THREE ESSAYS ON SECURITISATION

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ABBREVIATIONS

ABS - Asset-Backed Securitisation

BHC - Bank Holding Company

CBO - Collateralised Bond Obligation

CDO - Collateralised Debt Obligation

CE IO Strip - Credit-Enhancing Interest-Only Strip

CLO - Collateralised Loan Obligation

CRT - Credit Risk Transfer

EU – European Union

HHI - Herfindahl-Hirschman Index

IO Strip - Interest-Only Strip

MBS - Mortgage-Backed Securitisation

PSM - Propensity Score Matching

SIFMA - Securities Industry and Financial Markets Association

SPV - Special Purpose Vehicle

UK – United Kingdom

US – United States

ABSTRACT

Securitisation has been viewed as a key bank funding, risk management and performance improvement tool over the last two decades. However, the financial crisis of 2007-2009 has shown that engagement in securitisation might create significant financial problems for banks and consequently lead to widespread problems in the financial sector. This, therefore, has underlined the importance of understanding banks' securitisation activities, the benefits and risks inherent, and the consequences for the financial system.

This thesis comprises empirical research on the effects of securitisation on banks. The work is presented in three essays. The first essay investigates whether banks improve their performance through the use of the securitisation market by applying a propensity score matching approach. Specifically, we attempt to assess whether the access to the securitisation market led to lower cost of funding, less credit risk exposure, and higher profitability. Using US commercial bank data from 2001 to 2008, we first test these hypotheses using univariate analysis and find that securitising banks are, on average, more profitable institutions, with higher credit risk exposure, and higher cost of funding. However, the propensity score matching analysis does not provide evidence to suggest that securitisation had a significant impact upon bank performance. In other words, the analysis shows that securitisers would have had comparable cost of funding, credit risk, and profitability had they remained non-securitising. This evidence leads us to conclude that securitisation does not seem to outperform alternative funding, risk management, and profitability improvement techniques used by non-securitising banks that have *ex-ante* similar characteristics to those securitising.

The second essay investigates the impact of securitisation on the credit-risk taking behaviour of banks. Using US bank holding company data from 2001 to 2007, we find that banks with a greater balance of outstanding securitised assets choose asset

portfolios of lower credit risk. Examining securitisations by the type of underlying assets, we find that the negative relationship between outstanding securitisation and risk taking is primarily driven by securitisations of mortgages, home equity lines of credit, and other consumer loans. Securitisations of all other types of assets, on the other hand, seem to have no significant impact on bank credit-risk taking behaviour. We attribute these results to the recourse commonly provided in securitisation transactions, as it might alter the risk-taking appetite of the issuing banks across asset classes. Therefore, we conclude that the net impact of securitisation on the riskiness of issuing banks, and consequently on the soundness of the banking system, is ambiguous and will depend on the structure of transactions. In particular, it will depend on the relative magnitude of credit support provided by banks.

The third essay examines the relationship between banks' off-balance sheet securitisation structures and insolvency risk, with a particular focus on credit and liquidity support provided by these banks. Additionally, it examines the risk effect of credit-enhancing facilities and liquidity commitments provided by banks to securitisation structures of other institutions. Using US bank holding company data for the period from 2002 to 2007, we first find that credit enhancements provided by originating banks in their securitisation structures have a significant positive effect on insolvency risk of the banks. Second, examining credit enhancements by the form of underlying facility, we find that among credit-enhancing interest-only strips, subordinated securities, and standby letters of credit, the latter have the greatest positive association with bank insolvency risk. In contrast, liquidity provisions are found to have a significant risk-reducing effect. Finally, examining credit and liquidity support provided by banks to third-party securitisation structures, we find that credit enhancing third-party securitisations reduces insolvency risk of the banks, while liquidity provisions are found to be highly positively associated with their insolvency.

Summarising the main findings, the first essay finds no evidence of significant causal effects of securitisation on performance of securitising banks. The second essay finds evidence to suggest that outstanding securitisation has a negative impact on the credit-risk taking behaviour of banks; while the third essay finds that the interests retained by banks in connection to securitised assets significantly increase their insolvency risk. This shows that the net risk transfer for originating banks through securitisation might be ambiguous; however banks do account for the retained exposure to the securitised assets reducing credit risk taking. Taken together, the evidence from the three studies suggests that banks predominantly use securitisation for financing purposes rather than as a risk management or performance improvement mechanism.

This research contributes to a deeper understanding of the motives for and consequent implications of securitisation and provides valuable findings for the ongoing discussion of how to redesign the securitisation model and to reform the supervision and regulation of banks' engagement in securitisation activities in response to the recent financial crisis.

1 INTRODUCTION

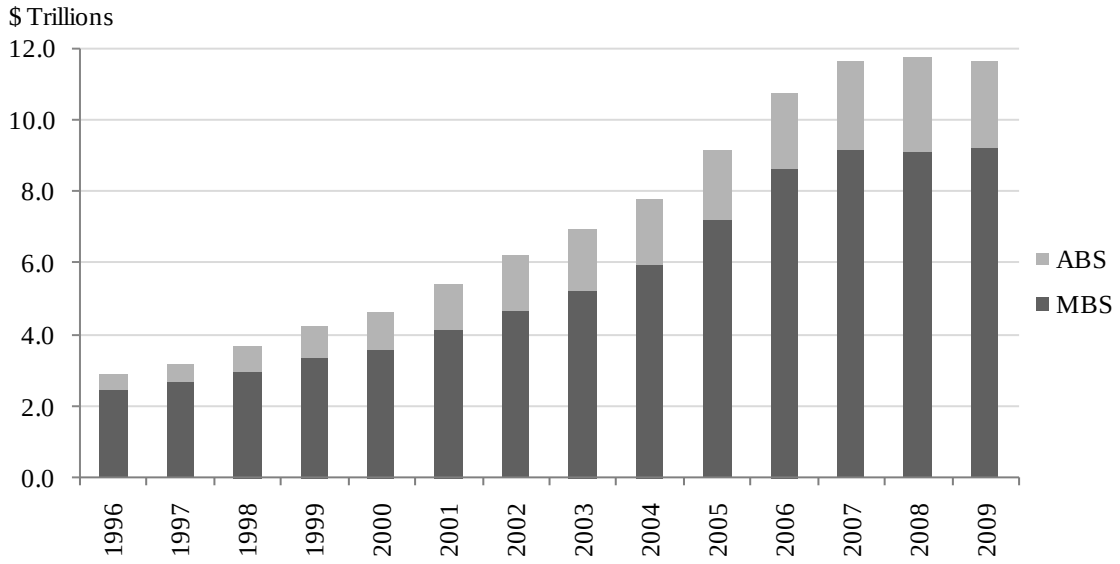
1.1 Introduction

Securitisation has been a key bank funding, risk management, and performance improvement tool over the last two decades. It began with structured financing of mortgage loans in the 1970s and has expanded remarkably in types of securitised assets, securitising firms, and investors in securitised products since the 1980s.

The decade preceding the financial crisis of 2007-2009 witnessed a tremendous growth of the market maintained by growing search for investment opportunities as a result of global imbalances, persistent demand from institutional investors for low-risk liquid asset-backed securities, unusually low interest rates and associated credit boom feeding in turn the property and stock markets. As shown in Figure 1.1, the market for US mortgage-backed securities (MBS) increased from $2.5 trillion in 1996 to $8.6 trillion at year-end 2006. The outstanding volume of asset-backed securities (ABS) reached $2.1 trillion at year-end 2006 from $0.4 trillion in 1996.

Following the period of extensive credit origination and its subsequent distribution via securitisation markets, concerns over losses on US subprime mortgage loans and an associated collapse in investor risk appetite triggered broad-based distress in markets for securitised instruments in June 2007. The problems started with subprime mortgage-related instruments, which experienced severe credit quality deterioration as the period of appreciating house prices in the US came to the end. Losses were magnified by increasingly illiquid markets and worsened further with a global loss of confidence following the failure of the investment bank Lehman Brothers in September 2008 and subsequent signs of global recession. As a result, spreads on securitised products soared freezing activities across global securitisation markets.

Figure 1.1 Outstanding US Securitisation 1996-2009



Source: Securities Industry and Financial Markets Association (SIFMA)

Currently securitisation markets remain weak with almost no public placement taking place and the most of new issues being retained by banks and used as collateral in government refinancing operations. However, policy-makers and market practitioners acknowledge the potential benefits of securitisation including credit risk transfer and diversification and attempt to restart securitisation market by introducing changes to the securitisation model in terms of simplicity and standardisation (ECB, 2009).

Further, reflecting the need to strengthen the regulation and supervision of bank securitisation activities raised by the financial crisis, the Basel Committee has recently finalised its proposals for enhancing the Basel II framework in the area of securitisation (2009). Specifically, proposals mainly focus on: (i) higher risk weights to securitisation exposures and, hence, higher minimum capital standards (Pillar I); (ii) addressing the bank's on- and off-balance sheet securitisations within the frameworks of internal capital adequacy assessment process and supervisory review and evaluation process (Pillar II); and (iii) strengthening disclosure requirements with regard to securitisation activities and off-balance sheet vehicles to enhance transparency (Pillar III). These

measures are deemed necessary to revive securitisation; however it will take time to restore the confidence in the market and induce investors to make new investments in securitised products.

1.2 Theoretical Framework for the Research

In general, securitisation can be defined as a structured process whereby a bank transforms its illiquid assets, traditionally held until maturity, into marketable securities. A typical securitisation transaction involves the pooling of homogenous assets with fixed or nearly fixed cash flows and transferring the pool to a special purpose vehicle (SPV), a bankruptcy-remote entity that in turn finances the purchase through the issuance of securities backed by the pool. In the most common case, the SPV employs tranching by issuing securities of different risk, duration, and other characteristics with the senior tranche of investment grade being supported by mezzanine tranches, which in turn are supported by an unrated subordinated equity tranche. This tranching technique enables the SPV to split the credit risk and place it with parties that are willing or best able to absorb it. To ensure high credit rating for asset-backed securities from rating agencies, the SPV obtains credit enhancements, most of which typically come from the originating bank and can be provided in various forms from standby letters of credit to the purchase of the most subordinated securities issued by the SPV.

In theory, the benefits of securitisation from the originating bank's perspective can be substantial. Specifically, by using securitisation, a bank may be able to: (i) diversify its loan portfolio (Pavel and Phillis, 1987); (ii) focus on activities in which it has a comparative advantage (Karaoglu, 2005; Pavel and Phillis, 1987; Thomas, 1999); (iii) finance both ongoing operations and the purchase of new assets (Flannery, 1994; James, 1988; Karaoglu, 2005; Lockwood, Rutherford and Herrera, 1996); (iv) reduce funding costs (Pennacchi, 1988; Rosenthal and Ocampo, 1988); (v) manage credit risk

(Cantor and Rouyer, 2000); and (vi) improve overall performance (Boot and Thakor, 1993; Lockwood, Rutherford and Herrera, 1996; Wolfe, 2000).

However, it has been shown that in practice securitisation might have adverse implications through a number of indirect channels, and these may include: (i) quality of assets securitised and of those retained on the balance sheet, which in turn might be driven by the regulatory capital arbitrage and earnings management motives (Ambrose, LaCour-Little and Sanders, 2005; Dionne and Harchaoui, 2003; Karaoglu, 2005); (ii) contractual and non-contractual credit enhancements, which might result in the originating bank retaining significant interests in the securitised asset pool (Landsman, Peasnell and Shakespeare, 2006; Niu and Richardson, 2006; Standard and Poor's, 2001; Wolfe, 2004); and (iii) post-securitisation lending behaviour in terms of both risk taking and the volume of credit supply (Cebenoyan and Strahan, 2004; Loutskina and Strahan, 2006; Panetta and Pozzolo, 2010; Purnanandam, 2009).

Summarising the previous research, the securitisation process offers substantial economic benefits for originating banks; however the realisation of these benefits will depend on the practical implementation of securitisations and the post-securitisation behaviour of banks. Therefore, the impact of securitisation on banks remains controversial.

1.3 Objectives and Contributions

This research attempts to provide further insights into banks' securitisation activities. It comprises empirical work on securitisation presented in three essays.

The first essay aims to assess whether banks improve their performance through the use of the securitisation market. The study makes two main contributions to the empirical literature on securitisation. First, it examines the impact of accessing the securitisation market on banks' performance in terms of the cost of funding, credit risk,

and overall profitability. Second, it attempts to gauge the impact of securitisation on bank performance by comparing securitising banks with non-securitising banks using a propensity score matching approach. To our knowledge, this methodology has not been employed in the past in this context.

The second essay aims to investigate the impact of securitisation on the credit-risk taking behaviour of banks. Specifically, it attempts to answer the following question: if banks retain significant exposure to the securitised assets through contractual and/or non-contractual arrangements, does the outstanding securitisation representing this exposure affect the credit-risk taking behaviour of the banks? The study makes two main contributions to the literature. First, it examines whether the aggregate outstanding securitisation affects banks' risk-taking behaviour. Second, it investigates whether the effect differs across securitisations of different asset classes.

The third essay aims to examine the relationship between banks' off-balance sheet securitisation structures and insolvency risk focusing on different forms of credit enhancement and liquidity support provided by the banks. Additionally, it attempts to examine the risk effect of credit-enhancing facilities and liquidity commitments provided by banks to securitisation structures of other institutions. The study makes three main contributions to the literature. First, it examines the risk effect of different credit enhancements including credit-enhancing interest-only strips, retained subordinated securities, and standby letters of credit. Second, it analyses additional contractual arrangements such as liquidity support and seller's interest in their effect on the risk of the originating bank. Finally, it examines the risk effects of credit and liquidity support provided by banks to other institutions' securitisation structures.

1.4 Data

For the empirical analysis we use data for US bank holding companies and commercial banks. The data are obtained from the banks' regulatory reports that contain

the complete balance sheet, income statement, and detailed supporting schedules, including a schedule of off-balance sheet securitisation activities. These forms are filed by all US banks on a quarterly basis and have been compiled in a database by the Federal Reserve Bank of Chicago since 1986.

Starting in June 2001, US regulation requires banks to provide more detailed information on their securitisation activities in the reporting forms. Specifically, banks are required to report outstanding securitisation, performance of the securitised assets including past due amounts, charge-offs and recoveries, and credit and liquidity support provided to their own and other institutions' securitisation structures. This securitisation data are to be reported broken down according to the underlying assets into seven categories: 1-4 family residential loans; home equity lines; credit card receivables; auto loans; other consumer loans; commercial and industrial loans; and all other loans, all leases, and all other assets. The introduction of the new securitisation data in the regulatory reports determines year 2001 as the start date for our analyses.

1.5 Empirical Design and Main Findings

In the first essay we evaluate whether banks improve their performance in terms of the cost of funding, credit risk, and profitability through securitisation using US commercial bank data. The sample spans from 2001 to 2008 and contains 9,748 banks including 9,290 non-securitisers and 458 securitisers. We first test the hypotheses using univariate analysis of securitisers and non-securitisers and find that securitising banks tend to be more profitable institutions, with higher credit risk exposure, and higher cost of funding. We then use a propensity score matching analysis to estimate the causal effect of securitisation. To do so, we focus on the sub-sample of non-securitisers and 176 first-time securitisers extracted from the group of securitisers. Applying propensity score matching, we build a control group from the non-securitisers to assess what would have happened to the first-time securitisers had they not securitised. We find that the

first-time securitisers would have had comparable cost of funding, credit risk, and profitability had they remained non-securitising. This leads us to suggest that securitisation does not seem to outperform alternative funding, risk management, and profitability improvement techniques used by non-securitising banks that have *ex-ante* similar characteristics to those securitising.

In the second essay we investigate the impact of securitisation on the credit-risk taking behaviour of banks using US bank holding company data. We use data for bank holding companies rather than for commercial banks because risk and capital management are typically administered at the highest level of the financial group. The sample covers the period from 2001 to 2007 and contains 2,190 banks including 1,960 non-securitisers and 230 securitisers. Applying fixed effects regression analysis on the sub-sample of securitisers, we first find that banks with a greater balance of outstanding securitised assets choose asset portfolios of lower credit risk. Examining securitisations by the type of underlying assets, we find that the negative relationship between outstanding securitisation and risk taking is primarily driven by securitisations of mortgages, home equity lines of credit, and other consumer loans. Securitisations of all other types of assets, on the other hand, seem to have no significant impact on bank credit-risk taking behaviour. We attribute these results to the recourse commonly provided in securitisation transactions, as it might alter the risk-taking appetite of the issuing banks across asset classes. Therefore, we conclude that the net impact of securitisation on the riskiness of issuing banks is ambiguous and will depend on the structure of the transactions. In particular, it will depend on the relative magnitude of credit support provided by banks.

In the third essay we use US bank holding company data to examine (i) the relationship between banks' securitisation structures and insolvency risk focusing on credit and liquidity support provided by these banks in their transactions, and (ii) the risk effect of credit-enhancing facilities and liquidity commitments provided by banks

to securitisation structures of other institutions. The selection procedure determined by the empirical design of the study leaves us with a sample of 194 securitising banks covering the period from 2002 to 2007. Using fixed effects regression analysis, we first find that credit enhancements provided by originating banks in their securitisation structures have a significant positive effect on insolvency risk of these banks. Second, examining credit enhancements by the form of underlying facility, we find that among credit-enhancing interest-only strips, subordinated securities, and standby letters of credit, the latter have the greatest positive association with bank insolvency risk. In contrast, liquidity provisions are found to have a significant risk-reducing effect. Finally, examining credit and liquidity support provided by banks to third-party securitisation structures, we find that credit enhancing third-party securitisations reduces insolvency risk of the banks, while liquidity provisions are found to be highly positively associated with bank insolvency.

1.6 Conclusion

Summarising the main findings, the first essay finds no evidence of significant causal effects of securitisation on performance of banks. In other words, securitising banks would have had comparable cost of funding, credit risk, and profitability had they not securitised. The second essay suggests that outstanding securitisation has a negative impact on the credit-risk taking behaviour of banks. The third essay shows that the interests retained by banks in connection to securitised assets significantly increase their insolvency risk. This result coupled with the finding of the second essay suggests that the net risk transfer for originating banks through securitisation might be ambiguous due to retained interests; however banks do account for the consequently arising exposure reducing credit risk taking. Taken together, the evidence from the conducted research suggests banks predominantly use securitisation for financing purposes rather than as a risk management or performance improvement mechanism.

This work contributes to a deeper understanding of the motives for securitisation and consequent implications for banks and thereby the banking system. It provides findings that are particularly valuable in light of the ongoing policy debate on redesigning the securitisation model and reforming the supervision and regulation of banks' engagement in securitisation activities in response to the recent financial crisis.

1.7 Outline of the Thesis

The remainder of the thesis is organised as follows. Chapter 2 presents background on securitisation. First it provides the market overview including a brief history of its development. It then discusses in detail the securitisation process including the participants and their roles, the mechanics of a securitisation transaction, the benefits offered to the major parties in the transaction, and the risks inherent in securitisation.

Chapter 3 reviews the relevant literature on securitisation. Specifically, it organises the literature in three strands. The first strand examines the motives for securitisation, analyses its potential benefits, and examines its effects. The second strand relates to the motives for and implications of credit enhancements in securitisation. The third strand investigates the impact of securitisation on bank lending behaviour in terms of risk taking and the volume of loan supply.

Chapters 4, 5, and 6 contain the empirical analysis of the thesis presented in three essays. Specifically, Chapter 4 presents the first essay on securitisation and bank performance. The study attempts to evaluate whether banks improve their performance in terms of the cost of funding, credit risk, and profitability through the use of the securitisation market.

Chapter 5 presents the second essay on securitisation and credit risk taking. The study aims to investigate the impact of securitisation on the credit-risk taking behaviour

of banks and to examine whether the impact differs across securitisations of different asset classes.

Chapter 6 presents the third essay on securitisation and bank insolvency. The study attempts to empirically examine the relationship between banks' off-balance sheet securitisation structures and insolvency risk focusing on different forms of credit enhancement and liquidity support provided by the banks. Additionally, it examines the risk effect of credit and liquidity support provided by banks to securitisation structures of other institutions.

Finally, Chapter 7 concludes the thesis. It summarises the main findings of the three studies, discusses the contribution of the conducted analysis, and suggests scope for future research.

2 BACKGROUND ON SECURITISATION

2.1 Definition and a Brief History of Securitisation

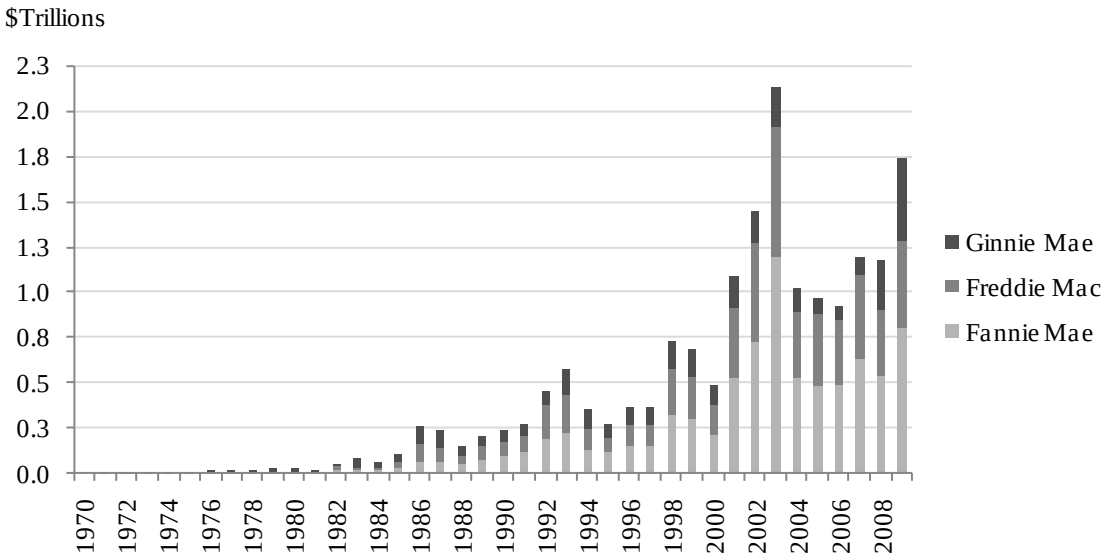
In general, securitisation can be defined as a structured process whereby homogenous financial assets are packaged, underwritten, and sold in the form of asset-backed securities. This structured finance technique allows credit originators to manage credit and concentration risks, diversify funding sources, reduce funding costs, and improve performance indicators.

Securitisation began in the 1970s with the structured financing of mortgage loans by a US government-sponsored agency, the Government National Mortgage Association (Ginnie Mae). As a result, investors were offered a new type of bond – a mortgage pass-through that passes the principal and the interest payments on mortgages to the holders of the security. Ginnie Mae was followed by private corporations chartered by the federal government, the Federal Home Loan Mortgage Corporation (Freddie Mac) and the Federal National Mortgage Association (Fannie Mae), which issued mortgage-backed securities in the early 1980s. These government-sponsored enterprises were to increase homeownership in the US by fostering secondary mortgage market. The guarantees provided by the government assured investors of the payment of principal and interest on the securities backed by mortgages and thereby promoted the growth of the agency securitisation (see Figure 2.1).

Government agencies and government-sponsored enterprises remained the main issuers in the market until the 1990s when other financial and non-financial institutions entered the market issuing mortgage-backed securities that in many cases deviated from the conforming structure of the government-sponsored securitisations. While the first private mortgage pass-through backed by conventional loans was issued by Bank of America in 1977, other institutions showed little interest in the area until the 1990s. However, from 2000 the issuance of private mortgage securitisation steadily ascended

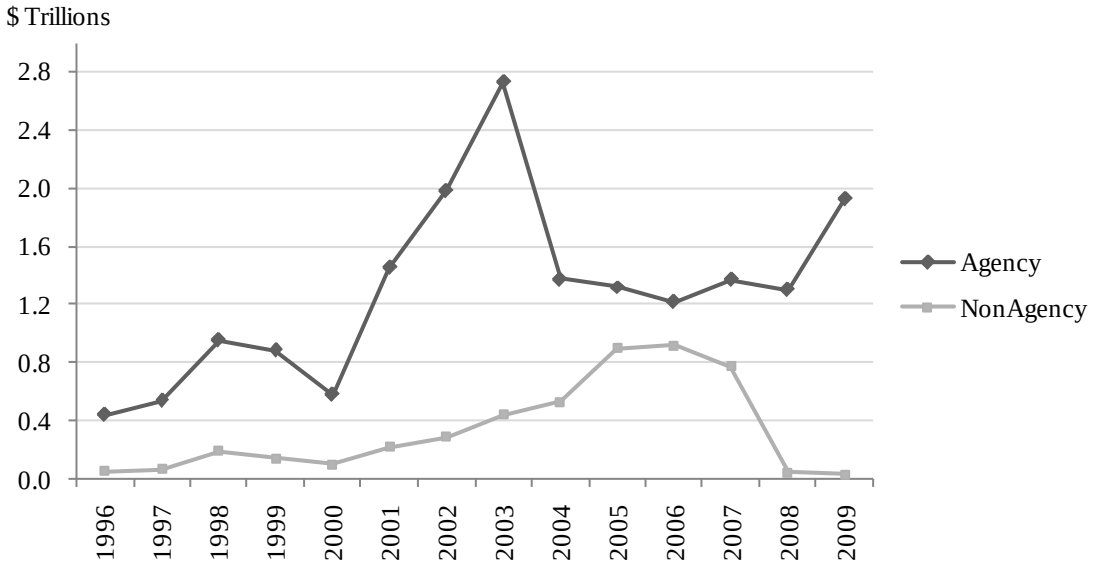
up until the onset of the financial crisis in 2007 closely reaching the agency issuance around year 2006 (see Figure 2.2).

Figure 2.1 US Agency Mortgage-Backed Securities Issuance 1970-2009



Source: Securities Industry and Financial Markets Association (SIFMA)

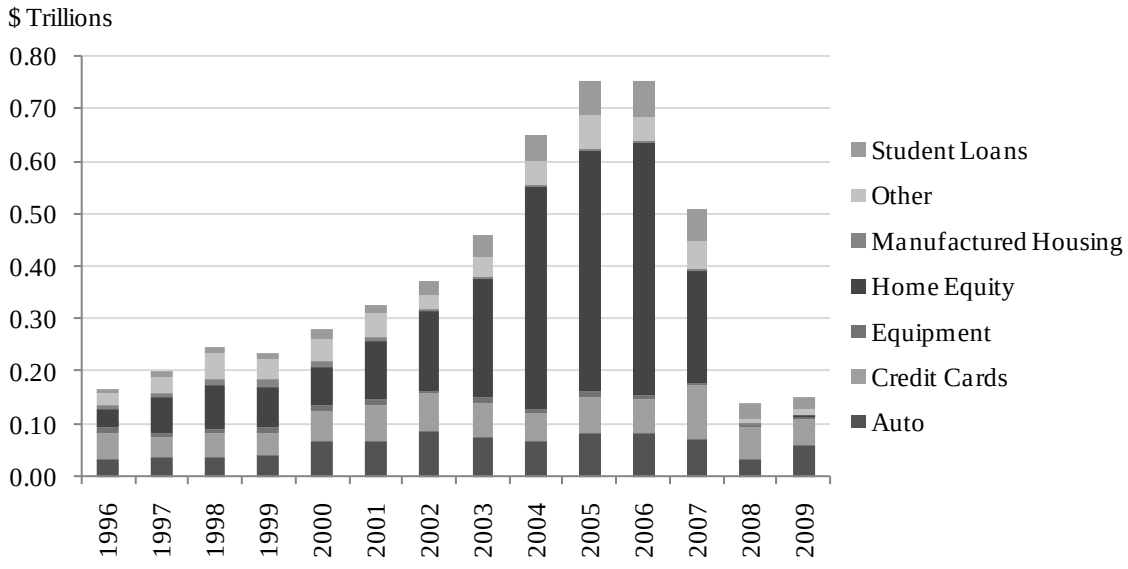
Figure 2.2 US Mortgage-Related Securities Issuance 1996-2009



Source: Securities Industry and Financial Markets Association (SIFMA)

As for asset-backed securitisation, the first transaction dates to 1985 and was backed by automobile loans, the most straightforward type of collateral due to the relatively short maturities of the loans that made the timing of cash flows more predictable and their statistical histories of performance that gave investors confidence. Auto loan securities were followed by the first issuance of credit card securities in 1986 which was the cornerstone of the asset-backed securitisation due to the revolving nature of credit card debt and related complications in structuring the transaction. Since then, the process and the structure of securitisation have evolved significantly, including the development of private credit enhancements such as over-collateralisation, third-party and structural enhancements. This expanded the list of securitised assets from three in 1985 to twenty three by 1996 including non-consumer loans and financial securities (Murray, 2001) and fostered the growth of the asset-backed securities issuance (see Figure 2.3).

Figure 2.3 US Asset-Backed Securities Issuance 1996-2009



Source: Securities Industry and Financial Markets Association (SIFMA)

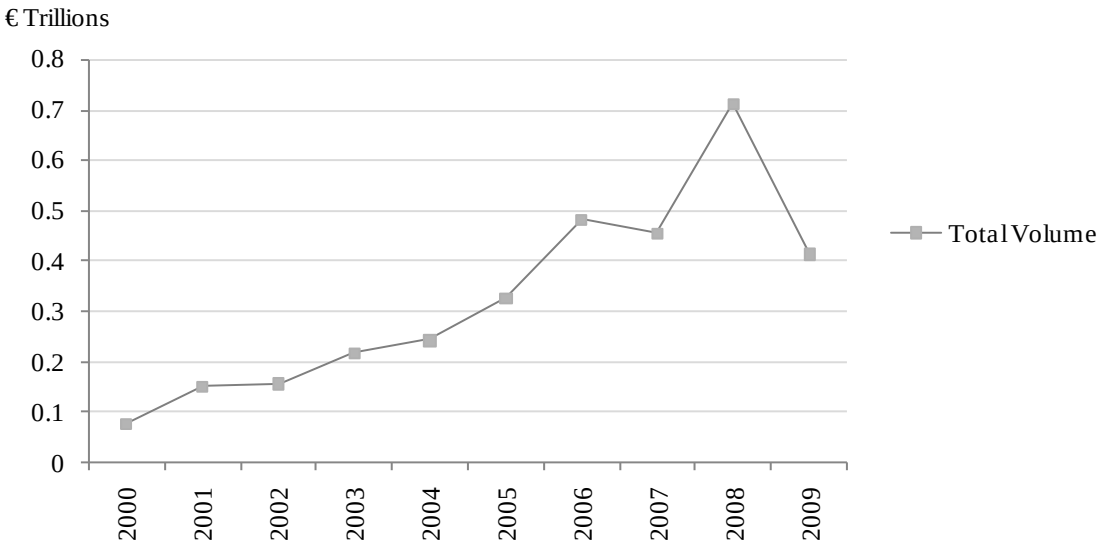
As a whole, the US securitisation market experienced a tremendous growth from the mid-1990s and up until the financial crisis of 2007-2009. The market for mortgage-backed securities (MBS) increased from $2.49 trillion in 1996 to $9.19 trillion outstanding at year-end 2009. The outstanding volume of asset-backed securities (ABS) reached $2.43 trillion at year-end 2009 from $0.4 trillion in 1996 (see Figure 1.1 on page 2). Along with the size, the market remarkably expanded in terms of the types of securitised assets, the issuing firms, and the investor base.

In contrast to the US securitisation market, the development of the European securitisation market started at the end of the 1990s and was triggered not by government agencies, but the increased demand from institutional investors, technological and financial innovation, and the introduction of euro (Altunbas, Gambacorta and Marques-Ibanez, 2009).

The EU market experienced a strong issuance growth from 2001 onwards (see Figure 2.4). The outstanding volume of mortgage-backed securities reached €1.21 trillion at year-end 2008, while €0.19 trillion for asset-backed securities (Securities Industry and Financial Markets Association (SIFMA)). However, as shown in Figure 2.5, the use of securitisation remains heterogeneous across European countries with the UK dominating the market.

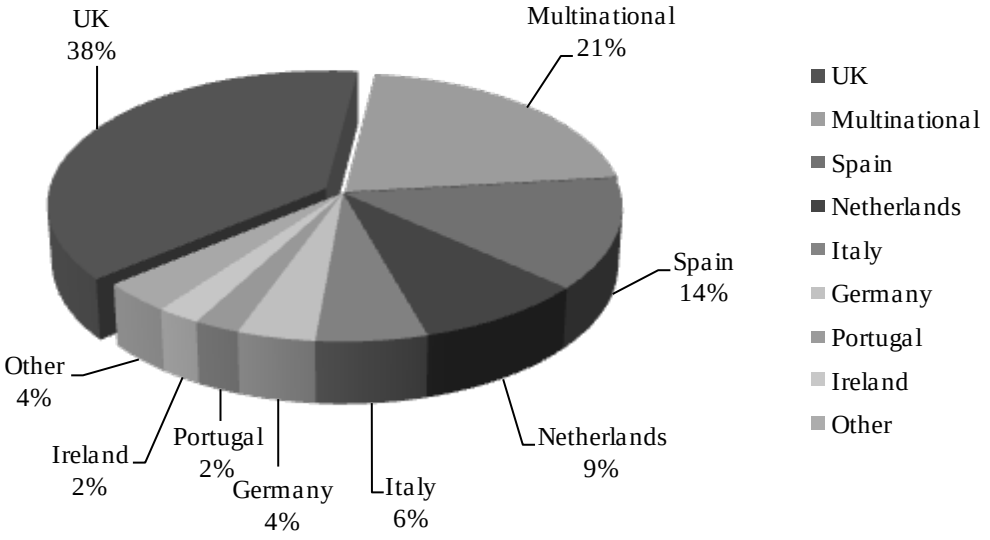
After the extended period of growth, global securitisation markets collapsed during the financial crisis of 2007-2009, where securitisation was named as one of the primary causes of the credit market turmoil. Reflecting the generalised loss of investor confidence, most of the issuance from the mid-2007 onwards has been in the US agency sector and in European securitisations used for refinancing activities with the European Central Bank.

Figure 2.4 European Total Securitisation Issuance 2000-2009



Source: Securities Industry and Financial Markets Association (SIFMA)

Figure 2.5 European Total Securitisation Issuance by Country in 2007



Source: European Securitisation Forum
Note: Multinational includes deals in which assets are originated from a variety of jurisdictions.

The development of securitisation over the past three decades has had a remarkable impact on the world financial system. It has modified the functioning of the banking markets from the traditional "originate-to-hold" model to the "originate-to-distribute" model, thereby significantly increasing the reliance of financial intermediaries on the capital market as a source of finance. Despite the weaknesses in the securitisation process revealed by the crisis, policy-makers as well as market practitioners acknowledge the potential of securitisation in credit risk transfer and diversification and attempt to revive securitisation by increasing transparency in the market and introducing standardisation and simplicity of transactions.

2.2 Securitisation Process

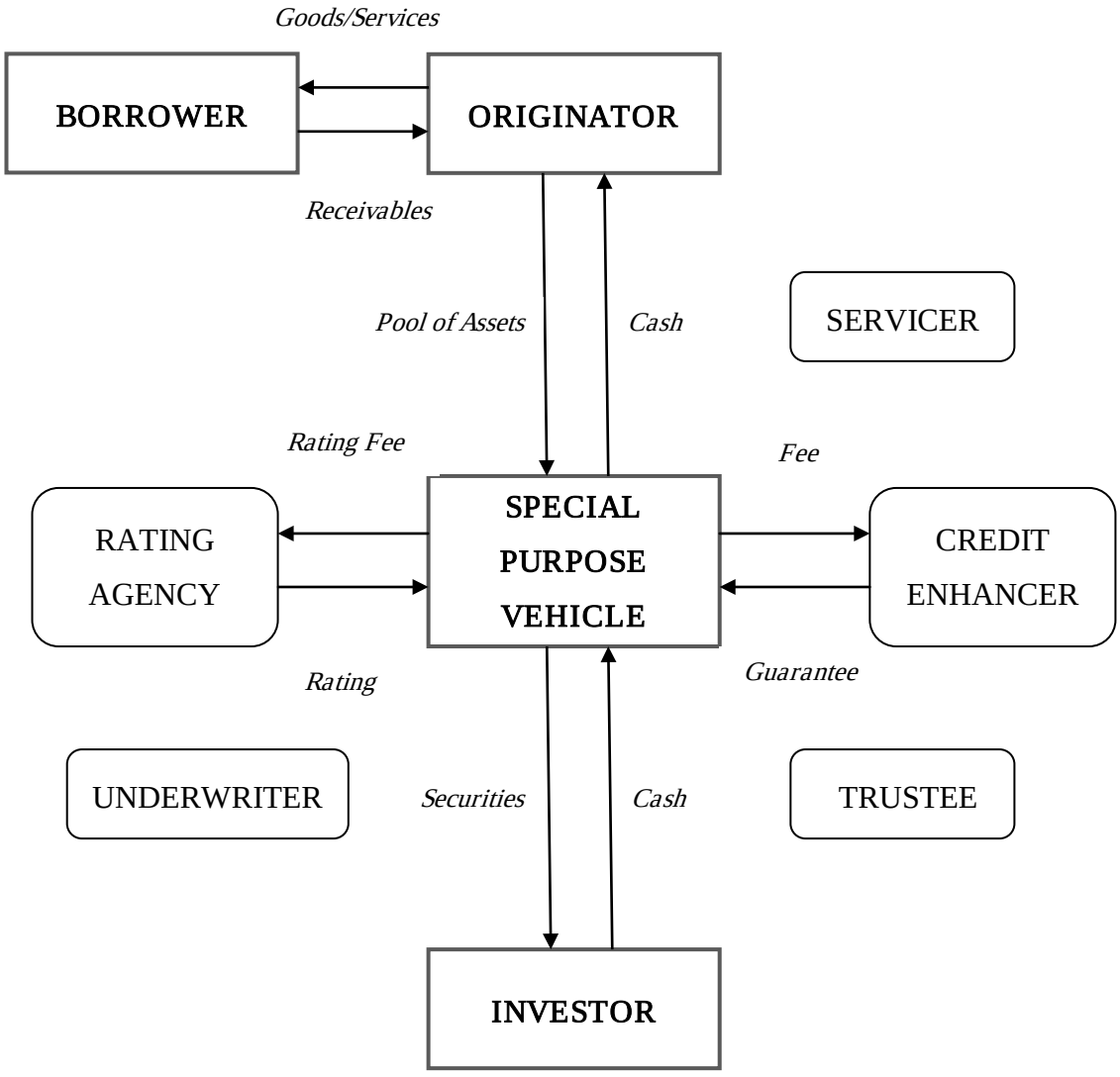
2.2.1 Participants and their Roles

A typical securitisation transaction involves the pooling of assets with fixed or nearly fixed cash flows that are then transferred to a special purpose vehicle (SPV), a bankruptcy-remote entity that in turn finances the purchase through the issuance of securities backed by the pool. This process involves a number of participants: borrower, originator, servicer, special purpose vehicle, credit enhancer, underwriter, trustee, and investor (see Figure 2.6).

Borrower

The borrower is the originator's debtor whose debt is transferred to the SPV; the customer relationship between the borrower and the originator is usually maintained as the former does not realise that his/her loans have been sold. As the borrower is responsible for the payment on the loan underlying the securitisation transaction, his/her credit standing determines the ultimate performance of the asset-backed securities.

Figure 2.6 Securitisation Transaction



Originator

The originator is an entity that creates the assets to be securitised. Originators may include finance companies, commercial banks, insurance companies, computer companies, airlines, manufacturers, etc.

Servicer

The servicer is an agent that collects regular payments on the underlying assets and transfers the proceeds to the special purpose vehicle. This servicing function is typically retained by the originator for a fixed servicing fee.

Special Purpose Vehicle

The special purpose vehicle (SPV) is a bankruptcy-remote entity set up by the originator for the specific purpose of the securitisation(s).

Trustee

The trustee is a third party retained for a fee to administer the trust that holds the underlying assets supporting asset-backed securities and is primarily concerned with preserving the rights of the investor. Generally, the trustee monitors the compliance by all the parties to the transaction with the pooling and servicing agreement and oversees the allocation of cash flows as prescribed by the agreement. The trustee is also responsible for reviewing periodic information on the performance of the underlying asset pool received from the originator/servicer and for declaring an event of default or amortisation based on the observed pool performance indicators.

Credit Enhancer

The credit enhancer is a third party that provides guarantees protecting investors in the event that cash flows from the underlying assets are insufficient to pay in a timely

manner the interest and principal due for the securities. This third-party credit support is used to improve the credit rating and thereby the pricing and marketability of the securities, which requires the credit enhancer to have a rating at least as high as the rating sought for the securities. Therefore, third-party credit enhancement is often provided by a highly rated bank or insurance company.

Rating Agency

The rating agency performs a critical role in the process - evaluating the credit quality of the transaction. The credit rating for the asset-backed securities assigned by the agency depends on the quality of underlying assets, the strength of the originator/servicer, the soundness of the structure, and the extent of provided credit and liquidity support.

Underwriter

The underwriter in the securitisation transaction is responsible for advising the originator on the structure of the asset-backed securities as well as the pricing and marketing them to investors.

Investor

The investors in asset-backed securities may include individual and institutional investors; the largest investors are typically fund managers, pension funds, insurance companies, and commercial banks.

2.2.2 Securitisation Mechanics

The primary difference between securitisation and loan sales is the structuring process. Before loan pools can be transformed into securities, they must be pooled and structured to modify the risks and returns to the investors. The structure of a transaction is governed by the terms of a pooling and servicing agreement, which is the main contractual document between the originator and the trustee.

The structuring process includes five major stages: (i) segregating the assets from the originator; (ii) creating a special purpose vehicle and transferring the asset pool to be securitised to the SPV; (iii) credit enhancing the asset pool; (iv) issuing securities backed by the pool; and (v) allocating cash flows.

2.2.2.1 Segregating the Assets

In the first stage of the process, the originator designates the accounts' receivables to be sold to the SPV so that to create a portfolio whose performance is consistent with the target quality of the sought securities. To do so, it first determines which accounts will be "designated" as those from which receivables may be included in the pool. The selection criteria might include the default performance, geographic location, maturity date, size of the credit, or age of the account relationship. It then selects the accounts' receivables to be securitised either on a random basis, in order to create selections that are representative of the total portfolio, or on an inclusive basis, so that all qualifying receivables are sold.[1]

2.2.2.2 Creating a Special Purpose Vehicle and Transferring the Assets

In the second stage, the originator creates a special purpose vehicle for the single purpose of holding the transferred underlying assets and the subsequent issuance of

[1] In a random selection, the originator determines how many accounts are needed to meet the target value of the securities; then the accounts are selected randomly.

asset-backed securities. The legal form of the SPV may be a limited partnership, a limited liability company, a trust, or a corporation. Typically, the SPV is thinly capitalised; it has no independent management or employees; the administrative functions are performed by the trustee and the assets are serviced via a servicing arrangement; and finally, the legal structure of the SPV eliminates bankruptcy.[2]

Having created an SPV, the originator transfers the designated assets onto the SPV's balance sheet. The transfer of assets must be in form of a "true sale", where the transferor (i.e., the originator) surrenders control over the financial assets and can, therefore, remove the assets from its balance sheet. This true sale condition serves as a protection of the SPV's and eventually investors' rights on the cash flows generated by the underlying receivables in the case of the originator's bankruptcy.

2.2.2.3 Credit-Enhancing the Asset Pool

In the third stage, the SPV obtains credit enhancements in order to reduce credit risk for investors, thereby increasing the credit rating of asset-backed securities. The nature and the amount of contractual credit enhancements required to obtain a specific credit rating for asset-backed securities are determined by the rating agency and underwriter depending on characteristics of underlying assets.[3] These credit enhancements may take different forms and can be provided internally, externally, or a combination of both; revolving loan securitisation also incorporate early amortisation triggers as additional investor credit risk protection.

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[2] See Gorton and Souleles (2005) for a discussion of special purpose vehicles.

[3] The expected performance of a specified pool of assets is typically based on credit scores, credit limits, outstanding balances, underwriting and collection practices, geographic diversification, historic performance, and the structure of the transaction. The ratings are assigned to each class in the series based on the credit quality of the pool of assets, the type of credit enhancement, and the structure of the series (FDIC, 2007).

Internal Credit Enhancements

Internal contractual credit enhancements are those generated by the cash flows from the underlying assets, by the structure of the transaction, and those provided by the originating bank. Examples of internal contractual arrangements include excess spread, spread accounts, subordinated securities, over-collateralisation, and standby letters of credit; liquidity provisions might also serve as a credit-enhancing facility if they provide credit support to the structure.

Excess Spread

Excess spread is a general feature of securitisation structures as the yield on the underlying loan portfolio for a given month generally exceeds the expenses of the SPV including the interest paid on the asset-backed securities, servicing costs, and expected losses. The excess spread is typically held on the originator's balance sheet in the form of interest-only (IO) strips. IO strips represent, in effect, the present value of the future expected income that the bank expects to receive on the securitised assets. The accounting requirement for recording the IO strip typically results in a gain on the sale of the sold assets since the originating bank is allowed to recognise future expected cash flows at the time of the sale. This gain in turn is recognised as income, thereby increasing the bank's capital position (FDIC, 2007).

IO strip is defined as credit-enhancing (CE IO) if it provides credit support to the securitisation structure, that is, its value declines with credit losses on underlying assets. In other words, CE IO strips are subordinated securities with no principal that receive the interest at a strip rate over time and are recorded as "other assets" on the originator's balance sheet and as "credit-enhancing interest-only strips" on the off-balance sheet securitisation schedule.

Subordinated Securities

Securitisations typically have a senior/subordinated or the so called tranched structure, where the senior tranche of investment grade is supported by mezzanine tranches, which in turn are supported by an unrated subordinated equity tranche. The latter is the most risky tranche of the securitisation transaction as it absorbs first losses and is commonly held by the originating bank as retained interest in the structure.[4]

In securitisation structures with both CE IO strips (which are present in every structure) and retained subordinated securities, typically the subordinated securities bear losses after the CE IO strips are exhausted.

Seller's Interest

Another form of credit enhancing the securitised pool is over-collateralisation; this represents bank's ownership interest, or the so called seller's interest, in the SPV's assets that has not been securitised and is, therefore, not pledged to back the issued securities. The principal amount of the seller's interest in a structure is defined as the total principal amount of assets included in the securitisation structure less the principal amount of assets attributable to investors in the form of issued securities. The size of the seller's interest is determined by the rating agency and is to ensure that there will be sufficient assets available to support the issued asset-backed securities.[5] Seller's interest can be held in the form of loans and/or securities, reported accordingly on the originator's balance sheet.

In respect of subordination, the holders of asset-backed securities and the holder of the seller's interest have the same priority on claims on the underlying assets; charge-

[4] The retained subordinated assets are reflected as "other assets" on the bank's balance sheet.

[5] Seller's interest absorbs fluctuations in the outstanding principal balances of the designated accounts. It is also available to ensure that sufficient assets exist following non-cash deductions in balances (dilution) due to charge reversals, such as merchandise returns, disputes, and fraudulent charges (FDIC, 2007).

offs are typically shared pro-rata between the seller's interest and the investors' securities (FDIC, 2007).

Liquidity Facility

Liquidity facility represents any arrangement, including servicer cash advances, in which the issuing entity is obliged to provide funding to the securitisation structure to ensure investors of timely payments on asset-backed securities or to ensure investors of payments in the event of market disruptions.

Typically, advances under liquidity facility are reimbursed from subsequent collections from the securitisation structure and are not subordinated to other claims on the cash flows from the underlying assets and, therefore, should generally not be construed as a form of credit enhancement. However, if the advances under such a facility are subordinated to other claims on the cash flows, the facility constitutes a credit enhancement (FDIC, 2010).

Standby Letter of Credit

A letter of credit provided to a securitisation structure presents an unfunded commitment that guarantees limited protection against losses, typically catastrophic losses, on the underlying assets. Issuers of letters of credit are obliged to honour demands for payment up to the specified amount. The latter is normally set at a fixed percentage of the asset-backed securities and is usually determined by the perceived credit risk in the underlying assets.

Implicit Recourse

Implicit recourse presents a non-contractual credit enhancement that originating institutions tend to provide in securitisation structures, the so called implicit recourse to the originator. The provision of implicit recourse violates the "true sale" requirement; however, it allows originators to maintain their reputation in the securitisation market for repeated sales.

From the regulatory perspective, recourse in securitisation would require the originator to hold capital against the entire amount of assets transferred. Therefore, implicit recourse in securitisation provides scope for regulatory capital arbitrage and is, consequently, of paramount concern for regulators. In an attempt to control implicit recourse practices, the Office of the Comptroller of the Currency issued a practical guidance, OCC Guidance 2002-20, "Interagency Guidance on Implicit Recourse in Asset Securitisations" (OCC, 2002). The document states that "banking organisations typically have provided implicit recourse in situations where the originating organisation perceived that the failure to provide this support, even though not contractually required, would damage its future access to the asset-backed securities market".

According to the OCC guidance, implicit recourse might include the originator: (i) selling assets to the SPV at a discount from the price specified in the securitisation documents; (ii) purchasing assets from the SPV at an amount greater than fair value; (iii) exchanging performing assets for non-performing assets in the SPV; and (iv) funding credit enhancements beyond contractual requirements.[6]

[6] For a discussion of implicit recourse also see Gorton and Souleles (2005), Higgins and Mason (2004), Vermilyea, Webb and Kish (2008).

External Credit Enhancements

External credit enhancements presents credit support provided to the securitisation structure by other institutions and may include a third-party letter of credit, cash collateral account, and surety bonds.

Third-Party Letter of Credit

A third-party letter of credit is similar to the standby letter of credit discussed earlier except that it is provided by a third-party institution. The advantage the external letter of credit is the additional analysis of the transaction by the third-party credit-enhancement provider, while the downside is the risk that issued asset-backed securities will be downgraded when the provider of the letter of credit is downgraded.

Cash Collateral Account

Cash collateral account presents a segregated trust account typically funded by a loan from a third-party bank at the issuance of the asset-backed securities. Cash collateral account is used to cover shortfalls in interest, principal, or servicing expenses if the excess spread falls below zero. The size of the loan is determined by the rating agency depending on the credit ratings sought for the securities; the loan is generally priced using a specified index plus a fixed spread and is subordinated in the repayment to the issued asset-backed securities.

Surety Bond

Finally, a surety bond is a guarantee issued by a third party, usually a highly rated mono-line insurance company. Surety bonds typically guarantee the principal and interest payments for specified asset-backed securities tranches. The premium paid to the surety bond issuer is determined by its perceived credit risk in the underlying assets

and is offset by the lower interest rate paid to the investors holding the insured securities tranches.

Early Amortisation Protection

In addition to the common credit enhancement techniques, revolving securitisations, as those backed by credit card receivables or home equity lines of credit, also use early amortisation triggers as a form of investor credit protection.

Early amortisation allows accelerating the repayment of investors' principal payments ahead of the scheduled maturity if the performance of the asset pool deteriorates. Early amortisation triggers are typically defined in the pooling and servicing agreement and may include events as: (i) the average excess spread for three preceding months below the required monthly amount; (ii) the seller's interest below a specified required amount; (iii) failure of the originator, servicer, or the credit enhancer to perform as required by the pooling and servicing agreement (OCC, 1997). In the accelerated repayment period following an early amortisation event, the investors' share of all principal collections is returned immediately as it is received by the SPV. This allows protecting the investors from prolonged exposure to deteriorating performance of the underlying assets or the default of the servicer.

In general, securitisation structures may contain any of the credit-enhancing facilities discussed above. The choice is typically determined by the costs and market placement factors. Aside from the coupon rate paid to investors, the cost of credit enhancements tends to be the largest expense. As a result, originating banks are constantly trying to minimise the costs associated with providing credit protection, which might be achieved through a greater reliance on the internally provided enhancements. This, in effect, may result in the banks retaining significant credit risk exposure in connection to the securitised portfolios through both explicit and implicit arrangements.

2.2.2.4 Issuing Interest in the Asset Pool

In the fourth stage, the SPV issues asset-backed securities. In the most common case, the securities are issued in tranches of different risk, duration, and other characteristics with the senior tranche of investment grade being supported by mezzanine tranches, which in turn are supported by an unrated subordinated equity tranche. The latter is the most risky tranche of the securitisation transaction and is commonly retained by the originating bank on its balance sheet. This tranching technique enables the SPV to split the credit risk and place it with parties that are willing or best able to absorb it.

2.2.2.5 Cash Flow Allocation

Finally, the last stage of the securitisation process includes allocation of the cash flows received from the securitised assets among the holders of asset-backed securities. The payment distribution depends on the type of issued securities, which is in turn determined by the nature of underlying loans.

Pass-Through Securities

The payment distribution for securities backed by instalment loans ("pass through" securities) is closely tied to the cash flows of the underlying loans. Specifically, the interest on the pass-through securities is paid monthly, while the principal included in each payment depends on the amortisation schedule and prepayment rate of the underlying loans.

Pay-Through Securities

The payment distribution for securities backed by revolving loans such as credit cards and home equity lines of credit ("pay through" securities) has two phases: (i) revolving period, and (ii) amortisation period.

During the revolving phase, monthly interest payments on the underlying assets are used to pay the SPV's expenses including interest payments on the asset-backed securities, while the principal collections are used to purchase new receivables generated in the designated accounts or to purchase a portion of the seller's interest. In the following amortisation phase, the principal collections are used to pay down the outstanding principal amount of the asset-backed securities.

2.3 Benefits

Securitisation offers substantial benefits to each of the major parties in the transaction, which explains the growth of the market over the past two decades.

For Originators

Securitisation provides financial institutions with a means to: (i) reduce regulatory capital requirements by transferring originated assets off the balance sheet; (ii) obtain an additional source of funding; (iii) lower the cost of funding as the issued asset-backed securities are typically assigned a higher credit rating than that of the originator; (iv) diversify portfolio by reducing firm-specific exposure, sectoral and geographic concentrations; (v) improve credit risk management by shifting the credit risk of the originated assets to external credit enhancers and investors; and (vi) enhance financial ratios as a result of the above and the fee income received for continuing loan origination and the commonly retained servicing function.

For Investors

Investors benefit from asset-backed securities issued in securitisation as they: (i) offer higher yields compared to other financial instruments of a similar credit quality[7] and generally better credit risk protection by means of credit enhancements; (ii) provide

[7] Higher yields are offered as a compensation for a possible prepayment risk and restricted secondary market for these securities.

a measure of flexibility as the payment streams can be structured to meet an investor's particular requirements; and (iii) release investors from the need to gain a detailed understanding of the underlying assets as a result of structural credit enhancements and diversified asset pools. These features of asset-backed securities meet the requirements of pension funds, insurance companies, and other institutional investors for safe fixed-income securities with specific payment stream and attractive yields and, therefore, boost institutional investor demand.

For Borrowers

Securitisation also benefits borrowers by: (i) increasing credit supply as a result of lenders being able to raise additional capital for new loans via the market; (ii) reducing borrowing expense, that is, the capital raised by lenders via the market typically has a lower cost which, in turn, can be passed onto the borrowers in the form of lower interest rates; and (iii) increasing availability of credit on terms that lenders may not have provided had they kept the loans on their balance sheets. As an example for the latter, the existence of securitisation markets may allow lenders to extend fixed rate debt preferred by many borrowers over variable rate debt without exposing themselves to interest rate risk.

2.4 Risks

Realisation of the benefits offered by securitisation requires prudent management of the risks inherent in the process. The risks arising for a bank from securitisation and their levels depend on the roles the bank plays in the transaction and the quality of assets it originates and/or services.

The primary risks associated with bank securitisation activities are identical to those that banks face in their lending activities and include credit risk, liquidity risk, capital risk, and reputation risk.

2.4.1 Credit Risk

Credit risk arises from the borrowers' failures to repay their debts. Securitisation structures are designed to reduce the credit risk of the originator by transferring the unexpected portion of the default risk to credit enhancers and investors. However, the originator typically retains exposure to the securitised pool through credit-enhancing interest-only strips (CE IO), retained subordinated securities, or other types of credit enhancement. As the pool performance deteriorates and charge-offs increase, excess spread and, thus, the value of the CE IO strip decline. Once the excess spread is exhausted, the risks of credit default then shift to the other credit enhancements, including those retained by the bank, such as subordinated securities. Therefore, the originator bears, in effect, a significant portion of the default risk of the securitised assets.

In addition, poor credit quality and performance of the asset pool may limit the bank's future access to the securitisation market, affecting the terms of subsequent issues or impacting costs from alternative funding sources. Therefore, to maintain its reputation with the market, the originator may be prone to securitise better quality assets while retaining lower quality assets on the balance sheet, the process often referred to as "cherry-picking".[8] Further, the originator often retains an additional degree of credit risk in the form implicit recourse. This may result in the originator absorbing more losses or providing credit enhancements beyond the contractual requirements.

Finally, credit risk exposure can arise from providing credit enhancements to third-party securitisations. Credit enhancing third-party securitisations exposes a bank to the credit risk of loans it did not originate and, therefore, requires a thorough understanding of the transaction structure and the underwriting policies.

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[8] Selecting receivables of higher or the highest quality for securitisation.

2.4.2 Liquidity Risk

Liquidity risk arises from a bank's inability to manage unplanned changes in funding sources or in meeting its obligations without incurring significant losses. While securitisation can provide a bank with an attractive alternative funding source, significant reliance on securitisation may increase liquidity risk.

The primary liquidity risk arises from the possibility that the securitised asset pool may require balance sheet funding at unexpected times; in revolving securitisations this arises from the possible return of receivables to the balance sheet as a result of early amortisation. The second concern is the risk of a bank not being able to sell new receivables and the need to fund them on-balance sheet. Finally, liquidity risk may arise from the bank's failure to recognise changes in market conditions that may impact its ability to liquidate assets quickly and with minimal loss.

2.4.3 Capital Risk

Capital risk arises from the possibility that the bank's capital may be insufficient to absorb or protect against losses arising from credit and other factors. This implies having sufficient capital to: (i) possibly fund new receivables if access to the securitisation market is hindered; (ii) withstand additional costs associated with funding in poor market conditions; and (iii) support unplanned balance sheet growth related to a complete withdrawal from the securitisation market.

2.4.4 Reputation Risk

Reputation risk is the risk to liquidity, earnings, and capital arising from negative market perception. The reputation of a bank in a securitisation market is of great importance and depends mainly on the quality of the underlying receivables and the efficiency at which the bank can service those receivables. Poorly performing assets or

servicing failures on existing securitisations may increase the costs and decrease the profitability of future transactions.

2.5 Summary

To summarise, securitisation presents a complex structured process involving transactions among participants with diverse incentives. Banks may engage in securitisation through a wide range of activities realising the benefits provided to each of the roles in the process. They may act as an originator of the assets to be securitised, as a servicing agent, and as a credit enhancer in their own securitisation structures. Banks may also engage in third-party securitisations acting as a trustee, as a provider of credit enhancement or liquidity support, as an underwriter of the issue, or as an investor in asset-backed securities.

However, engagement in securitisation activities also exposes banks to substantial risks and, if not implemented prudentially, might create significant financial problems for banks and consequently lead to widespread problems in the financial sector as has been shown by the recent market turmoil. Therefore, it is crucial to fully understand and evaluate the risks inherent in the process and manage them adequately while gaining from the benefits offered by securitisation.

3 LITERATURE REVIEW

There are three main strands in the literature on securitisation that are related to our research. The first strand examines the motives for securitisation, analyses and examines its effects. The second strand relates to the motives for and implications of credit enhancements in securitisations. The third strand investigates the impact of securitisation on bank lending behaviour including risk taking and the volume of loan supply.

3.1 Motivation for Securitisation

The research on motivations for securitisations can be divided into two distinct streams. The first stream examines the economic reasons behind securitisation decision such as diversification, financing, and risk management. The second stream relates to the securitisation motives emerging from the accounting treatment of transactions and includes regulatory capital arbitrage and earnings management.

3.1.1 Economic Motivations

Previous studies have found evidence indicating that firms securitise assets to: (i) diversify portfolio; (ii) focus on activities in which they have comparative advantages; (iii) finance both ongoing operations and the purchase of new assets; (iv) reduce funding costs; (v) improve performance indicators; and (vi) manage credit risk.

3.1.1.1 Diversification

Evidence supporting the diversification motive is found in an early study by Pavel and Phillis (1987). Using US commercial bank data for 1983-1985, the authors find that undiversified banks are more likely to sell or securitise loans. Specifically, the results show that the average sample bank has a 61.1 per cent probability of selling loans, and this probability would rise by more than 7 percentage points if the bank's level of

diversification decreases by one standard deviation. The authors also find evidence to suggest that loan sales did increase the diversification of the sample banks.

3.1.1.2 Comparative Advantage

Thomas (1999) suggests that banks may have a comparative advantage in originating and servicing loans relative to funding and may prefer to outsource, on an ongoing basis, the activity of comparative disadvantage while maintaining the origination and possibly servicing functions. Consistently, Pavel and Phillis (1987) and Karaoglu (2005) find that US banks are more likely to sell loans if they are more efficient in loan origination as suggested by their lower ratio of non-interest expense to total loans. Pavel and Phillis also find that a bank's comparative advantage in originating and servicing loans has the largest impact on determining the amount of loans that the bank decides to sell.

3.1.1.3 Financing

Michalak and Uhde (2009) find evidence to suggest that securitisation is predominantly used by banks as a source of funding; the study uses data on cash and synthetic securitisation transactions by European banks between 1997 and 2007. Based on the analysis of collateralised loan obligation (CLO) transactions by European banks from 1997 to 2004, Bannier and Haensel (2007) in turn suggest that securitisation is an appropriate funding tool for banks with high risk and low liquidity.

Using US bank holding company data for 1997-2000, Karaoglu (2005) finds that banks that sell or securitise loans tend to have a higher loan-to-deposit ratio, higher growth expectations (measured by the market-to-book ratio), and stronger motives to avoid underinvestment problem (measured by the interaction between the market-to-book ratio and debt-to-equity ratio). The role of securitisation in mitigating the

underinvestment problem of financial intermediaries is also suggested by James (1988), Flannery (1994), and Lockwood, Rutherford and Herrera (1996).

Pais (2005) empirically examines the financing hypothesis for the use of securitisation against the comparative advantage hypothesis. The analysis based on a sample of UK banks for 1990-1997 provides evidence in support of the financing hypothesis; that is, the use of securitisation by banks is driven by their financing needs rather than by a loss of their comparative advantage in performing the intermediary role.

Evidence supporting the financing hypothesis is also found in Minton, Sanders and Strahan (2004). The authors hypothesise that financial firms facing greater financial distress, for example those with high leverage and risky assets, should be more active in securitisation that other firms; further, banks and savings institutions ought to be less likely to securitise assets as they can borrow without bearing any financial distress costs due to government deposit insurance. Testing the hypotheses on US financial company data for 1993-2002, they find supporting evidence indicating that unregulated finance companies and investment banks are more likely to securitise than banks and that risky and highly leveraged financial institutions are more likely to engage in securitisation than the safer ones; at the same time, highly leveraged banks are found to be less likely to securitise than the better capitalised banks.

3.1.1.4 Cost of Funding

Pennacchi (1988) suggests that funding through loan sales is less expensive for banks compared with traditional equity or deposit financing as it avoids costs associated with required capital and reserves. Rosenthal and Ocampo (1988) argue that securitisation offers banks a way of lowering their cost of funding by separating the credit risk of securitised assets from the risk of the originating firm. Consistently, Gorton and Souleles (2005) suggest that securitisation reduces financing costs as the off-balance sheet debt issued via a special purpose vehicle does not include a premium

reflecting expected bankruptcy costs due to its legal isolation. Further, as suggested by Minton, Sanders and Strahan (2004), securitisation of low-risk assets may be less costly compared to the securitisation of riskier assets as the latter are harder for outside investors to value and are, therefore, more likely to be discounted due to the lemons problem (Akerlof, 1970).

3.1.1.5 Profitability

Theoretical work by Boot and Thakor (1993) shows that, in the presence of asymmetric information, pooling assets and issuing multiple financial claims with different risk characteristics against the pool cash flow enables the issuer to increase its expected revenue. Lockwood, Rutherford and Herrera (1996) note that the cash inflow from asset-backed securities issuance can be used to retire existing debt which in turn reduces interest expense and increases reported earnings. In a theoretical analysis, Wolfe (2000) shows that the establishment of an asset-backed securitisation pipeline will enable banks to improve their return on capital if they: (i) can securitise any asset they originate obtaining a fair market value; (ii) face capital adequacy requirements; (iii) face fixed rate deposit insurance premiums; and, finally, (iv) are concerned with the risk of insolvency.

Empirical evidence consistent with the profitability-enhancing motive for securitisation is found by Bannier and Haensel (2007); in a study of collateralised loan obligation (CLO) transactions by European banks from 1997 to 2004, the authors find that lowly performing banks are more likely to engage in securitisation. Consistently, Pais (2005) finds that poor performing institutions are more likely to engage in securitisation using a sample of UK banks for the period between 1990 to 1997. Affinito and Tagliaferri (2010) also find that less profitable institutions are more likely to securitise assets analysing Italian bank data for the pre-crisis period from 2000 to 2006;

they also find evidence to suggest that, once securitised, banks seem to reach higher profits.

3.1.1.6 Risk Management

Evidence supporting the credit risk transfer motive for securitisation is found in Pais (2005), Bannier and Haensel (2007), and Affinito and Tagliaferri (2010). Using UK, European, and Italian bank data, respectively, the studies find that banks with higher credit risk exposure are more likely to securitise their loans.

However, using Moody's analytical approach for securitisation, Cantor and Rouyer (2000) show that the credit risk position of the originator will improve if the riskiness of the securities sold to investors is higher than that of the originator prior to the securitisation; otherwise, the transaction might intensify the originator's net exposure to the default risk of its assets. The authors conclude that in many cases, due to the structure of transactions, the transfer of credit risk through securitisation is relatively insignificant in comparison to the other risks retained by the lender.

Empirical evidence on the efficiency of securitisation in risk transfer is controversial. Cebenoyan and Strahan (2004) investigate whether active management of credit risk exposure through loan sales market leads to lower risk. The study examines US commercial bank data for the 1988-1993 period and uses risk measures based on profits (time-series standard deviation of a bank's return on equity and return on assets) and loan losses (time-series standard deviation of a bank's loan loss provisions to total loans and of non-performing loans to total loans). The empirical results indicate a strong relationship between activities in the loan sales market and the profit–risk measures; however, the effect depends on the controls for capital structure and lending. Specifically, the results show that without the controls, banks active in risk management via loan sales market exhibit higher risk exposure than other banks; when controlling for capital structure and lending activities, these banks are found to be safer than their

peers, banks that have similar capital structures and loan portfolios but do not manage credit risk through loan sales market. The authors, therefore, conclude that active management of credit risk exposure through loan sales market does lead to lower risk; however, banks seem to use the achieved risk reduction to take on new risks.

Evidence consistent with the risk-reducing effect of securitisation is found by Jiangli and Pritsker (2008); using data on US bank holding companies from 2001 to 2007, the study estimates the effect of securitisation on bank insolvency risk measured by a time deposit premium. The study employs three different methodologies: the first approach assesses what would happen if securitisers had to take their securitised assets back on the balance sheet; the second approach compares average performance of banks that securitise with those of comparable size but not securitising; the final approach uses instrumental variable regression. The evidence from the three methodologies used is fairly consistent suggesting that mortgage securitisation reduces bank insolvency risk. Overall, the authors suggest a positive role for mortgage securitisation and attribute the turmoil in mortgage credit and securitisation markets during the recent crisis to excesses in those markets.

Other studies have found contradictory evidence on the risk effect of securitisation. In particular, Dionne and Harchaoui (2003) investigate the relationship between securitisation and credit risk estimating a system of equations on a sample of Canadian banks for the period between 1988 and 1998. Using two alternative credit risk measures, provisions for uncoverable loans to total assets and total risk-weighted assets to total assets, they find evidence indicating that securitisation activity tends to increase bank risk.

Consistent results are found by Michalak and Uhde (2009). Using a sample of 743 securitisations issued by 55 stock listed European banks over the period from 1997 to 2007, they find that credit risk securitisation has a negative impact on the financial

stability of banks measured by a z-score. Further, investigating the impact of credit risk securitisation on single components of the z-score measure, they find a positive impact of securitisation on bank leverage and return volatility and a negative relationship between securitisation and profitability.

Further, Krahnen and Wilde (2006) show that, under certain assumptions about bank reinvestment behaviour and capital structure choice, the issuance of collateralised debt obligations (CDOs) in true sale transactions can lead in theory to an increase in the issuing intermediary's systematic risk. Consistently, Franke and Krahnen (2005) suggest that expanding the loan business through securitisation should increase the granularity of a bank's loan portfolio and, therefore, expose the bank relatively more to the macroeconomic risks than to idiosyncratic risks. They hypothesise that, given a strong correlation between credit spreads and the market return, the issuance of securitisation and reinvestment of proceeds in new loans should raise the bank's systematic risk measured by stock beta. They find supporting evidence using event study methodology on a data set 75 collateralised debt obligations issued by 27 European banks in 2003.

Haensel and Krahnen (2007) find supporting empirical evidence examining the systematic risk effect of credit securitisation on a data set of 178 ABS-transactions undertaken by European banks in the period between 1997 and 2004. Using event study methodology on the ABS-issue announcements, they find that credit securitisation tends to increase the systematic risk of the issuing bank measured by equity beta. The evidence also suggests that the beta-increasing effect of securitisations is more prevalent for large financial institutions that engage repeatedly in securitisations.[9] Further, in a cross-sectional analysis, the authors find that the issuer's beta rises significantly more if the bank is financially weak and is domiciled in a bank-based financial system.

[9] The authors suggest that this may be because these large financial institutions are more likely to systematically alter their loan portfolio as a consequence of their access to the capital market.

3.1.2 Accounting-Based Motivations

The second type of motivation for securitisation is associated with the sale treatment of the transfer of financial assets. The sale accounting treatment of securitisations provides a means to reduce regulatory capital, a process often referred to as regulatory capital arbitrage, and to manage reported earnings. Research has provided evidence supporting each of these motivations.

3.1.2.1 Regulatory Capital Arbitrage

Jones (2000) defines regulatory capital arbitrage as a process where banks reduce their regulatory capital with little or no corresponding reduction in their overall economic risk and argues that securitisation and other financial innovations of recent years have provided banks with unprecedented opportunities to do so. Jones argues that regulatory capital arbitrage is driven by significant divergences between underlying economic risk and measures of risk embodied in regulatory capital ratios, which allows unbundling and repackaging of portfolio risks so to reduce the effective capital requirement per unit of economic risk pertained by a bank.

Calomiris and Mason (2004) empirically examine the regulatory capital arbitrage motivation for securitisation. Using US credit card bank data for 1996-2000, they find evidence to suggest that securitisation with implicit recourse provides an important means of avoiding minimum capital requirement. Further, Calomiris and Mason examine two views of the motivation for regulatory arbitrage, “safety net abuse” and “efficient contracting”, by analysing characteristics of securitising banks and their capital structure. They find that securitising banks tend to maintain their capital adequately with the market perception of their asset risk while in excess of their minimum regulatory requirements. The authors find this behaviour of securitising banks to be more consistent with the efficient contracting rather than with the safety net abuse view of securitisation with implicit recourse.

Using data on Canadian banks for the period between 1988 and 1998, Dionne and Harchaoui (2003) find evidence to suggest that regulation might encourage banks to hold more risky assets and to securitise their lower risk assets. Supporting the results of Dionne and Harchaoui (2003), Ambrose, LaCour-Little and Sanders (2005) find that, in response to regulatory capital incentives, lenders tend to retain riskier loans in their portfolios while selling safer loans to the secondary market. In particular, using data on US mortgage loans originated from 1995 and 1997 and observed through 2000, the authors find that securitised loans experienced lower *ex-post* defaults that those retained in banks' portfolios.

Contradictory evidence is found by Carey (1998); this study shows that the default rates on the loans kept by the originator are lower than the default rates on the loans sold to investors. Similarly, studies by Keys, Mukherjee, Seru and Vig (2010) and Mian and Sufi (2009) find evidence to suggest that in the last decade US banks securitised their worst mortgage loans.

In conclusion, Jones (2000) suggests that regulatory capital arbitrage is not the only incentive to engage in securitisation and that a bank will also securitise to benefit from increased economies of scale, to reduce the costs of debt financing, and to diversify funding sources. Pavel and Phillis (1987) also find that the regulatory motivation is dominated by the comparative advantage in originating and servicing loans and by the level of sophistication of banks in their decision to sell loans. Finally, Bannier and Haensel (2007) and Minton, Sanders and Strahan (2004) find evidence to undermine the view that securitisation market is driven by regulatory arbitrage and to support the efficient contracting hypothesis.

3.1.2.2 Earnings Management

Karaoglu (2005) examines whether banks use securitisations to manage earnings using US bank holding company data for 1997-2000. He finds that banks tend to use gains from loan transfers to influence reported earnings. Specifically, the evidence suggests that banks do so by choosing which loans to securitise and by biasing the estimated fair vales of retained interests. In addition, the use of securitisations for financial statement management is found to be positively associated with the degree of managerial discretion in financial reporting.

Consistently, Dechow, Myers and Shakespeare (2010) find evidence to suggest that managers use the discretion afforded under fair value accounting rules to manage reported securitisation gains. Specifically, using data for a broad range of industries and examining the period from 2000 to 2005, they find that firms are more likely to report larger securitisation gains when pre-securitisation income is low or below the level of the previous year. Further, Dechow, Myers and Shakespeare examine the discount rate used by firms to determine the fair value of the retained interests as a means of earnings management through securitisation. They find that the sample firms use lower discount rates when reporting securitisation losses compared to securitisation gains; this allows increasing the fair value of retained interests and thereby reducing securitisation losses.

In addition, Dechow and Shakespeare (2009) argue that managers have incentives to time their securitisations in order to maximise the window-dressing benefits offered by the securitisation accounting rules such as reducing leverage, increasing profits, and improving efficiency ratios. Consistent with this view, the authors find, for a sample of securitisations undertaken between 1987 and 2005, that transactions occur with greater frequency in the last few days of each month and in the last few days of each quarter.

3.2 Credit Enhancements

Other studies have analysed the motives for credit enhancements in securitisations and consequent implications for originators' performance.

3.2.1 Motives for Credit Enhancements

In a theoretical work, Pennacchi (1988) shows that banks' ability to sell loans is constrained by a moral hazard problem that arises from the banks having less incentive to efficiently monitor and service loans after they have been sold; however, banks can mitigate this problem through an incentive-efficient loan sales contract, and, therefore, maximise their loan sales volume and hence profitability.

Consistent with this view, Gorton and Pennacchi (1995) consider two possible features of bank loan sales which could reduce the moral hazard problem, in particular: (i) offering an implicit guarantee on the value of the loan, and (ii) retaining a portion of the loan on the bank's balance sheet. The authors argue that in these cases a bank retains some of the default risk of loans and, therefore, there still remains an incentive for the bank to screen and monitor borrowers. The theoretical model of the study suggests that: (i) banks will sell larger proportions of loans if they face greater internal funding cost as this is the direct cost of funding the retained loans; (ii) they will retain a greater proportion of more risky loans as for these loans the provision of bank credit services is more vital and loan buyers demand higher default premium; (iii) in addition, as the implicit guarantee substitutes the retention of a loan fraction as a means of committing to efficient credit screening, the lower the quality of this guarantee, or the higher the bank's insolvency probability, the greater the proportion of loans that the bank needs to retain. Gorton and Pennacchi test the model using a sample of over 800 US loan sales. The obtained empirical evidence strongly supports the model's proposition that a bank will retain a greater proportion of more risky loans, those with higher equilibrium loan sale yield. As a whole, the evidence suggests that a loan selling bank must retain a

portion of loans to convince the buyers of its commitment to the credit screening of the borrowers.

Further, Gorton and Souleles (2005) show, in a theoretical analysis, that an originator's ability to finance off-balance sheet via the debt of an SPV critically depends on the implicit guarantee contract between the originator and investors. The authors examine this by empirically testing the hypothesis that investors incorporate the risk of the originator's strength in pricing the debt of the SPV. Using a data set of credit card securitisation issues between 1988 and 1999, they find that the spread on the issued asset-backed securities does reflect the originator's ability to provide implicit recourse captured by the originator's senior unsecured bond rating.

Finally, Fender and Mitchell (2009a) theoretically examine the power of different contractual mechanisms to influence an originator's effort to screen borrowers when the originator plans to securitise the loans. The authors consider three potential mechanisms: (i) holding a "vertical slice" (i.e., share of the portfolio without subordinated features); (ii) holding an equity tranche of a structured transaction; and (iii) holding a mezzanine tranche. The results suggest that the screening effort associated with the contractual mechanisms depends on the realisation of a systematic factor. In particular, the equity tranche can be dominated by either a vertical slice or a mezzanine tranche if the probability of a downturn is likely and if the equity tranche is likely to be exhausted in a downturn. A vertical slice may dominate either the equity tranche or the mezzanine tranche; however, it is unlikely that a vertical slice will dominate both of these alternatives unless the vertical slice is very thick. Fender and Mitchell also note that if the choice of the magnitude and the form of retained interests is left to the originator, the retention mechanism chosen may well lead to suboptimal screening effort.

3.2.2 Implications of Credit Enhancements

It is argued in Standard and Poor's (2001) that if an originating firm retains a subordinated piece of a securitisation or a level of recourse close to the expected level of loss, essentially all of the economic risk remains with the firm.

Wolfe (2004) particularly highlights the importance of an equity tranche, referred to as “equity toxic waste”, due to the fact that all the default risk of the issue is absorbed by this tranche, and emphasises the need to ensure that banks treat the equity tranche in compliance with regulatory requirements and truly transfer credit risk when disposing of this unrated component of the transaction. Using a sample of 103 US credit card bank observations for years 1996 and 2000, Calomiris and Mason (2004) find that in credit card securitisations risk remains with securitising banks as a result of provided implicit guarantees.

Further, Niu and Richardson (2006) find evidence consistent with the perception that originating banks retain most of the risk related to the transfer of assets. In particular, they examine 535 securitisation disclosures of US originators from 1997 to 2003 and show that off-balance sheet debt related to securitisation has, on average, the same risk-relevance for explaining market measures of risk as on-balance sheet debt. This evidence supports the view that securitisations present, in substance, secured borrowings rather than sales and suggests that investors view off-balance sheet liabilities to be equivalent to the on-balance sheet leverage. Niu and Richardson also show the economically significant differences in leverage ratios arising from the sale accounting treatment of securitisations as opposed to secured borrowing treatment. Specifically, they find that the average outstanding amount of transferred receivables minus the related credit enhancements (retained interests) is about 4.3 times the market value of equity of the transferors. In other words, for their sample, the mean debt-to-equity ratio of 5.9 reported using sale accounting would have increased to 10.2 had the

transferors accounted for the transfers as secured borrowing. They also find that the association between securitisation gains and stock returns is lower for firms with a greater off-balance sheet securitisation volume; this suggests that investors assign lower valuation to securitisation-related earnings for firms with a higher perceived level of off-balance sheet risk.

Consistent evidence is found in Landsman, Peasnell and Shakespeare (2006). Examining securitisation disclosures of 112 US firms over the 2000-2004 period, the authors find that the market views the SPV's assets and liabilities as belonging to the originator. The study also examines whether the amount of interest retained in securitisation transactions affects the market's perception of the degree to which risk has been transferred to the SPV. The results show that the market does view securitisation transactions by originating firms with relatively high and low amounts of retained interest differently. In particular, whereas the market views asset securitisations with low retained interest as sales (i.e., risk transfer has taken place), asset securitisations with high retained interest are viewed as secured borrowings (i.e., risk transfer is incomplete).

Chen, Liu and Ryan (2008) examine characteristics of loan securitisations that determine the extent to which banks retain the risks of the off-balance sheet securitised loans. Using US bank holding company data for 2001-2006 in a risk-association analysis, the authors find that banks retain more risk in connection to securitised assets when: (i) the types of loans have larger and/or less externally verifiable credit risk; (ii) the loans are closed-ended and banks retain larger contractual interest in the loans; and (iii) the loans are closed-ended and banks retain types of contractual interests that more strongly concentrate the risk of the securitised loans.

Further, Standard and Poor's (2001) discusses the implicit or “moral” recourse, defining it as a moral obligation of the originator to support a troubled securitisation without legal requirement to do so, and argues that institutions that depend on securitisation as a funding source may be especially prone to providing this form of support.

Chen, Liu and Ryan (2008) find that banks have more incentive and ability to provide implicit recourse in revolving loan securitisations, such as credit card securitisations; the magnitude and type of retained contractual interests in these securitisations are found to be not risk-relevant. Similarly, Higgins and Mason (2004) highlight the importance of implicit recourse in credit card securitisations; the authors argue that providing implicit recourse in credit card securitisations allows banks to maintain their reputation for consistent credit quality over repeated securitisations while still taking advantage of removing assets off the balance sheet. Consistent with this view, Gorton and Souleles (2005) find that implicit recourse exists for the entire amount of transferred assets, especially for frequent securitisers concerned about their reputation with investors.

Vermilyea, Webb and Kish (2008) are first to develop a model of implicit recourse in securitisations. The model is based on the assumption that fraud losses on securitised assets are generally incurred by the originating bank, while credit losses are potentially borne by the owner of the securitised assets, that is, by the SPV and thus potentially by the ABS investors. Testing the model on US commercial bank data for 2001-2006, the authors find that banks that securitise credit card receivables are more likely to claim fraud losses and that banks with poorly performing securitisation portfolios are more likely to claim fraud.

Beneficial effects of implicit recourse are found in Higgins and Mason (2004). The study investigates the effects of the recourse to the originator by examining originators' short and long-term stock returns, long-term operating performance, and subsequent terms of securitisation using credit card securitisation data for 17 discrete recourse events that took place during the 1990s. The results suggest that recourse to securitised debt may benefit short- and long-term stock returns and long-term operating performance of originators. However, it appears that originators may face abnormal post-recourse delays before returning to the securitisation market, which the authors find to be similar to the commercial paper market.

3.3 Lending Behaviour

Other studies have analysed the impact of securitisation on bank lending behaviour in terms of risk taking and credit supply.

3.3.1 Risk Taking

Cebenoyan and Strahan (2004) suggest that banks use the risk reduction achieved through securitisation to engage in more profitable, but higher risk activities and to operate with greater financial leverage. The authors conclude that the benefit of advances in risk management in banking may be greater credit availability rather than reduced risk in the banking system.

Consistently, Dell'Ariccia, Igan and Laeven (2009) find that banks' increased ability to securitise loans appears to have affected lending standards. Using US individual mortgage loan application data for the period from 2000 to 2006, the authors find that in geographical areas with a greater proportion of originated loans being sold within one year from origination denial rates are lower. The evidence suggests that, during the period from 2000 to 2003, this effect is more pronounced for the prime mortgage market than the subprime market; however, during the period from 2004 to

2006, when securitisation of subprime loans increased dramatically, the effect becomes more pronounced for the subprime mortgage market. Securitisation also appears to have favoured the expansion of overall credit with a positive and significant effect of securitisation rates at the geographical level on the loan-to-income ratio of originated loans. This evidence partially supports the view that securitisation provides lenders with incentives to extend riskier loans.

Consistent evidence is found by Panetta and Pozzolo (2010). Using a sample of 12,830 banks from 140 countries that originated issues of asset-backed securities, mortgage-backed securities, collateralised loan obligations, or collateralised debt obligations in the period between 1991 and 2007, the study finds evidence to suggest that banks securitise to modify their asset portfolios, taking up riskier profit opportunities.

Purnanandam (2009) finds that, during the period from 2006 to 2008, US banks used the proceeds from securitisations to issue loans with higher than average default risk. The evidence shows that banks that participated in the originate-to-distribute mortgage market to a larger extent before the 2007 subprime crisis had significantly higher mortgage charge-offs after the crisis. The author concludes that the lack of screening incentives coupled with leverage-induced risk-taking behaviour significantly contributed to the sub-prime mortgage crisis.

3.3.2 Credit Supply

Goderis, Marsh, Vall Castello and Wagner (2006) find evidence to suggest that engagement in securitisation significantly increases banks' loan supply. Using data on 161 collateralised loan obligations issued by 64 banks between 1995 and 2004, they find that banks that adopt advanced credit risk management techniques experience a permanent increase in their target loan levels of around 50 per cent. The authors note

that equity capital would have to increase by around 60 per cent to have a similar impact on the target loan levels.

Hirtle (2008) also finds that greater use of credit risk transfer (CRT) techniques is associated with an increase in bank credit supply; however the author suggests that the impact of the growth of CRT might be narrow and primarily affect the terms of lending rather than the volume. In particular, using a data set of commercial and industrial loans originated by a sample of US commercial banks between 1997 and 2006, he finds evidence that as banks obtain additional credit risk protection through credit derivatives, they increase the supply of large term loans (newly negotiated loans to large corporate borrowers); however not for previously negotiated commitment lending.

Using US commercial bank data for 1976-2003, Loutskina (2005) also finds evidence to suggest that, by providing banks with an additional source of funding, securitisation increases banks' willingness to supply loans across sectors; in particular, banks' ability to securitise liquid mortgages tends to increase their willingness to supply illiquid business loans. The evidence also indicates that securitisation makes bank lending less sensitive to cost of fund shocks and, therefore, weakens the link from the monetary policy to bank lending.

Using European securitisation data for 1999-2005, Altunbas, Gambacorta and Marques-Ibanez (2009) also find that securitisation has strengthened the capacity of banks to supply new loans by providing banks with a source of additional funding and capital relief; however, this capacity is found to change over time and to depend on the business cycles and the banks' risk position. Consistent with Loutskina (2005), Altunbas, Gambacorta and Marques-Ibanez suggest that asset securitisation reduces the efficacy of monetary policy via the bank lending channel.

Finally, a study by Loutskina and Strahan (2006) shows that securitisation reduces the impact of bank financial condition on credit supply. Using data on US mortgage applications and originations from 1992 to 2003, the authors find that low-cost funding and increased balance-sheet liquidity from securitisation raise banks' willingness to approve hard-to-sell mortgage loan applications (the so called jumbo mortgages), while having no impact on their willingness to approve easy-to-sell mortgages. Consistent with Altunbas, Gambacorta and Marques-Ibanez (2009) and Loutskina (2005), Loutskina and Strahan (2006) conclude that, by extension, securitisation has weakened the link from bank funding conditions to credit supply in aggregate, thereby mitigating the real effects of monetary policy.

3.4 Summary of the Literature and Motivation for the Research

To summarise, previous research provides evidence that securitisations are undertaken to provide economic benefits. Specifically, it has been shown that by using securitisation a bank may be able to diversify its portfolio, to focus on activities of its comparative advantage, to raise funding, and to reduce funding costs, to better manage credit risk, and to improve performance. However, it has also been shown that in practice securitisation might have adverse implications for bank performance through a number of indirect channels, and these may include: (i) quality of assets securitised and of those retained on the balance sheet, which in turn might be driven by the regulatory capital arbitrage and earnings management motives; (ii) credit enhancement, which might result in the bank retaining significant interests in the securitised asset pool; and (iii) post-securitisation lending behaviour in terms of both risk taking and the volume of credit supply. Therefore, the previous research suggests that the net impact of securitisation might be ambiguous.

This research provides further insights into banks' securitisation activities and makes a valuable contribution to the existing literature on securitisation by addressing issues that have not been studied previously. Specifically, the first essay attempts to assess whether banks improve their performance in terms of the cost of funding, credit risk, and profitability through the use of the securitisation market. The second essay attempts to answer the following question: if banks retain significant exposure to the securitised assets through contractual and/or non-contractual arrangements, does the outstanding securitisation representing this exposure affect the credit-risk taking behaviour of the banks? Finally, the third essay attempts to empirically examine the relationship between banks' off-balance sheet securitisation activities and insolvency risk analysing different forms of credit enhancement and liquidity support provided by the banks to their own and third-party securitisation structures.

4 ESSAY I: SECURITISATION AND BANK PERFORMANCE

4.1 Introduction

In theory, the benefits of accessing the securitisation market from the originating bank's perspective can be substantial. By using securitisation, a bank may be able to: (i) lower its cost of funding; (ii) improve risk management; and (iii) increase profitability. However, the key to the realisation of these potential benefits of securitisation lies in the quality of the underlying receivables, which in turn is directly related to the underwriting and credit risk management employed. Therefore, in practice securitisation might have both positive and adverse implications for bank performance.

Specifically, for the cost of funding, securitisation allows banks to borrow funds from capital markets at a lower cost as the securities issued via an SPV can have a higher credit rating than that of the originator. This stems from the fact that the credit rating assigned to these securities by a rating agency is independent of the credit risk of the originating bank and is based on the expected performance of the underlying asset pool and provided credit enhancements (Rosenthal and Ocampo, 1988). Further, having established itself in the securitisation market, a bank has a broader choice of funding sources and can choose the best option based on the all-in-cost comparison (OCC, 1997). However, poorly performing receivables may hinder the bank's access to the market, require higher credit risk enhancements to achieve investment grade ratings and, therefore, considerably increase the cost of this funding source. Plus, continuing reliance on securitisations for raising funds may result in a bank outgrowing other funding alternatives, such as traditional borrowing facilities, and, therefore, present significant liquidity issues if this funding source becomes unavailable (FDIC, 2007).

Further, securitisation allows banks to reduce credit exposure by transferring the unexpected portion of the default risk to credit enhancers and outside investors (OCC,

1997; Rosenthal and Ocampo, 1988).[10] However, management's incentive to ensure the performance of the securitised pool may result in "cherry-picking"[11] when designing the securitisation transaction or providing implicit recourse during the lifetime of the structure (Gorton and Souleles, 2005; Higgins and Mason, 2004; Vermilyea, Webb and Kish, 2008). Securitisation may also trigger lax origination and monitoring processes (Diamond, 1984; Gorton and Pennacchi, 1995; Keys, Mukherjee, Seru and Vig, 2010). This could eventually lead to a lower quality balance sheet and higher default rates on loans in future.

Finally, securitisation enables banks to increase profitability through a number of channels including a better choice of funding sources and risk management discussed above. Further, in terms of operating choices, securitisation allows a bank to outsource, on an ongoing basis, activities of comparative disadvantage, e.g., funding, while maintaining activities of comparative advantage, e.g., origination and possibly servicing (Karaoglu, 2005; Lockwood, Rutherford and Herrera, 1996; Pavel and Phillis, 1987). Plus, retaining the servicing function on the transferred assets allows the originating bank to enhance fee income (FDIC, 2007). Furthermore, the additional capital released through securitisation can be used by a bank for expansion purposes or to retire existing debt, which in turn might increase earnings (OCC, 1997).

Therefore, the net impact of securitisation remains ambiguous and needs to be investigated empirically. Using US commercial banking data from 2001 to 2008, in this study we attempt to assess whether individual banks improve their performance in terms of cost of funding, credit risk, and profitability through the use of the securitisation market. We estimate the causal effect of securitisation on bank performance by applying a propensity score matching approach, which allows us to build the counterfactual and

[10] The expected losses of the portfolio absorbed by the equity tranche are typically borne by the originator.
[11] Selecting receivables of higher or the highest quality for securitisation.

evaluate the performance of securitising banks had they not securitised. Specifically, we look at the change in the performance of first-time securitisers to capture the effect of securitisation. If securitisation has a positive impact on bank performance, this should improve once banks start to securitise.

This study makes two main contributions to the empirical literature on securitisation. First, we examine the impact of accessing the securitisation market on banks' performance in terms of the cost of funding, risk, and overall profitability. Second, we attempt to gauge the impact of securitisation on bank performance by comparing securitising banks with non-securitising banks using a propensity score matching approach. To our knowledge, this methodology has not been employed in the past in this context. Additionally, we conduct this analysis using a comprehensive and updated data set that includes the latest available data on US commercial banks.

The results of the univariate analysis first show that securitising banks tend to be more profitable institutions, with higher credit risk exposure, and a higher cost of funding than non-securitising banks. However, the propensity score matching analysis does not provide evidence to suggest that securitisation had a beneficial impact upon bank performance. We find instead that, for non-securitising banks that have similar *ex-ante* characteristics to securitising banks, alternative forms of funding and the use of other profit-enhancing techniques had a similar impact upon performance. Therefore the results presented in this study show that, as well as leading to an increase in systemic risk, securitisation seems not to have improved the performance of individual banks compared to adequately matched non-securitising banks in the lead up to the crisis; rather it allowed the banks to maintain their risky and more profitable activities.

The rest of this essay is organised as follows: Section 4.2 discusses methodological issues in estimating the effects of securitisation on bank performance and describes the design of the study used to address these issues; Section 4.3 provides

theoretical background to the propensity score matching approach employed for the analysis; Section 4.4 presents the data and preliminary univariate analysis; Section 4.5 presents the practical implementation of the propensity score matching approach; Section 4.6 presents the results of the propensity score matching analysis; finally, Section 4.7 discusses the findings and concludes the essay.

4.2 Methodological Issues in Estimating Securitisation Effects

The analysis of the effects of securitisation on bank performance involves several methodological issues. First, comparing securitising banks with non-securitisers might yield biased estimates of the securitisation effect if the difference in performance comes from other observable or unobservable characteristics of the banks, rather than the securitisation status. Therefore, if securitisers are found to perform better, on average, than non-securitisers, the difference may be due to the effect of having accessed the securitisation market or due to differences in bank characteristics prior to securitisation. Second, considering securitising banks only eliminates the possibility of a hypothetical benchmark, that is, the performance that banks would have had had they not securitised. Furthermore, the observed change in performance might be due to unobservable shocks affecting all banks equally.

In this study, we focus on first-time securitisers in an attempt to assess the securitisation effect on bank performance. To understand the logic underlying the analysis conducted in this paper, consider the following three types of banks:

(i) “securitisers”, i.e., banks that have at least one securitisation transaction conducted at the beginning of the observation period;

(ii) “non-securitisers”, i.e., banks that never engage in securitisation throughout the period; and

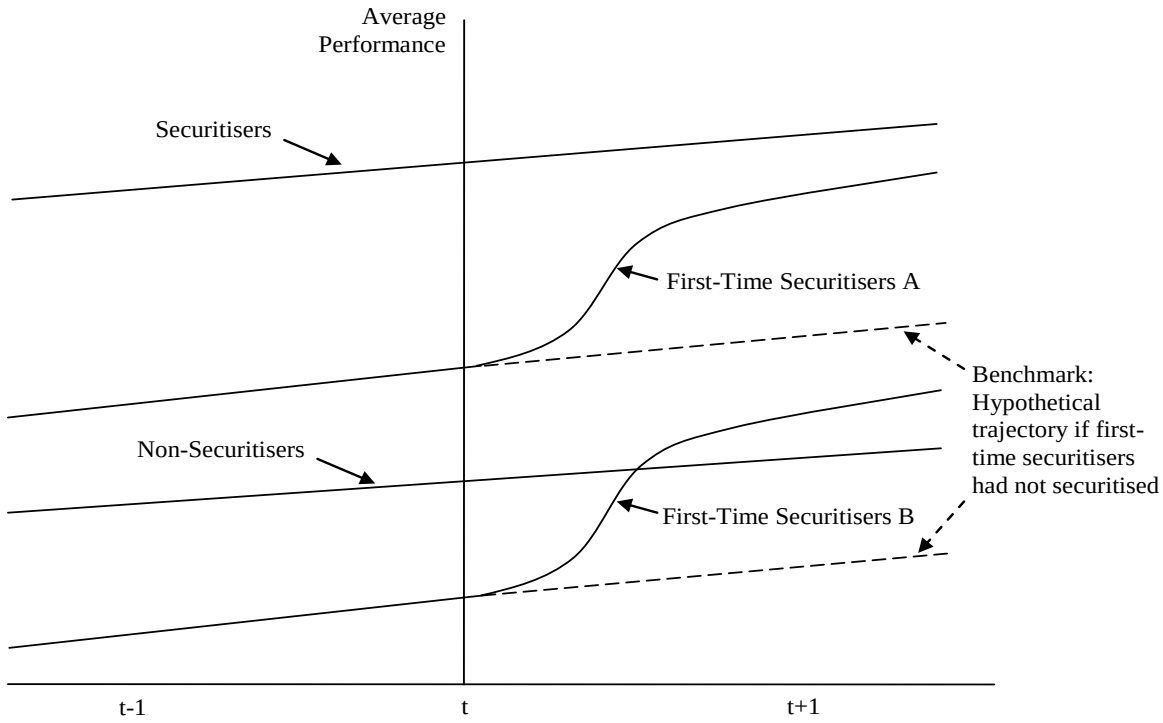
(iii) “first-time securitisers”, i.e., banks that switch from non-securitisers into securitisers at time *t* by conducting their first securitisation transaction.

Figure 4.1 illustrates the theoretical trajectories of average performances of the three types of banks and their relative positions. Recall that the proponents of securitisation argue that, when used properly, it should allow banks to improve their performance through a number of channels as discussed earlier. Therefore, the securitising banks are assumed to perform better than the non-securitising banks. This is reflected in the figure by drawing the performance trajectory of securitisers above the performance trajectory of non-securitisers. However, as noted above, this could be because securitisers were better performers prior to securitisation and/or the consequence of using the securitisation market.

Looking at first-time securitisers might help to capture the securitisation effect. In particular, if securitisation has a positive impact on bank performance, the latter should improve once these banks start to securitise. As shown in Figure 4.1, the performance trajectory of the first-time securitisers should become steeper and closer to the one of the securitisers after time *t*.

To test this hypothesis empirically, we need to know what would have happened to the performance of the first-time securitisers had they not securitised. As it is impossible to observe the same bank in both states, we need to find an appropriate proxy for the counterfactual performance of first-time securitisers. Referring to Figure 1.1, we need to find a proxy for the dotted lines.

Figure 4.1 Performance Trajectories



Note: The graph illustrates theoretical trajectories of average performances for: (i) securitisers, i.e., banks that have at least one securitisation transaction conducted at the beginning of the observation period (*t-1*); (ii) non-securitisers, i.e., banks that never engage in securitisation throughout the period (from *t-1* to *t+1*); and (iii) first-time securitisers, banks that switch from non-securitisers into securitisers by conducting their first securitisation transaction at time *t*. The first-time securitisers consist of *First-Time Securitisers A* and *First-Time Securitisers B*, which are better and worse performers, respectively, compared to non-securitisers at time *t-1*.

Good candidates for the counterfactual are the non-securitising banks. The trajectory of the non-securitisers after time *t* could be considered as a proxy for the dotted lines. However, this comparison would still entail a selection problem (Heckman and Smith, 1995) - first-time securitisers might be *ex-ante* different from those that never access the securitisation market. These banks might be either better or worse performers at time *t-1* compared to non-securitisers, which is reflected by the trajectories "First-Time Securitisers A" and "First-Time Securitisers B", accordingly.

To overcome this issue and estimate the securitisation effect, the *ex-post* performance of first-time securitisers (time *t+1*) should be compared with that of non-securitisers that are *ex-ante* as similar as possible to the former. This implies building a

control group from the non-securitisers whose trajectory of the *ex-ante* performance lies as close as possible to that of the first-time securitisers (time *t-1*). To carry out this analysis, we apply a propensity score matching approach.

4.3 Propensity Score Matching Approach

Matching has become a popular non-parametric approach for estimating causal effects and it is widely used in policy impact analysis. It is however relatively new to the finance literature: there are applications of the method to seasoned equity offerings in Cheng (2003), diversification in Villalonga (2004), and foreign investment in Girma, Gorg and Wagner (2009) and Navaretti and Castellani (2004).

The idea and methodology of matching can be applied in any evaluation study where it is possible to identify: (i) a treatment; (ii) a group of treated individuals; and (iii) a group of untreated individuals (Caliendo and Kopeinig, 2008). In this study, we apply propensity score matching (PSM) to gauge the causal effect of securitisation on bank performance with the first securitisation considered as the treatment, the first-time securitisers as the group of treated units, and the non-securitisers as the group of untreated units.[12]

To estimate the effect of securitisation, we need to know what would have happened to the performance of securitising banks had they not securitised. To do so, let S be a variable indicating securitisation activity and taking a value equal to one if bank i conducts a securitisation transaction for the first time in period t (time interval between *t-1* and *t*). Let $\Delta y^{1}_{i,t+1}$ be the performance gain achieved by bank i at time $t+1$ after having securitised assets in period t and $\Delta y^{0}_{i,t+1}$ be the hypothetical performance gain of

[12] The terms "cause" and "treatment" can be used interchangeably. In the context of our study, the first securitisation is the cause or treatment while the effect of the first securitisation is considered as the causal or treatment effect.

the same bank *i* at the same time *t+1* had it not securitised assets in period *t* (where $\Delta y_{i,t+1} = y_{i,t+1} - y_{i,t-1}$).

Therefore, the effect of securitisation on the performance of bank *i*, known in the evaluation literature as the average treatment effect on the treated, can be expressed as follows:

$$\hat{\alpha} = E(\Delta y^{1}_{i,t+1} \mid S = 1) - E(\Delta y^{0}_{i,t+1} \mid S = 1) \tag{4.1}$$

In equation (4.1), $E(\Delta y^{0}_{i,t+1} \mid S = 1)$, which represents the counterfactual mean or the hypothetical performance gain of a first-time securitiser had it not securitised, is unobservable. This constitutes the fundamental problem of causal inference in evaluation studies (Holland, 1986).

To overcome this problem, we need to find a proxy for the counterfactual mean $E(\Delta y^{0}_{i,t+1} \mid S = 1)$. Using the mean outcome for non-securitisers $E(\Delta y^{0}_{i,t+1} \mid S = 0)$ as a proxy for the counterfactual mean, equation (4.1) becomes:

$$\hat{\alpha} = E(\Delta y^{1}_{i,t+1} \mid S = 1) - E(\Delta y^{0}_{i,t+1} \mid S = 0 \tag{4.2}$$

Unless $E(\Delta y^{0}_{i,t+1} \mid S = 1) = E(\Delta y^{0}_{i,t+1} \mid S = 0$, equation (4.2) is a biased estimator of equation (4.1) as it would yield estimates of the securitisation effect plus selection bias (Heckman and Smith, 1995). Here the selection bias stems from the unit heterogeneity, or the fact that first-time securitisers and non-securitisers might be systematically different prior to the securitisation period *t* (that is, at time *t-1*).

In experimental studies the selection problem is dealt with by random assignment of treatment; this ensures that every individual has the same *ex-ante* chance of receiving treatment (Ravallion, 2003). In non-experimental studies the selection problem is of paramount concern as there is no direct estimate of the counterfactual mean analogous to the one based on randomisation (Dehejia and Wahba, 2002; Smith and Todd, 2005).

In general, there are three broad classes of estimators that allow reducing and possibly eliminating the selection bias in estimation of average treatment effects in a non-experimental context: (i) instrumental variables estimator; (ii) Heckman's (1979) two-stage estimator; and (iii) matching estimator.

The instrumental variables method requires the existence of at least one instrumental variable satisfying the following requirements: (i) it determines the treatment; and (ii) it is unrelated to unobserved heterogeneity. A number of studies have applied the instrumental variables estimator in the securitisation context with bank size commonly used as an instrument for securitisation decision (e.g., Jiangli and Pritsker, 2008). However, the instrument choice might create a potential issue with the application of the instrumental variables method. Specifically, in the treatment evaluation problem, it might be difficult to find a variable that satisfies the two requirements above (Blundell and Dias, 2000).

The Heckman selection estimator is a two-step method that uses an explicit model of the selection process to control for the part of the participation decision that is related with the error term in the outcome equation. It relies on exclusion restrictions for the identification of the average treatment effect. That is, the main assumption is the existence of at least one additional regressor in the treatment decision model that is related to the treatment decision and independent of unobserved heterogeneity. Panetta and Pozzolo (2010) have applied the two-stage Heckman procedure to control for the selection bias in estimation of securitisation effects. The Heckman selection estimator is

more robust than the IV estimator; however it is more demanding on the assumptions about the structure of the model (Blundell and Dias, 2000).

Finally, the matching method is a non-parametric approach to identifying the effect of the treatment on the outcome. The main idea behind the matching approach is to find a control group that is similar to the treatment group in all respects except with respect to the exposure to the treatment (Ravallion, 2003). It is more general as it assumes no particular specification and eliminates the selection bias by assuming that treatment assignment is a function of observable variables only. Thus, conditional on the observed variables, assignment can be taken to be random and the unconditional effect can be estimated as the expectation of the conditional effects over the distribution of the conditioning covariates in the treated group (Villalonga, 2004).

The matching method has not been employed in the securitisation context in the past. Applying this approach to the case of securitisation, we build the control group from non-securitisers that are similar to the first-time securitisers in all relevant pre-securitisation characteristics.

Therefore, the effect of securitisation could be presented as:

$$\hat{\alpha} = E(\Delta y^{1}_{i,t+1} \mid S = 1, X_{i,t-1}) - E(\Delta y^{0}_{i,t+1} \mid S = 0, X_{i,t-1}) \quad \textbf{(4.3)}$$

where $E(\Delta y^{1}_{i,t+1} \mid S = 1, X_{i,t-1})$ is the mean performance gain of the first-time securitisers at time *t+1* after securitising in period *t*; $E(\Delta y^{0}_{i,t+1} \mid S = 0, X_{i,t-1})$ is the mean performance gain of the control group at the same time *t+1*; and $X_{i,t-1}$ is a vector of observed conditioning covariates.

The implementation of the matching approach may be complicated when the set of conditioning covariates X is large. However, Rosenbaum and Rubin (1983) suggest

that dimensionality can be significantly reduced by using a propensity score, or the probability of receiving the treatment conditional on the relevant pre-treatment covariates.

Using the propensity score, the equation for the average securitisation effect becomes:

$$\hat{\alpha} = E(\Delta y^{1}_{i,t+1} \mid S = 1, p(X_{i,t-1})) - E(\Delta y^{0}_{i,t+1} \mid S = 0, p(X_{i,t-1})) \quad \textbf{(4.4)}$$

where p is a propensity score conditional on $X_{i,t-1}$.

In other words, the average securitisation effect is estimated as the difference between the mean performance gain of the first-time securitisers after their first securitisation and that of the banks that had *ex-ante* similar likelihood of securitising but did not.

For consistent estimates of the securitisation effect, two key assumptions must hold: first, the conditional independence assumption and, second, the overlap assumption. The conditional independence assumption requires the mean outcomes to be independent of the treatment after conditioning on a set of observable covariates (Smith and Todd, 2005) and can be formally stated as[13]:

$$(\Delta y^{0}_{i,t+1}, \Delta y^{1}_{i,t+1}) \perp S \mid X_{i,t-1}, \text{ or } (\Delta y^{0}_{i,t+1}, \Delta y^{1}_{i,t+1}) \perp S \mid p(X_{i,t-1}) \quad \textbf{(4.5)}$$

In other words, it assumes that there are no unobservable differences between first-time securitisers and non-securitisers after conditioning on $X_{i,t-1}$, so that any systematic differences in outcomes can be attributed to the securitisation effect.

[13] Symbol $\perp$ stands for orthogonality between two variables.

This is a strong assumption as there may be systematic differences between the first-time securitisers and non-securitisers outcomes, even after conditioning on the observables. Such discrepancies may arise, for example, because of differences in performance across geographical markets the first-time securitisers and non-securitisers operate in. However, in this study we estimate the securitisation effect on the change in the performance of banks measured as the difference in outcomes before and after securitisation (ΔInterestExpense/Liabilities, ΔNPL, and ΔROA). This is known as a difference-in-difference or double-difference matching strategy, where the first difference removes the unobserved heterogeneity and restores conditional independence and the second produces the impact estimate (Essama-Nssah, 2006; Smith and Todd, 2005). As suggested by Smith and Todd (2005), the difference-in-difference matching estimator is the most robust.

The overlap, or common support, assumption requires an overlap in the distribution of covariates between the treated units and the control group members to make matching possible and can be formally stated as:

$$0 < \Pr(S = 1 \mid X_{i,t-1}) < 1 \tag{4.6}$$

This assumption imposes a positive probability of either securitising (S=1) or not securitising (S=0) to ensure the existence of potential matches for each first-time securitiser among non-securitisers.

When the conditional independence and overlap assumptions are satisfied, the mean outcome observed for the matched non-participant group can be substituted for the missing counterfactual mean for the participants (Smith and Todd, 2005). In other words, if the two assumptions hold, we can use the mean outcome for the matched non-securitisers as a proxy for the performance gain that the first-time securitisers would have had had they not securitised (that is, $E(\Delta y^{0}_{i,t+1} \mid S = 1)$ in equation (4.1)).

4.4 Data and Preliminary Univariate Analysis

The data used in the empirical analysis of this essay are obtained from the Federal Reserve's Reports of Condition and Income (Call Reports) that are filed by insured commercial banks on a quarterly basis and contain a complete balance sheet, income statement, and detailed supporting schedules, including a schedule of off-balance sheet items. Starting from June 2001, US banks are required to provide detailed information on securitisation activities in their regulatory forms. Therefore, we use Call Reports from 2001:Q2 to the latest available of 2008:Q4 and average the data on a yearly basis to build the final data set of annual observations; the securitisation status of a bank is based on the quarterly data. The final data set contains 65,696 bank-years from 9,748 banks during 2001-2008.

As a preliminary step to the propensity score matching analysis (which is based on sub-samples of first-time securitisers and non-securitisers, as described above), we begin with a cross-sectional analysis of the full sample and compare the characteristics of banks that securitise with those that do not securitise. In this part, the first-time securitisers are included in the group of securitisers as we analyse the differences between banks that never securitise and those that securitise at least once throughout the sample period.

Table 4.1 presents the results of these comparisons and reports the means and standard deviations for the full sample.[14] There are 9,748 banks in the sample, of which 9,290 are non-securitisers and 458 are securitisers. Despite the significantly smaller percentage (4.7 % of the sample), securitisers account for nearly 68% of the sample total assets.[15]

[14] Details on the construction of the variables are provided in Appendix A.

[15] Calculated as the sum of the cross-sectional mean total assets of securitising banks over the sum of the cross-sectional mean total assets of all sample banks.

Table 4.1 Summary Statistics for all Sample Banks and Univariate Tests of Differences in Characteristics between Securitisers and Non-Securitisers

	All Banks		Non-Securitisers		Securitisers		Diff in Means		
Variable	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**(abs)**	**(%)**	**p-values**
Balance Sheet Structure									
Total Assets ($ billions)	1.1100	17.3223	0.3731	1.9786	16.0572	78.0081	15.6841	4203.73%	0.0000
Liquidity Ratio	0.2676	0.1421	0.2687	0.1426	0.2459	0.1302	-0.0228	-8.49%	0.0003
Loan Ratio	0.6339	0.1520	0.6330	0.1521	0.6517	0.1495	0.0187	2.95%	0.0093
Deposits/Assets Ratio	0.8023	0.1173	0.8056	0.1130	0.7341	0.1709	-0.0715	-8.88%	0.0000
Equity/Assets Ratio	0.1280	0.0904	0.1288	0.0915	0.1116	0.0625	-0.0172	-13.35%	0.0000
Loan Portfolio									
Real Estate Loan ratio	0.6556	0.1971	0.6569	0.1938	0.6284	0.2544	-0.0285	-4.34%	0.0184
C&I Loan Ratio	0.2275	0.1594	0.2292	0.1595	0.1943	0.1548	-0.0349	-15.23%	0.0000
Consumer Loan Ratio	0.0969	0.1147	0.0948	0.1068	0.1388	0.2165	0.0440	46.41%	0.0000
Other Loan Ratio	0.0200	0.0650	0.0191	0.0637	0.0385	0.0855	0.0194	101.57%	0.0000
Loan HHI	0.5834	0.1555	0.5821	0.1537	0.6083	0.1873	0.0262	4.50%	0.0034
Regulatory Capital									
Tier I Leverage Ratio	0.1375	0.1883	0.1391	0.1921	0.1055	0.0685	-0.0336	-24.16%	0.0000
Tier I Risk-Based Capital Ratio	0.2103	0.3218	0.2137	0.3286	0.1429	0.0930	-0.0708	-33.13%	0.0000
Total Risk-Based Capital Ratio	0.2217	0.3211	0.2249	0.3279	0.1578	0.0910	-0.0671	-29.84%	0.0000
Cost of Funding									
Interest Expense/ Liabilities	0.0159	0.0109	0.0159	0.0112	0.0165	0.0043	0.0006	3.77%	0.0033
Risk Characteristics									
NPL Ratio	0.0108	0.0171	0.0107	0.0174	0.0112	0.0095	0.0005	4.67%	0.3468
RWATA Ratio	0.6851	0.1413	0.6819	0.1287	0.7503	0.2914	0.0684	10.03%	0.0000
Charge-Off Ratio	0.0055	0.2398	0.0029	0.0291	0.0566	1.0985	0.0537	1851.72%	0.2967
Loan Loss Allowance Ratio	0.0146	0.0132	0.0146	0.0129	0.0162	0.0173	0.0016	10.96%	0.0502
Loan Loss Provision Ratio	0.0052	0.2262	0.0028	0.0220	0.0537	1.0389	0.0509	1817.86%	0.2948
Operating Performance									
Return on Assets	0.0041	0.0123	0.0039	0.0123	0.0071	0.0116	0.0032	82.05%	0.0000
Return on Equity	0.0683	1.2898	0.0684	1.3211	0.0663	0.0701	-0.0021	-3.07%	0.8814
Net Interest Margin	0.0229	0.0067	0.0229	0.0065	0.0233	0.0105	0.0004	1.75%	0.3938
Interest Income/ Net Operating Revenue	0.8363	0.1211	0.8414	0.1088	0.7324	0.2464	-0.1090	-12.95%	0.0000
Noninterest Income/ Net Operating Revenue	0.1637	0.1211	0.1586	0.1088	0.2676	0.2464	0.1090	68.73%	0.0000
Revenue HHI	0.7768	0.9089	0.7784	0.9043	0.7442	0.9974	-0.0342	-4.39%	0.4724

Note: The table presents descriptive statistics for: (i) all sample banks (9748 banks); (ii) non-securitisers (9290 banks); and (iii) securitisers (458 banks). *Mean* and *Std Dev* stand for the cross-sectional mean and standard deviation values of the individual bank time-series averages, accordingly. The last three columns report the comparison analysis of bank-specific characteristics between securitisers and non-securitisers (the former include the first-time securitisers). *Diff in Means* is calculated as the difference between securitisers' and non-securitisers' means, in absolute and percentage values, with the p-values of the tests on the equality of means reported in the last column.

The first panel of Table 4.1 shows the balance sheet structure of the banks in our sample – total assets, liquidity ratio, loan ratio, deposit ratio, and equity capital. The most significant difference is bank size, with the mean value of total assets for securitisers ($16.1 billion) being approximately 42 times larger than that for non-securitisers ($0.4 billion). This finding is consistent with previous research that documents that larger banks are more likely to securitise (Bannier and Haensel, 2007; Jiangli and Pritsker, 2008; Martín-Oliver and Saurina, 2007; Minton, Sanders and Strahan, 2004; Minton, Stulz and Williamson, 2008; Uzun and Webb, 2007). Further, securitisers tend to hold less liquid assets (25% versus 27% of total assets), which is consistent with them having better access to external funding and thus needing a smaller liquidity buffer compared to non-securitisers. The loan ratio is higher for securitisers with the mean value of 65% versus 63% for non-securitisers.

We turn next to the liability side of the balance sheet. Both securitisers and non-securitisers are mainly financed by deposits; however non-securitisers rely on this source of funding to a larger extent (81% of total assets versus 73% for securitisers). Further, 13% of total assets are funded by equity capital in the case of non-securitisers, while only 11% for securitisers.

The second panel of Table 4.1 contains information on banks' loan portfolio. The securitisers' loan portfolio is different in terms of both concentration and composition. In particular, it tends to be more concentrated, as indicated by the mean value of the Herfindahl-Hirschman Index (HHI) of 0.61 versus 0.58 for non-securitisers, with real estate loans constituting more than 60% of total loans in both samples. Despite the similar relative distribution, there are differences in terms of the loan share values between securitisers and non-securitisers. Specifically, securitisers tend to hold less real estate (63% versus 66%)[16] and commercial and industrial loans (19% versus 23%) and

[16] Minton, Stulz and Williamson (2008) find similar evidence using US bank holding company data.

more consumer loans (14% versus 10%) and other loans (4% versus 2%) on the balance sheet.

Comparing the regulatory capital, we see that securitisers have significantly less capital, on the risk-adjusted basis, than non-securitisers; nonetheless, they are overcapitalised in terms of regulatory requirements. For example, the mean total risk-based capital ratio for securitisers is 16% compared with 23% for non-securitisers. Securitisers also have lower Tier 1 leverage ratio than non-securitisers (11% versus 14%).[17] This finding is consistent with Cebenoyan and Strahan (2004) who find that banks that sell loans hold less capital. Similarly, Minton, Stulz and Williamson (2008) find evidence that risk-adjusted capital ratios are lower for the net buyers of credit protection.

The last three panels in Table 4.1 are of a particular interest for this study as they include the performance indicators that we consider in the propensity score matching analysis, that is, the cost of funding, risk, and profitability. First, the cost of funding, measured as interest expenses over liabilities, is significantly higher for securitisers (1.7% versus 1.6% for non-securitisers). This finding is inconsistent with the efficient contracting hypothesis that suggests that funding costs should fall in the presence of securitisation.

We also compare the risk profiles of securitisers and non-securitisers using five measures of risk that are presented in Table 4.1, including the non-performing loan (NPL) ratio employed in propensity score matching analysis. We find that securitisers are more risky in all measures used with statistical significance for the ratio of risk-weighted assets to total assets (RWATA) and for the loan loss allowance ratio. The difference in the charge-offs (5.7% of total assets for securitisers versus 0.3% for non-securitisers) and loan loss provisions (5.4% versus 0.3%, accordingly) is striking,

[17] Minton, Sanders and Strahan (2004) find similar results using US financial company data.

although not statistically significant. Similar results are found by Jiangli and Pritsker (2008) and Minton, Stulz and Williamson (2008) with provisions, charge-off and non-performing loan ratios higher for securitisers.[18] The greater degree of risk inherent in the balance sheets of securitising banks might also explain the observed higher funding costs reported above.

Finally, the last panel in Table 4.1 reports some indicators of operational performance of the banks in our sample. We find that return on assets, the profitability measure employed in the propensity score matching analysis, is significantly higher for securitisers (0.7% versus 0.4% for non-securitisers). As for the operating revenue structure, the main source of revenue for both securitisers and non-securitisers is interest income (over 70%); however the non-interest income share is significantly higher for securitisers (27% versus 16% for non-securitisers). The latter is consistent with securitisers having an additional source of income in the form of servicing fees and possibly more trading revenue.[19]

Taken together, the cross-sectional comparisons suggest that securitisers improve their profitability through expanding riskier and hence more profitable loans in their portfolios while paying a higher cost of funds for the excessive risk taking; securitising banks are also found to hold less equity capital and increase their non-interest income through fees and trading revenues.

[18] Jiangli and Pritsker (2008) suggest that this could reflect securitisation and/or size effect in allowing banks to extend loans with higher expected losses.

[19] Using US bank holding company data from 1999 to 2005, Minton, Stulz and Williamson (2008) find that the net buyers of credit protection have dramatically more trading revenue than other banks.

4.5 Propensity Score Matching Analysis

4.5.1 First-Time Securitisers and Non-Securitisers

To estimate the causal effect of securitisation in the propensity score matching analysis, we focus on two groups of banks: (i) first-time securitisers and (ii) non-securitisers. Given that securitisation is a recurring activity, we focus on the first observed transaction to build the sub-sample of first-time securitisers from the sample of securitising banks.[20] We drop the first-time securitisers of 2001 and 2008 as for these cases we are not able to collect pre- and post-securitisation information, accordingly.

Therefore, the treatment group for the propensity score matching analysis consists of banks that conduct first securitisation in any year from 2002 to 2007. The control group is built from banks that do not securitise over the 2001-2008 period (i.e., from the sample of non-securitisers used in the univariate analysis in section 4.4). This gives 198 first-time securitisers and 46,903 bank-years in the control group of non-securitisers over the 2002-2007 period. Panel A of Table 4.2 reports the statistics on the final unmatched sample by year. For example, looking at year 2004 in the table, the 23 first-time securitisers are banks that do not securitise in 2001, 2002, 2003 and securitise in 2004; while the 7,845 non-securitisers are banks that do not securitise throughout the whole sample period from 2001 to 2008.

4.5.2 Implementation of the Propensity Score Matching

The implementation of the propensity score matching approach can be broken down into three steps: (i) estimating propensity scores for first-time securitisers and non-securitisers; (ii) matching first-time securitisers with non-securitisers; and, finally, (iii) estimating the average securitisation effect.

---

[20] First securitisation during the lifetime of a bank in the sample.

Table 4.2 Statistics on the Number of First-time Securitisers and Non-Securitisers

Year	Panel A. Unmatched Sample			Panel B. Matched Sample		
	First-Time Securitisers	Non-Securitisers	Total	First-Time Securitisers	Non-Securitisers	Total
2002	30	8119	8149	24	24	48
2003	41	7983	8024	38	38	76
2004	23	7845	7868	22	22	44
2005	36	7758	7794	30	30	60
2006	25	7659	7684	24	24	48
2007	43	7539	7582	38	38	76
Total	**198**	**46903**	**47101**	**176**	**176**	**352**

Note: The table reports the statistics on the number of first-time securitisers and non-securitisers. Panel A shows the number of banks that conduct first securitisation in any year from 2002 to 2007 and their unmatched control group of non-securitisers. Panel B reports the statistics on the matched sample, i.e., first-time securitisers and their matches that have data for pre- and post-securitisation years and satisfy the common support condition.

First, to estimate the propensity scores, we use a probit regression of a dummy variable that has a unit value for the first securitisation, and zero otherwise.[21] For the probit model, suppose that a latent variable y^* follows:

$$y_i^* = x_i\beta + e_i \tag{4.7}$$

where e_i is independent of x_i, β is a vector of parameters, and $e_i \sim N(0,1)$.

Instead of observing y_i^*, we observe only a binary variable indicating the sign of y_i^*:

$$y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \le 0 \end{cases} \tag{4.8}$$

[21] Caliendo and Kopeinig (2008) suggest that logit and probit models are preferable among the discrete models and usually yield similar outcomes for binary treatment case.

We can easily obtain the distribution of y_i given x_i:

$$P(y_i = 1 \mid x_i) = P(y_i^* > 0 \mid x_i) = P(x_i\beta + e_i > 0 \mid x_i)$$
$$= P(e_i > -x_i\beta \mid x_i) = 1 - \Phi(x_i\beta) = \Phi(x_i\beta)$$

(4.9)

According to the matching literature, the regressors included in the model should reflect both the institutional settings of banks and the theoretical and empirical background on the determinants of banks decision to securitise. It is also worth noting that the main purpose of the propensity score estimation is not to predict the treatment, but to balance all the covariates between the two groups (Augurzky and Schmidt, 2001).

To do so, we define five sets of bank-specific variables. The first set reflects general characteristics of bank balance-sheet structure including bank size.[22] From the asset side, we include measures of bank liquidity, loans, and loan portfolio composition. The latter is captured in terms of both the breakdown of loans into four major categories (real estate, commercial and industrial, consumer, and other loans[23]) and the Herfindahl-Hirschman Index (HHI) calculated using the four named loan shares. From the liability side, we include deposit and equity ratios.

The next four sets of variables reflect the most commonly cited motivating factors for securitisation: regulatory capital relief, lower cost funding, risk management, and operating performance improvement. First, with respect to the regulatory capital relief hypothesis, we include the Tier I risk-based capital ratio (Bannier and Haensel, 2007; Calomiris and Mason, 2004; Minton, Stulz and Williamson, 2008; Uzun and Webb, 2007). The lower cost of funding hypothesis is captured by the average cost of debt calculated as the ratio of interest expenses to total liabilities (Martín-Oliver and Saurina,

[22] Bank size is measured as the natural logarithm of total assets. A few studies show that large banks are more likely to securitise because of the economies of scale enjoyed by large banks in underwriting and securitisation, or because of the diseconomies of scale in funding through deposits (Bannier and Haensel, 2007; Jiangli and Pritsker, 2008). Loutskina (2005) notes that only large banks have a sufficient number and homogeneity of loans to access securitisation market independently of other financial intermediaries.

[23] Other Loan Ratio is dropped from the probit model due to collinearity.

2007). To reflect the risk management hypothesis, we use the non-performing loan ratio (Martín-Oliver and Saurina, 2007; Minton, Stulz and Williamson, 2008; Pais, 2005). Finally, we capture bank operating performance by using a profitability measure such as return on assets (Bannier and Haensel, 2007; Minton, Sanders and Strahan, 2004; Minton, Stulz and Williamson, 2008; Pais, 2005).

One of the required conditions in the propensity score matching analysis is that the variables included in the model should not be affected by the treatment. To ensure this, the bank-specific variables employed in our propensity score model are lagged one year:

$$P(S_{i,t} = 1 | X_{i,t-1}, Z_{i,t-1}, St_i) \tag{4.10}$$

where $S_{i,t}$ is a first-securitisation dummy, $X_{i,t-1}$ is a vector of general balance sheet characteristics (*Size*$_{i,t-1}$, *Liquidity Ratio*$_{i,t-1}$, *Loan Ratio*$_{i,t-1}$, *C&I Loan Ratio*$_{i,t-1}$, *Consumer Loan Ratio*$_{i,t-1}$, *Other Loan Ratio*$_{i,t-1}$, *Loan HHI*$_{i,t-1}$, *Deposits/Assets Ratio*$_{i,t-1}$, *Equity/Assets Ratio*$_{i,t-1}$), $Z_{i,t-1}$ is a vector of variables capturing the four hypotheses on the motivation for securitisation (*Tier I Risk-Based Capital Ratio*$_{i,t-1}$, *Interest Expense/Liabilities Ratio*$_{i,t-1}$, *NPL Ratio*$_{i,t-1}$, *Return on Assets*$_{i,t-1}$), and St_i are state dummies.

We estimate the propensity scores for the 198 first-time securitisers and 46,903 bank-years of non-securitisers reported in Panel A of Table 4.2 running the probit model year by year. The Pseudo R-squared of the yearly regressions ranges from 0.08 to 0.21. For reporting reasons, we reproduce a pooled probit regression for the period from 2002 to 2007 as it yields qualitatively similar results.[24] The estimates of the pooled regression are reported in Table 4.3, where Model 2 additionally incorporates year and state dummies.

[24] The results of the yearly probit regressions are reported in Appendix G.

Table 4.3 Determinants of Securitisation Probability

	Model 1	Model 2
$Size_{i, t-1}$	0.145***	0.148***
	(0.021)	(0.024)
Liquidity $Ratio_{i, t-1}$	0.073	-0.144
	(0.376)	(0.389)
Loan $Ratio_{i, t-1}$	0.238	0.235
	(0.362)	(0.377)
C&I Loan $Ratio_{i, t-1}$	0.269	0.288
	(0.179)	(0.216)
Consumer Loan $Ratio_{i, t-1}$	0.162	0.265
	(0.223)	(0.228)
Other Loan $Ratio_{i, t-1}$	0.564*	0.487
	(0.286)	(0.322)
Loan $HHI_{i, t-1}$	0.310	0.281
	(0.212)	(0.231)
Deposits/Assets $Ratio_{i, t-1}$	-0.753***	-0.905***
	(0.214)	(0.226)
Equity/Assets $Ratio_{i, t-1}$	0.391	0.323
	(0.598)	(0.601)
Tier I Risk-Based Capital $Ratio_{i, t-1}$	-0.644*	-0.557*
	(0.287)	(0.260)
Interest Expense/Liabilities $Ratio_{i, t-1}$	1.092	0.439
	(0.780)	(0.938)
NPL $Ratio_{i, t-1}$	-0.835	-1.122
	(2.669)	(3.122)
Return on $Assets_{i, t-1}$	-5.681***	-5.309***
	(1.576)	(1.512)
State Dummies	No	Yes
Year Dummies	No	Yes
Pseudo R^2	0.051	0.084
Log Likelihood	-1211.53	-1163.67
Wald Chi-Square Test	139.33	304.17
(p-value)	0.000	0.000
No. of Observations	46187	44783

Note: The table presents the probit regression estimates of the likelihood to securitise assets. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All explanatory variables are lagged one year. Model 1 includes bank-specific characteristics. Model 2 adds state and year dummies. Robust (Huber-White) standard errors are reported in parentheses.*, **,*** stand for statistical significance at the 10%, 5% and 1% levels, respectively.

Overall, the results are supportive of our predictions, providing significant evidence for the funding, regulatory capital relief, and performance improvement hypotheses. In particular, we find that a bank is more likely to securitise if it has lower deposits to total assets, lower regulatory capital, and is less profitable. These results along with the significant positive estimate for the size variable are consistent with previous studies on banks' propensity to securitise.

Having estimated the propensity scores, we proceed to match first-time securitisers with non-securitisers. We employ nearest-neighbour matching where the unit chosen from the non-securitisers (i.e., unit *j* from the control group) as a match for the first-time securitiser (i.e., unit *i* from the treated group) is the one closest in terms of the propensity score[25]:

$$| p_i - p_j | = \min_{k \in \{S=0\}} \{ | p_i - p_k | \} \qquad (4.11)$$

To avoid the risk of bad matches entailed in this approach, we impose a 1% tolerance level on the maximum propensity score distance allowed (the so called caliper).[26] We run nearest-neighbour matching year by year to ensure that each first-time securitiser is matched with an observation from the non-securitiser group of the same year the first securitisation occurs.

The empirical setting requires restricting the initial unmatched sample of first-time securitisers and non-securitisers to those with data from one year before until one

[25] There is a range of matching estimators available. All of those compare the outcome of the treated units with the outcome of the control group members to determine the average treatment effect and differ in the way the neighbourhood for each treated unit is defined and the weights assigned to the neighbours (Caliendo and Kopeinig, 2008).

[26] Bad matches might occur if the closest neighbour is far away in terms of the propensity score. Applying caliper implies that a unit from the control group chosen as a match for a treated unit lies within the caliper ("propensity range") and is closest in terms of the propensity score. In this case, the matching quality rises; however, the variance of the estimates may increase if fewer matches can be performed as a result of excluding from the analysis the treated units with no matches found within the caliper (Smith and Todd, 2005).

year after the first-securitisation year. Further, we impose the common support, or overlap condition, discussed earlier, by prohibiting the perfect predictability of first securitisation given the observed covariates to ensure the existence of potential matches in the non-securitisers group.[27]

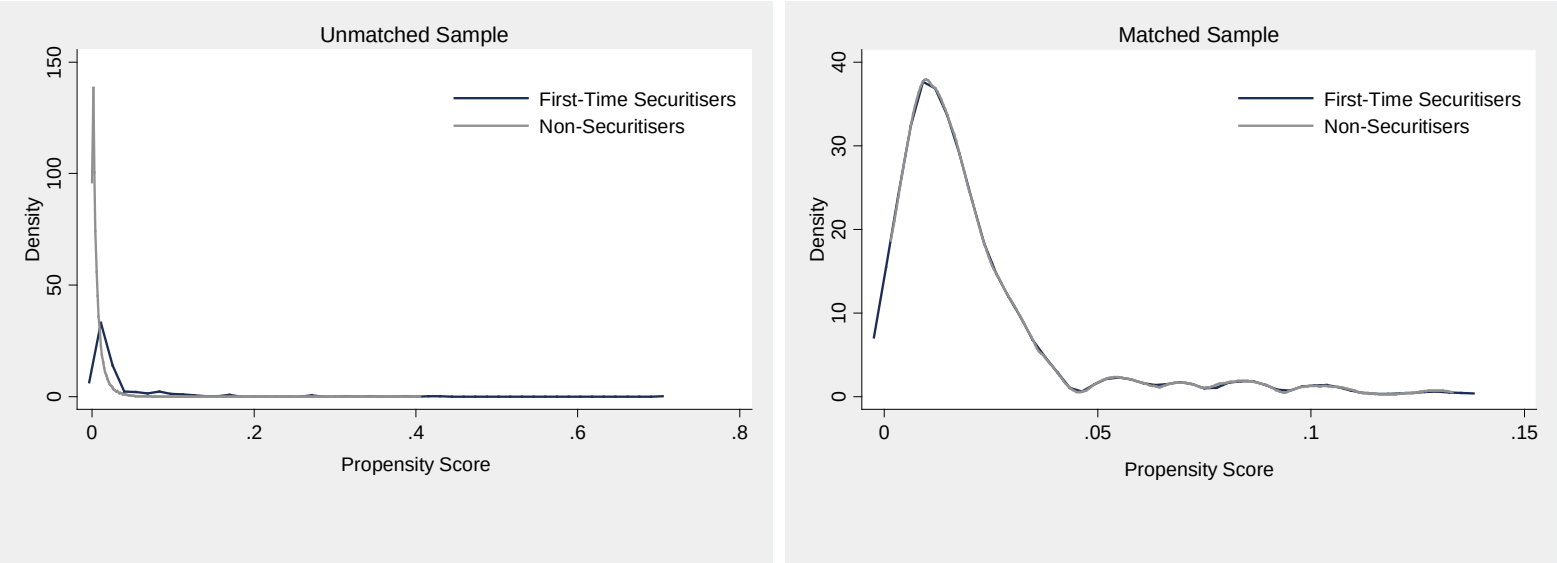
The matching procedure leaves us with 176 first-time securitisers and their 176 controls. This is the sample used for the estimation of the average securitisation effects. Panel B of Table 4.2 reports the number of completed matches by year.

To verify the quality of matching, we plot the distribution of the propensity score for the first-time securitisers and non-securitisers before and after matching (Figure 4.2). In the unmatched sample the propensity score distribution of the non-securitisers is skewed to the left, while it is very close to that of the first-time securitisers in the matched sample.

Further, since matching is conditioned on the propensity score rather than on all covariates, it also has to be checked whether the matching procedure is able to balance the distribution of all the relevant variables in both the control and treatment groups (Caliendo and Kopeinig, 2008). Rosenbaum and Rubin (1985) suggest a two-sample t-test for comparing the distributions of the covariates in the treated and matched control groups. In other words, we compare the first-time securitisers and non-securitisers before and after matching and check if there remain any differences in the balancing covariates after conditioning on the propensity score. The results of the tests are reported in Table 4.4. We find significant differences before matching, whereas in the matched sample the covariates are balanced in both groups suggesting successful matching.

[27] The analysis is conducted using PSMATCH2 module for Stata developed by Leuven and Sianesi (2003).

Figure 4.2 Distribution of the Propensity Score of First-Time Securitisers and Non-Securitisers before and after Matching



Note: The graphs plot the propensity score distribution of the first-time securitisers and non-securitisers for the 2002-2007 period, before and after matching. The propensity score is derived from the estimation of the probit equation (4.10) year by year.

Table 4.4 T-Test for Equality of Means of Covariates before and after Matching

	Unmatched Sample			Matched Sample		
Variable	**Treated**	**Control**	**Diff**	**Treated**	**Control**	**Diff**
$Size_{i, t-1}$	12.552	11.574	0.978***	12.339	12.357	-0.018
Liquidity $Ratio_{i, t-1}$	0.256	0.286	-0.029***	0.255	0.255	0.000
Loan $Ratio_{i, t-1}$	0.661	0.629	0.032***	0.664	0.669	-0.005
C&I Loan $Ratio_{i, t-1}$	0.214	0.235	-0.020*	0.216	0.219	-0.003
Consumer Loan $Ratio_{i, t-1}$	0.094	0.103	-0.009	0.089	0.076	0.013
Other Loan $Ratio_{i, t-1}$	0.030	0.017	0.013***	0.021	0.021	0.001
Loan $HHI_{i, t-1}$	0.604	0.566	0.038***	0.595	0.596	-0.001
Deposits/Assets $Ratio_{i, t-1}$	0.776	0.824	-0.048***	0.801	0.802	-0.001
Equity/Assets $Ratio_{i, t-1}$	0.111	0.115	-0.004	0.106	0.106	0.000
Tier I Risk-Based Capital $Ratio_{i, t-1}$	0.154	0.183	-0.028*	0.146	0.151	-0.004
Interest Expense/Liabilities $Ratio_{i, t-1}$	0.016	0.015	0.000	0.015	0.015	0.000
NPL $Ratio_{i, t-1}$	0.009	0.010	-0.001	0.009	0.007	0.002
Return on $Assets_{i, t-1}$	0.005	0.006	-0.001	0.006	0.006	0.000
No. of Observations (Total)	198	45989	(46187)	176	176	(352)

Note: The table reports the means of various bank-specific characteristic between the treated units (i.e., first-time securitisers) and controls (i.e., non-securitisers), before and after matching. The difference in means (column "Diff") is calculated as the difference between first-time securitisers' and non-securitisers' means. *, **,*** stand for statistical significance at the 10%, 5% and 1% levels, respectively. The last row shows the number of treated and control units in each group, with the total number of observations in a sample reported in brackets.

4.6 Empirical Results

We now use the matched sample to estimate the effects of securitisation on the three indicators of bank performance: cost of funding (interest expense to total liabilities ratio), risk (non-performing loans ratio), and profitability (return on assets).

To do so, we first pool the yearly matched first-time securitisers and non-securitisers. Second, we calculate the changes in performance using a one-year window around the first-securitisation year. Finally, we estimate the average securitisation effect as the difference in the mean changes in the performance indicators between the first-time securitisers and non-securitisers and its statistical significance.

Testing the statistical significance of the difference in means might entail a bias as the estimated variance of the securitisation effect might also include the variance due to the estimation of the propensity score and the common support condition. These estimation steps might add variation beyond the normal sampling variation (Heckman, Ichimura, Smith and Todd, 1998). To address this, we use a bootstrapping technique. The bootstrap is based on 500 bootstrap samples, where each bootstrap draw includes the re-estimation of the results, including the first steps of the estimation (i.e., propensity score, common support). The distribution of the obtained means should approximate the sampling distribution and, thus, the standard error of the population mean (Caliendo and Kopeinig, 2008).

We run the analysis for the whole 2002-2007 sample with 352 banks in total and also split the period into three sub-periods (i.e., 2002-2003, 2004-2005, and 2006-2007) to examine possible differences over time. The estimates of the average securitisation effects for the four estimation periods are reported in Table 4.5 as “Diff” with statistical significance in parentheses, where the latter is calculated based on bootstrapped standard errors.

Table 4.5 The Effect of Securitisation on Bank Cost of Funding, Risk, and Profitability

Variable	2002-2007			2002-2003			2004-2005			2006-2007		
	First-Time Securitisers	Non-Securitisers	Diff (t-stat)	First-Time Securitisers	Non-Securitisers	Diff (t-stat)	First-Time Securitisers	Non-Securitisers	Diff (t-stat)	First-Time Securitisers	Non-Securitisers	Diff (t-stat)
Funding Cost	-0.001	-0.001	0.000	-0.01	-0.01	0.000	0.004	0.004	0.000	0.003	0.003	0.000
			(-0.06)			(-0.08)			(0.00)			(-0.09)
Risk	0.002	0.003	-0.001	0.000	0.003	-0.003	-0.007	-0.003	-0.004	0.011	0.009	0.002
			(-0.71)			(-1.37)			(-0.72)			(-0.52)
Profitability	0.000	-0.001	0.001	0.001	-0.002	0.003	0.001	0.001	0.000	-0.002	-0.001	-0.001
			(-0.42)			(-1.22)			(-0.35)			(-0.45)
No. of Observations	176	176		62	62		52	52		62	62	

Note: The table presents the propensity score matching estimates of the average treatment effect of securitisation on the cost of funding, risk and profitability for the first-time securitisers. The average treatment effect is the difference in the performance change (i.e., from year *t-1* to year *t+1* with the treatment in year *t*) between the first-time securitisers and matched non-securitisers. The first-time securitisers are banks that conduct first securitisation in any year during the period of analysis and are matched with non-securitisers (i.e., banks that never engage in securitisation throughout the 2001-2008 period) on a year-by-year basis. The average treatment effects are reported as "Diff" in the table with *t*-statistics in parentheses based on bootstrapped standard errors. The first column shows the estimates for the full sample, which is further split into three subsamples. The last row reports the number of first-time securitisers and non-securitisers for each estimation period.

The interpretation of the estimates is as follows. The effect of securitisation on bank performance is positive when: (i) the *Diff* for cost of funding and risk is negative implying a (larger) drop or a smaller rise in the indicators for the first-time securitisers compared to non-securitisers; or (ii) *Diff* for profitability is positive implying a (larger) rise or a smaller drop in the profitability for the first-time securitisers compared to non-securitisers.

First, for the cost of funding, we find no evidence of the securitisation effect across all the periods considered. This may be due to the fact that originating banks may be required by investors to provide high credit enhancements in the first issues until their reputation in the securitisation market is established. This in turn may significantly raise the costs of the first transactions and hinder the potential reduction in the funding cost offered by the securitisation market.

As for the credit risk, we find a positive effect for banks that securitised in any year from 2002 to 2005 as compared to their controls, while the result is opposite for those that securitised in years 2006 and 2007. However, the estimates are statistically insignificant. This finding may be explained by the so-called "cherry-picking". Specifically, as the first issues are crucial for establishing reputation in the securitisation market, the originating banks may involve in selecting assets of higher credit quality for the transactions to ensure the performance of the receivables. Additionally, implicit recourse, commonly provided by originating banks to maintain reputation in the market, may result in the originating banks taking the non-performing securitised loans back onto the balance sheet and replacing them with better quality loans. Furthermore, having approached and established the securitisation market as an additional source of loan financing and liquidity, banks may tend to shift their loan portfolios towards higher risk assets. This may eventually lead to higher *ex-post* non-performing loans on the banks' books diminishing the credit risk-reducing effect of securitisation.

Finally, the effect of securitisation on profitability is found to be positive for the first-time securitisers of 2002-2003 and negative for those banks that securitised in 2006-2007. However, none of the estimates are statistically different from zero providing no evidence for significant impact of securitisation on profitability. This in turn reflects the insignificant effect of securitisation on the first-time securitisers' funding cost and credit risk.

In other words, the results of the propensity score matching analysis suggest that the first-time securitisers would have had comparable cost of funding, credit risk, and profitability had they remained non-securitisers. [28] Referring to Figure 4.1, according to the obtained evidence, the performance trajectories of the first-time securitisers (i.e., First-Time Securitisers A and First-Time Securitisers B) might slightly change the trend but remain close to the hypothetical trajectories presented by the dotted lines.

4.7 Conclusions

In this essay we conduct an empirical analysis of the effects of securitisation on bank performance. The theoretical predictions are that securitising banks should have lower cost of funding, lower credit risk exposure, and higher profitability compared to banks that do not securitise assets. Using US commercial bank data from 2001 to 2008, univariate analysis reveals that securitising banks do tend to be more profitable institutions, but with higher credit risk exposure and higher cost of funding compared to non-securitising banks.

To capture the securitisation effect, we assess what would have happened to the securitising banks had they not securitised. We do this by applying a propensity score matching approach and estimate the causal effects of securitisation by comparing the

[28] As a robustness test, we also perform radius matching. The basic idea of this variant is to use not only the nearest neighbour but all of the comparison units within the caliper. Using an identical caliper of 1%, we find that the results remain unchanged.

performance of first-time securitisers with that of banks that had *ex-ante* similar securitisation likelihood but remained non-securitisers.

We find that the first-time securitisers would have had comparable cost of funding, credit risk, and profitability had they not securitised. Consequently, we conclude that securitisation as a funding, risk management, and profitability improvement technique does not seem to outperform alternative approaches possibly used by the adequately matched non-securitising banks.

The results in this study raise important questions about the motives for banks' increasing securitisation activities over the past decade and consequent implications for the banking system and are of a particular interest in light of the recent financial crisis and the latest debates about the regulation and ultimate value of securitisation.

5 ESSAY II: SECURITISATION AND BANK CREDIT RISK TAKING[29]

5.1 Introduction

In the two decades leading up to the recent financial crisis banks have been operating in increasingly competitive markets, and as such have been forced to take on more risks and to seek out higher margin activities. Securitisation has facilitated this quest for higher margin business by allowing banks to convert illiquid loans into marketable securities and, therefore, release capital for other investment opportunities. The increasing volume of securitisation activity in the run up to the financial crisis raised concerns of researchers as well as those of analysts, investors, and regulators over the potential for an increase in systemic risk.

In general, previous empirical studies of the impact of securitisation on the issuing banks have suggested a positive link between securitisation and bank risk (Dionne and Harchaoui, 2003; Franke and Krahnen, 2005; Haensel and Krahnen, 2007; Michalak and Uhde, 2009). By allowing banks to convert illiquid assets into liquid funds, it has been argued that securitisation may well expand credit supply and cause banks to hold riskier assets. Evidence supporting the credit expansion hypothesis is found in Goderis, Marsh, Vall Castello and Wagner (2006), Hirtle (2008), Loutskina (2005), Loutskina and Strahan (2006); Loutskina and Strahan (2006) also show that securitisation reduces the influence of a bank's financial condition on credit supply. However, little evidence has been collected on how securitisation affects banks' willingness to increase the proportion of risky assets in their portfolios.

[29] This study is forthcoming as Casu, Barbara, Andrew Clare, Anna Sarkisyan and Stephen Thomas, Does Securitisation Reduce Credit Risk Taking? Empirical Evidence from US Bank Holding Companies, *European Journal of Finance*, Special Issue on Contemporary Issues in Financial Institutions and Markets.

Since securitisation provides banks with an additional source of loan financing and liquidity, it might motivate them to shift their portfolios towards higher risk/return assets (Cebenoyan and Strahan, 2004; Panetta and Pozzolo, 2010; Purnanandam, 2009). However, originating banks typically retain first-loss contractual interests and/or provide implicit recourse in securitisations to mitigate the moral hazard problem that arises from the banks having less incentive to efficiently monitor and service loans after they have been sold (Gorton and Pennacchi, 1995; Pennacchi, 1988). These arrangements mean that the risks inherent in the securitised assets have not been transferred to investors and are, in effect, still held by the originating bank, but off-balance sheet (Chen, Liu and Ryan, 2008; FDIC, 2007; Landsman, Peasnell and Shakespeare, 2006; Niu and Richardson, 2006; Standard and Poor's, 2001; Wolfe, 2004).

Therefore, outstanding securitisation exposes the issuing bank to the credit risk associated with the transferred assets. Assuming that the risk exposure arising from the securitised pool is understood by the bank, we hypothesise that this should have an impact on its risk-taking behaviour. In particular, greater outstanding securitisation, and, therefore, greater credit risk exposure arising from the pool, should make banks more risk-averse and motivate them to shift their portfolios towards assets of lower credit risk.

This study aims to contribute to the existing literature by assessing the impact of securitisation on the credit-risk taking behaviour of US bank holding companies. We first examine whether the aggregate outstanding securitisation affects banks' risk-taking behaviour. Second, we test whether the effect differs across securitisations of different asset classes using new data on banks' securitisation activities mandated by changes to regulatory forms in 2001, whereby banks report securitisation by type of underlying assets.

Our results show that bank credit-risk taking behaviour is negatively associated with securitisation, suggesting that banks with a greater balance of securitised assets outstanding choose asset portfolios of lower risk. Examining securitisations by type of underlying asset reveals that the negative relationship between outstanding securitisation and risk taking is primarily driven by securitisations of mortgages, home equity lines of credit, and other consumer loans. Securitisations of all other types of assets, on the other hand, seem to have no significant impact on bank credit-risk taking behaviour. We explain these results with reference to the "recourse hypothesis", that is, the credit risk retained by the issuing banks in connection to the securitised assets, through the recourse explicitly and/or implicitly provided in securitisation transactions.

The remainder of this essay is organised as follows: Section 5.2 describes the data and provides brief descriptive statistics of the sample; the empirical specification is presented in Section 5.3; Section 5.4 reports the results of the analysis; finally, Section 5.5 discusses the findings and concludes the essay.

5.2 Data and Descriptive Statistics

5.2.1 Data and Sample Selection

To study the effect of securitisation on bank credit-risk taking behaviour we use US bank holding company (BHC) data from Y-9C forms, which are filed on a quarterly basis by all BHCs and have been compiled in a data set by the Federal Reserve Bank of Chicago since 1986. We use data for bank holding companies rather than for commercial banks because risk and capital management are typically administered at the highest level of the financial group. In addition, securitisation may involve several subsidiaries of a BHC and affect capital and liquidity planning for the whole group (Aggarwal and Jacques, 2001; Thomas and Wang, 2004).

The Y-9C reports collate basic financial data from banks on a consolidated basis in the form of a balance sheet, an income statement, and detailed supporting schedules, including a schedule of off-balance sheet items. Since June 2001, US banks have been required to provide more detailed information on their securitisation activities in the regulatory forms. Specifically, Schedule HC-S of Y-9C form reports the breakdown of securitisation into seven categories: 1-4 family residential loans; home equity lines; credit card receivables; auto loans; other consumer loans; commercial and industrial loans; and all other loans, all leases, and all other assets. Securitisations are reported as an outstanding principal balance of the corresponding assets sold and securitised with servicing retained or with recourse or other seller-provided credit enhancements. The incorporation of the new data into FR Y-9C determines the start date of the sample period, which yields 27 quarters from the second quarter of 2001 to the fourth quarter of 2007.

When constructing the data set, we excluded banks with missing information on total assets, total loans, capital, and securitisation activities for any quarter of the sample period. When banks go through a merger or an acquisition, we maintain the code of the acquiring BHC while the acquired bank is eliminated from the sample.[30] To prevent the possibility of outliers driving the results, we exclude all bank-quarters with asset growth over the last quarter exceeding 50% and loan growth exceeding 100%. We also exclude banks in any quarters for which total loan-to-asset ratio is less than 0.1 or loan-to-deposit ratio exceeds 10. The final data set contains 42,685 bank-quarters for 2,190 BHCs.

[30] This might still entail a bias. In particular, a merger or an acquisition might cause significant changes in the acquiring bank's balance sheet composition and, therefore, have an impact on the analysis results. We control for this by imposing outliers limits on bank asset and loan growth, however, we acknowledge that it might still have an impact on the observed results through other bank-level characteristics.

5.2.2 Descriptive Statistics

Before turning to the main analysis, we compare securitisers and non-securitisers along five dimensions: (i) balance sheet structure; (ii) loan portfolio; (iii) regulatory capital; (iv) risk; and (v) operating performance.[31] Given that securitisation is a recurring activity, we assign a bank to the group of securitisers if we observe securitisation activity in any quarter of the bank's lifetime in the sample. This yields 230 securitisers and 1,960 non-securitisers in total for the period from 2001:Q2 to 2007:Q4. We use the quarterly data to calculate time-series averages for each BHC and then compare the averages in cross-sectional tests. The results of these comparisons are presented in Table 5.1, where we report means and standard deviations for all banks, securitisers, and non-securitisers, and the difference in means between the latter two with its statistical significance.[32]

Looking at the first panel of Table 5.1, the average amount of total assets for the sample BHCs is $5.3 billion. This is the most significant difference between securitisers and non-securitisers; the mean value of total assets for securitisers ($41billion) is approximately 41 times the mean size of non-securitisers ($1 billion). This finding is consistent with previous research that documents that larger banks are more likely to securitise (Bannier and Haensel, 2007; Jiangli and Pritsker, 2008; Martín-Oliver and Saurina, 2007; Minton, Sanders and Strahan, 2004; Minton, Stulz and Williamson, 2008; Uzun and Webb, 2007). Further, securitisers tend to hold less liquid assets (25% versus 27% of total assets), which is consistent with having a better access to external funding and thus needing a smaller liquidity buffer compared to non-securitisers.

[31] The construction of the variables is described in detail in Appendix B.

[32] In the regulatory reporting forms income statement items are reported on a year-to-date basis. Following Cebenoyan and Strahan (2004), to make measures of risk and profitability more familiar (charge-off ratio, loan loss provision ratio, return on assets and equity), we annualise the quarterly flow variables by multiplying by four.

Originated loans on average constitute 66% of BHC's total assets with no significant difference between securitisers and non-securitisers.

We turn next to the liability side of the balance sheet. Both securitisers and non-securitisers are mainly financed by deposits. However, non-securitisers rely on this source of funding to a larger extent (69% of total assets versus 62%). The capitalisation of the sample BHCs constitutes 9%, with no distinguishable difference between securitisers and non-securitisers. The proportion of loans to deposits is significantly higher for securitisers (1.12 versus 0.98).

The second panel of Table 5.1 contains information on bank loan portfolios. The securitisers' loan portfolio is different in terms of both concentration and composition. In particular, it tends to be more diversified, as indicated by the Herfindahl-Hirschman Index (HHI) of 0.56 versus 0.59 for non-securitisers.[33] Further, securitisers tend to hold significantly less real estate loans (67% versus 71%)[34] while keeping more consumer (10% versus 8%) and other loans (7% versus 5%) on the balance sheet.

Looking at the regulatory capital, one can see that the sample BHCs are on average relatively highly capitalised (e.g., 14.8% for the total risk-based capital ratio). Comparing securitisers and non-securitisers, we find that securitisers are less capitalised than non-securitisers on the risk-adjusted basis; however, the difference is not statistically significant. This is consistent with Cebenoyan and Strahan (2004) and Minton, Stulz and Williamson (2008), who find that banks that are engaged in credit risk management tend to hold less capital.

[33] Herfindahl-Hirschman Index is calculated using four loan categories: (i) real estate loans, (ii) commercial and industrial loans, (iii) consumer loans, and (iv) other loans; a higher value indicates higher loan portfolio concentration.

[34] Minton, Stulz and Williamson (2008) find similar evidence.

Table 5.1 Summary Statistics for all Sample Banks and Univariate Tests of Differences in Characteristics between Securitisers and Non-Securitisers

	All Banks			Securitisers			Non-Securitisers			Diff in Means		p-values
Variable	**N**	**Mean**	**StdDev**	**N**	**Mean**	**StdDev**	**N**	**Mean**	**StdDev**	**(abs)**	**(%)**	
Balance Sheet Structure												
Total Assets ($ billions)	2190	5.254	52.286	230	40.961	156.486	1960	1.064	5.001	39.897	3749.7%	0.000
Liquidity Ratio	2190	0.263	0.123	230	0.247	0.111	1960	0.265	0.124	-0.018	-6.8%	0.029
Loan Ratio	2190	0.664	0.125	230	0.660	0.123	1960	0.665	0.125	-0.005	-0.8%	0.577
Deposits/Assets Ratio	2190	0.681	0.088	230	0.621	0.124	1960	0.688	0.079	-0.067	-9.7%	0.000
Loans/Deposits Ratio	2190	0.999	0.289	230	1.122	0.380	1960	0.984	0.273	0.138	14.0%	0.000
Equity/Assets Ratio	2190	0.091	0.032	230	0.092	0.036	1960	0.091	0.032	0.001	1.1%	0.588
Loan Portfolio												
Real Estate Loan Ratio	2190	0.708	0.151	230	0.674	0.174	1960	0.712	0.148	-0.038	-5.3%	0.002
C&I Loan Ratio	2190	0.160	0.095	230	0.165	0.086	1960	0.159	0.095	0.006	3.8%	0.373
Consumer Loan Ratio	2190	0.080	0.085	230	0.096	0.115	1960	0.078	0.081	0.018	23.1%	0.018
Other Loan Ratio	2190	0.053	0.081	230	0.065	0.099	1960	0.051	0.079	0.014	27.5%	0.042
Loan HHI	2190	0.585	0.150	230	0.560	0.156	1960	0.588	0.150	-0.028	-4.8%	0.009
Regulatory Capital												
Tier I Leverage Ratio	2190	9.324	3.822	230	9.274	7.506	1960	9.330	3.120	-0.056	-0.6%	0.910
Tier I Risk-Based Capital	2190	13.327	6.636	230	12.743	12.168	1960	13.395	5.644	-0.652	-4.9%	0.423
Total Risk-Based Capital	2190	14.836	6.943	230	14.612	12.742	1960	14.862	5.906	-0.250	-1.7%	0.769
Risk Characteristics												
RWATA Ratio	2190	0.712	0.118	230	0.728	0.137	1960	0.710	0.115	0.018	2.5%	0.054
NPL Ratio	2190	0.009	0.008	230	0.010	0.007	1960	0.009	0.008	0.001	11.1%	0.038
Charge-Off Ratio	2190	0.003	0.007	230	0.005	0.012	1960	0.003	0.006	0.002	66.7%	0.017
Loan Loss Provision Ratio	2190	0.004	0.007	230	0.006	0.014	1960	0.004	0.005	0.002	50.0%	0.050
Operating performance												
Return on Assets	2190	0.011	0.007	230	0.012	0.013	1960	0.011	0.005	0.001	9.1%	0.076
Return on Equity	2190	0.124	0.076	230	0.123	0.126	1960	0.124	0.068	-0.001	-0.8%	0.970
Revenue HHI	2190	0.697	0.094	230	0.644	0.098	1960	0.703	0.092	-0.059	-8.4%	0.000
Interest Income/ Net Operating Revenue	2190	0.792	0.108	230	0.713	0.154	1960	0.801	0.097	-0.088	-11.0%	0.000
Securitisation Activity												
Securitised Assets/ Loans Ratio				230	0.144	0.515						
Securitised Assets/ Assets Ratio				230	0.084	0.299						
Credit Enhancements/ Securitised Assets Ratio				196	0.068	0.190						
Credit Enhancements/ Assets Ratio				230	0.003	0.010						

Note: The table presents descriptive statistics for: (i) all BHCs (2,190 banks); (ii) securitisers (230 banks); and (iii) non-securitisers (1,960 banks). *Mean* and *Std Dev* stand for the cross-sectional mean and standard deviation values of the individual bank time-series averages, accordingly. The last three columns report the comparison analysis of bank-specific characteristics between securitisers and non-securitisers. *Diff in Means* is calculated as the difference between securitisers' and non-securitisers' means, in absolute (abs) and percentage (%) values, with the p-values of t-tests on the equality of means reported in the last column.

Further, we consider four risk characteristics of the banks: (i) risk-weighted assets relative to total assets (RWATA); (ii) non-performing loans[35]; (iii) charge-offs[36]; and (iv) loan loss provisions. For the average BHC in the sample, the non-performing loans and charge-offs constitute 0.9% and 0.3% of total loans, respectively. The loan loss provisions constitute 0.4% relative to total loans. Comparing securitisers and non-securitisers, we find that securitisers are more risky according to all the measures used, with the differences being both economically and statistically significant. Similar results are found by Jiangli and Pritsker (2008) and Minton, Stulz and Williamson (2008) with provision, charge-off, and non-performing loan ratios higher for securitisers; Jiangli and Pritsker suggest that this could reflect securitisation and/or size effect in allowing banks to extend loans with higher expected losses.

Finally, we compare performance measures. The results suggest that securitisers have a higher return on assets compared to non-securitisers (1.2% versus 1.1%) with the difference being statistically significant.[37] As for the revenue structure, the interest income constitutes the main source of revenue for both securitisers and non-securitisers (over 70%); however concentration across the sources is lower for securitisers (two-part revenue HHI of 0.64 versus 0.7 for non-securitisers) due to a higher share of non-interest income in their net operating revenue. The latter is consistent with securitisers having an additional source of income in the form of servicing fees and possibly more trading revenue.[38]

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[35] Non-performing loans are defined as loans past due 90 days or more and still accruing interest, and nonaccrual loans.

[36] Net charge-offs are defined as charge-offs minus recoveries.

[37] We find no significant difference in the return on equity between securitisers and non-securitisers, which implies that securitisers have relatively higher equity capital.

[38] Using US bank holding company data from 1999 to 2005, Minton, Stulz and Williamson (2008) find that the net buyers of credit protection have dramatically more trading revenue than other banks.

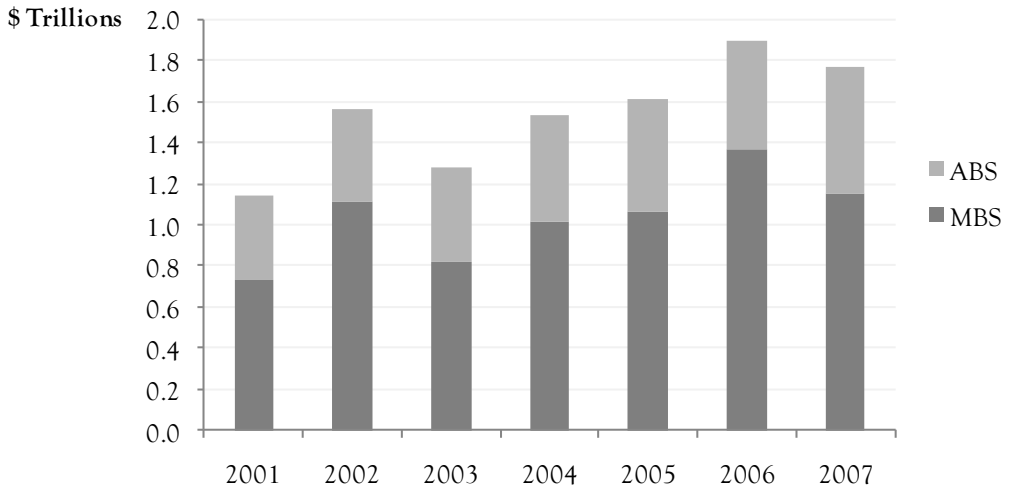
Taken together, these comparisons suggest that securitisers improve their profitability through holding riskier and, hence, more profitable loans in their portfolios and earning a higher share of revenue from non-interest income.

The last panel of Table 5.1 reports statistics on securitisation activities for the sample of securitising banks. The average amount of outstanding securitised assets equals 14.4% of bank's total loans, or 8.4% of total assets. The contractual credit enhancements provided by the banks to securitisation structures constitute, on average, 6.8% of securitised assets, or 0.3% of bank's total assets; these include credit enhancing interest-only strips, subordinated securities and other residual interests, and standby letters of credit.

Figure 5.1 shows the volume of outstanding balances of securitisation for the sample banks broken down into asset-backed and mortgage-backed securitisation for year-ends 2001-2007. It illustrates a general upward trend in total securitisation over the 2001-2007 period, with slight downturns in 2003 and 2007. It is worth noting that the value of securitised mortgages has been fluctuating over the period in general, with the maximum amount of around $1.37 trillion reached at the year-end 2006. However, the value of asset-backed securitisation has been growing steadily throughout the period, with the maximum value of $614 billion reached at year-end 2007 during the crisis of the US subprime mortgage markets.

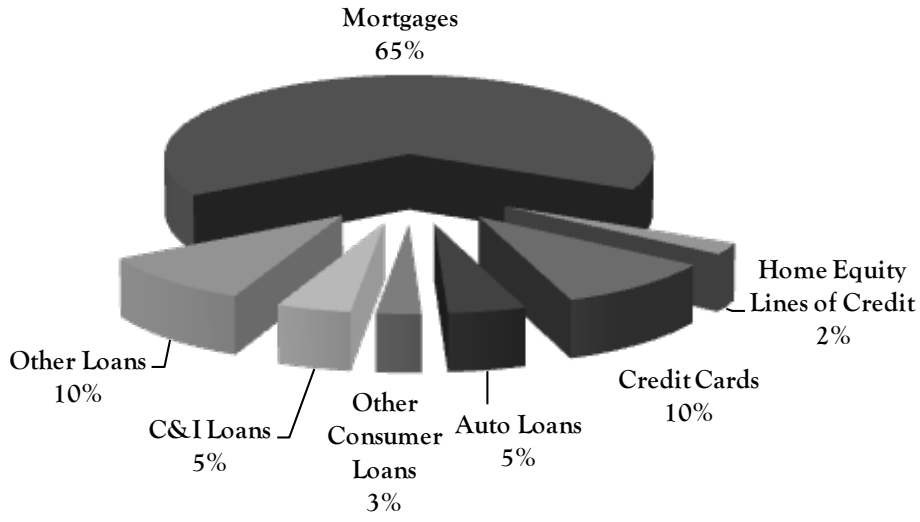
Figure 5.2 presents a breakdown of securitisation by asset type. It shows that mortgage-backed securitisation makes up the majority (i.e., 65%) of total securitisations. All other loans and leases and credit card receivables, major classes in asset-backed securitisation, constitute merely 10% each in total securitisation. As for commercial and industrial loans, auto loans, home equity lines of credit, and other consumer loans, their shares are relatively low and amount to 2-5% of total securitisation.

Figure 5.1 Yearly Values of Securitised Assets



Note: The figure presents the total balance of outstanding securitisation for the sample BHCs for year-ends 2001-2007. Total value of assets securitised is presented as the sum of MBS and ABS values; *MBS* stands for the value of mortgages securitised, while *ABS* indicates the value of securitised receivables other than mortgage loans, such as credit card receivables, auto loans, commercial and industrial loans, and home equity lines of credit. The values are in US$ trillions.

Figure 5.2 Securitisation Breakdown by Asset Type



Note: The figure illustrates the percentage distribution of securitisation by the type of assets securitised derived from the mean values for the sample BHCs. The asset categories are: (i) mortgages; (ii) home equity lines of credit; (iii) credit cards; (iv) auto loans; (v) other consumer loans; (vi) commercial and industrial (C&I) loans; and (vii) all other loans and leases.

5.3 Empirical Specification

We now turn to the empirical analysis to test whether outstanding securitisation has an impact on the risk-taking behaviour of the issuing bank. Our empirical model includes a number of control variables for bank characteristics and activities, which may influence bank risk-taking propensity or aversion (Dionne and Harchaoui, 2003; Stiroh, 2006; Uzun and Webb, 2007). In addition to the bank-specific characteristics, we include real GDP growth to control for macroeconomic effects; while time effects are captured by introducing quarter dummies.

The basic regression is:

$$\Delta CrR_{i,t} = \alpha_i + \beta_1 Sec_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 Loan_{i,t-1} + \beta_4 Cap_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 ChOff_{i,t-1} + \\ + \varphi' GDPG_t + \theta' Quarter_t + \varepsilon_{i,t} \quad (5.1)$$

where β, φ, and θ reflect the extent to which the relative factor of the model contributes to the change in the dependent variable, and $\varepsilon_{i,t}$ represents the error term for bank i in quarter t. The dependent variable, $\Delta CrR_{i,t}$, is the change in the credit risk of bank i's portfolio in period t; $Sec_{i,t-1}$ is securitisation; $Size_{i,t-1}$ is bank size; $Loan_{i,t-1}$ is loan ratio; $Cap_{i,t-1}$ is equity capital ratio; $ROA_{i,t-1}$ is return on assets; $ChOff_{i,t-1}$ is charge-off ratio; $GDPG_t$ is real GDP growth; and $Quarter_t$ is quarter dummies. The timing applied in this model is to ensure that the direction of causality goes from the explanatory variables to the dependent variable (Demsetz and Strahan, 1997; Stiroh, 2006). The detailed construction of the model variables and their expected signs are presented in Table 5.2.

Table 5.2 Definition of Model Variables

Variable	Definition	Construction	Expected Sign
CrR	Bank Credit Risk	Risk-Weighted Assets/Total Assets	Dependent Variable
Sec	Securitisation	Outstanding Securitised Assets/Total Assets	Negative
Size	Bank Size	Ln(Total Assets)	Positive
Loan	Loan Ratio	Loans /Total Assets	Negative
Cap	Capital Ratio	Equity Capital/Total Assets	Negative
ROA	Return on Assets	Net Income/Total Assets	Negative
ChOff	Charge-Off Ratio	Net Charge-Offs/Loans	Negative
GDPG	GDP Growth	GDP Real Growth Rate	

Note: This table presents definition, construction, and expected signs on the variables used in this study for the regression of bank credit risk taking. The bank-level balance sheet data are collected from the Federal Reserve's Y-9C reports (See Appendix B for details).

Following Aggarwal and Jacques (2001), Avery and Berger (1990), Berger (1995), Berger and Udell (1994), and Shrieves and Dahl (1992), we primarily measure the credit risk of a bank's portfolio (*CrR*) using a ratio of risk-weighted assets to total assets (RWATA).

Under Basel I, banks assets and off-balance sheet activities are allocated into four categories according to their credit risk: (i) assets with zero default risk (e.g., government securities, reserves); (ii) low-risk assets (e.g., interbank deposits); (iii) assets with medium default risk (e.g., mortgage loans); and (iv) high-risk assets (e.g., commercial loans). Each category is assigned a relative risk weight, ranging from zero to one.

Therefore, a bank's total risk-weighted assets (RWA) are derived as:

RWA = 0*Category I + 0.2*Category II + 0.5*Category III + 1.0*Category IV

Shrieves and Dahl (1992) suggest that the risk-weighted assets to total assets ratio captures two principal features of a bank's portfolio risk, that is, the allocation of assets across risk categories and the quality of loans. Further, Avery and Berger (1990) show that the relative risk weights used in the framework of the risk-based capital standards correlate with risky behaviour and have an adequate informational value in predicting future bank performance problems, such as portfolio losses and bank failures.

Kim and Santomero (1988) argue that banks might be prompted to shift to more risky assets by inefficiencies in regulatory capital requirements. According to this argument, bank risk increases due to the low quality of the assets left on the balance sheet while regulatory capital requirements remain unchanged, a process commonly referred to as "regulatory capital arbitrage".

Our study is different from the previous literature as it covers the period of the development process of Basel II, which supposedly aligns more closely regulatory capital charges on banks' assets, including securitisation positions, and the underlying credit risk. As remarked by Randall S. Kroszner, a member of the Board of Governors of Federal Reserve System, on July 12 2007, there has been "significant progress in risk measurement and management at many banks in the United States and elsewhere as a result of the Basel II development process".[39] Therefore, we hope our results on the effect of securitisation on bank risk-taking behaviour are less biased by regulatory capital arbitrage than previous empirical work.

[39] The Federal Reserve Board Website:
http://www.federalreserve.gov/newsevents/speech/kroszner20070712a.htm

Securitisation (*Sec*) is introduced as a bank's outstanding balance of securitised assets scaled by total assets. If the credit risk exposure arising from the securitised pool makes banks more risk-averse and motivates them to shift their portfolios towards assets of lower credit risk, there should be a negative association between banks' outstanding securitisation and credit risk taking.

Bank size (*Size*), measured as the natural logarithm of total assets, is included to capture its possible impact on bank risk taking through a number of channels, including funding and risk management opportunities. For example, Loutskina (2005) notes that only the largest banks in the US can have a sufficient quantity and homogeneity of loans to access the securitisation market independently of other financial intermediaries.[40] Therefore, given better access to external funds and the credit risk transfer market for large banks, one could expect a positive relation between bank size and its propensity to engage in high risk/return activities.

Additional balance sheet and income statement characteristics of each bank are introduced into the model to control for their possible impact on bank risk taking. From the balance sheet, we include the loan ratio and the capital ratio. The loan ratio (*Loan*) is measured as loans over total assets and reflects the size of a bank's loan portfolio. Considering loans as a bank's higher risk assets, a bank with a larger loan portfolio is expected to be more risk-averse.

Bank capital (*Cap*) is measured as the ratio of equity capital to total assets. Considering capital as a "buffer of uninsured private funds to absorb portfolio losses" (Avery and Berger, 1990) yields two views on the nature of the relationship between bank capital and risk taking. On the one hand, diversified owners which do not have a

[40] A number of studies document that large banks are more likely to securitise assets (Bannier and Haensel, 2007; Karaoglu, 2005; Uzun and Webb, 2007). Jiangli and Pritsker (2008) suggest that this may reflect economies of scale for large banks in underwriting and securitisation, or diseconomies of scale in funding through deposits.

significant fraction of their wealth placed in the bank might tend to advocate more risk taking after collecting funds from bondholders and depositors (Esty, 1998; Laeven and Levine, 2009).[41] On the other hand, managers with bank-specific human capital and private benefits of control might be expected to behave in a risk-averse rather than value maximising way (Demsetz and Lehn, 1985). As argued by Saunders, Strock and Travlos (1990) and Demsetz, Saidenberg and Strahan (1996), managerial ownership should also be taken into account as managers' incentives to engage in risk taking increase along with their shareholdings. However, Anderson and Fraser (2000) show that for US bank holding companies managerial shareholdings and risk taking became inversely related in the early 1990s following additional regulations (i.e., risk-adjusted deposit insurance premium). Therefore, we expect a negative coefficient on the capital ratio variable.

From the income statement, we include return on assets (*ROA*) and the charge-off ratio (*ChOff*) to account for the possible impact of present performance of a bank on its incentive to take on new risks. Particularly, one could argue that poor-performing banks (i.e., ones with a low return on their assets) might pursue risky activities to re-establish profitability. Following this argument, we expect a negative relation between bank profitability and risk. A negative relationship could also be expected between the charge-off ratio and risk taking. The charge-off ratio reflects the asset quality of a loan portfolio. Low quality loans in a preceding quarter (i.e., a high charge-off ratio) should discourage the bank manager from taking on extra risk in the following quarter and motivate investing in low risk/secure return assets.

[41] Stringent regulatory requirements might further contribute to the risk-taking incentives of owners and lead to them favouring riskier portfolios to compensate for the loss of utility (Buser, Chen and Kane, 1981; Koehn and Santomero, 1980).

5.4 Empirical Results

5.4.1 Primary Regression Analysis

We report our results in Table 5.3. The regression analysis is based on the sample of securitisers which contains 5,067 observations for 230 BHCs; however, the second quarter 2001 observations are lost due to differencing and lagging the model variables, which yields 4,837 bank-quarters in the final regression data set. Each regression uses bank fixed effects with standard errors clustered at the BHC level (reported in parentheses).[42] Quarter dummies are incorporated in all of the regressions, but are not reported in the table.[43]

The parameter estimate of most interest in terms of this study is that on securitisation. The coefficient on securitisation is found to be negative and significant at the 1% level. In other words, a greater outstanding securitisation balance is associated with banks choosing to invest in assets with lower credit risk. This evidence supports the proposed hypothesis that securitisation should have a negative effect on the risk-taking behaviour of the issuing bank as a result of credit exposure arising from the securitised pool.

Further examination of the results reported in Table 5.3 reveals that most of the control variables included in the model are statistically significant and have the expected signs. Beginning with bank size, the evidence suggests that larger banks tend to pursue higher risk activities. This is consistent with prior empirical studies and could be linked to the size-related diversification effect described by Demsetz and Strahan (1997).[44]

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[42] Appendix D reports the results of the Hausman specification test.

[43] The adjusted R-squared in the full model is 0.06, which is in line with previous studies on securitisation (e.g., Chen, Liu and Ryan, 2008; Michalak and Uhde, 2009; Panetta and Pozzolo, 2010).

[44] In particular, Demsetz and Strahan (1997) suggest that large bank holding companies use their diversification advantage to operate with greater leverage and to pursue riskier lending.

Table 5.3. Determinants of Bank Credit Risk Taking

	Model 1	Model 2	Model 3
$Sec_{i,t-1}$	-0.006	-0.006	-0.004
	(0.001)***	(0.001)***	(0.001)***
$Size_{i,t-1}$		0.005	0.006
		(-0.004)	(0.004)*
$Loan_{i,t-1}$			-0.118
			(0.014)***
$Cap_{i,t-1}$			-0.01
			(-0.071)
$ROA_{i,t-1}$			-0.027
			(-0.075)
$ChOff_{i,t-1}$			-0.153
			(0.092)*
$GDPG_t$	0.001	0.001	0.000
	(0.000)***	(0.000)***	(0.000)
Constant	-0.001	-0.072	-0.015
	(-0.002)	(-0.056)	(-0.051)
No. of Observations	4837	4837	4837
No. of Banks	230	230	230
Adjusted R^2	0.02	0.02	0.06

Note: The table presents the results of the regression analysis where the dependent variable is the change in credit risk of bank portfolio measured as a change in the risk-weighted assets to total assets ratio (Δ *RWATA)*. The independent variables are: (i) securitisation ratio; (ii) size; (iii) loan ratio; (iv) equity capital ratio; (v) return on assets; (vi) charge-off ratio; (vii) real GDP growth (see Table 5.2 for definitions of the variables and the expected signs). Balance sheet measures used are lagged one quarter. The columns represent three specifications of the regression model with Model 1 and Model 2 using a reduced form of the basic equation (5.1). Fixed effects regressions are run for the full sample of securitisers covering the period from 2001:Q2 to 2007:Q4. Quarter dummies are incorporated in all regressions (not reported). Robust standard errors reported in parentheses are corrected for clustering at the BHC-level. **, **,**** indicate significance at 10%, 5% and 1% levels, respectively.

The parameter estimate on the loan ratio reflects a significant negative impact of the size of the loan portfolio on bank risk taking. Not surprisingly, a greater amount of loans and, therefore, higher on-balance sheet credit risk exposure makes banks more risk-averse. Equity capital has the expected negative effect on bank risk taking; however, it is not statistically significant. The link between bank performance measures and risk taking is negative, as expected, and is statistically significant for the charge-off ratio. This shows that the current performance of a bank influences its risk-taking behaviour. In particular, a bank with a lower quality loan portfolio, captured by a higher charge-off ratio, is more risk-averse.

The result of a significant negative effect of securitisation on bank credit risk taking discussed above is derived using a broad category of securitisation which includes different classes of underlying assets. To examine the impact of securitisation in more detail, we decompose the aggregate measure of bank securitisation activities into seven categories according to the type of assets securitised, and these are: (i) mortgages; (ii) home equity lines of credit; (iii) credit card receivables; (iv) auto loans; (v) other consumer loans; (vi) commercial and industrial loans; and (vii) all other loans and leases.

For this part of the analysis, securitising banks are classified in the following way: a bank is considered as a mortgage securitiser if we observe outstanding mortgage securitisation in any quarter of its lifetime in the sample. The same definition applies to securitisers of other types of assets. We re-estimate equation (5.1) using the outstanding amount of securitised assets scaled by total assets for each of the aforementioned loan types. A bank is included in each asset-specific regression only if it is considered as a securitiser for the relevant asset type. The results of the regressions are presented in Table 5.4.

Table 5.4. Testing Securitisation by Asset Type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Sec_{i,t-1}$	-0.004***							
	(0.001)							
$Mortgages_{i,t-1}$		-0.004***						
		(0.001)						
Home Equity Lines of Credit $_{i,t-1}$			-0.388***					
			(0.109)					
Credit Card Receivables $_{i,t-1}$				-0.062				
				(0.060)				
Auto Loans $_{i,t-1}$					0.018			
					(0.027)			
Other Consumer Loans $_{i,t-1}$						-0.205**		
						(0.097)		
C&I Loans $_{i,t-1}$							-0.063	
							(0.053)	
Other Loans and Leases $_{i,t-1}$								-0.020
								(0.053)
$Size_{i,t-1}$	0.006*	0.009**	0.031***	0.002	0.010	0.028***	0.019**	0.006
	(0.004)	(0.005)	(0.009)	(0.006)	(0.010)	(0.008)	(0.009)	(0.006)
$Loan_{i,t-1}$	-0.118***	-0.103***	-0.147***	-0.138***	-0.115***	-0.084***	-0.194***	-0.179***
	(0.014)	(0.015)	(0.034)	(0.035)	(0.033)	(0.030)	(0.029)	(0.028)
$Cap_{i,t-1}$	-0.010	-0.098	-0.255**	-0.168	0.077	-0.273*	-0.278**	-0.138
	(0.071)	(0.060)	(0.111)	(0.113)	(0.092)	(0.147)	(0.119)	(0.097)
$ROA_{i,t-1}$	-0.027	0.163	-0.231	0.031	-0.079	-0.434	-0.001	-0.048
	(0.075)	(0.158)	(0.470)	(0.161)	(0.097)	(0.336)	(0.443)	(0.275)
$ChOff_{i,t-1}$	-0.153*	-0.074	-0.026	-0.228	-0.211	-0.121	-0.349	0.094
	(0.092)	(0.252)	(0.432)	(0.139)	(0.253)	(0.332)	(0.249)	(0.326)
$GDPG_t$	0.000	0.000	0.003**	0.001	0.002*	0.002	-0.000	0.001
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.015	-0.058	-0.437***	0.075	-0.121	-0.433***	-0.157	0.034
	(0.051)	(0.067)	(0.137)	(0.099)	(0.181)	(0.126)	(0.139)	(0.097)
No. of Observations	4837	3605	542	775	722	453	712	1047
No. of Banks	230	176	27	37	34	23	32	47
Adjusted R^2	0.056	0.049	0.151	0.084	0.090	0.102	0.101	0.120

Note: The table presents the results of regressions of bank credit risk taking (Δ *RWATA*) on securitisation activities by type of assets securitised, with the first column reporting the basic regression model. Columns 2-8 represent seven specifications of the basic regression model using the following categories of securitised assets: (i) mortgages; (ii) home equity lines of credit; (iii) credit card receivables; (iv) auto loans; (v) other consumer loans; (vi) C&I, or commercial and industrial loans; (vii) all other loans and leases. The sample covers the period from 2001:Q2 to 2007:Q4; quarter dummies are incorporated in all regressions (not reported). Robust standard errors reported in parentheses are corrected for clustering at the BHC-level. *, **,*** indicate significance at 10%, 5% and 1% levels, respectively.

Examining securitisations by the underlying asset type shows that they differ in their effect on the risk-taking behaviour of banks. In particular, the results suggest that securitisations of mortgages, home equity lines of credit, and other consumer loans have a negative and statistically significant effect on bank credit risk taking; among these, credit risk taking is associated most negatively with securitised home equity lines of credit. Similarly, the effect of securitised credit card receivables, commercial and industrial loans, and all other loans and leases is negative, however, not statistically significant. In contrast, the parameter estimate for securitisations of auto loans is found to be positive, but insignificant statistically.

5.4.2 Robustness Tests

To verify the evidence of a negative relation between outstanding securitisation and credit risk taking presented above, we perform a number of robustness tests that either examine sub-samples of the data or use alternative data definitions. Table 5.5 reports these results, where the first column reports the estimates for the full sample for ease of comparison.

One possible concern is that the results might differ across banks of different size. To examine this argument, we split the sample into two sub-samples: small banks and large banks. Following Loutskina (2005), we assign a bank-quarter to a group of small banks if its size is in the bottom 75% of the size distribution, and to the group of large banks if size is in the top 10% of the size distribution. The sub-samples contain 3,621 and 486 bank-quarters, accordingly. Beginning with the small banks, the coefficient on securitisation changes very little remaining negative and statistically significant. For the large banks, the coefficient remains negative; however, it is four times larger than that for the full sample and not statistically significant.

Table 5.5 Robustness Tests for the Determinants of Bank Credit Risk Taking

	(1) Δ RWATA				(2) Δ NPATA	(3) Δ RWATA
	All Banks	Small Banks	Large Banks	2001-2006	All Banks	All Banks
$Sec_{i,t-1}$	-0.0036	-0.003	-0.015	-0.0036	-0.0002	
	(0.0009)***	(0.0007)***	(-0.011)	(0.0010)**	(0.0001)**	
Credit Enhancements $_{i,t-1}$						-0.49
						(0.1298)***
$Size_{i,t-1}$	0.0065	0.0041	0.0288	0.0076	0.001	0.005
	(0.0036)*	(-0.0035)	(0.0089)***	(0.0043)*	(0.0003)***	(-0.0037)
$Loan_{i,t-1}$	-0.1178	-0.1297	-0.0928	-0.135	0.0019	-0.1538
	(0.0141)***	(0.0163)***	(0.0277)***	(0.0171)**	(-0.0015)	(0.0159)***
$Cap_{i,t-1}$	-0.0097	0.0214	-0.4945	0.0183	-0.005	-0.1079
	(-0.0711)	(-0.069)	(0.1351)***	(-0.0821)	(-0.0049)	(0.0380)***
$ROA_{i,t-1}$	-0.0268	-0.0857	0.4177	-0.0122	-0.0443	0.1239
	(-0.0751)	(-0.0683)	(-0.5776)	(-0.0882)	(-0.03)	(-0.1019)
$ChOff_{i,t-1}$	-0.1534	-0.1032	-0.281	-0.1143	-0.01	-0.6124
	(0.0923)*	(-0.0892)	(-0.4573)	(-0.1032)	(-0.0164)	(0.1263)***
$GDPG_{t}$	0.0005	0.0000	0.0010	0.0003	-0.0001	-0.0003
	(-0.0004)	(-0.0004)	(-0.0011)	(-0.0004)	(0.0000)***	(-0.0004)
Constant	-0.0151	0.0333	-0.4529	-0.0227	-0.0143	0.0446
	(-0.0514)	(-0.0492)	(0.1571)***	(-0.0608)	(0.0046)***	(-0.0549)
No. of Observations	4837	3621	486	4271	4837	3483
No. of Banks	230	181	25	230	230	229
Adjusted R^2	0.056	0.06	0.12	0.064	0.039	0.068

Note: Fixed effects regressions of bank risk taking on the following regressors: (i) securitisation ratio; (ii) size; (iii) loan ratio; (iv) equity capital ratio; (v) return on assets; (vi) charge-off ratio; (vii) real GDP growth; and (viii) quarter dummies (not reported). All the balance sheet measures are lagged one quarter. Column 1 represents four specifications of the basic model based on: (i) full sample; (ii) sub-sample of small banks; (iii) sub-sample of large banks; and (iv) sub-period 2001:Q2-2006:Q4. Column 2 uses the change in the non-performing assets to total assets ratio (Δ *NPATA*) as the dependent variable. Column 3 uses a credit exposure proxy (*Credit Enhancements*) as a substitute for the securitisation ratio in the basic regression model. Robust standard errors reported in parentheses are corrected for clustering at the BHC-level. *, **, *** indicate significance at 10%, 5% and 1% levels, respectively.

A second possible concern is that the results might be affected by the onset of the US subprime mortgage crisis. To address this concern, we drop the 2007-year observations and re-estimate the regression for the 4,271 observations from the second quarter of 2001 to the fourth quarter of 2006. The results remain qualitatively unchanged.

A third concern is that the risk-weighted assets to total assets ratio might be inefficient in capturing the true credit risk position of a bank. As suggested by the capital arbitrage hypothesis, banks might shift towards riskier assets within regulatory risk bands. To test this argument, we use a ratio of non-performing assets to total assets (NPATA) as a measure of bank credit risk; this should reflect the true riskiness of a bank's portfolio given its backward-looking aspect.[45] The results remain unchanged, indicating a negative relation between securitisation and the non-performing assets to total assets ratio, and, therefore, confirm our finding that securitisation leads to banks choosing portfolios of lower credit risk.

Finally, we test the "recourse hypothesis": we suggest that the negative relationship between outstanding securitisation and credit risk taking may be the result of the credit risk exposure arising from the securitised assets through recourse. As discussed earlier, recourse can be provided explicitly and/or implicitly. The implicit nature of the latter eliminates the possibility of its identification and, therefore, measuring its magnitude. The explicit recourse is, however, reported by US banks and, therefore, can be tested. In particular, we use the ratio of credit enhancements provided by the originating bank to securitisation structures (i.e., the sum of credit enhancing interest-only strips, subordinated securities, and standby letters of credit) scaled by the bank's total assets as a proxy for the credit exposure arising from the securitised assets.

[45] We use non-performing asset ratio (non-performing assets scaled by total assets) rather than non-performing loan ratio as we aim to test the change in the riskiness of bank's total assets and not just loans. The former additionally incorporates non-performing debt securities and other assets. See Appendix B for details.

We re-estimate the main regression substituting the credit exposure proxy for the outstanding securitisation. The results show that the credit exposure arising from securitised assets has a negative and statistically significant impact on bank risk taking and, therefore, provide evidence for the proposed recourse hypothesis. In addition, the variation in the effect of securitisation across different underlying asset classes, found in Table 5.4, provides further support for the proposed hypothesis. As suggested by Chen, Liu and Ryan (2008), banks are likely to retain less risk, through both contractual and non-contractual arrangements, in mortgage-backed securitisations due to relatively low and easy externally verifiable credit risk of mortgage loans. This could explain mortgage securitisations having a smaller impact on the risk-aversion of the issuers compared to securitisations of home equity lines of credit. Additionally, mortgages are close-ended loans as opposed to revolving loans, such as home equity lines of credit, which makes securitisations of the latter more implicit recourse requiring (Chen, Liu and Ryan, 2008; Higgins and Mason, 2004).

5.5 Conclusions

This essay investigated the impact of securitisation on the credit-risk taking behaviour of US bank holding companies during the period from 2001 to 2007.

The empirical results indicate a significant negative impact of securitisation on bank credit risk taking, suggesting that banks with a greater amount of assets securitised are more risk-averse in their activities. Examining securitisation by the type of underlying assets suggests that the negative relationship between securitisation and risk taking is primarily driven by securitisations of mortgages, home equity lines of credit, and other consumer loans; among these, credit risk taking is associated most negatively with securitised home equity lines of credit. Securitisations of all other types of assets seem to have no significant impact on bank credit-risk taking behaviour. We explain these findings by the “recourse hypothesis”. This arises because issuing banks

commonly provide recourse, explicitly and/or implicitly, in securitisation transactions, which in turn might differ depending on the securitisation structure and, specifically, on the underlying assets.

Taken as a whole, securitisation activities are found to have a negative impact on the credit-risk taking behaviour of banks. However, if the proposed recourse hypothesis is correct, the credit risk-reducing effect of securitisation might be offset by banks' greater risk arising from the securitised pool. Therefore, the net impact of securitisation on the riskiness of issuing banks is ambiguous and will depend on the structure of transactions, in particular, on the relative magnitude of credit support provided by banks.

Several recent proposals suggest requiring originating banks to retain exposure to securitisations, through a tranche or a vertical slice of the portfolio, to better align the incentives in the market.[46] In this regard, this study contributes to the ongoing discussions by showing that, while the net risk transfer through securitisation for originating banks might be ambiguous due to retained interests, banks do account for the consequently arising exposure reducing credit risk taking.

[46] See Fender and Mitchell (2009b) for discussion.

6 ESSAY III: SECURITISATION STRUCTURE AND BANK INSOLVENCY RISK

6.1 Introduction

The financial crisis of 2007-2009 has exposed the risks inherent in securitisation. It has shown that the incentive structure of securitisation created adverse selection and moral hazard problems, as well as a lack of transparency and assessment of credit risks. Lenders lacked incentives to screen and monitor borrowers, as lending decisions were made with the assumption that the risks of such transactions would be passed onto third-party investors. Eventually, this led to widespread problems in the banking sector.

Proper alignment of incentives in securitisation is likely to remain the key issue for policy-makers and market practitioners in their attempt to recover the market from the financial crisis. A number of proposals have been issued requiring originating institutions to retain some exposure in connection to the assets they securitise, the so called skin in the game.[47] However, as has been revealed by the crisis, it is important to fully understand the potential risk implications of the retained interest for the originating institutions and, thereby for the banking system, along with its potential in reducing the incentive problem in the securitisation process.

This essay aims to examine the relationship between banks' involvement in their off-balance sheet securitisation structures and insolvency risk, with a particular focus on credit enhancement and liquidity support provided by the banks. Additionally, it examines the risk effect of credit-enhancing facilities and liquidity commitments provided by banks to securitisation structures of other institutions.

[47] See Fender and Mitchell (2009b) for discussion.

Theoretical studies on interest retention in securitisation mainly focus on the impact it has on the monitoring and screening effort by the originating institution. In particular, early studies by Gorton and Pennacchi (1995) and Pennacchi (1988) suggest that retention of interest in securitised assets helps to mitigate the moral hazard problem arising from originators having less incentive to efficiently monitor and service loans after they have been sold. A recent study by Fender and Mitchell (2009a) attempts to examine the impact of interest retention on the originator's screening effort when the originator plans to securitise the loans. In a theoretical analysis, the authors find that contractual mechanisms, including holding an equity tranche, a mezzanine tranche, or a "vertical" slice of the portfolio (a share of the entire portfolio), do affect the screening effort by the originating institution; however, the effect varies across the arrangements depending on their sensitivities to systemic risk factors.

Another strand of research has analysed the implications of interests retained in connection to the securitised assets for the originating institutions (Calomiris and Mason, 2004; Landsman, Peasnell and Shakespeare, 2006; Standard and Poor's, 2001; Wolfe, 2004). The evidence across the studies is consistent and suggests that retention of interest, including contractual and non-contractual credit enhancements, leads to the risk remaining with securitising banks. However, little research has been done to assess the effect that different credit-enhancing arrangements and liquidity provisions provided by banks in their securitisations have on the soundness of the banks. Further, to our knowledge, the risk effects of credit enhancement and liquidity support provided to third-party securitisations have not been studied previously.

The most related prior study is by Chen, Liu and Ryan (2008), which provides evidence that certain general characteristics of banks' loan securitisations determine the extent to which banks retain risks in connection to the off-balance sheet securitised assets. In a risk-association analysis applied to US bank holding company data for 2001-2006, the authors find that banks retain more risk when: (i) the types of loans have

higher and/or less externally verifiable credit risk; (ii) the loans are closed-ended and banks retain larger contractual interests in the loans; and (iii) the loans are closed-ended and banks retain types of contractual interests that more strongly concentrate the risk of the securitised loans.[48]

Our research is different from that of Chen, Liu and Ryan (2008) in three ways that yield the contributions of our study to the literature. First, unlike that study we do not attempt to identify the characteristics of banks' loan securitisations that are associated with a market measure of their equity risk and quantify those associations. We focus on analysing the relationship between banks' securitisation activities and insolvency risk measured as a bank's distance to default (a z-score measure). Second, we consider a wider range of securitisation characteristics. Specifically, aside from credit-enhancing interest-only strips and retained subordinated securities analysed in Chen, Liu and Ryan (2008), we additionally examine standby letters of credit, seller's interest, and liquidity provisions. Finally, we examine credit enhancements and liquidity commitments provided to other institutions' securitisation structures. These analyses provide wider insights into banks' securitisation activities and make a valuable contribution to the existing research on securitisation.

Specifically, this study attempts to address the following research questions: (i) Does outstanding securitisation representing assumed implicit guarantees affect insolvency risk of originating banks? (ii) Does credit enhancement provided by originating banks to their securitisation structures affect insolvency risk of these banks? Does the effect differ across different forms of enhancement? (iii) Does liquidity support provided by originating banks to their securitisation structures affect insolvency risk of the banks? (iv) Does seller's interest retained by originating banks in their

[48] The three research hypotheses of the study are tested by estimating the association of a measure of banks' equity risk measured as future stock return volatility with the characteristics of their loan securitisations.

securitisation structures affect insolvency risk of the banks? (v) Does credit enhancement provided to securitisation structures of other institutions affect insolvency risk of the providing banks? (vi) Does the liquidity support provided to securitisation structures of other institutions affect insolvency risk of the providing banks?

Using US bank holding company data for the period from 2002 to 2007, we first find that credit enhancements provided by originating banks in their securitisation structures have a significant positive effect on insolvency risk of these banks. Second, examining credit enhancements by the form of underlying facility, we find that among credit-enhancing interest-only strips, subordinated securities, and standby letters of credit, the latter have the greatest positive association with bank insolvency risk, statistically significant at one per cent level. In contrast, liquidity provisions are found to have a significant risk-reducing effect. Finally, examining credit and liquidity support provided by banks to third-party securitisation structures, we find that credit enhancing third-party securitisations reduces insolvency risk of banks, while liquidity provisions are found to be highly positively associated with bank insolvency.

The evidence provided in this study contributes to a deeper understanding of the risks arising from various forms of banks' engagement in securitisation activities and consequent financial stability implications. The findings are particularly valuable in light of the ongoing policy debate on the originating banks' involvement in securitisations.

The remainder of this essay is organised as follows: Section 6.2 describes the data and provides brief descriptive statistics of the sample; the empirical specification is presented in Section 6.3; Section 6.4 reports the results of the analysis; finally, Section 6.5 discusses the findings and concludes the essay.

6.2 Data and Descriptive Statistics

6.2.1 Data and Sample Selection

To study the effect of securitisation on bank insolvency risk, we use US bank holding company (BHC) data from Y-9C forms obtained from the Federal Reserve Bank of Chicago.[49] The Y-9C reports are filed by all BHCs since 1986 and collate quarterly bank financial data on a consolidated basis in the form of a balance sheet, an income statement, and detailed supporting schedules, including a schedule of off-balance sheet items.

Since June 2001, US banks have been required to provide detailed information on their securitisation activities in the regulatory forms. Specifically, banks are required to report the following items on the securitisation schedule (Schedule HC-S of the Y-9C report): (i) securitised assets, as an outstanding principal balance of assets sold and securitised with servicing retained or with recourse or other seller-provided credit enhancements; (ii) maximum credit exposure arising from recourse or other seller-provided credit enhancements provided to the reported securitisation structures in the form of (a) credit-enhancing interest-only strips, (b) subordinated securities and other residual interests, and (c) standby letters of credit and other enhancements;[50] (iii) unused commitments to provide liquidity to securitisation structures; (iv) past due amounts, charge-offs, and recoveries on the securitised assets; (v) seller's interests in the form of securities and loans[51]; (vi) past due amounts, charge-offs, and recoveries in seller's interests.

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[49] As in chapter 5, we use data for bank holding companies rather than for commercial banks because risk and capital management are typically administered at the highest level of the financial group. Additionally, securitisation may involve several subsidiaries of a BHC and affect capital and liquidity planning for the whole group (Aggarwal and Jacques, 2001; Thomas and Wang, 2004).

[50] Credit-enhancing interest-only strips are reported from the second quarter of 2001; subordinated securities and standby letters of credit are reported from the first quarter of 2003.

[51] Seller's interest is reported only for mortgage, home equity line, and credit card securitisations.

The schedule also provides information on: (i) maximum amount of credit exposure arising from credit enhancements provided by the reporting institution to other institutions' securitisation structures (an aggregate measure of credit enhancements including standby letters of credit, purchased subordinated securities, and other enhancements); and (ii) reporting institution's unused commitments to provide liquidity to other institutions' securitisation structures.

The data on securitisation activities are reported broken down into seven categories according to the underlying assets: (i) 1-4 family residential loans; (ii) home equity lines; (iii) credit card receivables; (iv) auto loans; (v) other consumer loans; (vi) commercial and industrial loans; and (viii) all other loans, all leases, and all other assets.

The incorporation of the new data into the Y-9C reporting forms and the empirical design of this study determine year 2002 as the start date of the sample period, which yields 24 quarters from the first quarter of 2002 to the fourth quarter of 2007.

When constructing the data set, we excluded banks with missing information on total assets, liquidity, loans, deposits, capital, and securitisation activities for any quarter of the sample period. When banks go through a merger or an acquisition, we maintain the code of the acquiring BHC while the acquired bank is eliminated from the sample. Further, to prevent the possibility of outliers driving the results, we exclude all bank-quarters with asset growth over the last quarter exceeding 50% and loan growth exceeding 100%. We also exclude banks with data for less than 2 full years. We then assign a bank as a securitiser if there is a non-zero outstanding securitisation in at least one quarter and keep only securitising banks in the final data set. This yields 3,668 bank-quarters (917 bank-years) for 194 securitising BHCs.

6.2.2 Descriptive Statistics

Before turning to the main regression analysis, we analyse the sample banks along: (i) balance sheet structure; (ii) loan portfolio; (iii) regulatory capital; (iv) risk; (v) operating performance; and (vi) securitisation activities.[52] In doing, so we use quarterly data to calculate time-series averages for each BHC, which are then used to obtain the statistics for the sample. Results of the descriptive analysis are presented in tables 6.1-6.3.

Table 6.1 reports full sample statistics on the balance sheet structure, loan portfolio, regulatory capital, risk, and operating performance. Looking at the first panel of Table 6.1, we find that the average assets for the sample BHCs have a mean of over $47 billion and a wide range from $0.4 billion to $1,541 billion. Further, the sample banks hold, on average, 26% of total assets in the form of liquid assets and around 1% in the form of trading assets. Originated loans constitute around 64% of BHCs' total assets.

Looking at the loan composition in the second panel of Table 6.1, we find that real estate loans constitute the main asset class in the banks' loan portfolios (67% of total loans), followed by commercial and industrial loans (16% of total loans), while consumer and other loans make up around 10% and 8%, accordingly. As a whole, banks' loan portfolios are diversified as suggested by the mean loan Herfindahl-Hirschman Index (HHI) of 0.56. [53]

[52] The construction of the variables is described in detail in Appendix B.

[53] Loan Herfindahl-Hirschman Index (HHI) is calculated using four loan categories: (i) real estate loans, (ii) commercial and industrial loans, (iii) consumer loans, and (iv) other loans; a higher HHI value indicates higher loan portfolio concentration.

Table 6.1 Sample Descriptive Statistics

	Full Sample			
Variable	**Mean**	**StdDev**	**Min**	**Max**
Balance Sheet Structure				
Total Assets ($ billions)	47.1847	174.3366	0.0401	1514.0439
Liquidity Ratio	0.2547	0.1187	0.0426	0.6778
Loan Ratio	0.6428	0.1414	0.0638	0.8936
Trading Assets/Assets Ratio	0.0122	0.0403	0.0000	0.2915
Deposits/Assets Ratio	0.6083	0.1377	0.0219	0.8472
Equity/Assets Ratio	0.0970	0.0577	0.0403	0.6684
Loan Portfolio				
Real Estate Loan Ratio	0.6667	0.1913	0.0004	0.9914
C&I Loan Ratio	0.1611	0.0838	0.0000	0.5750
Consumer Loan Ratio	0.0951	0.1177	0.0000	0.9079
Other Loan Ratio	0.0771	0.1278	0.0000	0.9699
Loan HHI	0.5627	0.1637	0.2716	0.9830
Regulatory Capital				
Tier I Leverage Ratio	9.9122	9.9193	3.4890	128.5069
Tier I Risk-Based Capital Ratio	13.7379	15.9813	4.0330	209.6163
Total Risk-Based Capital Ratio	15.7320	16.6774	5.3355	224.6125
Operating Performance				
Interest Income/ Net Operating Revenue	0.6954	0.1746	0.0261	0.9718
Revenue HHI	0.6440	0.0998	0.5005	0.9665
Interest Margin	0.0215	0.0082	0.0056	0.1106
ROA	0.0131	0.0164	-0.0194	0.1955
ROE	0.1206	0.1609	-1.9044	0.5340
Risk Characteristics				
RWATA Ratio	0.7339	0.1173	0.4232	1.0498
NPL/Loans Ratio	0.0099	0.0074	0.0000	0.0426
Charge-Off Ratio	0.0028	0.0076	-0.0007	0.0988
Loan Loss Allowance Ratio	0.0148	0.0148	0.0019	0.2074
Loan Loss Provision Ratio	0.0014	0.0036	-0.0002	0.0473
Z-Score	47.4968	47.2790	2.3823	444.2055
RAROA	5.3958	6.1692	-0.8321	58.4938
StdDevROA	0.0052	0.0097	0.0002	0.0863
RAROE	5.0489	6.4688	-0.8669	71.6062
StdDevROE	0.1019	0.6571	0.0021	9.1648
StdDevNPL	0.0046	0.0047	0.0001	0.0307
No. of BHCs (Bank-Quarters)	194 (3668)			

Note: The table presents general descriptive statistics for the full sample of 194 banks. *Mean*, *Std Dev*, *Min*, and *Max* stand for the cross-sectional mean, standard deviation, minimum and maximum values of the individual bank time-series averages, accordingly. For the definition and construction of the variables see Appendix B.

Turning to the liability side, the sample banks are mainly financed by deposits, which constitute around 61% of total assets; the capitalisation of the sample BHCs is around 10%. Looking at the regulatory capital in the third panel of Table 6.1, we see that the sample BHCs tend to be relatively highly capitalised (e.g., 15.7% for the total risk-based capital ratio).

We next consider banks' performance measures reported in the fourth panel of Table 6.1. The results suggest that the interest income constitutes the main source of revenue for the sample banks (around 70%) with the two-part revenue HHI of 0.64. As for the net income, it constitutes, on average, 12% of equity or 1.3% of total assets of the sample banks.

The last panel of Table 6.1 reports the risk characteristics of the banks. We find that for the average BHC in the sample the risk-weighted assets to total assets (RWATA) ratio equals 0.73. Non-performing loans and charge-offs constitute 1% and 0.3% of total loans, respectively, while the loan loss provisions constitute 0.1% relative to total loans.

We next proceed to securitisation statistics for the full sample reported in Table 6.2. Looking at the first panel of Table 6.2, one can see considerable variation in the amount of outstanding securitised assets, ranging from zero to 317% of total assets with the mean value of 9%. This magnitude of variation is mainly driven by mortgage securitisation, which is also the major securitisation type for the sample (6.6% of total assets) followed by credit card securitisations (1.3% of total assets).

Table 6.2 Statistics for Securitisation Activity

	Full Sample			
Variable	**Mean**	**StdDev**	**Min**	**Max**
Securitisation Activity				
Sec/Assets Ratio	9.05	31.56	0.00	317.02
MortSec/Assets Ratio	6.57	29.12	0.00	316.07
HELSec/Assets Ratio	0.17	1.20	0.00	15.57
CCSec/Assets Ratio	1.31	10.26	0.00	133.33
AutoSec/Assets Ratio	0.22	1.24	0.00	13.79
OthConsSec/Assets Ratio	0.22	1.59	0.00	18.82
CISec/Assets Ratio	0.10	0.43	0.00	2.98
OthSec/Assets Ratio	0.45	3.00	0.00	39.58
Credit Enhancements				
SecExp Ratio	0.25	0.85	0.00	6.91
CEI Ratio	0.08	0.40	0.00	3.78
CEIMort Ratio	0.05	0.37	0.00	3.78
CEIHEL Ratio	0.00	0.01	0.00	0.07
CEICC Ratio	0.02	0.14	0.00	1.81
CEIAuto Ratio	0.01	0.04	0.00	0.33
CEIOthCon Ratio	0.00	0.02	0.00	0.21
CEICI Ratio	0.00	0.01	0.00	0.10
CEIOth Ratio	0.00	0.01	0.00	0.10
SubSec Ratio	0.13	0.52	0.00	5.26
SubSecMort Ratio	0.03	0.15	0.00	1.67
SubSecHEL Ratio	0.01	0.06	0.00	0.67
SubSecCC Ratio	0.05	0.31	0.00	3.82
SubSecAuto Ratio	0.00	0.01	0.00	0.06
SubSecOthCons Ratio	0.02	0.20	0.00	2.38
SubSecCI Ratio	0.00	0.01	0.00	0.12
SubSecOth Ratio	0.02	0.19	0.00	2.65
SLC Ratio	0.09	0.64	0.00	7.45
SLCMort Ratio	0.07	0.64	0.00	7.45
SLCHEL Ratio	0.00	0.01	0.00	0.07
SLCCC Ratio	0.00	0.00	0.00	0.03
SLCAuto Ratio	0.00	0.02	0.00	0.23
SLCOthCons Ratio	0.00	0.00	0.00	0.02
SLCCI Ratio	0.00	0.01	0.00	0.12
SLCOth Ratio	0.01	0.06	0.00	0.87

(continued on next page)

Table 6.2 (continued)

	Full Sample			
Variable	**Mean**	**StdDev**	**Min**	**Max**
Liquidity Provisions				
LiqProv Ratio	0.03	0.22	0.00	2.77
LiqProvMort Ratio	0.00	0.01	0.00	0.08
LiqProvHEL Ratio	0.00	0.04	0.00	0.49
LiqProvCC Ratio	0.00	0.00	0.00	0.01
LiqProvAuto Ratio	0.00	0.01	0.00	0.18
LiqProvOthCons Ratio	0.02	0.20	0.00	2.74
LiqProvCI Ratio	0.00	0.00	0.00	0.03
LiqProvOth Ratio	0.01	0.07	0.00	0.85
Seller's Interest				
SellerInterest Ratio	0.32	1.84	0.00	20.96
SellerInterestHEL Ratio	0.02	0.24	0.00	3.32
SellerInterestCC Ratio	0.29	1.77	0.00	20.44
SellerInterestCI Ratio	0.01	0.11	0.00	1.19
Other Institutions' Securitisations				
OthersSecExp Ratio	0.04	0.47	0.00	6.54
OthersSecExpMort Ratio	0.03	0.47	0.00	6.54
OthersSecExpHEL Ratio	0.00	0.00	0.00	0.00
OthersSecExpCC Ratio	0.00	0.00	0.00	0.03
OthersSecExpAuto Ratio	0.00	0.00	0.00	0.01
OthersSecExpOthCons Ratio	0.00	0.00	0.00	0.01
OthersSecExpCI Ratio	0.00	0.00	0.00	0.04
OthersSecExpOth Ratio	0.00	0.01	0.00	0.16
OthersSecLiqProv Ratio	0.02	0.21	0.00	2.97
OthersSecLiqProvMort Ratio	0.00	0.00	0.00	0.01
OthersSecLiqProvHEL Ratio	0.00	0.00	0.00	0.00
OthersSecLiqProvCC Ratio	0.00	0.02	0.00	0.27
OthersSecLiqProvAuto Ratio	0.00	0.03	0.00	0.35
OthersSecLiqProvOthCons Ratio	0.00	0.00	0.00	0.03
OthersSecLiqProvCI Ratio	0.00	0.04	0.00	0.51
OthersSecLiqProvOth Ratio	0.01	0.15	0.00	2.05
No. of BHCs (Bank-Quarters)	194 (3668)			

Note: The table presents statistics on securitisation activities of 194 sample banks. *Mean*, *Std Dev*, *Min*, and *Max* stand for the cross-sectional mean, standard deviation, minimum and maximum values (in %) of the individual bank time-series averages, accordingly. For the definition and construction of the variables see Appendix B.

The second panel of Table 6.2 reports statistics on the credit enhancements provided by banks to their own securitisation structures. The results show that the credit exposure arising from credit enhancements constitutes, on average, 0.25% of total assets; this includes an average of 0.08% in the form of credit-enhancing interest-only strips, 0.13% in the form of subordinated securities and other residual interests, and 0.09% in the form of standby letters of credit. The next two panels of Table 6.2 show that the mean of liquidity provisions is 0.03%, while that of the seller's interest is around 0.3% of total assets.[54]

The last panel of Table 6.2 contains information on banks' engagement in other institutions' securitisation structures. We find that the credit exposure arising from credit enhancements provided to other institutions' securitisations constitutes 0.04% of banks' total assets, which is significantly lower than the exposure arising from banks' own securitisation structures; however, banks' commitments to provide liquidity to third-party securitisations are close in the relative size to those provided to their own structures constituting 0.02% of total assets.

To analyse banks' securitisation activities not diluted by zero securitisation values, Table 6.3 provides statistics for observations with: (i) non-zero total outstanding securitisation; (ii) non-zero mortgage securitisation; (iii) non-zero home equity line securitisation; (iv) non-zero credit card securitisation; (v) non-zero auto securitisation; (vi) non-zero other consumer loan securitisation; (vii) non-zero commercial and industrial securitisation; and (viii) non-zero all other loans, leases, and assets securitisation.

First, looking at the statistics on the number of banks across the securitised asset classes in Table 6.3, one can see that most of the sample banks conduct mortgage securitisations (140 BHCs), followed by securitisations of other loans and leases (44

[54] Seller's interest in mortgage, home equity line, and credit card securitisations.

BHCs); the number of banks conducting the other types of securitisations is relatively similar and ranges from 21 banks for other consumer loan securitisation to 32 banks for home equity line and credit card securitisations.[55]

Examining the results for observations with non-zero total securitisation presented in the first column of Table 6.3, we find that the mean of outstanding securitisation constitutes around 13% of banks' total assets. Mean credit enhancements provided to banks' own securitisations constitute around 0.3% of total assets, or around 6% of outstanding securitisation balance. Of those 6%, 2% are attributable to credit-enhancing interest-only strips, around 3% are attributable to retained subordinated securities, and around 2% are attributable to standby letters of credit. Banks' commitments to provide liquidity to their own securitisations constitute 0.03% of total assets, or 1% of outstanding securitisation; ownership (or seller's) interest carried in the form of securities and/or loans is around 0.4% of total assets, or 2% of outstanding securitisation. Interestingly, non-performing securitised loans constitute around 0.6%, which is lower than the on-balance sheet non-performing loan ratio of 1% (see Table 6.1); however, the charge-offs on securitised loans of 0.4% are higher than those on the on-balance sheet loans of 0.3%.

This securitisation statistics differs across securitisations of different asset classes presented in the following columns 2-8 of Table 6.3. For the outstanding securitisation reported as a percentage of total assets in the first panel of Table 6.3, mortgage and credit card securitisations stand out with the mean value of 13% and 9%, accordingly. This finding suggests that mortgage and credit card securitisations have relatively high transaction values. For the rest asset classes, the mean outstanding securitisation values relative to total assets are quite similar, ranging from a minimum of 1.6% for home equity lines to a maximum of 2.7% for other loans and leases.

[55] It is common for a bank to engage in several types of securitisation (e.g., most of the mortgage securitisers in the sample engage in securitisations of other asset classes).

Table 6.3 Statistics for Securitisation Activity by Asset Type

	Non-Zero Total Securitisation		Non-Zero Mortgage		Non-Zero HEL		Non-Zero Credit Card		Non-Zero Auto		Non-Zero Other Consumer		Non-Zero C&I		Non-Zero All Other	
Variable	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**
Outstanding Securitisation																
Sec/Assets Ratio	**12.47**	50.29	**13.33**	57.20	**1.60**	3.20	**8.47**	24.50	**1.90**	3.73	**2.29**	4.53	**1.64**	2.17	**2.68**	6.17
Credit Enhancements																
SecExp Ratio	**0.28**	0.91	**0.21**	0.87	**0.09**	0.15	**0.40**	0.99	**0.08**	0.13	**0.17**	0.37	**0.06**	0.15	**0.10**	0.36
SecExp/Sec Ratio	**5.63**	16.49	**5.10**	16.59	**8.81**	13.26	**3.44**	5.51	**8.63**	9.57	**10.77**	21.24	**3.76**	7.75	**8.40**	18.55
CEI Ratio	**0.11**	0.49	**0.09**	0.53	**0.03**	0.04	**0.13**	0.39	**0.06**	0.10	**0.04**	0.07	**0.04**	0.13	**0.01**	0.03
CEI/Sec Ratio	**2.03**	10.56	**1.40**	9.21	**2.61**	4.27	**0.78**	1.58	**4.74**	4.78	**7.86**	21.80	**1.13**	2.46	**0.73**	1.68
SubSec Ratio	**0.15**	0.55	**0.05**	0.18	**0.07**	0.17	**0.37**	0.84	**0.02**	0.03	**0.20**	0.59	**0.03**	0.07	**0.09**	0.40
SubSec/Sec Ratio	**2.84**	11.52	**3.06**	13.55	**5.03**	8.36	**3.19**	5.01	**3.13**	5.03	**3.39**	5.07	**2.50**	5.50	**6.14**	16.80
SLC Ratio	**0.09**	0.65	**0.11**	0.77	**0.01**	0.03	**0.00**	0.02	**0.02**	0.05	**0.00**	0.00	**0.01**	0.04	**0.03**	0.13
SLC/Sec Ratio	**1.99**	10.97	**1.95**	10.92	**2.13**	8.62	**0.35**	1.25	**2.63**	8.85	**0.43**	1.05	**1.49**	3.84	**3.28**	12.79
Liquidity Provisions																
LiqProv Ratio	**0.03**	0.24	**0.00**	0.01	**0.02**	0.10	**0.00**	0.00	**0.01**	0.04	**0.15**	0.60	**0.00**	0.01	**0.07**	0.30
LiqProv/Sec Ratio	**1.01**	7.29	**0.12**	0.84	**1.22**	5.75	**0.01**	0.02	**0.04**	0.22	**7.38**	17.13	**1.70**	7.24	**5.26**	20.56
Seller's Interest																
SellerInterest Ratio	**0.35**	1.90			**0.17**	0.67	**2.06**	4.22					**0.10**	0.29		
SellerInterest/Sec Ratio	**2.10**	7.95			**7.78**	9.75	**37.44**	83.80					**10.97**	23.72		
Non-Performing Assets and Charge-Offs																
SecNPL/Sec Ratio	**0.64**	1.75	**0.94**	2.82	**1.42**	2.00	**0.98**	0.97	**0.42**	0.54	**2.58**	2.33	**0.38**	0.57	**0.22**	0.50
SecChargeOffs/Sec Ratio	**0.42**	1.27	**0.17**	0.74	**0.62**	1.09	**2.21**	2.64	**1.51**	2.72	**1.32**	1.85	**0.41**	0.93	**0.10**	1.29
No. of BHCs (Bank-Quarters)	194 (1977)		140 (1407)		24 (293)		32 (307)		32 (376)		21 (302)		27 (268)		44 (489)	

Note: The table presents descriptive statistics on securitisation activities for observations with: (i) non-zero total outstanding securitisation; (ii) non-zero mortgage securitisation; (iii) non-zero home equity line securitisation; (iv) non-zero credit card securitisation; (v) non-zero auto securitisation; (vi) non-zero other consumer loan securitisation; (vii) non-zero commercial and industrial securitisation; and (viii) non-zero all other loan, lease and asset securitisation. *Mean* and *Std Dev* stand for the cross-sectional mean and standard deviation values (in %) of the individual bank time-series averages, accordingly. *N* reports the number of observations in the according sub-sample. For the definition and construction of the variables see Appendix B.

Analysing credit enhancements across securitisations presented in the second panel of Table 6.3, we see that the pattern is changed. Banks tend to retain the greatest credit exposure in other consumer securitisations (11% of outstanding securitisation), followed by home equity line, auto, and other loan and lease securitisations (from 8% to 9%). Credit exposure retained in the rest securitisations is relatively small, varying from its minimum value of 3% in credit card securitisations to 5% in mortgage securitisations.

We also find that the distribution of the credit exposure across the three forms of retained interests (credit-enhancing interest-only strips, subordinated securities, and standby letters of credit) differs considerably across securitisations. First, for the credit-enhancing interest-only strips, the maximum mean value of 8% (relative to outstanding securitisation) is observed in other consumer loan securitisations, followed by 5% in auto securitisations and 3% in home equity line securitisations. For the rest securitisations, the value varies from its minimum of less than 1% in securitisations of credit card receivables and other loans and leases to slightly above 1% in securitisations of mortgages and commercial and industrial loans. Second, for the subordinated securities, the maximum value of 6% (of outstanding securitisation) is observed in other loan and lease securitisations, followed by 5% in home equity line securitisations. For the rest securitisations, the value is relatively similar, with a slight variation around 3% and the minimum value of 2.5% in securitisations of commercial and industrial loans. Finally, for the standby letters of credit, we find that this form of credit enhancement seems to be most used in other loan and lease securitisations (above 3% of outstanding securitisation), followed by auto securitisations with a value of around 3%. The value for mortgage, home equity line, and commercial and industrial loan securitisations is around 2%, while the minimum mean value of less than 0.5% is observed in securitisations of credit card receivables and other consumer loans.

We next look at the statistics on liquidity provisions and seller's interest across securitisations presented in the third and fourth panels of Table 6.3. The results suggest that liquidity provisions are most used in other consumer loan and other loan and lease securitisations constituting 7% and 5% of outstanding securitised assets, accordingly. The value for home equity line and commercial and industrial loan securitisations is 1-2%, while it is significantly less than 1% for mortgage, credit card, and auto securitisations. As for the seller's interest, there is a striking difference between the maximum mean value of 37% (relative to outstanding securitisation) in credit card securitisations and that of 11% and 8% in commercial and industrial loan and home equity line securitisations, respectively.

Finally, comparing the performance of securitised loans reported in the last panel of Table 6.3, we find the highest non-performing loan ratio of around 3% of outstanding securitisation in other consumer loan securitisations, while for the rest securitisations it ranges from a minimum of 0.2% in other loan and lease securitisations to a maximum of 1% in mortgage and credit card securitisations. Interestingly, the statistics for the charge-off ratio are different and suggest two clusters: (i) credit card, auto, and other consumer loan securitisations with charge-offs of 1-2% of securitised loans; and (ii) the rest of securitisations with charge-offs of less than 1%.

To summarise the securitisation statistics, we find that while mortgage and credit card securitisations have the highest outstanding securitisation balances as a percentage of total assets, the maximum credit exposure is retained in securitisations of other consumer loans, home equity lines, auto, and other loans and leases. Other consumer loan securitisations also have the highest value for credit-enhancing interest-only strips as a percentage of outstanding securitisation. This suggests the highest excess spread in securitisation structures of other consumer loans, which in turn might be the result of higher interest received from the underlying pool of loans and/or lower interest paid on the issued securities; the highest non-performing loans and relatively high charge-offs in

other consumer loan securitisations provide some supporting evidence for the former. As for the retained subordinated securities and provided standby letters of credit, the highest values are observed in other loan and lease securitisations. Further, in both other consumer loan and other loan and lease securitisations we observe the highest liquidity provisions. Finally, the highest charge-offs are found in credit card securitisations along with the maximum value for seller's interest.

6.3 Empirical Specification

To address the research questions of this study presented in section 6.1, we estimate the relationship between banks' securitisation activities and insolvency risk controlling for a number of risk-relevant bank characteristics.

6.3.1 Bank Risk

Our primary measure of bank insolvency risk is a z-score, denoted by Z. The z-score has become a popular measure of bank risk and has been widely used in the banking literature (see Beck, Hesse, Kick and Westernhagen, 2009; De Nicolo, 2000; Hesse and Cihák, 2007; Laeven and Levine, 2009; Mercieca, Schaeck and Wolfe, 2007; Michalak and Uhde, 2009; Stiroh and Rumble, 2006). Specifically, the z-score measures the distance from insolvency for a given bank combining bank profitability, capitalisation, and volatility of returns. Defining insolvency as a situation in which losses (negative profits) exceed equity capital, insolvency risk can be expressed as:

$$P(-\pi < E) = P(-ROA < EA) = \int_{-\infty}^{EA} F(ROA)dr$$

where π is profits, E is equity capital, ROA $(= \pi / A)$ is return on assets, EA $(= E / A)$ is the equity capital to assets ratio, and $F(ROA)$ is return distribution with first and second moments $\overline{ROA}$ and σ^2_{ROA}, respectively.

As shown by Roy (1952), assuming profits are normally distributed:

$$P(-ROA < EA) < \frac{\sigma_{ROA}^2}{(\overline{ROA} + \overline{EA})^2} = \frac{1}{Z^2}$$

Therefore:

$$Z = \frac{\overline{ROA} + \overline{EA}}{\sigma_{ROA}}$$

where $\overline{ROA}$ is the average return on assets, $\overline{EA}$ is the average equity capital ratio, and σ_{ROA} is the standard deviation of return on assets.

In other words, the z-score is an indicator of a bank's probability of insolvency in the sense that it estimates the number of standard deviations that the bank's profits have to fall below its expected value before its equity becomes negative. A higher z-score indicates that a bank is more stable, where the value of the z-score depends positively on the bank's profitability and capital ratio and negatively on the variability of the bank's profits.

Additional measures include bank risk-adjusted return on assets and equity, denoted by $RAROA$ and $RAROE$, respectively. These are used in robustness tests calculated as:

$$RAROA = \frac{\overline{ROA}}{\sigma_{ROA}}$$

$$RAROE = \frac{\overline{ROE}}{\sigma_{ROE}}$$

where $\overline{ROE}$ is the average return on equity and σ_{ROE} is the standard deviation of return on equity.

6.3.2 Securitisation

We consider securitisation activities of a bank as: (i) total outstanding securitised assets (Sec); (ii) maximum credit exposure arising from recourse or other credit enhancements provided to the bank's securitisation structures ($SecExp$); (iii) commitments to provide liquidity to the bank's securitisations ($LiqProv$); (iv) ownership (or seller's) interest in the bank's securitisation structures ($SellerInterest$); (v) maximum credit exposure arising from recourse or other credit enhancement provided by the bank to other institutions' securitisations ($OthersSecExp$); and (vi) liquidity support provided to other institutions' securitisations ($OthersLiqProvExp$).

We also decompose the aggregate credit exposure, $SecExp$, by the form of underlying enhancement into: (i) credit-enhancing interest-only strips ($CEIOS$); (ii) retained subordinated securities ($SubSec$); and (iii) standby letters of credit (SLC). All the securitisation variables included in the model are scaled by total assets.

6.3.3 Control Variables

We control for a number of additional bank balance sheet and income statement characteristics potentially affecting insolvency risk. Bank size ($Size$), measured as a natural logarithm of total assets, is included to control for any systematic differences across size classes, including funding and risk-management opportunities; we expect a positive relation between bank size and risk (Hesse and Cihák, 2007; Hirtle and Stiroh, 2007; Laeven and Levine, 2009; Stiroh and Rumble, 2006).

Next, we include bank liquidity in the form of cash and securities (Liq) and anticipate higher liquidity buffers to be associated with lower insolvency risk (Laeven and Levine, 2009). Trading assets ($Trading$) are included to control for their potential risk-increasing effect due to their highly volatile nature. Both liquidity and trading assets are scaled by total assets.

To control for possible differences in riskiness of banks with different loan portfolio concentration, we introduce a four-loan Herfindahl-Hirschman Index ($HHILoan$); we expect loan portfolio concentration to be positively associated with risk (Hirtle and Stiroh, 2007; Mercieca, Schaeck and Wolfe, 2007). We also control for bank's capitalisation introducing an equity capital ratio ($Capital$) as lower capital has been shown to be associated with higher risk (Hirtle and Stiroh, 2007; Mercieca, Schaeck and Wolfe, 2007; Stiroh and Rumble, 2006).

Further, we control for potential revenue diversification effect on bank risk using a two-part revenue Herfindahl-Hirschman Index ($HHIRev$); diversification in revenue sources has been shown to be negatively associated with return volatility and insolvency risk (Hirtle and Stiroh, 2007; Stiroh and Rumble, 2006). Finally, following Stiroh and Rumble (2006), we include bank's asset growth ($AssetGrowth$), in a linear and quadratic form, to control for differences between growing and contracting banks.[56]

6.3.4 Model Specification

Our basic model is:

$$Z_{i,t} = \alpha_i + \beta_1 Sec_{i,t} + \beta_2 SecExp_{i,t} + \beta_3 SecLiqProv_{i,t} + \beta_4 SellerInterest_{i,t} + \beta_5 OthersSecExp_{i,t} + \\ + \beta_6 OthersSecLiqProv_{i,t} + \gamma_1 Size_{i,t} + \gamma_2 Liq_{i,t} + \gamma_3 HHILoan_{i,t} + \gamma_4 Trading_{i,t} + \gamma_5 Capital_{i,t} + \\ + \gamma_6 HHIRev_{i,t} + \gamma_7 AssetGrowth_{i,t} + \gamma_8 AssetGrowth_{i,t}^2 + \theta' Year_t + \varepsilon_{i,t} \qquad (6.1)$$

where β, γ, and θ are coefficient estimates, and $\varepsilon_{i,t}$ is the error term for bank i in quarter t ($\varepsilon_{i,t} \sim i.i.d.\ (0, \sigma^2)$). The dependent variable, $Z_{i,t}$, is insolvency risk of bank i in period t; $Sec_{i,t}$ is total outstanding securitisation; $SecExp_{i,t}$ is securitisation exposure to the bank's own securitisations; $LiqProv_{i,t}$ is liquidity provisions to the bank's own

[56] See Appendix B for detailed construction of the variables.

securitisations; $SellerInterest_{i,t}$ is seller's interest in the bank's securitisations; $OthersSecExp_{i,t}$ is bank's exposure to other institutions' securitisations; $OthersLiqProv_{i,t}$ is bank's liquidity provisions to other institutions' securitisations; $Size_{i,t}$ is bank size; $Liq_{i,t}$ is liquidity; $HHILoan_{i,t}$ is loan portfolio concentration; $Trading_{i,t}$ is trading assets; $Capital_{i,t}$ is equity capital; $HHIRev_{i,t}$ is revenue diversification; $AssetGrowth_{i,t}$ is asset growth; and $Year_t$ is year dummies capturing time effects.

Our most expanded model, decomposing securitisation exposure by the form of underlying enhancement, is:

$$Z_{i,t} = \alpha_i + \beta_1 Sec_{i,t} + \beta_2 CEIOS_{i,t} + \beta_3 SubSec_{i,t} + \beta_4 SLC_{i,t} + \beta_5 SecLiqProv_{i,t} + \beta_6 SellerInterest_{i,t} + \\ + \beta_7 OthersSecExp_{i,t} + \beta_8 OthersSecLiqProv_{i,t} + \gamma_1 Size_{i,t} + \gamma_2 Liq_{i,t} + \gamma_3 HHILoan_{i,t} + \gamma_4 Trading_{i,t} + \\ + \gamma_5 Capital_{i,t} + \gamma_6 HHIRev_{i,t} + \gamma_7 AssetGrowth_{i,t} + \gamma_8 AssetGrowth_{i,t}^2 + \theta' Year_t + \varepsilon_{i,t} \quad (6.2)$$

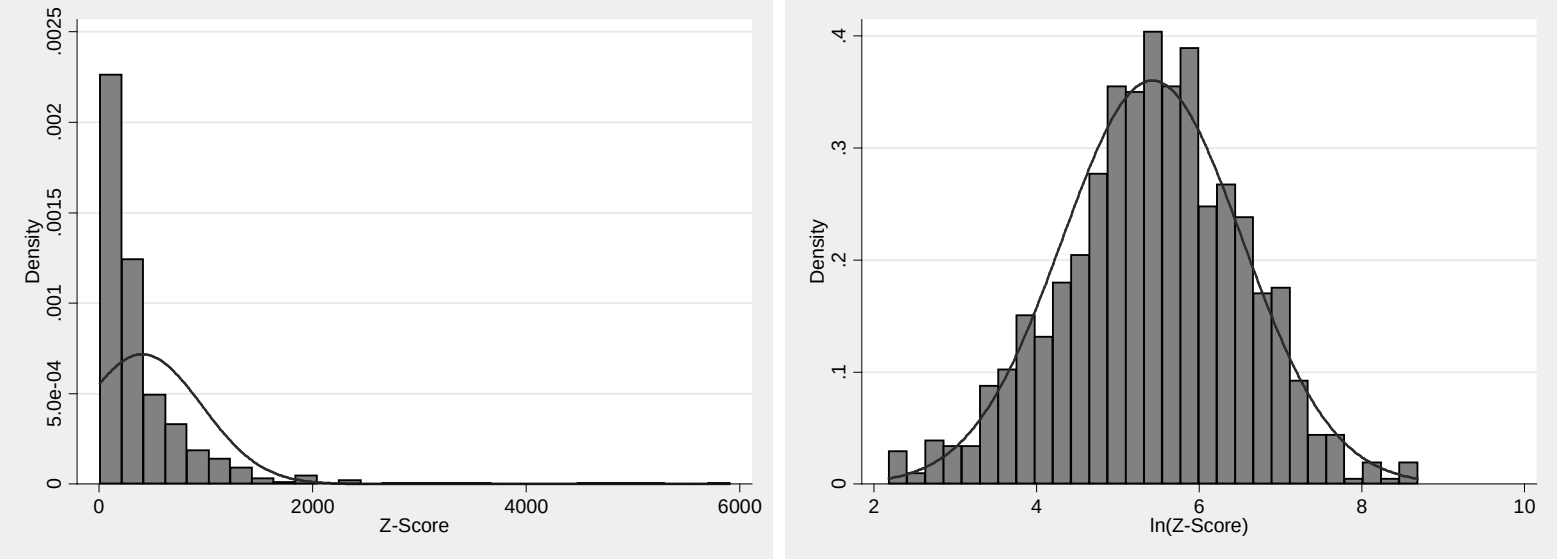
where $CEIOS_{i,t}$ is credit-enhancing interest-only strips, $SubSec_{i,t}$ is subordinated securities, and $SLC_{i,t}$ is standby letters of credit.

6.4 Empirical Results

6.4.1 Regression Data Set

For the regression analysis, we build a data set from annual bank observations. Specifically, for each bank-year we: (i) calculate averages and standard deviations of variables over the four quarterly observations; (ii) calculate yearly z-score, risk-adjusted return on assets and equity based on the yearly averages and standard deviations; and (iii) construct a panel of BHC/year observations. As previously mentioned, we keep banks with at least 2 full years of data.

Figure 6.1 Distribution of Z-Score and Ln(Z-Score)



Note: The graphs plot the distribution of Z-Score and ln(Z-Score) derived from the regression data set for the 2002-2007 period, where the z-score of a bank is calculated yearly using the averages and standard deviations across four quarters of a year.

As shown in Figure 6.1 (left plot), the yearly z-score obtained for the sample is highly skewed; therefore, we use a natural logarithm of the z-score, which is normally distributed (right plot).

We also winsorise all our dependent variables at 1% level to minimise the effect of outliers.[57] In the remainder of the essay, we use labels: (i) "z-score" referring to the 1% winsorised natural logarithm of the z-score; (ii) "RAROA" referring to the 1% winsorised risk-adjusted return on assets; and (iii) "RAROE" referring to the 1% winsorised risk-adjusted return on equity.

Further, the examination of the relationship between the yearly z-score and securitisation variables suggests non-linear association. Therefore, in the regression analysis, we use a logarithmic form for all the securitisation variables.[58]

6.4.2 Primary Regression Analysis

We now turn to the primary regression analysis of the relationship between banks' engagement in securitisation activities and insolvency risk. We estimate the relationship using fixed effects regression model presented in equation (6.1).[59] Table 6.4 presents the results of nested regressions estimations. [60] The analysis is based on the full sample of 917 bank-years for 194 BHCs from 2002 to 2007. The obtained adjusted R-squared ranges from 12.1% in the restricted model presentation to 14.1% in the expanded model.

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[57] Winsorisation consists of replacing the data below the N^{th} percentile with the N^{th}, i.e., a 1% winsorisation implies replacing the data below 1^{st} percentile with the 1^{st} percentile data.

[58] As there are zero securitisation observations in the data set, we use a natural logarithm of a unit plus the according securitisation measure.

[59] Appendix F reports the results of the Hausman specification test.

[60] Appendix E reports the correlation coefficients for the explanatory variables.

Table 6.4 Effects of Securitisation Structures on Bank Insolvency Risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Sec_{i,t}$	-0.48	-0.44	-0.59*	-0.45	-0.46	-0.49	-0.48
	(-1.129)	(-1.054)	(-1.830)	(-1.072)	(-1.094)	(-1.163)	(-1.158)
$SecExp_{i,t}$		-15.79**		-15.73**	-15.98**	-15.82**	-16.03**
		(-2.306)		(-2.308)	(-2.379)	(-2.348)	(-2.397)
$CEIOS_{i,t}$			16.74				
			(0.613)				
$SubSec_{i,t}$			-7.54				
			(-0.793)				
$SLC_{i,t}$			-33.35***				
			(-5.089)				
$SecLiqProv_{i,t}$				42.78*	42.68*	43.20*	48.07**
				(1.874)	(1.867)	(1.891)	(2.125)
$SellerInterest_{i,t}$					4.93	4.97	5.09
					(0.789)	(0.795)	(0.805)
$OthersSecExp_{i,t}$						16.71***	16.83***
						(14.895)	(13.810)
$OthersSecLiqProv_{i,t}$							-56.28***
							(-3.330)
$Size_{i,t}$	-1.02***	-1.02***	-1.11***	-1.01***	-1.00***	-1.00***	-0.99***
	(-4.151)	(-4.274)	(-3.681)	(-4.249)	(-4.134)	(-4.138)	(-4.066)
$Liq_{i,t}$	1.55	1.35	-0.38	1.30	1.27	1.20	1.15
	(1.498)	(1.391)	(-0.338)	(1.348)	(1.307)	(1.230)	(1.179)
$HHILoan_{i,t}$	1.07	1.04	0.85	1.05	0.93	0.91	0.81
	(1.203)	(1.208)	(0.792)	(1.219)	(1.037)	(1.014)	(0.901)
$Trading_{i,t}$	-4.54	-3.45	-5.05	-3.54	-3.58	-3.65	-2.53
	(-1.011)	(-0.713)	(-0.850)	(-0.745)	(-0.762)	(-0.782)	(-0.545)
$Capital_{i,t}$	1.27	0.40	0.04	0.47	0.95	1.05	0.97
	(0.720)	(0.222)	(0.014)	(0.262)	(0.465)	(0.513)	(0.476)
$HHIRev_{i,t}$	0.58	0.55	1.19	0.53	0.54	0.53	0.49
	(0.793)	(0.711)	(1.283)	(0.681)	(0.697)	(0.687)	(0.635)
$AssetGrowth_{i,t}$	8.40***	7.64***	7.80**	7.69***	7.81***	7.91***	7.70***
	(3.907)	(3.475)	(2.324)	(3.499)	(3.470)	(3.513)	(3.468)
$AssetGrowth_{i,t}^2$	-80.88***	-75.04***	-71.00**	-74.75***	-77.20***	-77.68***	-76.31***
	(-3.676)	(-3.362)	(-2.025)	(-3.348)	(-3.330)	(-3.341)	(-3.323)
$Year_t$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	19.11***	19.36***	20.81***	19.25***	19.02***	19.08***	18.97***
	(5.284)	(5.432)	(4.642)	(5.414)	(5.305)	(5.313)	(5.279)
No. of Observations	917	917	766	917	917	917	917
No. of of BHCs	194	194	194	194	194	194	194
Adjusted R^2	0.121	0.132	0.146	0.133	0.133	0.138	0.141

Note: The table presents the results of nested regressions of bank insolvency risk on securitisation variables. The dependent variable is a z-score (*Z*) measuring a bank's distance to default and calculated yearly as the bank's yearly average return on assets plus yearly average capital to assets ratio divided by the standard deviation of return on assets over the four quarters of the year. We use a natural logarithm of the z-score, winsorised at 1% level. The independent variables are computed as averages for each BHC over four quarters in a given year. We use natural logarithms for securitisation variables, which include: (i) securitisation ratio (*Sec*); (ii) credit exposure arising from credit enhancements (*SecExp*); (iii) credit-enhancing interest-only strips (*CEIOS*); (iv) subordinated securities (*SubSec*); (v) standby letters of credit (*SLC*); (vi) liquidity provisions (*LiqProv*); (vii) sellers' interest (*SellerInterest*); (viii) credit exposure arising from credit-enhancing other institutions' securitisations (*OthersSecExp*); (ix) liquidity provisions to other institutions'' securitisations (*OthersLiqProv*). The control variables include: (i) bank size, measured as a natural logarithm of total assets (*Size*); (iii) liquidity ratio (*Liq*); (iv) loan concentration, measured by Herfindahl-Hirschman Index (*HHILoan*); (v) trading assets ratio (*Trading*); (vi) capital ratio (*Capital*); (vii) revenue concentration, measured by Herfindahl-Hirschman Index (*HHIRev*); (viii) asset growth (*Growth*); and (ix) asset growth squared ($AssetGrowth^2$) (see Appendix B for the definition and construction of the variables). Fixed effects regressions are run for the full sample of BHCs covering the period from 2002 to 2007 with exemption of column 3 where the regression is run for 2003-2007. Year dummies are incorporated in all regressions. Robust standard errors reported in parentheses are corrected for clustering at the BHC-level. *, **,*** indicate significance at 10%, 5% and 1% levels, respectively.

The first column of Table 6.4 reports the estimation results of the model with total outstanding securitisation, capturing implicit recourse, and control variables. The coefficient on securitisation is found to be negative, however, not statistically significant. Therefore, we find no evidence of a significant effect of implicit recourse in securitisations on the soundness of originating banks.

Examining the control variables, we find a positive association between bank size and insolvency risk (a negative effect on the z-score). This finding is consistent with previous studies (Hesse and Cihák, 2007; Stiroh, 2006; Stiroh and Rumble, 2006). The effect of asset growth is found to be reducing bank insolvency risk, while the result is opposite for the asset growth squared. The latter is also reported by Mercieca, Schaeck and Wolfe (2007) and Stiroh and Rumble (2006). This finding might be interpreted as the asset growth being advantageous; however, the effect depends negatively on the level of the asset growth.

Further, the evidence suggests that liquidity, capital, and both loan and revenue diversification have a risk-reducing effect, while trading assets seem to increase bank insolvency risk. These results confirm the expected associations and are consistent across all the models; however, the estimates are not statistically significant (with exception of model 3, which is a special case and will be discussed later in the section).

The second column of Table 6.4 introduces securitisation exposure in the model; this raises the adjusted R-squared by 0.9% to 13.2%. The coefficient on the securitisation exposure emerges negative and statistically significant at 5% level. In other words, the exposure arising from retained interests in securitisation structures and constituting only 0.25% of total assets has a significant risk-increasing effect for originating banks.

We further expand the model in column 3 of Table 6.4 decomposing securitisation exposure by the form of retained interest into credit-enhancing interest-only strips, subordinated securities, and standby letters of credit. This model specification requires a caveat. Credit-enhancing interest-only strips are reported by banks starting from the second quarter of 2001, while the starting reporting date for subordinated securities and standby letters of credit is the first quarter of 2003. As this model specification is crucial in terms of this study, we drop the 2002 observations and estimate the model for the 2003-2007 period. Examining the results, we find that in the 2003-2007 specification the coefficient on outstanding securitisation remains negative, but becomes statistically significant at 10% level; the estimates for the control variables remain unchanged. Looking at retained interests, credit-enhancing interest-only strips are found to have a negative but statistically insignificant effect on bank risk; the effect of subordinated securities is found to be risk-increasing, however, also statistically insignificant; most interestingly, the effect of standby letters of credit on bank risk is found to be positive and statistically significant at 1% level suggesting that this form of retained interest, which makes around 1% of total assets, significantly increases insolvency risk of originating banks. It is also worth noting that the 2003-2007 model specification has the highest R-squared of 14.6%.

In the following columns 4-7 of Table 6.4 we control for the securitisation exposure arising from retained interests in the aggregated form to avoid losing the data for year 2002. The model in column 4 introduces banks' liquidity provisions to their own securitisation structures. The effect of liquidity provisions on the z-score is found to be positive and statistically significant at 10% level; this suggests a risk-reducing effect of liquidity provisions, a result remaining consistent in all models where the variable is included. In column 5 of Table 6.4 we add seller's interest in the estimation,

which is found to have a positive effect on bank risk; however, the estimate is not statistically significant.[61]

Finally, we test the risk effects of banks' engagement in enhancing third-party securitisation structures in columns 6-7 of Table 6.4. First, in column 6, we test the effect of providing credit enhancements to other institutions' securitisations, including standby letters of credit, subordinated securities, and other facilities. We find that credit-enhancing interests in third-party securitisations have a negative effect on insolvency risk of the banks; the result is statistically significant at 1% level. This finding may be referred to a possible positive diversification effect that investing in other institutions' structures might have on bank performance. Next, in column 7, we test the effect of liquidity support provided to other institutions' securitisations. We find that liquidity provision commitments in third-party securitisation structures, in opposite, have a positive effect on bank risk decreasing the z-score; the estimate is significant at 1% level.

Summarising the main results, we find interesting evidence on the effects that different forms of engagement in securitisation activities have on bank insolvency risk. Addressing the research questions formulated in section 6.1 in sequence: (i) we find that outstanding securitisation, representing possible implicit recourse provided to securitisation structures, does not have a significant effect bank insolvency risk; (ii) credit exposure, arising through interests retained in securitisation structures and constituting a much smaller percentage of total assets, in turn significantly reduces banks' distance to default; among the three forms of credit enhancement examined, we find robust evidence of a significant risk-increasing effect of standby letters of credit; (iii) we find a risk-reducing effect for banks' liquidity provisions to their own securitisation structures; (iv) seller's interest is found to have no significant effect on

[61] Seller's interest retained in mortgage, home equity line, and credit card securitisations.

bank insolvency risk; (v) the evidence suggests that credit enhancement provided to other institutions' securitisations reduces insolvency risk; while (vi) liquidity facilities provided to other institutions' securitisation structures tend to significantly increase bank insolvency.

6.4.3 Robustness Tests

We conduct a number of additional tests to verify the robustness of our results, which are presented in Table 6.5.

Specifically, we first address a possible outliers concern by winsorising the z-score measure at higher 2.5% and 5% levels and re-estimating equations (6.1) and (6.2) for each of the winsorisation levels. The results of the regressions are reported in columns 1-4 of Table 6.5. We find that all the coefficients remain qualitatively unchanged, except that for liquidity provisions which emerges statistically insignificant in 2003-2007 regressions (columns 2 and 4).

We next use different measures for the dependent variable. Following Stiroh (2007), we use banks' risk-adjusted return on assets and equity. We re-estimate equations (6.1) and (6.2), consistently winsorising the measures at 1% level. The results of the regressions are reported in columns 5-8 of Table 6.5. Looking at the RAROA regressions (columns 5 and 6), we find that the results for securitisation activities remain unchanged. This is also the case for the RAROE regressions (columns 7 and 8), except for the coefficient on the seller's interest which remains negative, but becomes statistically significant in the 2003-2007 specification (column 8).

Overall, the additional analyses confirm our main findings with the effects of banks' engagement in securitisation activities found to be consistent and robust to the conducted tests.

Table 6.5 Robustness Tests for the Effects of Securitisation Structures on Bank Insolvency Risk

	Z-Score(w025)		Z-Score(w05)		RAROA		RAROE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Sec_{i,t}$	-0.36	-0.47	-0.14	-0.25	-0.92	-1.54	-0.11	2.70
	(-0.891)	(-1.479)	(-0.396)	(-0.853)	(-0.210)	(-0.274)	(-0.020)	(0.792)
$SecExp_{i,t}$	-15.17**		-13.83**		-201.87**		-133.54**	
	(-2.276)		(-2.216)		(-2.121)		(-2.126)	
$CEIOS_{i,t}$		19.91		19.23		-163.57		42.88
		(0.727)		(0.758)		(-0.435)		(0.228)
$SubSec_{i,t}$		-5.95		-5.37		-123.02		-120.31
		(-0.706)		(-0.654)		(-0.717)		(-1.336)
$SLC_{i,t}$		-32.14***		-27.73***		-482.53***		-175.87**
		(-4.879)		(-4.557)		(-3.270)		(-1.989)
$SecLiqProv_{i,t}$	47.72**	27.69	46.59**	25.43	862.86*	775.87*	1,011.31*	718.97*
	(2.268)	(1.018)	(2.338)	(0.978)	(1.797)	(1.872)	(1.858)	(1.853)
$SellerInterest_{i,t}$	4.70	-3.51	4.11	-3.37	-34.34	-104.58	-63.26	-166.45*
	(0.756)	(-0.365)	(0.707)	(-0.377)	(-0.643)	(-1.272)	(-1.207)	(-1.967)
$OthersSecExp_{i,t}$	14.80***	5.49***	12.17***	5.17***	41.51***	41.41*	56.94***	52.73***
	(12.672)	(2.741)	(11.260)	(2.817)	(2.988)	(1.776)	(4.404)	(2.641)
$OthersSecLiqProv_{i,t}$	-59.05***	-109.94*	-58.10***	-91.45	-1,309.8***	-3,210.4***	-913.3***	-2,043.9***
	(-3.467)	(-1.796)	(-3.481)	(-1.640)	(-9.385)	(-3.117)	(-6.520)	(-3.308)
$Size_{i,t}$	-0.96***	-1.06***	-0.91***	-0.98***	-9.87***	-14.24***	-10.35***	-12.08***
	(-4.066)	(-3.566)	(-4.031)	(-3.433)	(-2.747)	(-3.541)	(-3.190)	(-3.936)
$Liq_{i,t}$	1.14	-0.39	1.11	-0.33	22.17*	10.68	12.90	-7.34
	(1.194)	(-0.353)	(1.198)	(-0.306)	(1.681)	(0.780)	(0.894)	(-0.550)
$HHILoan_{i,t}$	-2.26	-5.16	-2.22	-4.96	33.14***	30.90**	27.55***	28.51**
	(-0.487)	(-0.893)	(-0.504)	(-0.896)	(2.734)	(2.127)	(2.828)	(2.597)
$Trading_{i,t}$	0.81	-0.54	0.56	-1.09	7.13	24.19	56.89	44.35
	(0.412)	(-0.223)	(0.305)	(-0.489)	(0.154)	(0.350)	(0.923)	(0.606)
$Capital_{i,t}$	6.90***	7.11**	5.72***	6.02**	-9.93	-57.00*	-27.03	-58.06**
	(3.188)	(2.154)	(2.831)	(1.978)	(-0.483)	(-1.914)	(-1.488)	(-2.464)
$HHIRev_{i,t}$	-70.15***	-63.66*	-60.23***	-54.02*	10.27	14.55	4.66	9.28
	(-3.131)	(-1.835)	(-2.858)	(-1.674)	(1.271)	(1.527)	(0.527)	(1.307)
$AssetGrowth_{i,t}$	0.47	1.16	0.50	1.11	61.33**	81.09*	28.27	19.42
	(0.606)	(1.264)	(0.656)	(1.222)	(2.353)	(1.824)	(1.272)	(0.746)
$AssetGrowth_{i,t}^2$	0.82	0.88	0.81	0.88	-600.98**	-640.65	-538.17**	-306.26
	(0.917)	(0.779)	(0.931)	(0.803)	(-2.212)	(-1.426)	(-2.170)	(-1.107)
$Year_t$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	18.64***	20.20***	17.87***	19.06***	129.46**	200.07***	146.49***	176.28***
	(5.300)	(4.563)	(5.295)	(4.461)	(2.410)	(3.393)	(2.929)	(3.772)
No. of Observations	917	766	917	766	917	766	917	766
No. of BHCs	194	194	194	194	194	194	194	194
Adjusted R^2	0.135	0.141	0.127	0.130	0.075	0.095	0.067	0.063

Note: The table presents the results of additional analyses that test different dependent variables in the basic and expanded models (equations (6.1) and (6.2)). Columns 1-2 use a 2.5% winsorised z-score as the dependent variable (*Z-Score(w025)*); columns 3-4 apply a higher winsorisation level of 5% (*Z-Score(w05)*). Columns 5-6 use a risk-adjusted return on assets, winsorised at 1% level, as the dependent variable. The dependent variable in columns 7-8 is a risk-adjusted return on equity winsorised at 1%. The dependent variables in all the regressions are computed on a yearly basis using averages and standard deviations for each BHC over four quarters in a given year. The independent variables are averages of four quarterly observations in a year for each BHC. We use natural logarithms for securitisation variables, which include: (i) securitisation ratio (*Sec*); (ii) credit exposure arising from credit enhancements (*SecExp*); (iii) credit-enhancing interest-only strips (*CEIOS*); (iv) subordinated securities (*SubSec*); (v) standby letters of credit (*SLC*); (vi) liquidity provisions (*LiqProv*); (vii) sellers' interest (*SellerInterest*); (viii) credit exposure arising from credit-enhancing other institutions' securitisations (*OthersSecExp*); (ix) liquidity provisions to other institutions'' securitisations (*OthersLiqProv*). The control variables include: (i) size, measured as a natural logarithm of total assets (*Size*) ; (iii) liquidity ratio (*Liq*); (iv) loan concentration, measured by Herfindahl-Hirschman Index (*HHILoan*); (v) trading assets ratio (*Trading*); (vi) capital ratio (*Capital*); (vii) revenue concentration, measured by Herfindahl-Hirschman Index (*HHIRev*); (viii) asset growth (*Growth*); and (ix) asset growth squared (*AssetGrowth*^{2}) (see Appendix B for the definition and construction of the variables). Fixed effects regressions are run for the full sample of BHCs from 2002 to 2007 in the basic model (columns 1, 3, 5, and 7) and from 2003 to 2007 in the expanded model (columns 2, 4, 6, and 8). Year dummies are incorporated in all regressions. Robust standard errors reported in parentheses are corrected for clustering at the BHC-level. *, **,*** indicate significance at 10%, 5% and 1% levels, respectively.

6.5 Conclusions

In this essay we used US bank holding company data for the period from 2002 to 2007 to estimate the relationship between banks' off-balance sheet securitisation structures and insolvency risk. In doing so, we particularly focused on credit enhancement and liquidity support provided by banks to their own as well as third-party securitisations.

First, we find that credit enhancement provided by originating banks to their own securitisation structures has a significant positive effect on insolvency risk of the banks. Second, examining credit enhancement by the form of underlying facility, we find that among credit-enhancing interest-only strips, subordinated securities, and standby letters of credit, the latter have the greatest positive association with bank insolvency risk. In contrast, liquidity provisions are found to have a significant risk-reducing effect. Finally, examining credit and liquidity support provided by banks to third-party securitisation structures, we find that credit enhancing third-party securitisations reduces insolvency risk, while liquidity provisions are found to be highly positively associated with bank insolvency.

According to the European Central Bank Financial Stability Review (ECB, 2009), policy-makers acknowledge the potential benefits of securitisation in credit risk transfer and diversification and aim at reviving the securitisation market by introducing more standardised and simple securitisation structures reducing the dependence and involvement of the originator in the transactions. In this regard, our results contribute to a deeper understanding of the risks arising from banks' securitisation activities, including securitising assets as well as enhancing third-party securitisations, and have direct implications for the ongoing discussions on how to redesign the securitisation model and restart the market.

7 CONCLUSION

The past two decades witnessed significant developments in global securitisation markets. This was driven by the numerous benefits offered to the market participants, strong encouragement by regulators based on the perception that securitisation strengthens the banking system as a whole through credit risk transfer and diversification, and favouring macroeconomic conditions. However, along with the size of the market, the level of innovation and complexity of transactions has also increased. This, coupled with the incentive structure of the securitisation model, opacity of information on the securitised products, and associated excessive reliance on external credit ratings based on model assumptions, posed challenges for the appropriate assessment of risks by investors, regulators, credit rating agencies, and originators themselves, thereby increasing the fragility of the financial system.

The risks inherent in the securitisation process have unfolded during the financial crisis of 2007-2009. The crisis has shown that the "originate and distribute" model introduced by securitisation created a lack of transparency and assessment of credit risk, as well as adverse selection and moral hazard problems. Originators lacked incentives to screen and monitor borrowers, as lending decisions were made with the assumption that the risks of such transactions would be passed onto outside investors. Credit rating agencies were less willing to monitor properly on a continuing basis the performance of securitised assets and effect timely credit rating downgrades. Investors lacked incentives to conduct due diligence in the risk assessment of securitised products relying excessively on credit ratings and thus failing to play an effective disciplining role in the process. Finally, regulators failed to comprehend the potential threat to the financial stability arising from the regulatory capital and accounting arbitrage through securitisation and the excessive use of structured finance by banks for funding introducing a new element of volatility and instability into the model of banking institutions, and consequently provide due regulation and supervision.

The financial market turmoil of the past two years has also shown that a relatively contained problem in the bank securitisation market can spread to other financial markets and freeze considerable parts of the financial system. This contagion effect further magnifies the importance of understanding banks' engagement in securitisation activities by regulators and market participants, the benefits and risks inherent, and the potential financial system implications.

Against this background, this thesis attempts to provide valuable insights into bank securitisation activities. It comprises empirical research on the effects of securitisation presented in three essays.

In the first essay we analyse the effects of securitisation on performance of US commercial banks during the pre-crisis period from 2002 to 2007. The theoretical predictions are that securitisation should lead to lower funding costs, lower credit risk exposure, and higher profitability. First, testing the hypotheses in the univariate analysis of securitisers and non-securitisers, we find that securitising banks do tend to be more profitable institutions, but with higher credit risk exposure and a higher cost of funding compared to non-securitising banks. To assess the causal securitisation effect, we further focus on the first-time securitisers and attempt to estimate their counterfactual performance, or the performance these banks would have had had they not securitised. Using a propensity score matching approach, we build a sample of non-securitisers with *ex-ante* similar securitisation likelihood and use their *ex-ante* performance as the counterfactual performance of the first-time securitisers. The analysis suggests that the first-time securitisers would have comparable cost of funding, credit risk, and profitability had they not securitised. Consequently, we conclude that securitisation as a funding, risk management, and profitability improvement technique does not seem to outperform alternative techniques possibly used by adequately matched non-securitising banks. This evidence raises important questions about the

motives for and the ultimate value of banks' increasing securitisation activities over the past decade.

In the second essay we investigate the impact of securitisation on the credit-risk taking behaviour of US bank holding companies during the period from 2001 to 2007. In a panel data regression analysis, we first we find a significant negative impact of securitisation on bank credit risk taking, suggesting that banks with a greater amount of assets securitised are more risk-averse in their activities. Examining securitisation by the type of underlying assets, we find that the negative relationship between securitisation and risk taking is primarily driven by securitisations of mortgages, home equity lines of credit, and other consumer loans; among these, credit risk taking is associated most negatively with securitised home equity lines of credit. Securitisations of all other types of assets seem to have no significant impact on bank credit-risk taking behaviour. We explain these findings by the banks' credit risk exposure to securitised assets retained through explicit and/or implicit recourse provided in the transactions. If the proposed "recourse hypothesis" is correct, the credit risk-reducing effect of securitisation might be offset by banks' greater risk arising from the securitised pool. Therefore, the net impact of securitisation on the riskiness of issuing banks is ambiguous and will depend on the structure of transactions, in particular, on the relative magnitude of credit support provided by banks.

We examine credit and liquidity support in the third essay. Specifically, using the sample for US bank holding companies, we empirically estimate the relationship between insolvency risk and different forms of credit enhancement and liquidity support provided by banks to their own and other institutions' securitisation structures. First, we find that credit enhancement provided by originating banks to their own securitisation structures has a significant positive effect on insolvency risk of the banks. Second, examining credit enhancement by the form of underlying facility, we find that among credit-enhancing interest-only strips, subordinated securities, and standby letters of

credit, the latter have the greatest positive association with bank insolvency risk. In contrast, liquidity provisions are found to have a significant risk-reducing effect. Finally, examining credit and liquidity support provided by banks to third-party securitisation structures, we find that credit enhancing third-party securitisations reduces insolvency risk, while liquidity provisions are found to be highly positively associated with insolvency risk of the banks.

In summary, the evidence is consistent across the three studies. We find that securitisation might have a risk-reducing effect as banks with greater outstanding securitisation chose asset portfolios of lower credit risk. However, we also find that interests retained by originating banks in connection to the securitised assets tend to significantly increase bank insolvency risk and may, therefore, offset the beneficial effects of securitisation. This in turn is consistent and partially explains the finding that securitisation seems not to have improved performance of banks in the lead-up to the crisis.

Taken together, the evidence leads us to conclude that securitisation as structured by the banks seems to have been used for funding, rather that as a risk management or performance improvement technique. Further, it suggests that securitisation might have had have beneficial effects on originating banks; however, these effects seem to be offset by the originating banks' excessive involvement in transactions.

Relating these findings to current developments in the market, several sets of measures have been proposed to address weaknesses in the securitisation process in response to the lessons of the financial crisis. The proposals refer to the regulatory capital framework as well as the structural weaknesses revealed by the crisis. Among the proposed changes in the regulatory framework are higher risk weights on securitisation exposures retained by originators and hence higher minimum capital requirements; while the structural changes include introducing more standardised and

simple securitisation structures and reducing the dependence and the involvement of the originator in the transactions. Therefore, the findings of this research may be particularly valuable for the ongoing discussions of the weaknesses of the securitisation process and the changes in the securitisation model needed to restart the market.

The research could be further enhanced by analysing the European securitisation market. Specifically, by conducting a comparison of the securitisation behaviour of European banks and examining whether the structural model and, consequently, the effect of securitisation differ due to differences in accounting standards and regulation. This research would contribute to the continuing search for a consensus in regulation and accounting standards for securitisation across the markets.

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APPENDICES

Appendix A Commercial Bank Data Definition and Construction

Variable	Definition	Construction (Call Report Data Items)
Balance Sheet Structure		
Total Assets	Total Assets	RCFD2170
Liquidity Ratio	Liquid Assets/Assets Ratio	(RCFD0081 + RCFD0071 + RCFD1754 + RCFD1773)/RCFD2170
Loan Ratio	Loans/Assets Ratio	RCFD1400/RCFD2170
Deposits/Assets Ratio	Deposits/Assets Ratio	RCFD2200/RCFD2170
Equity/Assets Ratio	Equity Capital/Assets Ratio	RCFD3210/RCFD2170
Loan Portfolio Composition		
Real Estate Loan Ratio	Real Estate Loans/Assets Ratio	RCFD1410/RCFD1400
C&I Loan Ratio	Commercial and Industrial Loans/Assets Ratio	(RCFD1590 + RCFD1766)/RCFD1400
Consumer Loan Ratio	Consumer Loans/Assets Ratio	RCFD1975/RCFD1400
Other Loan Ratio	Other Loans/Assets Ratio	(RCFD1400 - RCFD1410 - RCFD1766 - RCFD1590 - RCFD1975)/RCFD1400
Loan HHI	Loan Herfindahl-Hirschman Index	(RCFD1410/RCFD1400)^2 + (RCFD1590 + RCFD1766/RCFD1400)^2 + +RCFD1975/RCFD1400)^2 + ((RCFD1400 - RCFD1410 - RCFD1766 -RCFD1590- - RCFD1975)/RCFD1400)^2
Regulatory Capital		
Tier I Leverage Ratio	Tier I Leverage Ratio	RCFD7204
Tier I Risk-Based Capital Ratio	Tier I Risk-Based Capital Ratio	RCFD7206
Total Risk-Based Capital Ratio	Total Risk-Based Capital Ratio	RCFD7205

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Appendix A (continued)

Variable	Definition	Construction (Call Report Data Items)
Cost of Funding		
Interest Expense/Liabilities	Interest Expense/Liabilities Ratio	RIAD4073/RCFD2948
Risk Characteristics		
NPL Ratio	Non-Performing Loans/Assets Ratio	(RCFD1407 + RCFD1403)/RCFD1400
RWATA Ratio	Risk-Weighted Assets/Total Assets Ratio	RCFDA223/RCFD2170
Charge-Off Ratio	Net Charge-Offs/Loans Ratio	RIAD4635/RCFD1400
Allowance Ratio	Allowance for Loan Losses/Loans Ratio	RCFD3123/RCFD1400
Loan Loss Provision Ratio	Provision for Loan Losses/Loans Ratio	RIAD4230/RCFD1400
Operating Performance		
Return on Assets	Net Income/Total Assets	RIAD4340/RCFD2170
Return on Equity	Net Income/Equity Capital	RIAD4340/RCFD3210
Net Interest Margin	Net Interest Income/Total Assets	RIAD4074/RCFD2170
Interest Income/Net Operating Revenue	Interest Income/Net Operating Revenue	RIAD4074/(RIAD4074 + RIAD4079)
Noninterest Income/Net Operating Revenue	Non-Interest Income/Net Operating Revenue	RIAD4079/(RIAD4074 + RIAD4079)
Revenue HHI	Revenue Herfindahl-Hirschman Index	(RIAD4074/(RIAD4074 + RIAD4079))^2 + (RIAD4079/(RIAD4074 + +RIAD4079))^2

Note: Variables used in chapter 4. Commercial bank data items are taken from Federal Reserve's Reports of Condition and Income (Call Reports).

Appendix B Bank Holding Company Data Definition and Construction

Variable	Definition	Construction (FR Y-9C Data Items)
Balance Sheet Structure		
Total Assets	Total Assets	BHCK2170
Liquidity Ratio	Liquid Assets/Assets Ratio	(BHCK0081 + BHCK0395 + BHCK0397 + BHCK1754 + BHCK1773)/BHCK2170
Loan Ratio	Loans/Assets Ratio	BHCK 2122/BHCK2170
Loans/Deposits Ratio	Loans/Deposits Ratio	BHCK3516/(BHCK3517 + BHCK3404)
Trading Assets/Assets Ratio	Trading Assets/Assets Ratio	BHCK3545/BHCK2170
Deposits/Assets Ratio	Deposits/Assets Ratio	(BHCK3517+ BHCK3404)/BHCK3368
Equity/Assets Ratio	Equity Capital/Assets Ratio	BHCK3210/BHCK2170
Loan Portfolio		
Real Estate Loan Ratio	Real Estate Loans/Assets Ratio	BHCK1410/(BHCK2122 + BHCK2123)
C&I Loan Ratio	Commercial and Industrial Loans/Assets Ratio	(BHCK1763 + BHCK1764)/(BHCK2122 + BHCK2123)
Consumer Loan Ratio	Consumer Loans/Assets Ratio	(BHCKB538 + BHCKB539 + BHCK2011)/(BHCK2122 + BHCK2123)
Other Loan Ratio	Other Loans/Assets Ratio	(BHCK2122 + BHCK2123 - BHCK1410 - BHCK1763 - BHCK1764 - BHCKB538 - BHCKB539 - BHCK2011)/(BHCK2122 + BHCK2123)
Loan HHI	Loan Herfindahl-Hirschman Index	(BHCK1410/(BHCK2122 + BHCK2123))^2 + ((BHCK1763 + BHCK1764)/ (BHCK2122 + BHCK2123))^2 + ((BHCKB538 + BHCKB539 + BHCK2011)/ (BHCK2122 + BHCK2123))^2 + ((BHCK2122 + BHCK2123 - BHCK1410 - BHCK1763 - BHCK1764 - BHCKB538 - BHCKB539 - BHCK2011)/(BHCK2122 + BHCK2123))^2
Regulatory Capital		
Tier I Leverage Ratio	Tier I Leverage Ratio	BHCK7204
Tier I Risk-Based Capital Ratio	Tier I Risk-Based Capital Ratio	BHCK7206
Total Risk-Based Capital Ratio	Total Risk-Based Capital Ratio	BHCK7205

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Appendix B (continued)

Variable	Definition	Construction (FR Y-9C Data Items)
Operating Performance		
Interest Income/Net Operating Revenue	Interest Income/Net Operating Revenue	BHCK4074/(BHCK4074 + BHCK4079)
Revenue HHI	Revenue Herfindahl-Hirschman Index	(BHCK4074/(BHCK4074 + BHCK4079))^2 + (BHCK4079/(BHCK4074 + BHCK4079))^2
Interest Margin	Net Interest Income/Total Assets	BHCK4074/BHCK3368
Return on Assets (ROA)	Net Income/Total Assets	BHCK4340/BHCK3519
Return on Equity (ROE)	Net Income/Equity Capital	BHCK4340/BHCK3368
Risk Characteristics		
RWATA Ratio	Risk-Weighted Assets/Total Assets Ratio	BHCKA223/BHCK2170
Non-Performing Loan (NPL) Ratio	Non-Performing Loans/Assets Ratio	BHCK5524 + BHCK 5525 + BHCK 5526 - BHCK3505 - BHCK 3506 - BHCK 3507)/ BHCK 3368
NPL/Loans Ratio	Non-Performing Loans/Loans Ratio	(BHCK5525 + BHCK5526 - BHCK3506 - BHCK3507)/BHCK3516
Charge-Off Ratio	Net Charge-Offs/Loans Ratio	(BHCK4635 - BHCK4605)/BHCK3516
Loan Loss Allowance Ratio	Allowance for Loan Losses/Loans Ratio	BHCK3123/BHCK3516
Loan Loss Provision Ratio	Quarterly Provision for Loan Losses/Loans Ratio	BHCK4230/BHCK3516
Z-Score (Z)	Z-Score	
RAROA	Risk-Adjusted Return on Assets	
StdDevROA	Standard Deviation of Return on Assets	
RAROE	Risk-Adjusted Return on Equity	
StdDevROE	Standard Deviation of Return on Equity	
StdDevNPL	Standard Deviation of Non-Performing Loan Ratio	

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Appendix B (continued)

Variable	Definition	Construction (FR Y-9C Data Items)
Securitisation		
Sec/Assets Ratio	Securitised Assets/Total Assets Ratio	(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710+ BHCKB711)/BHCK2170
SecExp Ratio	Credit Enhancements/Total Assets Ratio	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718 + BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399 + BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/BHCK2170
SecExp/Sec Ratio	Credit Enhancements/Securitised Assets Ratio	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718 + BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399 + BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
CEI Ratio	Credit-Enhancing Interest-Only Strips/Total Assets Ratio	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718)/BHCK2170
CEI/Sec Ratio	Credit-Enhancing Interest-Only Strips/Securitised Assets Ratio	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
SubSec Ratio	Subordinated Securities/Total Assets Ratio	(BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399)/BHCK2170
SubSec/Sec Ratio	Subordinated Securities/Securitised Assets Ratio	(BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
SLC Ratio	Standby Letters of Credit/Total Assets Ratio	(BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/BHCK2170
SLC/Sec Ratio	Standby Letters of Credit/Securitised Assets Ratio	(BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)

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Appendix B (continued)

Variable	Definition	Construction (FR Y-9C Data Items)
LiqProv Ratio	Liquidity Provision Commitments/Total Assets Ratio	(BHCKB726 + BHCKB727 + BHCKB728 + BHCKB729 + BHCKB730 + BHCKB731 + BHCKB732)/BHCK2170
LiqProv/Sec Ratio	Liquidity Provision Commitments/Securitised Assets Ratio	(BHCKB726 + BHCKB727 + BHCKB728 + BHCKB729 + BHCKB730 + BHCKB731 + BHCKB732)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
SecNPL/Sec Ratio	Past Due Securitised Assets/Securitised Assets Ratio	(BHCKB740 + BHCKB741 + BHCKB742 + BHCKB743 + BHCKB744 + BHCKB745 + BHCKB746)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
SecChargeOffs/Sec Ratio	Net Charge-Offs on Securitised Assets/Securitised Assets	(BHCKB747 + BHCKB748 + BHCKB749 + BHCKB750+ BHCKB751 + BHCKB752 + BHCKB753 - BHCKB754 - BHCKB755 - BHCKB756 - BHCKB757 - BHCKB758 - BHCKB759 - BHCKB760)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
SellerInterest Ratio	Seller's Interest/Total Assets	(BHCKB761 + BHCKB762 + BHCKB763 + BHCKB500 + BHCKB501 + BHCKB502)/BHCK2170
SellerInterest/Sec Ratio	Seller's Interest/Securitised Assets	(BHCKB761 + BHCKB762 + BHCKB763 + BHCKB500 + BHCKB501 + BHCKB502)/(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
OthersSecExp Ratio	Credit Enhancements to Other Institutions' Securitisations/Total Assets	(BHCKB776+ BHCKB777+ BHCKB778 + BHCKB779 + BHCKB780 + BHCKB781 + BHCKB782)/BHCK2170
OthersSecLiqProv Ratio	Liquidity Provision Commitments to Other Institutions' Securitisations/Total Assets	(BHCKB783 + BHCKB784+ BHCKB785+ BHCKB786+ BHCKB787+ BHCKB788 + BHCKB789)/BHCK2170

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Appendix B (continued)

Variable	Definition	Construction (FR Y-9C Data Items)
-Mort-	Mortgage	
-HEL-	Home Equity Line	
-CC-	Credit Card	
-Auto-	Auto	
-Cons-	Consumer	
-CI-	Commercial & Industrial	
-Oth-	Other Loan and Lease	

Note: Definition and construction of variables used in chapters 5 and 6. Bank holding company data items are taken from FR Y-9C forms.

Appendix C Correlation Matrix for the Determinants of Bank Credit Risk Taking

	$Sec_{i,t-1}$	$Size_{i,t-1}$	$Loan_{i,t-1}$	$Cap_{i,t-1}$	$ROA_{i,t-1}$	$ChOff_{i,t-1}$
$Sec_{i,t-1}$	1					
$Size_{i,t-1}$	0.1396	1				
	0.0000					
$Loan_{i,t-1}$	-0.0728	-0.2103	1			
	0.0000	0.0000				
$Cap_{i,t-1}$	0.0643	-0.0600	-0.1324	1		
	0.0000	0.0000	0.0000			
$ROA_{i,t-1}$	0.0617	0.0172	0.0151	0.6023	1	
	0.0000	0.2323	0.2942	0.0000		
$ChOff_{i,t-1}$	0.0636	0.0973	0.0182	0.3873	0.7237	1
	0.0000	0.0000	0.2055	0.0000	0.0000	

Note: The table presents pairwise correlations for explanatory variables used in the regression of bank credit risk taking (equation (5.1)). Statistical significance (*p*-value) is presented under the coefficients. For the definition and construction of the variables see Appendix B.

Appendix D Hausman Specification Test for the Determinants of Bank Credit Risk Taking

	Coefficients		Difference	S.E.
	FE	RE		
	(b)	(B)	(b-B)	SqRt(diag(V_b-V_B))
$Sec_{i,t-1}$	-0.0046	-0.0032	-0.0014	0.0014
$Size_{i,t-1}$	0.0118	-0.0003	0.0121	0.0016
$Loan_{i,t-1}$	-0.1177	-0.0045	-0.1132	0.0084
$Cap_{i,t-1}$	0.0160	0.0279	-0.0120	0.0247
$ROA_{i,t-1}$	-0.1292	-0.0377	-0.0915	0.0325
$ChOff_{i,t-1}$	-0.1751	-0.1632	-0.0118	0.0594

b = Consistent under Ho and Ha
B = Inconsistent under Ha, efficient under Ho
Test: Ho: Difference in coefficients not systematic

chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
chi2(6) = 222.77
Prob>chi2 = 0.0000

Note: The table report the results of the Hausman specification test for regression of bank credit risk taking (equation (5.1)). Hausman specification test compares fixed effects versus random effects estimates; under the null hypothesis, the individual effects are uncorrelated with the other regressors in the model and can be treated as random (see Hausman (1978)).The statistically significant difference (H_0 is rejected) is interpreted as evidence for applying the fixed effects model.

Appendix E Correlation Matrix for the Effects of Securitisation Structures on Bank Insolvency Risk

	Sec	SecExp	CEIOS	SubSec	SLC	SecLiqProv	SellerInterest	OthersSecExp	OthersSecLiqProv	Size	Liq	HHILoan	Trading	Capital	HHIRev	AssetGrowth
Sec	1															
SecExp	0.22	1														
	0.00															
CEIOS	0.15	0.54	1													
	0.00	0.00														
SubSec	0.32	0.59	0.22	1												
	0.00	0.00	0.00													
SLC	0.1	0.73	0.01	0.06	1											
	0.01	0.00	0.77	0.12												
SecLiqProv	0.01	0.06	0	0.18	-0.01	1										
	0.77	0.09	0.95	0.00	0.73											
SellerInterest	0.28	0.38	0.29	0.68	-0.01	-0.01	1									
	0.00	0.00	0.00	0.00	0.71	0.70										
OthersSecExp	0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	1								
	0.91	0.70	0.77	0.75	0.85	0.86	0.86									
OthersSecLiqProv	-0.01	0	-0.01	0	0	0.07	0.01	0.02	1							
	0.68	0.90	0.81	0.97	0.90	0.04	0.73	0.62								
Size	0.13	0.16	0.06	0.16	0.11	0.18	0.2	-0.05	0.13	1						
	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.17	0.00							
Liq	-0.1	0.04	0.16	-0.09	0.02	0.07	-0.07	-0.03	0.06	-0.16	1					
	0.00	0.19	0.00	0.02	0.61	0.04	0.03	0.44	0.08	0.00						
HHILoan	0.16	0.07	0.07	0	0.05	0.08	0.05	0	-0.08	-0.3	0.07	1				
	0.00	0.04	0.03	0.99	0.17	0.02	0.11	0.88	0.02	0.00	0.04					
Trading	0.14	0.07	0.08	0.09	0.01	0.08	0.11	0	0.13	0.55	-0.14	-0.19	1			
	0.00	0.03	0.01	0.02	0.86	0.01	0.00	0.90	0.00	0.00	0.00	0.00				
Capital	0.04	0.1	0.09	0.2	-0.04	-0.03	0.11	-0.03	-0.01	-0.04	0.14	-0.13	-0.05	1		
	0.25	0.00	0.01	0.00	0.33	0.39	0.00	0.38	0.67	0.25	0.00	0.00	0.17			
HHIRev	-0.11	-0.07	-0.02	-0.09	-0.03	-0.09	-0.1	-0.01	-0.04	-0.44	0.12	0.24	-0.21	0.15	1	
	0.00	0.03	0.57	0.01	0.35	0.01	0.00	0.85	0.24	0.00	0.00	0.00	0.00	0.00		
AssetGrowth	0.04	-0.02	0.06	0.01	-0.09	0	0.07	-0.01	-0.03	0.1	-0.11	0.1	0.1	-0.08	-0.07	1
	0.20	0.47	0.06	0.77	0.01	0.99	0.02	0.79	0.35	0.00	0.00	0.00	0.00	0.01	0.02	

Note: The table presents pairwise correlations for explanatory variables used in the regression of bank insolvency risk (equation (6.2)). Statistical significance (*p*-value) is presented under the coefficients. For the definition and construction of the variables see Appendix B.

Appendix F Hausman Specification Test for the Effects of Securitisation Structures on Bank Insolvency Risk

	Coefficients		Difference	S.E.
	FE	RE		
	(b)	(B)	(b-B)	SqRt(diag(V_b-V_B))
$Sec_{i,t}$	-0.7238	-0.4378	-0.2860	0.2276
$SecExp_{i,t}$	-15.2056	-17.0811	1.8755	2.7892
$SecLiqProv_{i,t}$	59.8677	30.9199	28.9478	23.4479
$SellerInterest_{i,t}$	4.9574	1.1877	3.7698	5.7734
$OthersSecExp_{i,t}$	16.4452	9.0911	7.3541	3.7868
$OthersSecLiqProv_{i,t}$	-59.2418	-34.6074	-24.6345	25.0951
$Size_{i,t}$	-0.7165	0.0995	-0.8160	0.1568
$Liq_{i,t}$	1.3821	1.2884	0.0938	0.7509
$Trading_{i,t}$	-5.7973	-5.9396	0.1424	3.7737
$Capital_{i,t}$	1.5679	-0.4113	1.9792	1.7463
$AssetGrowth_{i,t}$	8.7366	7.4834	1.2532	0.8392
$AssetGrowth^2_{i,t}$	-83.7147	-62.1525	-21.5622	8.7363
$HHIRev_{i,t}$	0.7584	0.0231	0.7354	0.4383
$HHILoan_{i,t}$	1.4160	-0.3056	1.7217	0.7372

b = Consistent under Ho and Ha
B = Inconsistent under Ha, efficient under Ho
Test: Ho: Difference in coefficients not systematic

chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
chi2(6) = 50.52
Prob>chi2 = 0.0000

Note: The table report the results of the Hausman specification test for regression of bank insolvency risk (equation (6.1)). Hausman specification test compares fixed effects versus random effects estimates; under the null hypothesis, the individual effects are uncorrelated with the other regressors in the model and can be treated as random (see Hausman (1978)).The statistically significant difference (H_0 is rejected) is interpreted as evidence for applying the fixed effects model.

Appendix G Determinants of Securitisation Probability by Year for 2002-2007

Year 2002	**Coef**	**StdErr**	**z**	**P>z**	**95% Confidence Interval**	
$Size_{i, t-1}$	0.221	0.063	3.500	0.000	0.097	0.345
Liquidity $Ratio_{i, t-1}$	-0.864	1.296	-0.67(	0.505	-3.403	1.676
Loan $Ratio_{i, t-1}$	1.290	1.225	1.050	0.292	-1.111	3.690
C&I Loans $Ratio_{i, t-1}$	0.593	0.613	0.970	0.334	-0.609	1.794
Consumer Loans $Ratio_{i, t-1}$	1.331	0.563	2.360	0.018	0.227	2.435
Other Loans $Ratio_{i, t-1}$	1.183	1.088	1.090	0.277	-0.949	3.315
Loan $HHI_{i, t-1}$	-0.051	0.689	-0.07(	0.941	-1.401	1.299
Deposits/Assets $Ratio_{i, t-1}$	-0.719	0.790	-0.91(	0.363	-2.267	0.830
Equity/Assets $Ratio_{i, t-1}$	-0.888	2.499	-0.36(	0.722	-5.786	4.010
Tier I Risk-Based Capital $Ratio_{i, t-1}$	0.458	0.891	0.510	0.607	-1.288	2.204
Interest Expense/Liabilities $Ratio_{i, t-}$	-1.165	4.779	-0.24(	0.807	-10.531	8.202
NPL $Ratio_{i, t-1}$	-13.798	10.234	-1.35(	0.178	-33.857	6.260
Return on $Assets_{i, t-1}$	-6.812	10.569	-0.64(	0.519	-27.525	13.902
State Dummies	Yes					
Pseudo R^2	0.197					
Log Likelihood	-139.546					
No. of Observations	4288					

Note: The table presents the probit regression estimates of the likelihood to securitise assets for year 2002. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All bank-specific explanatory variables are lagged one year.

Appendix G (continued)

Year 2003	Coef	StdErr	z	P>z	95% Confidence Interval	
$Size_{i, t-1}$	0.221	0.063	3.500	0.000	0.097	0.345
Liquidity $Ratio_{i, t-1}$	-0.864	1.296	-0.670	0.505	-3.403	1.676
Loan $Ratio_{i, t-1}$	1.290	1.225	1.050	0.292	-1.111	3.690
C&I Loans $Ratio_{i, t-1}$	0.593	0.613	0.970	0.334	-0.609	1.794
Consumer Loans $Ratio_{i, t-1}$	1.331	0.563	2.360	0.018	0.227	2.435
Other Loans $Ratio_{i, t-1}$	1.183	1.088	1.090	0.277	-0.949	3.315
Loan $HHI_{i, t-1}$	-0.051	0.689	-0.070	0.941	-1.401	1.299
Deposits/Assets $Ratio_{i, t-1}$	-0.719	0.790	-0.910	0.363	-2.267	0.830
Equity/Assets $Ratio_{i, t-1}$	-0.888	2.499	-0.360	0.722	-5.786	4.010
Tier I Risk-Based Capital $Ratio_{i, t-1}$	0.458	0.891	0.510	0.607	-1.288	2.204
Interest Expense/Liabilities $Ratio_{i, t-1}$	-1.165	4.779	-0.240	0.807	-10.531	8.202
NPL $Ratio_{i, t-1}$	-13.798	10.234	-1.350	0.178	-33.857	6.260
Return on $Assets_{i, t-1}$	-6.812	10.569	-0.640	0.519	-27.525	13.902
State Dummies	Yes					
Pseudo R^2	0.120					
Log Likelihood	-202.558					
No. of Observations	4154					

Note: The table presents the probit regression estimates of the likelihood to securitise assets for year 2003. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All bank-specific explanatory variables are lagged one year.

Appendix G (continued)

Year 2004	**Coef**	**StdErr**	**z**	**P>z**	**95% Confidence Interval**	
$Size_{i, t-1}$	-0.044	0.097	-0.460	0.648	-0.233	0.145
Liquidity $Ratio_{i, t-1}$	-0.151	1.725	-0.090	0.930	-3.533	3.230
Loan $Ratio_{i, t-1}$	-0.648	1.748	-0.370	0.711	-4.074	2.778
C&I Loans $Ratio_{i, t-1}$	-0.184	0.857	-0.220	0.830	-1.864	1.496
Consumer Loans $Ratio_{i, t-1}$	-3.755	2.415	-1.560	0.120	-8.488	0.977
Other Loans $Ratio_{i, t-1}$	-3.581	4.470	-0.800	0.423	-12.342	5.180
Loan $HHI_{i, t-1}$	-0.436	1.133	-0.390	0.700	-2.657	1.784
Deposits/Assets $Ratio_{i, t-1}$	-0.433	1.249	-0.350	0.729	-2.881	2.016
Equity/Assets $Ratio_{i, t-1}$	3.609	4.064	0.890	0.375	-4.356	11.574
Tier I Risk-Based Capital $Ratio_{i, t-1}$	-4.754	3.234	-1.470	0.142	-11.092	1.584
Interest Expense/Liabilities $Ratio_{i, t-1}$	25.551	27.717	0.920	0.357	-28.774	79.876
NPL $Ratio_{i, t-1}$	1.632	5.392	0.300	0.762	-8.936	12.200
Return on $Assets_{i, t-1}$	20.271	15.014	1.350	0.177	-9.157	49.698
State Dummies	Yes					
Pseudo R^2	0.082					
Log Likelihood	-129.811					
No. of Observations	3956					

Note: The table presents the probit regression estimates of the likelihood to securitise assets for year 2004. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All bank-specific explanatory variables are lagged one year.

Appendix G (continued)

Year 2005	**Coef**	**StdErr**	**z**	**P>z**	**95% Confidence Interval**	
$Size_{i, t-1}$	0.377	0.069	5.430	0.000	0.241	0.512
Liquidity $Ratio_{i, t-1}$	1.693	1.982	0.850	0.393	-2.193	5.578
Loan $Ratio_{i, t-1}$	2.683	1.895	1.420	0.157	-1.031	6.396
C&I Loans $Ratio_{i, t-1}$	0.696	0.745	0.930	0.350	-0.764	2.156
Consumer Loans $Ratio_{i, t-1}$	0.281	0.853	0.330	0.742	-1.391	1.952
Other Loans $Ratio_{i, t-1}$	1.541	1.383	1.110	0.265	-1.170	4.252
Loan $HHI_{i, t-1}$	0.329	0.790	0.420	0.677	-1.219	1.876
Deposits/Assets $Ratio_{i, t-1}$	-0.218	0.926	-0.240	0.814	-2.034	1.597
Equity/Assets $Ratio_{i, t-1}$	2.775	3.226	0.860	0.390	-3.548	9.098
Tier I Risk-Based Capital $Ratio_{i, t-1}$	-1.514	1.854	-0.820	0.414	-5.147	2.119
Interest Expense/Liabilities $Ratio_{i, t-1}$	41.289	26.068	1.580	0.113	-9.804	92.382
NPL $Ratio_{i, t-1}$	2.714	2.339	1.160	0.246	-1.871	7.299
Return on $Assets_{i, t-1}$	-31.310	12.354	-2.530	0.011	-55.523	-7.096
State Dummies	Yes					
Pseudo R^2	0.201					
Log Likelihood	-149.443					
No. of Observations	4081					

Note: The table presents the probit regression estimates of the likelihood to securitise assets for year 2005. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All bank-specific explanatory variables are lagged one year.

Appendix G (continued)

Year 2006	**Coef**	**StdErr**	**z**	**P>z**	**95% Confidence Interval**	
$Size_{i, t-1}$	0.058	0.081	0.720	0.471	-0.100	0.217
Liquidity $Ratio_{i, t-1}$	2.260	1.855	1.220	0.223	-1.375	5.896
Loan $Ratio_{i, t-1}$	2.042	1.904	1.070	0.283	-1.689	5.774
C&I Loans $Ratio_{i, t-1}$	-1.008	1.416	-0.710	0.477	-3.783	1.767
Consumer Loans $Ratio_{i, t-1}$	-5.138	2.916	-1.760	0.078	-10.853	0.576
Other Loans $Ratio_{i, t-1}$	-1.474	3.330	-0.440	0.658	-8.001	5.053
Loan $HHI_{i, t-1}$	-0.987	1.471	-0.670	0.502	-3.870	1.896
Deposits/Assets $Ratio_{i, t-1}$	-0.629	1.111	-0.570	0.572	-2.807	1.550
Equity/Assets $Ratio_{i, t-1}$	1.268	3.026	0.420	0.675	-4.664	7.200
Tier I Risk-Based Capital $Ratio_{i, t-1}$	-0.833	1.325	-0.630	0.530	-3.430	1.765
Interest Expense/Liabilities $Ratio_{i, t-1}$	-35.511	31.137	-1.140	0.254	-96.538	25.516
NPL $Ratio_{i, t-1}$	-18.918	14.554	-1.300	0.194	-47.444	9.607
Return on $Assets_{i, t-1}$	-13.215	11.036	-1.200	0.231	-34.844	8.415
State Dummies	Yes					
Pseudo R^2	0.096					
Log Likelihood	-134.745					
No. of Observations	3576					

Note: The table presents the probit regression estimates of the likelihood to securitise assets for year 2006. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All bank-specific explanatory variables are lagged one year.

Appendix G (continued)

Year 2007	**Coef**	**StdErr**	**z**	**P>z**	**95% Confidence Interval**	
$Size_{i, t-1}$	0.146	0.059	2.500	0.012	0.032	0.261
Liquidity $Ratio_{i, t-1}$	-0.332	1.108	-0.300	0.765	-2.504	1.841
Loan $Ratio_{i, t-1}$	-1.015	1.158	-0.880	0.381	-3.285	1.255
C&I Loans $Ratio_{i, t-1}$	0.878	0.660	1.330	0.183	-0.414	2.171
Consumer Loans $Ratio_{i, t-1}$	0.895	0.717	1.250	0.212	-0.510	2.300
Other Loans $Ratio_{i, t-1}$	-2.670	2.949	-0.910	0.365	-8.450	3.109
Loan $HHI_{i, t-1}$	1.224	0.657	1.860	0.062	-0.063	2.512
Deposits/Assets $Ratio_{i, t-1}$	-1.414	0.808	-1.750	0.080	-2.999	0.170
Equity/Assets $Ratio_{i, t-1}$	-1.478	2.376	-0.620	0.534	-6.134	3.178
Tier I Risk-Based Capital $Ratio_{i, t-1}$	-1.503	1.289	-1.170	0.244	-4.030	1.023
Interest Expense/Liabilities $Ratio_{i, t-1}$	0.876	19.500	0.040	0.964	-37.344	39.095
NPL $Ratio_{i, t-1}$	-17.216	10.062	-1.710	0.087	-36.938	2.506
Return on $Assets_{i, t-1}$	-18.069	9.059	-1.990	0.046	-35.824	-0.315
State Dummies	Yes					
Pseudo R^2	0.113					
Log Likelihood	-210.161					
No. of Observations	3931					

Note: The table presents the probit regression estimates of the likelihood to securitise assets for year 2007. The dependent variable equals to one for first-time securitisers and zero for non-securitisers. All bank-specific explanatory variables are lagged one year.