight repos and money market funds, which are main sources of lending to investment banks (Duygan-Bump et al. 2010; Rosengren, 2014). Also, our findings suggest that the shadow short rate as recently developed by Wu and Hia (2014) confirms the presence of a risk-taking channel in line with our previous findings and verifies the suitability of this measure in examining the effect of UMP on bank risk-taking. These results have important policy implications for regulators and policy makers alike. If UMPs play an important role in boosting economic growth and increasing spending, then it seems imperative that regulators should put emphasis on strategies that would reduce the undertaken risk of investment banks particularly after their transformation into BHCs. The reason is that as BHCs investment banks could have access in the Federal Deposit Insurance Coverage (FDIC) (Volcker, 2010) and that might in turn rises the associated risk due to increased moral hazard. Moreover, their access to governmental support could represent potentially cost for the taxpayer and thus effective monitoring and screening operations are warranted.

This thesis has provided a comprehensive research on the bank-specific determinants of the performance of investment banks prior to and during the crisis, but there remain some limitations and challenges for future research. There is a long discussion in the banking literature on determining which methodology is most appropriate for estimating bank performance. In this thesis, we opt for a number of different bank performance measures including cost, profit and technical efficiency estimates using a structural method (SFA). We also use numerous non-structural measures, such as ROA and ROE, as financial indicators reveal different type of information compared to structural measures of bank efficiency estimation. However, in this research we do not employ a non-parametric method, such as DEA, to estimate bank performance and further test the impact of bank-specific variables on investment bank performance. On the one hand, DEA's main advantage compared to SFA is that its implementation does not require a priori information on functional forms (cost, profit or technical production functions) and hence there is a low likelihood of estimation bias on efficiency scores. One the other hand, the main drawback of DEA is that assumes no noise in the efficiency estimation and hence denotes the whole distance of the frontier as inefficiency. However, in future research, it would be an interesting endeavour to estimate efficiency scores using DEA and in turn further test for the robustness of our results.

Moreover, due to data and language limitations, we only have looked in this thesis on the impact of corporate governance on the US investment bank performance. Therefore, a further analysis would enable for the examination of the impact of corporate governance on the performance of investment banks in European countries. This is of particular research interest since regulators in Europe, after the burst of the latest crisis, have also put emphasis on mandates and restrictions with regards to executive compensation, ownership and governance control of banks. In particular, regarding the governance of UK banks, the Walker (2009) report, appointed by the government after the financial crisis, critically discusses and make suggestions for a number of governance-related issues, such as the board structure and expertise, managers' engagement and executive remuneration.

References

Abu-Bader, S., and Abu-Qarn, A. (2008). Financial development and economic growth: the Egyptian experience. Journal of Policy Modelling, 30, pages 887–898.

Acharya, V., and Richardson, M. (2009). Causes of the financial crisis. Critical Review, 21, pages 195-210.

Acharya, V., Hasan, I., and Saunders, A. (2006). Should Banks be Diversified? Evidence from Individual Bank Portfolios. Journal of Business, 79, pages 1355–412.

Adams, R., Almeida, and Ferreira, D. (2005). Powerful CEOs and their impact on corporate performance. Review of Financial Studies, 18, pages 1403-1432.

Adams, R., and Ferreira, D. (2007). A theory of friendly boards. The Journal of Finance, 62, pages 217-250.

Adams, R., and Mehran, H. (2003). Is corporate governance different for bank holding companies? Economic Policy Review, 9, pages 123–142.

Adams, R., and Mehran, H. (2008). Corporate performance, board structure, and their determinants in the banking industry. FRB of New York staff report, No.330.

Adams, R., and Mehran, H. (2012). Bank board structure and performance: Evidence for large bank holding companies. Journal of Financial Intermediation, 21, pages 243-267.

Adrian, T., and Shin, H. (2008). Financial intermediaries, financial stability, and monetary policy. FRB of New York staff report No.346.

Adrian, T., and Shin, H. (2009). Money, liquidity, and monetary policy. The American Economic Review, 99, pages 600-605.

Adrian, T., and Shin, H. (2010). Liquidity and leverage. Journal of Financial Intermediation, 19, pages 418-437.

Aebi, V., Sabato, G., and Schmid, M. (2012). Risk management, corporate governance, and bank performance in the financial crisis. Journal of Banking and Finance, 36, pages 3213-3226.

Aigner, D., Lovell, C., and Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. Journal of Econometrics, 6, pages 21-37.

Albertazzi, U., and Gambacorta, L. (2009). Bank profitability and the business cycle. Journal of Financial Stability, 5, pages 393-409.

Allen, F., and Carletti, E. (2010). An Overview of the Crisis: Causes, Consequences, and Solutions. International Review of Finance, 10, pages 1-26.

Allen, L., and Rai, A. (1996). Operational Efficiency in banking: An international comparison. Journal of Banking and Finance, 20, pages 655-672.

Al-Najjar, B. (2014). Corporate governance, tourism growth and firm performance: Evidence from publicly listed tourism firms in five Middle Eastern countries. Tourism Management, 42, pages 342-351.

Altunbas, Y., and Marques, D. (2008). Mergers and Acquisitions and Bank Performance in Europe: The Role of Strategic Similarities, Journal of Economics and Business, 60, pages 204–22.

Altunbas, Y., Gambacorta, L., and Marques-Ibanez, D. (2010). Does monetary policy affect bank risk-taking?. Bank for International Settlements.

Altunbas, Y., Gambacorta, L. and Marques-Ibanez, D. (2012). Do bank characteristics influence the effect of monetary policy on bank risk?. Economics Letters, 117, pages 220-222.

Altunbaş, Y., Gardener, E., Molyneux, P., and Moore, B. (2001). Efficiency in European banking. European Economic Review, 45, pages 1931-1955.

Altunbas, Y., Ming-Hau L., Molyneux P., and Seth R. (2000). Efficiency and risk in Japanese banking. Journal of Banking and Finance, 24, pages 1605-1628.

Alvarez, J., and Svejenova, S. (2005). Sharing executive power: Roles and relationships at the top. Cambridge University Press.

Amel D., Barnes C., Panetta F., and Salleo C. (2004). Consolidation and efficiency in the financial sector: a review of the international evidence. Journal of Banking and Finance, 28, pages 2493–519.

Anderson, R., and Fraser, D. (2000). Corporate control, bank risk taking, and the health of the banking industry. Journal of Banking and Finance, 24, pages 1383-1398.

Andres, P., and Vallelado, E. (2008). Corporate governance in banking: The role of the board of directors. Journal of Banking and Finance, 32, pages 2570-2580.

Antzoulatos, A., Panopoulou, E., and Tsoumas, C. (2011). The enigma of noninterest income convergence. Applied Financial Economics, 21, pages 1309-1316.

Arellano, M., and Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The Review of Economic Studies, 58, pages 277-297.

Arellano, M., and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, 68, pages 29-51.

Athanasoglou, P., Brissimis, S., and Delis, M. (2008). Bank specific, industry specific and macroeconomic determinants of bank profitability. Journal of International Financial Markets, Institutions and Money, 18, pages 121-136.

Baglioni, A., Beccalli, E., Boitani, A., and Monticini, A. (2013). Is the leverage of European banks procyclical?. Empirical Economics, 45, pages 1251-1266.

Baliga, B., Moyer, R., and Rao, R. (1996). CEO duality and firm performance: what's the fuss?. Strategic Management Journal, 17, pages 41-53.

Ballinger, G., and Marcel, J. (2010). The use of an interim CEO during succession episodes and firm performance. Strategic Management Journal, 31, pages 262-283.

Bao, J., and Edmans A. (2011). Do investment banks matter for M&A returns? Review of Financial Studies, 24, pages 2286–2315.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17, pages 99-120.

Barro, J., and Barro, R. (1990). Pay, performance, and turnover of bank CEOs. National Bureau of Economic Research (No. w3262).

Barro, R., Sala-i-Martin, X., Blanchard, O., and Hall, R. (1991). Convergence across states and regions. Brookings papers on economic activity, 1, pages 107-182

Barry, T., Lepetit, L., and Tarazi, A. (2011). Ownership structure and risk in publicly held and privately owned banks. Journal of Banking and Finance, 35, pages 1327 – 1340.

Barth, J., Lin, C., Ma, Y., Seade, J., and Song, F. (2013). Do bank regulation, supervision and monitoring enhance or impede bank efficiency?. Journal of Banking and Finance, 37, pages 2879-2892.

Battese, G., and Coelli, T. (1988). Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. Journal of Econometrics, 38, pages 387-399.

Bauer, D., and Rudebusch, D. (2013). The Shadow Rate, Taylor Rules, and Monetary Policy Lift-off.

Bauer, P., Berger, A., Ferrier, G., and Humphrey, D. (1998). Consistency conditions for regulatory analysis of financial institutions: a comparison of frontier efficiency methods. Journal of Economics and Business, 50, pages 85-114.

Baxter, J., and Wright, E. (2000). The glass ceiling hypothesis a comparative study of the united states, sweden, and australia. Gender and society, 14, pages 275-294.

Baxter, L. (2012). A Current Assessment of Some Extraterritorial Impacts of The Dodd-Frank Act with Special Focus on The Volcker Rule and Derivatives Regulation. Korean Journal of Banking and Financial Law, 5, pages 4-29.

Baysinger, B., and Hoskisson, R. (1990). The composition of boards of directors and strategic control: Effects on corporate strategy. Academy of Management Review, 15, pages 72-87.

Beatty, R., and Welch I. (1996). Issuer Expenses and Legal Liability in Initial Public Offerings, Journal of Law and Economics, 39, pages 545-602.

Bebchuk, L., and Fried, J. (2003). Executive compensation as an agency problem. National Bureau of Economic Research (No. w9813).

Bebchuk, L., Cohen, A., and Ferrell, A. (2009). What matters in corporate governance? Review of Financial Studies, 22, pages 783–827.

Beccalli, E. (2004). Cross- country comparisons of efficiency: Evidence from the UK and Italian investment firms. Journal of Banking and Finance, 28, pages 1363-1383.

Beccalli, E. (2007). Does IT investment improve bank performance? Evidence from Europe. Journal of Banking and Finance, 31, pages 2205-2230.

Beccalli, E., Casu, B., and Girardone, C. (2006). Efficiency and stock performance in European banking. Journal of Business Finance and Accounting, 33, pages 245-262.

Beck, T., Demirguc-Kunt, A., and Maksimovic, V. (2004). Bank competition and access to finance: international evidence. Journal of Money, Credit, and Banking, 36, pages 627–648.

Bekaert, G., Hoerova, M., and Duca, L. (2013). Risk, uncertainty and monetary policy. Journal of Monetary Economics, 60, pages 771-788.

Beltratti, A., and Stulz, R. (2012). The credit crisis around the globe: Why did some banks perform better?. Journal of Financial Economics, 105, pages 1-17.

Berger, A., and Bonaccorsi di Patti, E. (2006). Capital structure and firm performance: A new approach to testing agency theory and an application to the banking industry. Journal of Banking and Finance, 30, pages 1065-1102.

Berger, A., and De-Young, R. (1997). Problem loans and cost efficiency in commercial banks. Journal of Banking and Finance, 21, pages 849-870.

Berger, A., and Humphrey, D. (1997). Efficiency of financial institutions: International survey and directions for future research. European journal of operational research, 98, pages 175-212.

Berger, A., and Mester, L. (1999). What explains the dramatic changes in cost and profit performance of the US banking industry?. Federal Reserve Bank of Philadelphia (No. 99-1).

Berger, A., and Mester, L. (2003). Explaining the dramatic changes in performance of US banks: technological change, deregulation, and dynamic changes in competition. Journal of Financial Intermediation, 12, pages 57-95.

Berger, A., Bonime, S., Covitz, D., and Hancock, D. (2000). Why are bank profits so persistent? The roles of product market competition, informational opacity, and regional/macroeconomic shocks. Journal of Banking and Finance, 24, pages 1203-1235.

Berger, A., Kick, T., and Schaeck, K. (2014). Executive board composition and bank risk taking. Journal of Corporate Finance, 28, pages 48-65.

Berger, N., and De-Young, R. (1997). Problem loans and cost efficiency in commercial banks. Journal of Banking and Finance, 21, pages 849–870.

Berger, N., and Humphrey, B. (1997). Efficiency of financial institutions: International survey and directions for future research. European Journal of Operational Research, 98, pages 175-212.

Berger, N., and Mester, L. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions?.Journal of Banking and Finance, 21, pages 895-947.

Berger, N., De-Young, R., Genay, H., and Udell, G. (2000). Globalization of financial institutions: Evidence from cross-border banking performance. Brookings-Wharton papers on financial services, 2000, pages 23-120.

Bernanke, S., and Blinder, S. (1992). The federal funds rate and the channels of monetary transmission. The American Economic Review, 82, pages 901-921.

Bertay, C., Demirguc-Kunt, A., and Huizinga, H. (2013). Do we need big banks? Evidence on performance, strategy and market discipline. Journal of Financial Intermediation, 22, pages 532-558.

Bick, A. (2007). Pitfalls in panel threshold models: The role of regime dependent intercepts. Working Paper, Goethe University.

Bikker, J., and Hu, H. (2002). Cyclical patterns in profits, provisioning and lending of banks. De Nederlandsche Bank.

Black, K., and Hazelwood, N. (2013). The effect of TARP on bank risk-taking. Journal of Financial Stability, 9, pages 790-803.

Blundell, R., and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87, pages 115-143.

Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, Office of the Comptroller of the Currency, Treasury, and Office of Thrift Supervision. (2010). 'Guidance on Sound Incentive Compensation Policies'. June 25 2010, http://www.fdic.gov/news/news/press/2010/pr10138a.pdf

Bonin, J., Hasan, I., and Wachtel, P. (2005). Bank performance, efficiency and ownership in transition countries. Journal of Banking and Finance, 29, pages 31-53.

Booth, J., and Deli, D. (1999). On executives of financial institutions as outside directors. Journal of Corporate Finance, 5, pages 227-250.

Bordo, D., and Jeanne, O. (2002). Boom-busts in asset prices, economic instability, and monetary policy. National Bureau of Economic Research No. w8966.

Borio, C., and Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism?. Journal of Financial Stability, 8, pages 236-251.

Bos, J., and Koetter, M. (2011). Handling losses in translog profit models. Applied Economics, 43, pages 307-312.

Bourke, P. (1989). Concentration and Other Determinants of Bank Profitability in Europe, North America and Australia. Journal of Banking and Finance, 13, pages 65-79.

Bowers, H., and Miller, R. (1990). Choice of investment banker and shareholders' wealth of firms involved in acquisitions. Financial Management, pages 34-44.

Boyd, B. (1995). CEO duality and firm performance: A contingency model. Strategic Management Journal, 16, pages 301-312.

Boyd, J., and Graham, S. (1986). Risk, regulation, and bank holding company expansion into nonbanking. Federal Reserve Bank of Minneapolis, Quarterly Review, 10, pages 2-17.

Brissimis, S., Delis, M., and Papanikolaou, N. (2008). Exploring the nexus between banking sector reform and performance: Evidence from newly acceded EU countries. Journal of Banking and Finance, 32, pages 2674-2683.

Brunner, K., and Meltzer, H. (1973). Mr. Hicks and the" Monetarists". Economica, pages 44-59.

Brunnermeier, M. (2009). Deciphering the 2007–08 liquidity and credit crunch. Journal of Economic Perspectives, 23, pages 77–100.

Brunnermeier, M., and Pedersen, L. (2009). Market liquidity and funding liquidity. Review of Financial studies, 22, pages 2201-2238.

Bruno, V., and Shin, S. (2015). Capital flows and the risk-taking channel of monetary policy. Journal of Monetary Economics, 71, 119-132.

Buch, M., Eickmeier, S., and Prieto, E. (2014). In search for yield? Survey-based evidence on bank risk taking. Journal of Economic Dynamics and Control, 43, 12-30.

Bullard, J. (2013). Perspectives on the current stance of monetary policy. Federal Reserve Bank of St. Louis Speech, (Feb 21).

Burgess, S. (2011). Measuring financial sector output and its contribution to UK GDP. Bank of England Quarterly Bulletin, 51, pages 234-246.

Bushman, R., Chen, Q., Engel, E., and Smith, A. (2004). Financial accounting information, organizational complexity and corporate governance systems. Journal of Accounting and Economics, 37, pages 167-201.

Busta, I. (2007). Board effectiveness and the impact of the legal family in the European banking industry. FMA European Conference.

Cagan, P. (1972). The channels of monetary effects on interest rates. New York: National Bureau of Economic Research. Vol. 97.

Campbell, K., and Minguez-Vera, A. (2008). Gender diversity in the boardroom and firm financial performance. Journal of Business Ethics, 83, pages 435-451.

Caporale, G., Hunter, J., and Ali, F. (2014). On the linkages between stock prices and exchange rates: Evidence from the banking crisis of 2007–2010. International Review of Financial Analysis, 33, pages 87-103.

Caner, M., and Hansen, B. (2004). Instrumental variable estimation of a threshold model. Econometric Theory, 20, pages 813–843.

Carbo Valverde, S., and Rodriguez, F. (2007). The determinants of bank margins in European banking. Journal of Banking and Finance, 31, pages 2043-2063.

Carpenter, M., and Sanders, W. (2002). Top management team compensation: the missing link between CEO pay and firm performance?. Strategic Management Journal, 23, pages 367-375.

Caselli, S., Chiarella, C., Gatti, S., and Gigante, G. (2013). The Capital Markets for Italian Companies: A resource to re-launch the country and renew growth. University of Bocconi.

Casu B., Girardone C., and Molyneux P. (2004). Productivity change in European banking: a comparison of parametric and non-parametric approaches. Journal of Banking and Finance, 28, pages 2521–40.

Casu, B., and Girardone, C. (2006). Bank competition and efficiency in the single European market. The Manchester School, 74, pages 441-468.

Casu, B., and Girardone, C. (2010). Integration and efficiency convergence in EU banking markets. Omega, 38, pages 260-267.

Chan, K. (1993). Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model. Annals of Statistics, 21, pages 520–533.

Charnes, A., Cooper, W., and Rhodes, E. (1978). Measuring the efficiency of decision making units. European Journal of Operational Research, 2, pages 429-444.

Child, J. (1972). Organizational structure, environment and performance: the role of strategic choice. Sociology, 6, pages 1-22.

Chiorazzo, V., Milani, C., and Salvini, F. (2008). Income diversification and bank performance: Evidence from Italian banks. Journal of Financial Services Research, 33, pages 181-203.

Choi, S., and Hasan, I. (2005). Ownership, governance, and bank performance: Korean experience. Financial Markets, Institutions and Instruments, 14, pages 215-242.

Claessens, S., and Laeven, L. (2004). What drives bank competition? Some international evidence. Journal of Money, Credit and Banking, 36, pages 563-583.

Claus, E., Claus, I., Krippner, L. (2014). Asset markets and monetary policy shocks at the zero lower bound. Working paper.

Coles, J., Daniel, N., and Naveen, L. (2008). Boards: Does one size fit all?. Journal of Financial Economics, 87, pages 329-356.

Cordella, T., and Yeyati, L. (2002). Financial opening, deposit insurance, and risk in a model of banking competition. European Economic Review, 46, pages 471-485.

Cornett, M., Marcus, A., Tehranian, H. (2008). Corporate governance and pay-for-performance: the impact of earnings management. Journal of Financial Economics, 87, pages 357–373.

Crawford, A., Ezzell, J., Miles, J. (1995). Bank CEO pay–performance relations and the effects of deregulation. Journal of Business, 68, pages 231–256.

Cuesta, R. , Lovell, C., and Zofío, J. (2009). Environmental efficiency measurement with translog distance functions: A parametric approach. Ecological Economics, 68, pages 2232-2242.

Daily, C., and Dalton, D. (1994). Bankruptcy and corporate governance: The impact of board composition and structure. Academy of Management Journal, 37, pages 1603-1617.

Daily, C., and Dalton, D. (1992). The relationship between governance structure and corporate performance in entrepreneurial firms. Journal of Business Venturing, 7, pages 375-386.

Dalton, D., and Daily, C. (1998). Board independence: So what? Corporate Board, 19, 113, pages 15-19.

Dalton, D., Daily, C., Ellstrand, A., and Johnson, J. (1998). Meta-analytic reviews of board composition, leadership structure, and financial performance. Strategic Management Journal, 19, pages 269-290.

De Haas, R., and Van Lelyveld, I. (2010). Internal capital markets and lending by multinational bank subsidiaries. Journal of Financial Intermediation, 19, pages 1-25.

De Jonghe, O., Disli, M., and Schoors, K. (2012). Corporate Governance, Opaque Bank Activities, and Risk/Return Efficiency: Pre-and Post-Crisis Evidence from Turkey. Journal of Financial Services Research, 41, pages 51-80.

De Nicolo, G., Dell'Ariccia, G., Laeven, L., and Valencia, F. (2010). Monetary policy and bank risk taking. International Monetary Fund.

Delis, M. (2012). Bank competition, financial reform, and institutions: The importance of being developed. Journal of Development Economics, 97, pages 450-465.

Delis, M., and Kouretas, G. (2011). Interest rates and bank risk-taking. Journal of Banking & Finance, 35, pages 840-855.

Delis, M., Hasan, I., and Mylonidis, N. (2011). The risk-taking channel of monetary policy in the USA: Evidence from micro-level data. Working paper.

Delis, M., and Staikouras, P. (2011). Supervisory effectiveness and bank risk. Review of Finance, 15, pages 511-543.

Dell’Ariccia, M., Igan, D., and Laeven, L. (2012). Credit booms and lending standards: Evidence from the subprime mortgage market. Journal of Money, Credit and Banking, 44, pages 367-384.

Dell'Ariccia, M., Laeven, M., and Suarez, M. (2013). Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States. International Monetary Fund. No. 13-143.

Dell'Ariccia, M., Marquez, M. , and Laeven, M. (2010). Monetary policy, leverage, and bank risk-taking. International Monetary Fund. No. 10-276.

Demirguc-Kunt, A., and Huizinga, H. (1999). Determinants of Commercial Bank Interest Margins and Profitability: Some International Evidence. World Bank Economic Review, 13, pages 379-408.

Demirgüç-Kunt, A., and Huizinga, H. (2010). Bank activity and funding strategies: The impact on risk and returns. Journal of Financial Economics, 98, pages 626-650.

Demirguc-Kunt, A., and Maksimovic, V. (2002). Funding growth in bank-based and market-based financial systems: evidence from firm-level data. Journal of Financial Economics, 65, pages 337-363.

Denis, D. (2001). Twenty-five years of corporate governance research… and counting. Review of financial economics, 10, pages 191-212.

De-Young, R., and Roland, K. (2001). Product mix and earnings volatility at commercial banks: Evidence from a degree of total leverage model. Journal of Financial Intermediation, 10, pages 54–84.

De-Young, R., Rice, T. (2004). Non-interest income and financial performance at US commercial banks. Financial Review, 39, pages 101–127.

Diamond, D., and Rajan, R. (2001). Banks, short-term debt and financial crises: theory, policy implications and applications. In Carnegie-Rochester Conference Series on Public Policy, 54, pages 37-71.

Dietrich, A., Hess, K., and Wanzenried, G. (2014). The good and bad news about the new liquidity rules of Basel III in Western European countries. Journal of Banking and Finance, 44, pages 13-25.

Dietrich, A., and Wanzenried, G. (2011). Determinants of bank profitability before and during the crisis: Evidence from Switzerland. Journal of International Financial Markets, Institutions and Money, 21, pages 307-327.

Dietsch, M., and Lozano-Vivas, A. (2000). How the environment determines banking efficiency: A comparison between French and Spanish industries. Journal of Banking and Finance, 24, pages 985-1004.

Dodd-Frank Wall Street Reform and Consumer Protection Act. (2010). Pub. L. No. 111–203, § 619, 24 Stat. 1376.

Donaldson, L. (1990). The ethereal hand: Organizational economics and management theory. Academy of Management Review, 15, pages 369-381.

Donaldson, L., and Davis, J. (1991). Stewardship theory or agency theory: CEO governance and shareholder returns. Australian Journal of Management, 16, pages 49-64.

Eagly, A., and Carli, L. (2003). The female leadership advantage: An evaluation of the evidence. The Leadership Quarterly, 14, pages 807-834.

Eichengreen, B., Mody, A., Nedeljkovic, M., and Sarno, L. (2012). How the subprime crisis went global: Evidence from bank credit default swap spreads. Journal of International Money and Finance, 31, pages 1299-1318.

Eisenberg, T., Sundgren, S., and Wells, M., (1998). Larger board size and decreasing firm value in small firms. Journal of Financial Economics , 48, pages 35– 54.

Erkens, D., Hung, M., and Matos, P. (2012). Corporate governance in the 2007–2008 financial crisis: Evidence from financial institutions worldwide. Journal of Corporate Finance, 18, pages 389-411.

Fahlenbrach, R., and Stulz, R. (2011). Bank CEO incentives and the credit crisis. Journal of Financial Economics, 99, pages 11-26.

Fang, L. (2005). Investment bank reputation and the price and quality of underwriting services. Journal of Finance, 60, pages 2729-2761.

Färe, R., and Primont, D. (1995). Multi-Output Production and Duality: Theory and Applications. Kluwer Academic Publishers, Dordrecht.

Fernando, C., May, A., and Megginson, W. (2012). The value of investment banking relationships: evidence from the collapse of Lehman Brothers. The Journal of Finance, 67, pages 235-270.

Finkelstein, S., and D'aveni, R. (1994). CEO duality as a double-edged sword: How boards of directors balance entrenchment avoidance and unity of command. Academy of Management Journal, 37, pages 1079-1108.

Finkelstein, S., and Hambrick D. (1996). Strategic leadership: Top executives and their effects on organization. West Publishing Company, NY.

Fiordelisi F., Marques-Ibanez, and D., Molyneux, P. (2011). Efficiency and Risk in European Banking. Journal of Banking and Finance, 35, pages 1315-1326.

Fiordelisi, F., and Molyneux, P. (2010). The determinants of shareholder value in European banking. Journal of Banking and Finance, 34, pages 1189–1200.

Francis, B., Hasan, I., Song, L., and Yeung, B. (2014). What determines bank-specific variations in bank stock returns? Global evidence. Journal of Financial Intermediation, 24, 312–324.

Francis, B., Hasan, I., and Wu, Q. (2012). Do corporate boards matter during the current financial crisis?. Review of Financial Economics, 21, pages 39-52.

Francoeur, C., Labelle, R., and Sinclair-Desgagné, B. (2008). Gender diversity in corporate governance and top management. Journal of Business Ethics, 81, pages 83-95.

Fraser, D. , Madura, J., and Weigand, R. (2002). Sources of bank interest rate risk. Financial Review, 37, pages351-367.

Fratzscher, M., Lo Duca, M., and Straub, R. (2013). On the international spillovers of US quantitative easing.Working paper.

Friedman, M., and Schwartz, A. (1986). Has government any role in money?. Journal of Monetary Economics, 17, pages 37-62.

Fries, S., and Taci, A. (2005). Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries. Journal of Banking and Finance, 29, pages 55-81.

Frye, M. (2004). Equity ‐ based compensation for employees: firm performance and determinants. Journal of Financial Research, 27, pages 31-54.

Fung, M. (2006). Scale economies, X-efficiency, and convergence of productivity among bank holding companies. Journal of banking and finance, 30, pages 2857-2874.

Fungacova, Z., Solanko, L., and Weill, L. (2014). Does competition influence the bank lending channel in the euro area? Journal of Banking & Finance, 49, 356-366.

Furfine, C. (2001). Banks as monitors of other banks: Evidence from the overnight federal funds market. Journal of Business, 74, pages 33–57.

Gaganis, C. and Pasiouras, F. (2013). Financial supervision regimes and bank efficiency: International evidence. Journal of Banking and Finance, 37, pages 5463-5475.

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2011). The financial market effects of the Federal Reserve’s large-scale asset purchases. International Journal of Central Banking, 7(1), 3-43

Gambacorta, L., and Van Rixtel, A. (2013). Structural bank regulation initiatives: approaches and implications . Bank for International Settlements.

Gambacorta, L., Hofmann, B., and Peersman, G. (2014). The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross‐Country Analysis. Journal of Money, Credit and Banking, 46, pages 615-642.

García-Meca, E., García-Sánchez, M., and Martínez-Ferrero, J. (2015). Board diversity and its effects on bank performance: An international analysis. Journal of Banking & Finance, 53, 202-214.

Gatev, E., Schuermann T., and Strahan P. (2009). Managing Banks Liquidity Risk: How Deposit-Loan Synergies Vary with Market Conditions. Review of Financial Studies, 22, pages 995-1020.

Gatev, E., Strahan P. (2006). Banks' Advantage in Hedging Liquidity Risk: Theory and Evidence from the Commercial Paper Market. Journal of Finance, 61, pages 867-892.

Gerdesmeier, D., Reimers, E., and Roffia, B. (2010). Asset Price Misalignments and the Role of Money and Credit. International Finance, 13, pages 377-407.

Gilchrist, S., and Zakrajšek, E. (2013). The Impact of the Federal Reserve's Large‐Scale Asset Purchase Programs on Corporate Credit Risk. Journal of Money, Credit and Banking, 45, pages 29-57.

Gillan, S., and Starks, L. (2000). Corporate governance proposals and shareholder activism: The role of institutional investors. Journal of financial Economics, 57, pages 275-305.

Goddard, J., Liu, H., Molyneux, P., and Wilson, J. (2011). The persistence of bank profit. Journal of Banking and Finance, 35, pages 2881-2890.

Goddard, J., Molyneux, P., and Wilson, J. (2004). The profitability of European banks: a cross - sectional and dynamic panel analysis. The Manchester School, 72, pages 363-381.

Goldberg, L. (2009). Understanding banking sector globalization. IMF Staff Papers, pages 171-197.

Gomez-Mejia, L., and Wiseman, R. (1997). Reframing Executive Compensation: An Assessment and Outlook. Journal of Management, 23, pages 291-374.

Goodwin - Stewart, J., and Kent, P. (2006). Relation between external audit fees, audit committee characteristics and internal audit. Accounting and Finance, 46, pages 387-404.

Gorton, G., and Rosen, R. (1995). Corporate control, portfolio choice, and the decline of banking. The Journal of Finance, 50, pages 1377-1420.

Grammatikos, T., Saunders, A., and Swary, I. (1986). Returns and risks of US bank foreign currency activities. The Journal of Finance, 41, pages 671-682.

Gropp, R., Gruendl, C., and Guettler, A. (2013). The Impact of Public Guarantees on Bank Risk-Taking: Evidence from a Natural Experiment. Review of Finance,14, pages 1-32.

Gropp, R., Vesala, J., and Vulpes, G. (2006). Equity and bond market signals as leading indicators of bank fragility. Journal of Money, Credit and Banking, 1, 399-428.

Grossman, S., and Hart, O. (1983). An analysis of the principal-agent problem. Econometrica: Journal of the Econometric Society, 51, pages 7-45.

Hagendorff (2014) Corporate Governance in Banking, in Oxford Handbook of Banking, Oxford University Press.

Hambrick, D. (1995). Fragmentation and the other problems CEOs have with their top management teams. California Management Review, 37, pages 110-127.

Hansen, B. (1997). Inference in TAR models. Studies in Nonlinear Dynamics and Econometrics, 2, pages 1-14.

Hansen, B. (1999). Threshold effects in non-dynamic panels: estimation, testing and inference. Journal of Econometrics, 93, pages 345–368.

Harris, M., and Raviv, A. (1979). Optimal incentive contracts with imperfect information. Journal of Economic Theory, 20, pages 231-259.

Hasan, I., and Marton, K. (2003). Development and efficiency of the banking sector in a transitional economy: Hungarian experience. Journal of Banking and Finance, 27, pages 2249-2271.

He, J., and Wang, H. (2009). Innovative knowledge assets and economic performance: The asymmetric roles of incentives and monitoring. Academy of Management Journal, 52, pages 919-938.

Henderson, A., and Fredrickson, J. (2001). Top management team coordination needs and the CEO pay gap: A competitive test of economic and Behavioral views. Academy of Management Journal, 44, pages 96-117.

Hillegeist, S., and Penalva, F. (2003). Stock option incentives and firm performance. Social Science Research Network Working Paper Series.

Holzl, W. (2006). Convergence of financial systems: Towards an evolutionary perspective. Journal of Institutional Economics, 2, pages 69-70.

Hubbard, R., and Palia, D. (1995). Executive pay and performance Evidence from the US banking industry. Journal of Financial Economics, 39, pages 105-130.

Hughes, P., and Mester, M. (2010). Efficiency in banking theory and evidence, in Oxford Handbook of Bankings, Oxford University Press, Oxford, pages-463-485.

Hunter, W., and Jagtiani, J. (2003). An analysis of advisor choice, fees, and effort in mergers and acquisitions. Review of Financial Economics, 12, pages 65-81.

Iannotta, G., Nocera, G., and Sironi, A. (2007). Ownership structure, risk and performance in the European banking industry. Journal of Banking and Finance, 31, pages 2127-2149.

Ioannidou, V., Ongena, S., and Peydró, J. (2015). Monetary policy, risk-taking, and pricing: Evidence from a quasi-natural experiment. Review of Finance, 19 , pages 95-144.

Isik, I., and Hassan, M. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. Journal of Banking and Finance, 26, pages 719-766.

Isik, I., and Kabir Hassan, M. (2003). Financial deregulation and total factor productivity change: An empirical study of Turkish commercial banks. Journal of Banking and Finance, 27, pages 1455-1485.

Ismail, A. (2010). Are good financial advisors really good? The performance of investment banks in the M&A market. Review of Quantitative Finance and Accounting, 35, pages 411–429.

Jensen, C., and Meckling, H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 3, pages 305-360.

Jensen, M. (1993). The modern industrial revolution, exit, and the failure of internal control systems. The Journal of Finance, 48, pages 831-880.

Jensen, M., and Murphy, K. (1990). Performance pay and top-management incentives. Journal of Political Economy, 98, pages 225-264.

Jensen, M., and Warner, J. (1988). The distribution of power among corporate managers, shareholders, and directors. Journal of Financial Economics, 20, pages 3-24.

Jimenez, G., Ongena, S., Peydró, J., and Saurina, J. (2014). Hazardous Times for Monetary Policy: What Do Twenty‐Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk‐Taking?. Econometrica, 82, pages 463-505.

Jondrow, J., Knox Lovell, A., Materov, S., and Schmidt, P. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. Journal of Econometrics, 19, pages 233-238.

Joyce, M., Lasaosa, A., Stevens, I., and Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. International Journal of Central Banking, 7, pages 113-161.

Joyce, M., Miles, D., Scott, A., and Vayanos, D. (2012). Quantitative Easing and Unconventional Monetary Policy–an Introduction. The Economic Journal, 122, pages 271-288.

Kalemli-Ozcan, S., Sorensen, B., and Yesiltas, S. (2012). Leverage across firms, banks, and countries. Journal of International Economics, 88, pages 284-298.

Kapetanios, G., Mumtaz, H., Stevens, I., and Theodoridis, K. (2012). Assessing the Economy - wide Effects of Quantitative Easing*. The Economic Journal, 122, pages 316-347.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. The American Economic Review, 80, pages 1183-1200.

Kim, H., and Singleton, J. (2012). Term structure models and the zero bound: an empirical investigation of Japanese yields. Journal of Econometrics, 170, pages 32-49.

Kirkpatrick, G. (2009). Corporate governance lessons from the financial crisis (Vol. 1). OECD.

Klapper, L., and Love, I. (2004). Corporate governance, investor protection, and performance in emerging markets. Journal of Corporate Finance, 10, pages 703-728.

Kobayashi, T., Spiegel, M., and Yamori, N. (2006). Quantitative easing and Japanese bank equity values. Journal of the Japanese and International Economies, 20, pages 699-721.

Koetter, M. (2006). Measurement Matters—Alternative Input Price Proxies for Bank Efficiency Analyses. Journal of Financial Services Research, 30, pages 199-227.

Kolasinski, A. , and Kothari, S. (2008). Investment banking and analyst objectivity: Evidence from analysts affiliated with mergers and acquisitions advisors. Journal of Financial and Quantitative Analysis, 43, pages 817-842.

Kremer, S., Bick, A., and Nautz, D. (2013). Inflation and growth: new evidence from a dynamic panel threshold analysis. Empirical Economics, 44, pages 861-878.

Krippner, L. (2013). Measuring the stance of monetary policy in zero lower bound environments. Economics Letters, 118, pages 135-138.

Krishnamurthy, A. (2009). How debt markets have malfunctioned in the crisis. National Bureau of Economic Research No. w15542.

Kumbhakar, S., and Lovell, K. (2003). Stochastic frontier analysis. Cambridge University Press.

Kwan, S. (2003). Operating performance of banks among Asian economies: An international and time series comparison. Journal of Banking and Finance, 27, pages 471-489.

Laeven, L., and Levine, R. (2007). Is there a diversification discount in financial conglomerates?. Journal of Financial Economics, 85, pages 331–367.

Laeven, L., and Levine, R. (2009). Bank governance, regulation and risk taking. Journal of Financial Economics, 93, pages 259-275.

Lambert, F., and Ueda, K. (2014). The Effects of Unconventional Monetary Policies on Bank Soundness. International Monetary Fund. No. 14-152.

Lawrence, P., and Lorsch, J. (1967). Differentiation and integration in complex organizations. Administrative science quarterly, 12, 1-47.

Lensink, R., Meesters, A., and Naaborg, I. (2008). Bank efficiency and foreign ownership: Do good institutions matter?. Journal of Banking and Finance, 32, pages 834-844.

Lepetit, L., Nys, E., Rous, P., and Tarazi, A. (2008). Bank income structure and risk: an empirical analysis of European banks. Journal of Banking and Finance, 32, pages 1452–1467.

Levine, R. (1997). Financial Development and Economic Growth: Views and Agenda. Journal of Economic Literature, 35, pages 688-726.

Levine, R. (2004). The corporate governance of the banks: A concise discussion of concepts and evidence. Working Paper, World Bank Policy Research.

Liang, Q., Xu, P., and Jiraporn, P. (2013). Board characteristics and Chinese bank performance. Journal of Banking and Finance, 37, pages 2953-2968.

Liikanen, E. (2012). High-level Expert Group on reforming the structure of the EU banking sector. Final report.

Lin, Y. (2009) The impact of the financial crisis on developing countries. Text of a lecture delivered at Korea Development Institute, Seoul, 31 October.

Lin, Y. (2005). Corporate governance, leadership structure and CEO compensation: Evidence from Taiwan. Corporate Governance: An International Review, 13, pages 824-835.

Lin, X., and Zhang, Y. (2009). Bank Ownership Reform and Bank Performance in China. Journal of Banking and Finance, 33, pages 20-29.

Linck, J., Netter, J., and Yang, T. (2008). The determinants of board structure. Journal of Financial Economics, 87, pages 308-328.

Lipton, M., and Lorsch, J. (1992). A modest proposal for improved corporate governance. The Business Lawyer, 48, pages 59-77.

Lozano-Vivas, A., and Pasiouras, F. (2010). The impact of non-traditional activities on the estimation of bank efficiency: international evidence. Journal of Banking and Finance, 34, pages 1436-1449.

Lyonnet, V., and Werner, R. (2012). Lessons from the Bank of England on quantitative easing and other unconventional monetary policies. International Review of Financial Analysis, 25, pages 94-105.

Maddaloni, A., and Peydró, L. (2011). Bank risk-taking, securitization, supervision, and low interest rates: Evidence from the Euro-area and the US lending standards. Review of Financial Studies, 24, pages 2121-2165.

Madura, J. and Schnusenberg, O. (2000) Effect of Federal Reserve policies on bank equity returns, Journal of Financial Research, 23, pages 421–47.

Mamatzakis, E., Kalyvas, A., and Piesse, J. (2013). Does Regulation in Credit, Labour and Business Matter for Bank Performance in the EU-10 Economies?. International Journal of the Economics of Business, 20, pages 341-385.

Mamatzakis, E., Staikouras, C., and Koutsomanoli-Filippaki, A. (2008). Bank efficiency in the new European Union member states: Is there convergence?. International Review of Financial Analysis, 17, pages 1156-1172.

Martin, C., and Milas, C. (2012). Quantitative easing: a sceptical survey. Oxford Review of Economic Policy, 28, pages 750-764.

Maudos, J., and Guevara, J. (2007). The cost of market power in banking: social welfare loss vs. cost inefficiency. Journal of Banking and Finance, 31, pages 2103–2125.

Maudos, J., and Solis, L. (2009). The determinants of net interest income in the Mexican banking system: an integrated model. Journal of Banking and Finance, 33, pages 1920–1931.

Mayer, C., and Carlin, W. (2008). Multinational Ownership and Subsidiary Investment. Working paper.

Meaning, J., and Zhu, F. (2012). The impact of Federal Reserve asset purchase programmes: another twist. BIS Quarterly Review, March.

Merciera, S., Schaeck K., and Wolfe S. (2007). Small European banks: Benefits from diversification?. Journal of Banking and Finance, 31, pages 1975–98.

Mester, L. (1996). A study of bank efficiency taking into account risk-preferences. Journal of Banking and Finance, 20, pages 1025-1045.

Mester, L. J. (1993). Efficiency in the savings and loan industry. Journal of Banking & Finance, 17(2), 267-286.

Micco, A., Panizza, U., and Yanez, M. (2007). Bank ownership and performance. Does politics matter?. Journal of Banking and Finance, 31, pages 219-241.

Miller, M., and Noulas, G. (1997). Portfolio mix and large-bank profitability in the USA.

Mishra, C., and Nielsen, J. (2000). Board independence and compensation policies in large bank holding companies. Financial Management, 29, pages 51-69.

Molyneux, P., and Thornton, J. (1992). Determinants of European bank profitability: a note. Journal of Banking and Finance, 16, pages 1173-1178.

Morana, C. (2008). International stock markets co-movements: the role of economic and financial integration. Empirical Economics, 35, pages 333-359.

Morgan, D., and Stiroh, K. (2001). Market discipline of banks: The asset test. Journal of Financial Services Research, 20, pages 195–208.

Murphy, K. (1999). Executive compensation. Handbook of labour economics, 3, pages 2485-2563.

Myers, C. (1977). Determinants of corporate borrowing. Journal of Financial Economics, 5, pages 147-175.

Pasiouras, F. (2008). International evidence on the impact of regulations and supervision on banks' technical efficiency: an application of two-stage data envelopment analysis. Review of Quantitative Finance and Accounting, 30, pages 187-223.

Pasiouras, F., and Kosmidou, K. (2007). Factors influencing the profitability of domestic and foreign commercial banks in the European Union. Research in International Business and Finance, 21, pages 222–237.

Pasiouras, F., Tanna, S., and Zopounidis, C. (2009). The impact of banking regulations on banks' cost and profit efficiency: Cross-country evidence. International Review of Financial Analysis, 18, pages 294-302.

Pathan, S. (2009). Strong boards, CEO power and bank risk-taking. Journal of Banking and Finance, 33, pages 1340-1350.

Pathan, S., and Faff, R. (2013). Does board structure in banks really affect their performance?. Journal of Banking and Finance, 37, pages 1573-1589.

Pathan, S., and Skully, M. (2010). Endogenously structured boards of directors in banks. Journal of Banking and Finance, 34, pages 1590-1606.

Pfeffer, J. (1972). Size and composition of corporate boards of directors: The organization and its environment. Administrative Science Quarterly, 18, pages 218-228.

Phillips, P., and Sul, D. (2007). Transition modelling and econometric convergence tests. Econometrica, 75, pages 1771-1855.

Pi, L., and Timme, S. G. (1993). Corporate control and bank efficiency. Journal of Banking and Finance, 17, pages 515-530.

Procédé du Commandant Cholesky. (1924) Note sur une méthode de résolution des équations normales provenant de l'application de la méthode des moindres carrés à un système d'équations linéaires en nombre inférieur à celui des inconnues. -Application de la méthode à la résolution d'un système défini d'équations linéaires, 2, pages 67-77.

Radic, N., Fiordelisi, F., and Girardone, C. (2012). Efficiency and Risk-taking in Pre-crisis Investment Banks. Journal of Financial Services Research, 41, pages 81-101.

Rau, P. (2000). Investment bank market share, contingent fee payments, and the performance of acquiring firms. Journal of Financial Economics, 56, pages 293-324.

Rechner, P., and Dalton, D. (1989). The impact of CEO as board chairperson on corporate performance: evidence vs. rhetoric. The Academy of Management Executive, 3, pages 141-143.

Reichlin, L. (2013). Monetary policy and banks in the euro area: the tale of two crises. Journal of Macroeconomics, 39, pages 387-340.

Revell, J. (1979). Inflation & Financial Institutions. Financial Times Limited.

Roache, S. K., & Rousset, M. (2013). Unconventional monetary policy and asset price risk. IMF working paper.

Robinson, G., and Dechant, K. (1997). Building a business case for diversity. The Academy of Management Executive, 11, pages 21-31.

Roodman, D. (2006). How to do xtabond2: An introduction to difference and system GMM in Stata. Center for Global Development. Working paper No.103.

Santomero, A. (1997). Deposit insurance: do we need it and why?. Cyprus Economic Society.

Schroder, M., Borell, M., Gropp, R., Iliewa, Z., Jaroszek, L., Lang, G., Schmidt, S., and Trela, K. (2012). The role of investment banking for the German economy: Final report for Deutsche Bank AG No. 12-01.

Sealey, J., and Lindley, J. (1977). Inputs, Outputs, and Theory of Production and Cost of Depository Financial Institutions. The Journal of Finance, 32, pages 1251-1266..

Shandre, M., and James, A. (2004). Financial development and economic growth in Australia: An Empirical Analysis. Empirical Economics, 29, pages 247–260.

Shrader, C., Blackburn, V., and Iles, P. (1997). Women in management and firm financial performance: An exploratory study. Journal of Managerial Issues, 9, 355-372.

Sironi, A. (2003). Testing for market discipline in the European banking industry: Evidence from subordinated debt issues. Journal of Money, Credit, and Banking, 35, pages 443-472.

Staikouras, C., Mamatzakis, E., and Koutsomanoli- Filippaki, A. (2008). Cost efficiency of the banking industry in the South Eastern European region. Journal of International Financial Markets, Institutions and Money, 18, pages 483–497.

Staikouras, P., Staikouras, C., and Agoraki, M. (2007). The effect of board size and composition on European bank performance. European Journal of Law and Economics, 23, pages 1-27.

Steeley, J. M. (2015). The side effects of quantitative easing: Evidence from the UK bond market. Journal of international money and finance, 51, 303-336.

Steeley, J. M., & Matyushkin, A. (2015). The effects of quantitative easing on the volatility of the gilt-edged market. International review of financial analysis, 37, 113-128.

Stiroh, K. (2004). Diversification in banking: Is noninterest income the answer?. Journal of Money, Credit, and Banking, 36, pages 853–882.

Stowell, D. (2012). Investment Banks, Hedge Funds, and Private Equity. Academic Press.

Sun, L., and Chang, T. (2011). A comprehensive analysis of the effects of risk measures on bank efficiency: Evidence from emerging Asian countries. Journal of Banking and Finance, 35, pages 1727-1735.

Swiss Bankers Association and The Boston Consulting Group (2011). Summary: Banking in transition – future prospects for banking in Switzerland.

Tanna, S., Pasiouras, F., and Nnadi, M. (2011). The effect of board size and composition on the efficiency of UK banks. International Journal of the Economics of Business, 18, pages 441-462.

Taylor, B. (1993, December). Discretion versus policy rules in practice. In Carnegie-Rochester conference series on public policy (Vol. 39, pp. 195-214). North-Holland.

Thomson Reuters, (2007). Global Investment Banking Review. Various issues.

Thomson Reuters, (2012). Global Investment Banking Review. Various issues.

Thomson Reuters, (2013). Global Investment Banking Review. Various issues.

Tobin, J. (1963). An essay on the principles of debt management. Cowles Foundation for Research in Economics at Yale University.

Tobin, J. (1969). A general equilibrium approach to monetary theory. Journal of money, credit and banking, 1, pages 15-29.

Tomljanovich, M., and Ying, Y. (2005). We're all connected: business cycle synchronization in G-7 countries. URL: http://academics. hamilton. edu/economics/home/marc_t. pdf.

Tortosa-Ausina, E. (2002). Exploring efficiency differences over time in the Spanish banking industry. European Journal of Operational Research, 139, pages 643-664.

Vafeas, N. (1999). Board meeting frequency and firm performance. Journal of Financial Economics, 53, pages 113-142.

Vallascas, F., and Hagendorff, J. (2013). CEO Bonus Compensation and Bank Default Risk: Evidence from the US and Europe. Financial Markets, Institutions and Instruments, 22, pages 47-89.

Vander, V. (2002). Cost and Profit Efficiency of Financial Conglomerates and Universal Banks in Europe. Journal of Money, Credit and Banking, 34, pages 254-282.

Vickers, J., and Lagarde, C. (2013). Banking reform in Britain and Europe. Various issues.

Vinals, J., and Moghadam R. (2012). Financial System Stability Assessment. International Monetary Fund France.

Voutsinas, K., and Werner, R. (2011a). Credit supply and corporate capital structure: Evidence from Japan. International Review of Financial Analysis, 20, pages 320-334.

Voutsinas, K., and Werner, R. (2011b). New evidence on the effectiveness of Quantitative Easing in Japan. CFS working paper No. 2011/30.

Weill, L. (2009). Convergence in banking efficiency across European countries. Journal of International Financial Markets, Institutions and Money, 19, pages 818-833.

Weisbach, M. (1988). Outside directors and CEO turnover. Journal of financial Economics, 20, pages 431-460.

Werner, R. (1995). How to create a recovery through 'Quantitative Monetary Easing'. The Nihon Keizai Shinbun (Nikkei), 9, page 1-26.

Westphal, J. (1998). Board games: How CEOs adapt to increases in structural board independence from management. Administrative Science Quarterly, 43, 511-537.

Westphal, J. (1999). Collaboration in the boardroom: Behavioral and performance consequences of CEO-board social ties. Academy of Management Journal, 42, pages 7-24.

Whaley, E. (2000). The investor fear gauge. Journal of Portfolio Management, 26, pages 12–17.

Wheelock, D., and Wilson, P. (2000). Why do banks disappear? The determinants of US bank failures and acquisitions. Review of Economics and Statistics, 82, pages 127–138.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. Journal of Econometrics, 126, pages 25-51.

Wintoki, M., Linck, J., and Netter, J. (2012). Endogeneity and the dynamics of internal corporate governance. Journal of Financial Economics, 105, pages 581-606.

Wiseman, R., and Gomez-Mejia, L. (1998). A behavioural agency model of managerial risk taking. Academy of management Review, 23, pages 133-153.

Wu, J., and Xia, D. (2014). Measuring the macroeconomic impact of monetary policy at the zero lower bound. National Bureau of Economic Research. No. w20117.

Xie, B., Davidson, W., and DaDalt, P. (2003). Earnings management and corporate governance: the role of the board and the audit committee. Journal of Corporate Finance, 9, pages 295-316.

Yermack, D. (1996). Higher market valuation of companies with a small board of directors. Journal of Financial Economics, 40, pages 185-211.

Yin, H., and Yang, J. (2013). Bank characteristics and stock reactions to federal funds rate target changes. Applied Financial Economics, 23, pages 1755-1764.

Zajac, E., and Westphal, J. (1995). Accounting for the explanations of CEO compensation: Substance and symbolism. Administrative Science Quarterly, 40, 283-308.