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RETAINED INTERESTS IN SECURITISATIONS AND IMPLICATIONS FOR BANK SOLVENCY

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ABSTRACT

Using US bank holding company data for the period 2001 to 2007, this paper examines the relationship between banks' retained interests in securitisations and insolvency risk. We find that the provision of credit enhancements and guarantees significantly increases bank insolvency risk, albeit this varies for different levels of securitisation outstanding. Specifically, retained interests increase insolvency risk for "large-scale" securitisers while having a risk-reducing effect for "small-scale" and/or first-time securitisers. In addition, we find that the type of facility provided has implications for bank risk, with those with the most subordinated (first-loss) position having the greater impact on banks' default risk. Finally, we find that engagement in third-party securitisations has no significant effect on bank risk.

NON-TECHNICAL SUMMARY

The process of securitisation is composed of three main steps: (i) the pooling of assets; (ii) the creation of a special purpose vehicle (SPV) and the transfer of the asset pool to the SPV; and (iii) the structuring of the transaction. The latter involves the provision of credit enhancements and guarantees to protect investors from potential losses on the securitised assets. These may take different forms and can be provided internally, externally, or a combination of both. The practice of providing internal credit enhancements to securitisation structures resulted in banks retaining on their balance sheets the risks of their off-balance sheet securitised assets. As a consequence, in the run up to the 2007-2009 financial crisis, many securitisation transactions created imperfect credit risk transfers, leading to risks being concentrated in the banking system rather than passed on to investors.

Post crisis, national and international regulators have proposed a number of rules aiming to address the shortcomings of the securitisation markets. A key issue that regulators are trying to address relates to the alignment of incentives associated with securitisation. This resulted in the introduction of "risk retention rules" that require banks to maintain an interest in their own securitisations, based on the assumption that retaining "skin in the game" induces banks to improve screening and monitoring of borrowers. Examples of the proposed rules requiring securitisers to retain a portion of the credit risk in the assets that they securitise include Article 122a of the Capital Requirements Directive (CRD II) in the EU and Section 941 of the 2010 Dodd-Frank Act in the US.

Notwithstanding their potential to minimise asymmetric information problems and foster a better alignment of incentives, retained interests also expose banks to the risk of their securitised assets. It is then somewhat surprising, given the mandatory risk retention proposed by the aforementioned policy recommendations, that no research to date has analysed empirically the implications of retained interests on bank insolvency risk. In addition, despite the relevance attached by policy makers to the structure of acceptable forms of risk retention, there is no empirical evidence, as far as we are aware, to evaluate whether the effects of retained interests are comparable across different forms of retention.

Against this background, this paper makes three contributions to previous literature. First, using US bank holding company data for 2001-2007, we analyse the relationship between the total economic interests retained by banks in off-balance sheet securitisations and insolvency risk, measured as distance to default. Second, we investigate whether various forms of retained interests have a differential impact on bank risk. Finally, we consider the impact of the provision of enhancements and guarantees to third-party securitisations on bank risk.

We find that total retained interests and guarantees offered to own securitisation structures significantly increase bank insolvency risk, albeit this varies for different levels of securitisation outstanding. Specifically, our evidence suggests that for "large-scale"

securitisers retained interests increase overall risk, while having a risk-reducing effect for "small-scale" and/or first-time securitisers. In addition, we find that the type of facility provided, as well as the possible interaction among different facilities, have implications for bank risk. Specifically, the risk-increasing effect appears to be driven mainly by the subordinated structure of facilities, with those with most subordinated (first-loss) position having greater impact on banks' risk of default. In addition, we find that credit enhancements tend to increase bank risk whereas liquidity provisions do not. Finally, we find that engagement in third-party securitisations through providing credit and/or liquidity support does not have significant effect on the risk of the banks.

The results of this study have relevance to on-going policy developments, including the recent proposals by the Financial Stability Board and by the International Organisation of Securities Commissions (FSB 2012, IOSCO 2012). Specifically, while there have been calls for a standardised risk retention rule applied homogeneously across securitisations, we argue that there are fundamental factors that should be taken into account when designing the risk retention framework and that the perceived benefits of risk retention should be balanced with the potential costs. The proposed rules currently allow for some variation in the amount of risk that banks may retain, on the basis of the quality and characteristics of the assets securitised and on the economic environment at the time of securitisation. Our results, however, indicate that it is necessary to consider also the type of retained interests and the strategy of securitisers (that is, "small-scale" versus "large-scale") when structuring the amount of risk to be retained for a particular securitisation. In other words, when designing the risk retention framework for securitisation, regulators should also consider bank risk at the institutional level, with a view to balancing the incentive structure embedded in interest retention with the use of securitisation as a tool to manage credit risk.

1 INTRODUCTION

The development of securitisation over the past three decades has modified the functioning of banks from a traditional "originate-to-hold" to an "originate-to-distribute" model, which increased the reliance of financial intermediaries on capital markets as a source of finance. After an extended period of growth, global securitisation markets collapsed in 2008, as the financial crisis exposed the problems inherent in the securitisation process (including misaligned incentives of participants and informational asymmetries). Evidence suggests that banks used increasingly complex securitisation structures that ultimately resulted in little credit risk transfer (Acharya, Schnabl, and Suarez 2012).

Conventional securitisation comprises three main steps. The first step is the pooling of assets. The second step involves the creation of a special purpose vehicle (SPV) and the transfer of the asset pool to the SPV. The third step is the structuring of the transaction. When structuring the transaction, the key stage is the provision of credit enhancements and guarantees to protect investors from potential losses on the securitised assets. Credit enhancements represent contractual arrangements in which a bank retains or assumes securitisation exposure and, in substance, provides some degree of added protection to other parties in the transaction (BCBS 2002). These enhancements may take different forms and can be provided internally, externally, or by a combination of both.[1] Internal credit enhancements and guarantees (also known as retained interests) can be generated by the cash flows from the underlying assets (excess spread), by the structure of the transaction (subordinated securities), or can be provided by the originating bank (liquidity provisions, seller's interest, and stand-by letters of credit). External (or third-party) credit enhancements include the credit support provided to other institutions' securitisation structures and may take the form of a third-party letter of credit, cash collateral account, and surety bonds.[2]

Credit enhancements are present in all securitisation transactions. The type and the amount of credit enhancements necessary to achieve a specific credit rating for the resulting asset-backed securities are normally determined by rating agencies and underwriters when structuring the transaction, and are based on the expected performance of the underlying pool of assets (Ashcraft and Schuermann 2008). Credit enhancements are also used to maintain the assigned rating levels and therefore can vary during the lifetime of a structured transaction.[3] Recent figures indicate an upward trend in the use of credit enhancements: total enhancements provided by US bank holding companies, including both those provided to own and to third-party securitisations, increased from $25 billion in 2001, Quarter 2, to $70 billion in 2009, Quarter 1 (Mandel, Morgan, and Wei 2012).

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[1] The seller/originator may also provide non-contractual internal credit enhancements, which can be defined as credit support beyond the originator's contractual obligations. This is commonly referred to as "implicit recourse", and is a particular problem normally associated with the securitisation of revolving assets, such as for example, credit card receivables. The existence of implicit recourse is difficult to measure.

[2] Ashcraft and Schuermann (2008) provide a detailed discussion of the structural features of securitisation.

[3] See, for example, the case of an increase in credit enhancement for outstanding notes at JPMorgan Chase in 2009: http://www.reuters.com/article/2009/05/12/idUS260368+12-May-2009+BW20090512.

The growth in the provision of credit enhancements raises the question of the role of retained interests in the securitisation process and ultimately their resultant effect on bank risk. It has long been common practice for securitisers to retain an economic interest in their own securitisation structures, which in theory should result in a better alignment of interests with investors in asset-backed securities (Pennacchi 1988, Gorton and Pennacchi 1995). Post crisis, the alignment of incentives in securitisation is of crucial importance for both regulators and industry standard-setters. Indeed, recent policy recommendations require banks to retain an interest in securitisations therefore relying on the assumption that having an originator to retain a long-term economic exposure (the so called "skin in the game") can better align interests between originators and investors and incentivise the former to originate high quality assets (BIS 2011, Geithner 2011).[4] In other words, retained interests should, in theory, induce better underwriting standards and increase banks' incentives to screen and monitor borrowers, and thereby lower overall bank risk.

Notwithstanding their potential to minimise asymmetric information problems and foster a better alignment of incentives between banks and investors, retained interests also expose banks to the risk of the securitised assets. In addition, given the lower capital requirements associated with retained interests, the structuring of transactions created a significant concentration of risks, thereby increasing banks' insolvency risk (Shin 2009, Acharya, Schnabl, and Suarez 2012). In many cases, the simple act of securitising loans decreased a bank's capital requirements substantially.[5] The fact that the risk inherent to securitised assets was not passed on to investors but remained on banks' balance sheets, in the form of retained interests and guarantees, is considered one of the key reasons for the severity of the financial crisis (Shin 2009).

Post crisis, a key issue for regulators has been the introduction of "risk retention rules" that require banks to maintain an interest in their own securitisations.[6] These rules are based on the assumption that retaining "skin in the game" induces banks to improve screening and monitoring of borrowers. However, the potential benefits of risk retention do not come without costs. There is a general consensus in the literature that the retention of economic interests in securitisation may result in the risk to remain with the originating bank (Calomiris and Mason 2004, Gorton and Souleles 2006, Niu and Richardson 2006, Shin 2009). It is then

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[4] The G20 Leaders' statement of the Pittsburgh Summit (September 2009) recommended that securitisers should retain a part of the risk of the underlying assets. This measure intends to correct the misalignment of incentives and encourage originators to apply rigorous lending policies (BIS 2011). This guideline has already been included within some regulations, including Section 941 of the 2010 Dodd-Frank Act in the US and Article 122a of the 2011 Capital Requirements Directive (CRD II) in the EU.

[5] A key issue that surfaced during the financial crisis relates to the fact that securitisation allowed banks to reduce their capital reserves without reducing their risk exposure. A bank could securitise a loan and keep all the resulting securities on its own balance sheet still achieving a reduction in its capital requirements without having effectively reduced risk. This was because the risk weight attached to more senior tranches was lower than those attached to the original loan (for example, 50% for a loan versus 20% for AAA and AA tranches). See for example, Goldman Sachs (2009), Erel, Nadauld, and Stulz (2012).

[6] For example, in the EU, Article 122a of the Capital Requirements Directive. In the US, Section 941 of the Dodd-Frank Act requires securitisers to retain a material portion (generally 5 percent) of credit risk of securitised exposures and prohibits the originator or the sponsor from directly or indirectly hedging or otherwise transferring this risk.

somewhat surprising, given the mandatory risk retention proposed by recent policy recommendations, that no research to date has analysed empirically the implications of retained interests on bank insolvency risk. In addition, despite the relevance attached by policy makers to the structure of acceptable forms of risk retention, there is no empirical evidence, as far as we are aware, to evaluate whether the effects of retained interests are comparable across different forms of retention.[7]

It is against this background that this study examines the relationship between banks' retained interests in securitisations and insolvency risk. Using US bank holding company data for 2001-2007, we make three contributions to the literature. First, we analyse the relationship between the total economic interests retained by banks in off-balance sheet securitisations and insolvency risk. Second, we investigate whether various forms of retained interests have a differential impact on bank risk. Finally, we consider banks' engagement in third-party securitisations.

More specifically, we analyse the relationship between bank retained interests and insolvency risk, measured as distance to default (via a z-score measure). Subsequently, we investigate whether various forms of retained interests have a differential impact on bank risk, with differences potentially arising from the type and/or subordination of underlying facilities. Specifically, we consider the following forms of retained interests: (i) credit enhancements, including credit-enhancing interest-only strips (excess spread between the interest generated by the underlying pool of assets and that on the issued securities backed by the pool); subordinated securities (tranches of asset-backed securities); and standby letters of credit (unfunded commitment that guarantees limited protection against losses on the underlying assets); (ii) liquidity support (a commitment to provide funding to the securitisation to ensure investors of timely payments on asset-backed securities); and (iii) seller's interest (the difference between the total amount of assets included in the securitisation and the amount of assets underlying issued securities, also known as over-collateralisation). Finally, we consider the impact of the provision of credit enhancements and guarantees to third-party securitisations on bank risk.

Our results provide evidence of a negative and significant impact of retained interests on bank insolvency risk. These results are consistent across several model specifications. A key issue that arises when attempting to estimate the impact of retained interests on bank insolvency risk is the potential endogeneity bias that may result from reverse causality. That is, the level of retained interests may be driven by the risk of the originating bank. To address this concern, we implement an instrumental variable (IV) technique. Our baseline finding of a significant and negative effect of retained interests on insolvency risk holds in the IV analysis. This therefore suggests that endogeneity of the securitisation decision does not drive our main results.

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[7] The acceptable forms of risk retention include: (i) a vertical slice (where a securitiser retains a pro rata piece of every tranche in the securitisation); (ii) a horizontal slice (where a securitiser retains a first-loss interest in the securitisation structure); and (iii) a representative sample (where a securitiser retains a randomly selected subset of assets representing the securitised pool in terms of credit risk) (Geithner 2011).

An investigation of different forms of retained interests reveals that credit enhancements and seller's interest have a risk-increasing effect, while the provision of liquidity does not seem to affect bank risk. We tentatively explain this result with reference to the intrinsic nature of liquidity support to posit that liquidity provisions are, in general, excess funds provided by the originator to the SPV as a buffer, so the first loss is absorbed by the SPV.

The data allow us to analyse the effect of credit enhancements in more detail by decomposing them according to the underlying facility. The results show that credit-enhancing interest-only strips have the strongest risk-increasing effect, consistently with their subordinated (first-loss) position, followed by standby letters of credit. On the other hand, subordinated securities do not seem to impact bank risk. This is a particularly interesting result, as it offers some support to the theoretical literature on the mitigating effect on bank risk taking of holding a subordinated/equity tranche. Further, we find that engagement in third-party securitisations does not have significant effect on bank risk.

An investigation of the risk effects of retained interests for different levels of securitisation outstanding reveals a risk-reducing effect for banks with a low securitisation activity, and a risk-increasing effect for banks with a high securitisation activity. This evidence suggests that for "small-scale" securitisers and/or first-time securitisers the "skin in the game" improves incentives to originate high quality assets and therefore reduces the overall risk. For "large-scale" securitisers, retained interests seem to serve mainly as a buffer against the default risk of the collateral therefore increasing bank risk.

Overall, the findings presented in this study have a direct relevance for on-going policy developments. Specifically, while a standardised risk retention rule applied homogeneously across securitisations may allow for "*greater transparency, measurability, and certainty of implementation*" (Geithner 2011), we argue that there are fundamental factors that should be taken into account when structuring the risk retention framework. The proposed rules do allow for some variation in the amount of risk that banks may retain, on the basis of the quality and characteristics of the assets securitised and on the economic environment at the time of securitisation. Our results, however, seem to indicate that it is necessary to consider also the type of retained interests and the strategy of securitisers (that is, "small-scale" versus "large-scale") when structuring the amount of risk that should be retained for a particular securitisation. In other words, our results suggest that, when designing the risk retention framework for securitisation, regulators should also consider the bank risk perspective with a view to balance the incentive structure embedded in interest retention with the use of securitisation as a tool to manage credit risk.

The remainder of the paper is organised as follows. Section 2 discusses the role of interest retention in securitisation and reviews the relevant literature. Section 3 describes the data selection and sample specification. The empirical specification is presented in Section 4, while Section 5 reports the results of the main empirical analyses. Section 6 describes the robustness tests and Section 7 discusses the findings and concludes the paper.

2 THE ROLE OF RETAINED INTERESTS IN SECURITISATION

The existence of retained interests in securitisation raises three crucial questions: Why do banks retain an economic interest in securitisations? How much to retain? What are the risk implications of different retention mechanisms? These questions are central to both the current academic and policy debates on the future of securitisation markets and are key to our empirical investigation. Below we review the extant literature and detail how our analysis contributes to the understanding of these issues.

2.1 Why Do Banks Retain an Economic Interest in Securitisations?

The literature puts forward a number of key factors driving risk retention: information asymmetries, signalling, liquidity creation, and regulatory arbitrage. Below we briefly review this literature.

A. Information Asymmetries

The process of securitisation raises issues of information asymmetries and misaligned incentives between the banks and the final investors in asset-backed securities. Banks have private information on the quality of the loans they securitise. As investors do not observe this information, they may require a "lemon discount" which can drive the price of the resulting securities below their book value. This results from the fact that the incentive structure of securitisation can create adverse selection (low quality loans are securitised) and moral hazard problems (as loans can be sold, lenders lack incentives to screen and monitor borrowers).

The asymmetric information problem may constrain a bank's ability to securitise loans. As a consequence, in order to attract investors to buy asset-backed securities, banks must be able to offer explicit and/or implicit contractual design features that help mitigate adverse selection and moral hazard (Pennacchi 1988). Gorton and Pennacchi (1995) consider two possible features of bank loan sales which could reduce the asymmetric information problem: (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 the loans and therefore there still remains an incentive for the bank to screen and monitor borrowers.

Gorton and Souleles (2006) show 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. Consistent with this, Landsman, Peasnell, and Shakespeare (2008) show that markets view securitisation transactions by originating firms with relatively low retained interests as sales (that is, risk transfer has taken place), whereas asset securitisations with high retained interests are viewed as secured borrowings (that is, risk transfer is incomplete).

Fender and Mitchell (2009) examine the power of different contractual mechanisms to influence an originator's effort to screen borrowers when the originator plans to securitise the loans. Analysing three potential retention mechanisms (holding an equity tranche, a mezzanine tranche, or a "vertical" slice of the portfolio), they find that the screening effort

varies across the arrangements depending on their sensitivities to systemic risk factors. Specifically, they find that the equity tranche may be dominated by either a vertical slice or by a mezzanine slice if a downturn is likely, and if the equity tranche is likely to be exhausted in a downturn. On the other hand, a vertical slice is unlikely to dominate both the equity tranche and the mezzanine tranche, unless it is very "thick".

B. Signalling

A variant of the asymmetric information hypothesis is the idea that banks that are securitising high quality assets use retention mechanisms to "signal" the quality of the assets being securitised. In this case, the signalling should imply a positive relationship between the level of retained interest and the performance of the securitised assets (Mandel, Morgan, and Wei 2012). This strand of the theory builds upon the theoretical literature on the role of collateral in bank lending (Besanko and Thakor 1987, Manove, Padilla, and Pagano 2001, Inderst and Mueller 2007). However, the empirical evidence seems to contradict the signalling motive and finds that riskier borrowers pledge more collateral and that collateralised loans are more likely to default ex-post (Berger and Udell 1990, 1995, Dennis, Nandy, and Sharpe 2000, Jiménez and Saurina 2004, Jiménez, Salas, and Saurina 2006).

A number of recent studies have considered the hypothesis that retained interests are a signalling mechanism used to partially solve asymmetric information problems when structuring securitisation transactions. Albertazzi et al. (2011) find evidence to suggest that banks can effectively overcome, or at least mitigate, the negative effects of asymmetric information by retaining the most junior (equity) tranche as a signalling device of (unobservable) quality of the securitised portfolio or to express a commitment to keep monitoring borrowers. Downing, Jaffee, and Wallace (2009) also provide evidence of asymmetric information playing an important role in the functioning of the securitisation markets.

Demiroglu and James (2012) examine the relationship between risk retention and the ex-post performance of mortgage-backed securities. Their results seem to suggest that retaining an interest in securitisation is significantly related to ex-post loan performance and that performance is better when the originator retains "skin in the game". The positive relationship between performance and "skin in the game" is however confined to low documentation mortgages or deals that principally contain these mortgages.

Erel, Nadauld, and Stulz (2012) focus on the holdings of highly-rated tranches of US banks and identify a number of possible determinants: (i) signalling (which they define as "securitisation business by-product"); (ii) regulatory arbitrage; (iii) bad incentives; (iv) risk management failure; (v) good deals; and (vi) too-big-to-fail. In their study, the securitisation business by-product hypothesis aims to test whether holding tranches of originated securitisation deals serves as a credible signal of deal quality to potential investors. As such, the expectation is that banks that are active in securitisation hold a larger amount of highly-rated tranches as a fraction of their assets. Consistent with this hypothesis, they find that banks that were active in securitisation held larger amounts of highly-rated tranches, as a fraction of total assets, than other banks.

C. Liquidity

Another reason for risk retention has been suggested by Dang, Gorton, and Holmström (2012), who argue that the purpose of securitisation is to create information-insensitive securities, which are defined as securities that are immune from adverse selection when trading (that is, the values of these securities do not depend on the information known only to informed agents). This property makes the information-insensitive security liquid. The idea is that, by offering credit enhancements, the originator can de-link the ex-ante credit risk of the asset pool and therefore issue securities that are independent from the credit risk of the collateral. The incentive for structuring transactions with credit enhancements and other contractual retained interests is thus to ensure the liquidity of the securities.

Pagano and Volpin (2012) investigate whether originators face a conflict between expanding the placement of complex financial instruments and preserving the transparency and liquidity of their secondary markets. This conflict exists and creates an incentive for originators to negotiate with credit rating agencies a low level of transparency, that is, relatively coarse and uninformative ratings. In line with the model of Dang, Gorton, and Holmström (2012), Pagano and Volpin suggest that the elimination of some price-relevant information is functional to enhanced liquidity in the asset-backed securities new issue market. However, they also show that the opaqueness at the issue stage comes at the cost of a less liquid or even totally frozen secondary market and of a sharper price decline in case of default.

D. Regulatory Arbitrage

Finally, the provision of contractual guarantees to securitisations may allow banks to reduce their economic capital while maintaining a stable regulatory capital ratio. Under the Basle Accords, capital requirement for holdings of highly rated tranches were less onerous than those for the underlying assets. In terms of minimising capital requirements, banks were better off to securitise loans and to hold the resulting securities on their books, or even better in their off-balance sheet structures (Erel, Nadauld, and Stulz 2012). It is often argued that banks used the more advantageous capital requirements for the purpose of regulatory arbitrage.

A recent study by Acharya, Schnabl, and Suarez (2012) shows that the structure of risk sharing in asset-backed commercial paper (ABCP) conduits implied recourse back to banks' balance sheets. They find that banks used conduits to securitise assets without transferring credit risk and explain the results as evidence of regulatory capital arbitrage. However, Erel, Nadauld, and Stulz (2012) find no evidence in support of the regulatory capital arbitrage hypothesis. In particular, they find no evidence that banks with ABCP programmes held more highly-rated tranches.

2.2   How much to Retain?

A key factor driving the choice of the type and amount of guarantees provided in securitisations are cost considerations. External credit enhancements and guarantees are more costly in terms of up-front fees, normally have limits on the exposure, and are typically used

after the internally provided guarantees have been exhausted. The characteristics of the loans securitised, the amount of guarantees required to achieve a higher credit rating, as well as the cost of such guarantees, all play a role in the structuring of the transaction and may give banks incentives to provide internal credit enhancements. In other words, banks may retain a larger amount of contractual interests if the assets securitised are more opaque, if the assets are riskier, and if the cost of obtaining external guarantees is ex-ante higher.

A study by Chen, Liu, and Ryan (2008) provides evidence that certain general characteristics of banks' loan securitisations determine the extent to which banks retain risks in connection to their off-balance sheet securitised assets. 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. These results are consistent with Park (2011), who shows that credit enhancement mechanisms, including tranching, reflect the risk of the underlying portfolio.

2.3   *What are the Risk Implications of Different Retention Mechanisms?*

The priority of claims is an important feature of structured transactions, although the mechanisms of interest subordination are somewhat opaque and ad-hoc in complex structures. Given the subordinated structure of credit-enhancing mechanisms, different arrangements may have different implications for bank overall risk. In addition, the interaction between different forms of support may increase the complexity of the relationship. While there is a general consensus in the literature that retention of a subordinated piece or a level of recourse close to the expected level of loss essentially results in all of the economic risk to remain with the intermediary (Calomiris and Mason 2004, Niu and Richardson 2006, Shin 2009), to date there is little empirical evidence on the effects of different forms of interest retention on bank insolvency risk, as well as possible interactions among them. Recent research examines the power of different contractual mechanisms on an originator's screening effort and concludes that equity tranche retention might not always be the most effective arrangement (Fender and Mitchell 2009). However, attention has focused mainly on tranching and has largely ignored other commitment mechanisms. This is surprising, given that the recent policy recommendations impose mandatory risk retention in securitisation as well as a "menu" of acceptable forms of risk retention.

From this review of the recent literature it is clear that key questions are still unanswered. This study contributes to the current academic and policy debates and provides an analysis of the relationship between interests retained by banks in their off-balance sheet securitisations and insolvency risk. In addition, we complement the recent literature by considering a wide range of contractual risk retention mechanisms, including credit enhancements and liquidity provisions, as well as credit and liquidity support provided to other institutions' securitisation structures. Proper alignment of incentives in securitisation remains of crucial importance for both market practitioners and regulators. An improved

understanding of the commitment mechanisms that banks offer to their securitisation structures, as well as their interactions, are one of the key issues to help align bank incentives with those of investors and markets. Policy recommendations concerning the future of securitisation require a better understanding of these issues.

3   DATA SELECTION AND SAMPLE SPECIFICATION

In this paper we use US bank holding company (BHC) data from Y-9C forms obtained from the Federal Reserve Bank of Chicago.[8] 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;[9] (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;[10] (vi) past due amounts, charge-offs, and recoveries in seller's interests. 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.[11]

The incorporation of the new data into the Y-9C reporting forms and the empirical design of this study determine year 2001 as the start date of the sample period, which yields 27 quarters from the second quarter of 2001 to the fourth quarter of 2007. To analyse the effect of interests retained in securitisations, we construct a data set of securitising banks. We define a bank as a securitiser if there is a non-zero outstanding securitisation in at least one

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[8] 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).

[9] 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.

[10] Seller's interest is reported only for home equity line, credit card, and commercial and industrial loan securitisations.

[11] 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.

quarter over the sample period. Given that retained interests, our variable of interest, are present in all securitisation structures (as a minimum, in the form of excess spread), by including the whole population of securitising banks in the sample we avoid a possible selection bias.

When constructing the data set, we exclude banks with missing information on total assets, liquidity, loans, deposits, capital, income, and securitisation activities for any quarter of the sample period. We also exclude banks with data for less than 2 full years.[12] When banks go through a merger or an acquisition, the code of the acquiring BHC is maintained. Next, we average the quarterly data over the quarters in a year to create bank-year observations. Finally, to prevent the possibility of outliers driving the results, we winsorise all yearly variables at the 1% level.[13] This selection procedure yields 1097 bank-years for 197 securitising BHCs covering the period 2001-2007.

4   EMPIRICAL SPECIFICATION

To evaluate the relationship between banks' retained interests in securitisations and insolvency risk, we estimate the following random effects panel regression model (Model (1)).

$$\log(Z_{i,t}) = \alpha + \beta \log(Retained\ Interest\ Ratio_{i,t-1}) + \gamma Controls_{i,t-1} + \theta Year_t + v_{i,t}$$

$$(1)$$

where β, γ, and θ are coefficient estimates, and $v_{i,t}$ is the error term. The dependent variable, $Z_{i,t}$ is the insolvency risk of bank i in period t; $Retained\ Interest\ Ratio_{i,t-1}$ is retained interests in securitisation;[14] $Controls_{i,t-1}$ is a set of bank-specific control variables; $Year_t$ is year dummy variables capturing time effects. To alleviate possible endogeneity problems, all bank-specific regressors employed in our models are lagged by one period.

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.[15] The z-score measures the distance from insolvency for a given bank combining bank profitability, capitalisation, and volatility of returns:

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

$$(2)$$

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[12] For 2001, "full year" refers to the last three quarters of the year as the sample starts from the second quarter of 2001.

[13] Winsorisation consists of replacing the data below the Nth percentile with the Nth, i.e., a 1% winsorisation implies replacing the data below the 1st percentile with the 1st percentile data.

[14] As there are observations with zero retained interests in the data set, we use a logarithm of a unit plus the relevant retained interest ratio.

[15] 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. See Stiroh and Rumble (2006), Hesse and Čihák (2007), Mercieca, Schaeck, and Wolfe (2007), Laeven and Levine (2009).

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

To construct z-scores, some studies use the standard deviation of returns over the lifetime of a bank in the sample (Laeven and Levine 2009), while others use a rolling time window (Čihák et al. 2012). We follow Stiroh and Rumble (2006) and use the standard deviation of return on assets over the four quarters in a year. This approach allows us to incorporate the variation in all the three components of the z-score over a bank's lifetime in the sample. As shown in Figure 1, 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. In the remainder of the paper, we use the label ''z-score'' in referring to the natural logarithm of the z-score.

<Insert Figure 1 about here>

We investigate the effects of retained interests on bank z-scores controlling for a set of variables, captured in $Controls$, that are likely to influence bank insolvency risk. We begin by including the logarithm of the ratio of outstanding securitised assets to total assets ($\log(Securitisation\ Ratio)$) to control for banks off-balance sheet securitisation activity and, possibly, for the provision of implicit recourse.[16] In general, previous empirical studies have suggested a positive link between securitisation and bank risk (Dionne and Harchaoui 2003, Franke and Krahnen 2006, Hänsel and Krahnen 2007, Michalak and Uhde 2012). On the other hand, greater outstanding securitisation might increase bank risk aversion, and thereby reduce risk taking (Casu et al. 2011). We also include a number of balance sheet and income statement characteristics potentially affecting insolvency risk. Specifically, we include bank liquidity in the form of cash and securities ($Liquidity\ Ratio$) and anticipate higher liquidity buffers to be associated with lower insolvency risk (Laeven and Levine 2009). Trading assets ($Trading\ Ratio$) 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 ($Loan\ HHI$); 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 capitalisation introducing an equity capital ratio ($Capital\ Ratio$); lower capital has been associated with higher risk (Stiroh and Rumble 2006, Hirtle and Stiroh 2007, Mercieca, Schaeck, and Wolfe 2007). Further, we control for potential revenue diversification effect on bank risk using a two-part revenue Herfindahl-Hirschman Index ($Revenue\ HHI$); diversification in revenue sources has been shown to be negatively associated with return volatility and insolvency risk (Stiroh and Rumble 2006, Hirtle and Stiroh 2007). Following Stiroh and Rumble (2006), we also include banks' asset growth ($Asset\ Growth$).[17] Finally, to control for any systematic differences across banks of different size, we create indicators based on total assets. Following Cebenoyan and Strahan (2004) and Demsetz (2000), to avoid imposing a linear (or log-linear) relationship between size and the dependent variable, we include dummy indicators for eight asset size

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[16]As there are observations with zero securitisation in the data set, we use a logarithm of a unit plus the securitisation ratio.

[17] See Appendix A for detailed construction of the variables.

levels (*Asset Level 1-8*), with the lowest size group (*Asset Level 1*) acting as the omitted category.

Given the subordination mechanism of credit-enhancing arrangements, we hypothesise that different arrangements have different implications for bank overall risk. To this end, in Model (2) we decompose the aggregate retained interests into credit enhancements (*Credit Enhancement Ratio*), liquidity provisions (*Liquidity Provision Ratio*), and seller's interest (*Seller's Interest Ratio*). In addition, as the data allow us, in Model (3) we further decompose credit enhancements by the form of underlying facility into credit-enhancing interest-only strips (*Credit-Enhancing IO Strips Ratio*), retained subordinated securities (*Subordinated Security Ratio*), and standby letters of credit (*Standby Letter of Credit Ratio*). All else being equal, we expect the relationship between the different forms of credit enhancements and insolvency risk to be driven, to a large extent, by the level of subordination of the former.

In addition to the different types of facility used to provide credit enhancements, the interaction between forms of support may add complexity to the relationship between retained interests and insolvency risk. In Model (4), we test the effect of credit enhancements for a given level of liquidity provisions, and vice versa, by introducing in the model interaction terms between credit enhancements and a high liquidity provision dummy (the latter is equal to one for observations with liquidity provisions above the mean value) and between liquidity provisions and a high credit enhancement dummy (the latter is equal to one for observations with credit enhancements above the mean value), denoted by $CredEnh \times HighLiqProvDummy$ and $LiqProv \times HighCredEnhDummy$, respectively.

In our final model, Model (5), in addition to interests retained by banks in own securitisation structures, we include interests in third-party securitisation structures, both in the form of third-party credit enhancements (*Third-Party Credit Enhancement Ratio*) and liquidity provisions (*Third-Party Liquidity Provision Ratio*). In the run up to the financial crisis, large banks were also active providers of third-party enhancements to other institutions' securitisation structures, in direct competition with insurance companies.

5   RESULTS

5.1   Summary Statistics

Before turning to the main regression analysis, we examine the sample banks along: (i) balance sheet structure; (ii) loan portfolio; (iii) regulatory capital; (iv) operating performance; (v) risk characteristics; and (vi) securitisation activities.[18] To this end, we calculate time-series averages for each BHC, which are then used to obtain the statistics for the sample. The results are presented in Table 1.

<Insert Table 1 about here>

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[18] The construction of the variables is described in detail in Appendix A.

We find that the average size of BHCs in the sample is slightly over $46 billion, with a wide range from around $0.2 billion to $1,150 billion in total assets. Of those assets, on average, 25% is held in the form of liquid assets and around 1% in the form of trading assets. The loan portfolio constitutes around 64% of BHCs' total assets and is, on average, diversified as suggested by the loan Herfindahl-Hirschman Index (HHI) of 0.56.[19] Turning to the liability side, the sample banks are mainly financed by deposits, which constitute around 60% of total assets. The capitalisation of the sample BHCs is around 10%; looking at the regulatory capital, the sample BHCs tend to be relatively highly capitalised (for example, the mean of total risk-based capital ratio is around 14%).

Looking at the performance measures, the data suggest that interest income constitutes the main source of revenue for the sample banks (around 69%), with the two-part revenue HHI of 0.64. As for the net income, it constitutes, on average, around 14% of equity or 1% of total assets of the sample banks. Looking at 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 is 0.73; non-performing loans constitute 1% of total loans, while the charge-offs and loan loss provisions constitute around 0.5% relative to total loans.

We next proceed to discuss some securitisation statistics, which are reported in the last panel of Table 1. The data show that the amount of outstanding securitised assets constitutes, on average, around 8% of banks' total assets, while contractual interests retained in connection to securitised assets in the form of credit enhancements, liquidity support, and seller's interest, constitute in aggregate 0.5% of total assets. Looking at the distribution across the forms of retained interests, credit enhancements constitute 0.2% of total assets, liquidity provisions constitute 0.02%, and seller's interest constitutes 0.3% of total assets.[20] Finally, breaking down credit enhancements by the form of underlying facility, we find that credit-enhancing interest-only strips constitute, on average, 0.07% of total assets, subordinated securities constitute 0.11%, and standby letters of credit constitute 0.06% of total assets. Table 1 also reports information on banks' engagement in other institutions' securitisations in the form of credit and/or liquidity support. We find that the credit exposure arising from credit enhancements provided by the sample banks to other institutions' securitisations constitutes 0.003% of banks' total assets, while banks' commitments to provide liquidity constitute 0.004% of total assets.

To analyse the data on banks' securitisation activities not diluted by zero securitisation values, Table 2 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 loan, lease, and asset securitisation.

<Insert Table 2 about here>

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[19] 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.
[20] Seller's interest in home equity line, credit card, commercial and industrial loan securitisations.

First, looking at the statistics on the number of banks across the securitised asset classes, one can see that most of the sample banks conduct mortgage securitisations, followed by securitisations of all other loans and leases; while the smallest number of banks is engaged in other consumer loan securitisation.[21] The data show that the mean of total outstanding securitisation is around 9% of banks' total assets.

Looking at the structure of securitisations, retained interests constitute, on average, 8% of securitised assets outstanding, with the highest value of 17% in credit card securitisations. Looking at the break down of retained interests: (i) credit enhancements constitute around 5% of securitised assets (around 1% in the form of credit-enhancing interest-only strips; 2% in the form of subordinated securities; and 1% in the form of standby letters of credit); (ii) liquidity provisions constitute around 0.4%; and (iii) the seller's interest constitutes around 2% of securitised assets.

Analysing the provision of retained interests by the type of assets securitised, we find the highest level of credit enhancements is provided in auto securitisations; the highest level of liquidity provisions is offered to other consumer loan securitisations; and the highest seller's interest is retained in credit card securitisations.

Looking at the quality of assets, non-performing securitised loans constitute around 0.6% of securitised assets, which is nearly half the size of the on-balance sheet non-performing loan ratio (1%, reported in Table 1); however, the charge-offs on securitised loans of 0.4% is comparable to those on the on-balance sheet loans (0.5%, reported in Table 1). Interestingly, other consumer securitisations show the highest non-performing loan ratio and the second highest charge-off ratio, exceeded only by charge-offs in credit card securitisations; while securitisations of all other loans and assets seem to have the highest credit quality of underlying assets in terms of non-performing loans and charge-offs.

5.2 Main Findings

We now turn to the regression analysis to test the relationship between banks' retained interests in securitisations and insolvency risk. We estimate random effects regressions[22] using the sample of 900 bank-years for 197 BHCs from 2002 to 2007.[23] In each regression, the standard errors are adjusted to control for clustering at the bank level. The correlation matrix between the main regression variables is reported in Appendix B.

<Insert Table 3 about here>

Table 3 reports the first set of results of our investigation into the effect of banks' retained interests on insolvency risk. The first column of Table 3 reports the results of our Model (1) presented in equation (1). The coefficient on retained interests is negative and statistically significant at the 1% level. In other words, the interests retained by the originating

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[21] 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).

[22] Appendix C reports the results of the Hausman specification test.

[23] As the empirical specification requires lagging the explanatory variables, the 2001 observations have to be dropped from the estimations.

banks in their securitisations and constituting, on average, only 0.5% of the banks' total assets significantly increase their insolvency risk.

Column (2) of Table 3 reports the results of Model (2), where we decompose total retained interests by the form of underlying facility into credit enhancements, liquidity provisions, and seller's interest. We find that credit enhancements and seller's interest have a risk-increasing effect; in both cases the coefficients are statistically significant at the 5% level. Liquidity provisions do not seem to affect bank risk. We tentatively explain these results by considering the type of facility and the subordination structure of a "typical" securitisation transaction. Specifically, liquidity provisions are, in general, excess funds provided by the originator to the SPV as a buffer, so the first loss is absorbed by the SPV rather than by the bank. As a consequence, liquidity provisions seem not to have an impact on bank risk. On the other hand, credit enhancements appear to have the strongest risk-increasing effect, consistent with their subordination to other forms of retained interests.

As credit enhancements seem to drive the negative impact of retained interests on bank risk, we analyse this relationship in more detail and expand the model by the type of underlying credit-enhancing facility (Model (3)). Specifically, in column (3) of Table 3, we decompose credit enhancements into credit-enhancing interest-only strips, subordinated securities, and standby letters of credit.[24] The results show that among the three forms of credit enhancements, credit-enhancing interest-only strips have the strongest and statistically significant risk-increasing effect, consistent with their subordinated (first-loss) position. Standby letters of credit also have a statistically significant risk-increasing effect; while the coefficient on subordinated securities emerges positive, albeit not statistically significant. These results are consistent with the subordinated structure of securitisation transactions and indicate that further efforts should be made to understand the subordination mechanisms more clearly. While it might be desirable to keep retention mechanisms flexible, as proposed by Section 941 of the 2010 Dodd-Frank Act, our results support the idea of increased disclosure of the subordination structure of retained interests and the capital structure of the resulting charges.

Next, we control for the interaction between forms of retained interests. Recall that in Model (4) we test the effect of credit enhancements for a given level of liquidity provisions and liquidity provisions for a given level of credit enhancements by introducing interaction terms between credit enhancements and a high liquidity provision dummy and between liquidity provisions and a high credit enhancements dummy ($CredEnh \times HighLiqProvDummy$ and $LiqProv \times HighCredEnhDummy$, respectively). The results are reported in column (4) of Table 3. Interestingly, the evidence suggests that the effect of credit enhancements reverses to risk-decreasing in securitisations with high liquidity provisions; while the level of credit enhancements is found to have no significant impact of the risk effect of liquidity provisions. This result might again be explained by the intrinsic

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[24] 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 for this study, we drop the 2002 and 2003 observations (the latter is dropped due to lagging the explanatory variables) and estimate the model for the 2004-2007 period. In all other model specifications we control for credit enhancements in the aggregated form to avoid losing the data for year 2002.

nature of liquidity provisions and the subordination structure; for example, if liquidity is offered to the SPV in the form of a cash account, the latter is junior to the claims of subordinated securities. As a consequence, a higher liquidity buffer would absorb a portion of risk that would not revert back on the bank balance sheet.

Finally, in Model (5) we test whether interests in third-party securitisations affect bank insolvency risk. A bank's interests in third-party securitisations is measured by credit and liquidity support provided by the bank to other institutions' securitisation structures (*Others' Credit Enhancement Ratio* and *Others' Liquidity Provision Ratio*, respectively). The results are reported in column (5) of Table 3. The data show that interests in third-party securitisations in either form do not have significant effect on risk of the banks.

Examining the control variables, the data show no significant relationship between outstanding securitisation and bank risk. We find, as expected, a negative and statistically significant effect of liquidity on bank insolvency risk (a positive effect on the z-score) suggesting that higher levels of liquid assets reduce bank risk. In contrast, the effect of trading assets on risk is found to be positive (a negative relationship with the z-score) and statistically significant at the 1% level. Further, the estimates for capital, asset growth, loan and revenue diversification are not statistically significant. These results remain consistent in all specifications.

Summarising the main results, we find evidence that different forms of banks' engagement in securitisation structures have different effects on bank insolvency risk. Specifically, we find that the aggregate amount of retained interests significantly increases insolvency risk. Decomposing retained interests by the form of underlying facility, we find that credit enhancements and seller's interest have a positive and statistically significant association with bank insolvency risk, while this is not the case for liquidity provisions. In addition, we find evidence to suggest that the risk-increasing effect of credit enhancements is mainly driven by credit-enhancing interest-only strips and standby letters of credit, consistently with the claims' subordination structure. We also find that the effect of credit enhancements reverses to risk-decreasing in securitisations with high liquidity provisions; while the level of credit enhancements is found to have no significant impact of the risk effect of liquidity provisions. Finally, we find that banks' engagement in third-party securitisations, both through credit enhancements and liquidity provisions, has no significant effect on insolvency risk.

5.3   Components of Z-Score

The use of the z-score as a measure of risk entails the possibility of the results being driven by one of the components constituting the measure. To analyse the effect of retained interests on the z-score in more detail and to identify the drivers of the relationship between the two, we decompose the z-score into its individual components: capital ratio, return on assets, and standard deviation of return on assets. We re-estimate equation (1) with each of the components as the dependent variable. In the regression of the capital ratio, we omit the capital ratio from the control variables to avoid biased estimates. The results of the three estimations are presented in Table 4.

<Insert Table 4 about here>

Our findings indicate that the negative relationship between z-scores and retained interests is mainly driven by the increasing effect of retained interests on the volatility of returns.

5.4 Level of Securitisation Activity

In our main regression analysis, we control for the level of securitisation by introducing an outstanding securitisation variable in the model (that is, the ratio of outstanding securitised assets to total assets). The data showed no significant effect of outstanding securitisation on the bank risk.

However, the level of securitisation activity may have an impact on the risk effect of retained interests. Specifically, a bank entering the securitisation market for the first time and/or still establishing its reputation in the market is likely to securitise asset pools of moderate size and to include assets of good quality to ensure the performance of securitisations (Higgins and Mason 2004, Casu et al. 2013). In this case, retained interests should not significantly affect bank insolvency risk as the losses on the underlying assets are likely to be within the expected or normal rate of portfolio credit loss, already embedded in the structure (OCC 1997). This bank is also likely to originate good quality loans after the securitisation, either for subsequent securitisations or to keep on the balance sheet. In other words, for first-time/small-scale securitisers, retained interests may increase banks' incentives to screen and monitor borrowers. Consequently, in line with the signalling hypothesis discussed in the literature, for banks with a low securitisation activity, we would expect retained interests to be negatively associated with bank insolvency risk.

In contrast, a bank that is an active securitiser and that securitises assets in large volumes may be more likely to lower its lending standards to attract new borrowers (Shin 2009). This would lead to a deterioration of the credit quality of assets to be securitised and hence to an increase in the riskiness of any interests retained in connection to those assets. Moreover, a bank that is active in the securitisation market as an issuer tends to have a pipeline of securitisations and thus retained interests are likely to grow over time as securitisation activity increases (Erel, Nadauld, and Stulz 2012). This may lead to a concentration of risks (in the form of retained interests in outstanding securitisations) on the bank's books. This may be further exacerbated if a bank uses securitisation for regulatory capital arbitrage, that is, the guarantees are structured to reduce capital requirements while providing recourse to the bank's balance sheets for outside investors (Acharya, Schnabl, and Suarez 2012). Erel, Nadauld, and Stulz (2012) suggest that large banks are more likely to use securitisation to reduce regulatory capital charges because of the fixed costs of securitisation; large banks are also likely to securitise more frequent and larger pools of assets (Loutskina 2011). Consequently, for (large) banks with a high level of securitisation activity ("large-scale" securitisers), we would expect retained interests to increase bank insolvency risk.

To test whether the effect of retained interests varies with the level of securitisation activity, we split the sample banks into three sub-samples based on their average level of outstanding securitisation across the sample years. We create three quantile categories (low,

medium, and high) for the total outstanding securitisation variable (*Securitisation Ratio*) and then assign each bank to one of the three categories based on the bank's time-series average securitisation. We then estimate the regression in equation (1) for each sub-sample. The results are reported in Table 5.

<Insert Table 5 about here>

The data suggest that the risk effect of retained interests varies with the level of securitisation. In line with our expectations, we find that the effect of retained interests is risk-reducing for banks with low levels of securitisation activity and reverses to risk-increasing for banks with high levels of securitisation activity. This evidence suggests that for "small-scale" securitisers and/or first-time securitisers the "skin in the game" seems to improve their incentives to originate high quality assets. On the other hand, risk retention appears to lose its power to provide incentives to reduce the overall risk for "large-scale" securitisers. This finding is particularly relevant to the current policy debate as it emphasises the importance of considering securitisation activity at the individual bank level when designing risk retention requirements.

5.5 Instrumental Variable Analysis

An important issue that arises when attempting to estimate the effects of securitisation on bank performance is that the securitisation decision may be endogenous, that is, banks determine whether to access the securitisation market, when to securitise, and how to structure the transaction (Casu et al. 2013). In this specific context, the endogeneity bias may arise from the potential reverse causality, that is, the level of retained interests may be driven by the risk of the originating bank. Specifically, the financial condition of the bank might influence the amount of credit enhancements necessary to achieve a certain rating or to ensure the placement of the securities backed by the underlying assets. This would results in the estimates from the baseline regression (Model (1) in Table 3) to be biased. While using a lag of retained interests in the baseline specification can partially address the endogeneity issue, we verify our results by employing an instrumental variable (IV) approach in the regression specification in equation (1).

To use the IV approach, we need to find a valid instrument, an observable variable not in equation (1), that satisfies two conditions, relevance and exclusion (Wooldridge 2002). The relevance condition requires a non-zero relationship between the instrument and the endogenous variable, that is, retained interests. The exclusion condition requires the instrument to be uncorrelated with the error term in equation (1). As a candidate for the instrument, we choose the ratio of net charge-offs on securitised assets to securitised assets, in a logarithmic form and lagged by one period. Net charge-offs represent the amount of loans securitised by a bank that have been charged off or otherwise designated as losses by the SPV minus recoveries on securitised assets (FRB 2007).

With regards to the relevance condition, the volume of retained interests, by construction, depends on the quality of underlying assets; retained interests are also used to maintain the assigned rating level of the outstanding securities based on the performance of the underlying pool (Mandel, Morgan, and Wei 2012). Therefore, we expect a strong positive

relationship between retained interests and charge-offs on securitised assets. As for the exclusion condition, we expect no direct impact on the originating bank's insolvency risk of charge-offs on securitised assets, as the latter should be borne by the SPV and not by the originating bank (Vermilyea, Webb, and Kish 2008). Confirming our expectations, Appendix B shows that the charge-offs on securitised assets are strongly (positively) correlated with retained interests, while they are weakly correlated with the z-score.

For the IV analysis, we employ a two-stage least squares (2SLS) estimator with random effects and a robust-clustering at the bank level. The results of the estimation are reported in Table 6. The first column reports the first stage regression, where our instrument, $\log(Charge\text{-}Off_{Sec}\ Ratio)$, enters positively and statistically significant, while all control variables exhibit the expected signs. All else equal, the data show that the lower the quality of the underlying assets (the higher the charge-offs on securitised assets), the higher the retained interests of the originating bank.

Further verifying the validity of our instrument, Table 6 reports the underidentification and weak identification tests. For the former, we use Kleibergen-Paap rank LM statistic which is robust under heteroskedasticity and clustering on identifier in the case of a single endogenous variable and a single instrument (Michalak and Uhde 2012). The value of the test is 7.803, rejecting the null hypothesis that the equation is underidentified at the 0.5% level. For the weak identification, the Kleibergen-Paap rank Wald F statistic is at 13.19, close to the Stock and Yogo (2005) 10% critical value of 16.38, rejecting the null hypothesis of a weak correlation between the endogenous variable and the instrument, that is, between retained interests and charge-offs on securitised assets.

The second stage of our instrumental variable analysis is reported in the second column of Table 6. The results confirm our main finding of a significant and negative effect of retained interests on insolvency risk (positive effect on the z-score) Therefore, the data show that the endogeneity of the securitisation decision does not seem to drive our main results.

6   OTHER ROBUSTNESS TESTS

We conduct a series of additional tests to verify the robustness of our main results to outliers, alternative risk measures, and sub-periods. The tests are discussed below in more detail with the results presented in Table 7.

<Insert Table 7 about here>

6.1   Outliers

Our first concern is the possibility that outliers in terms of risk, that is, banks close to insolvency, might drive our results. We address this concern by winsorising our risk measure, the z-score, at higher 2.5% and 5% levels. We then re-estimate Model (2) for each of the winsorisation levels. The results of the regressions are reported in columns (1)-(2) of Table 7. The data show that all the coefficients remain qualitatively unchanged confirming our main results.

6.2 Measures of Risk

The second concern is the robustness of our results to alternative measures of risk. To address this, we use different measures for the dependent variable. Following Stiroh and Rumble (2006), we use banks' risk-adjusted return on assets and equity. Following Berger, Klapper, and Turk-Ariss (2009), we also use the ratio of non-performing loans to loans as a proxy for bank soundness. We re-estimate Model (2), consistently winsorising the risk measures at the 1% level. The results of the regressions are reported in columns (3)-(5) of Table 7. The evidence from the estimations confirms our main result of a significant risk-increasing effect of credit enhancements and seller' interest.

6.3 Sub-Periods

As our sample covers the 2001-2007 period, there is a concern that the results might be affected by the outset of the financial crisis in 2007. To test the robustness of the results to alternative time periods, we split the sample period into 2002-2005 (which can be considered a more "stable" period) and 2006-2007 (when the first signs of the crisis could be reflected in the amount and risk effect of contractual retained interests). We re-estimate Model (2) for each of the sub-periods and report the results in column (6) of Table 7.

We find that the effect of credit enhancements remains risk-increasing and statistically significant for both periods; interestingly though, the magnitude of the effect more than doubles in the 2006-2007 regression. The latter is consistent with the view that the risk effect of credit enhancements provided by banks in securitisations was magnified by the outset of the financial crisis. This could be driven either by a deterioration in the quality of the assets being securitised (as posited by recent literature, including Mian and Sufi (2009), Keys et al. (2010), Dell'Ariccia, Igan, and Laeven (2012)), or by an increase in the use of commitments and guarantees (Acharya, Schnabl, and Suarez 2012), or possibly both.

Overall, we find that our main findings are consistent across several robustness tests and that the positive relationship between contractual retained interests and risk holds throughout the analyses.

7   CONCLUSIONS

The academic literature has provided various motives for the retention of economic interests in securitisations by the originating banks. These include mitigation of information asymmetries, regulatory arbitrage, and liquidity creation. However, as the 2007-2009 financial crisis showed, the practice of retaining contractual interests in securitisation structures resulted in the originating banks retaining on their balance sheets the risk of securitised assets. This contributed to the collapse of the securitisation market. Given the current regulatory efforts to revive the market and the importance attached to risk retention mechanisms in terms of their role in potentially aligning the incentives of banks and investors in the securitisation process (the so called "skin in the game"), an improved understanding of these aforementioned issues is crucial. Despite their importance, attention has focussed

mainly on tranching and, specifically on the retention of the equity tranche, and has largely ignored other commitment mechanisms.

This paper contributes to the current debate by examining the relationship between different forms of retained interests and bank insolvency risk. Using US bank holding company data for the period from 2001 to 2007, we find that the overall level of contractual retained interests and guarantees offered to own securitisation structures increases bank insolvency risk, although this varies for different levels of securitisation outstanding. Specifically, for "large-scale" securitisers retained interests increase overall risk, while for "small-scale" and/or first-time securitisers they appear to have a risk-reducing effect.

In addition, we find that the type of facility provided, as well as the possible interactions among different facilities, have implications for bank risk. Specifically, we find that credit enhancements and seller's interest have a risk-increasing effect, while the provision of liquidity support does not appear to impact risk. The results also show that the effect of credit enhancements is reversed to risk-decreasing in securitisations with high liquidity provisions, while the level of credit enhancements is found to have no significant impact of the risk effect of liquidity provisions. We explain this result by the intrinsic nature of liquidity support. Specifically, liquidity can be provided to the SPV under different arrangements; if it is provided as a separate reserve fund then it is commonly used to cover shortfalls and it is junior to all other claims. This entails that the losses that can be covered by the provision are borne by the SPV and should not affect the originating bank's insolvency risk.

Analysing credit enhancements in more detail, we find that credit-enhancing interest-only strips have the strongest risk-increasing effect, consistently with their subordinated (first-loss) position. Standby letters of credit also have a risk-increasing effect, while the empirical results show no evidence of a significant risk effect of subordinated securities. This is a particularly interesting result as it offers some support to the theoretical literature on the mitigating effect on bank risk taking of holding a subordinated/equity tranche. Finally, we find that engagement in third-party securitisations through providing credit and/or liquidity support does not have significant effect on bank risk.

Overall, our results highlight that the relationship between retained interests and bank insolvency risk varies according to the type of provision offered, the subordination structure, and it is altered by interactions among provisions. While it might be desirable not to become too prescriptive in the choice of retention mechanisms available to originating banks, our results support the idea of increased transparency and mandatory disclosure of retained interests with a clear indication of the subordination mechanisms. The results also indicate that the risk effect of credit enhancements increased at the onset of the crisis. This could be explained either by a deterioration of the quality of assets being securitised at the time (hence requiring higher credit and liquidity support to achieve a high enough debt rating to be marketable) or by an increased use of commitments and guarantees on behalf of banks for other purposes (for example, regulatory capital arbitrage and liquidity creation).

In conclusion, the results presented in this paper contribute to a deeper understanding of the risks arising from banks' securitisation activities, and have direct implications for the on-going discussions on how to redesign the securitisation model and restart this important

market. Indeed, 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.

Figure 1 Distribution of Z-Score and Ln(Z-Score)
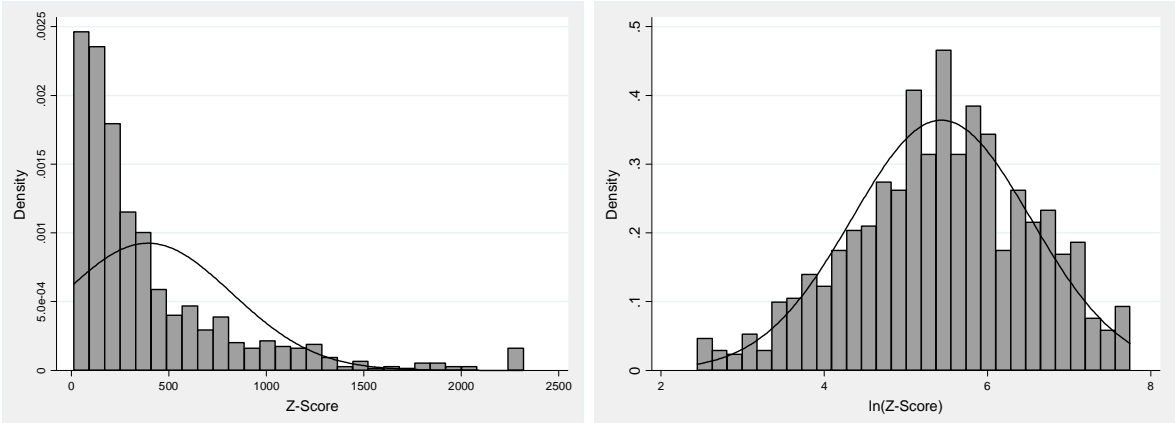
Note: The graphs plot the distribution of Z-Score and ln(Z-Score) derived from the regression data set for the 2002-2007 period, where the z-score of a bank is calculated yearly using the averages and standard deviations across four quarters of a year and winsorised at the 1% level.

Table 1 Sample Descriptive Statistics

Variable	Mean	Std Dev	Min	Max
		Full Sample		
Balance Sheet Structure				
Total Assets ($ billions)	46.0724	150.8538	0.1692	1150.00
Liquidity Ratio	0.2502	0.1147	0.0360	0.6048
Loan Ratio	0.6408	0.1420	0.0762	0.8863
Trading Ratio	0.0130	0.0391	0.0000	0.2294
Deposit Ratio	0.5976	0.1485	0.0457	0.8350
Capital Ratio	0.0954	0.0458	0.0477	0.4640
Loan Portfolio				
Real Estate Loan Ratio	0.6566	0.1925	0.0296	0.9732
C&I Loan Ratio	0.1609	0.0854	0.0003	0.4156
Consumer Loan Ratio	0.1008	0.1169	0.0004	0.7206
Other Loan Ratio	0.0779	0.1163	0.0000	0.6635
Loan HHI	0.5551	0.1636	0.2820	0.9530
Regulatory Capital				
Tier I Leverage Ratio	9.0867	4.5593	3.2075	46.1747
Tier I Risk-Based Capital Ratio	12.4529	6.5569	4.5300	65.7928
Total Risk-Based Capital Ratio	14.3632	6.3301	5.8450	67.1647
Performance				
Interest Income/Net Operating Revenue	0.6920	0.1751	0.1154	0.9435
Revenue HHI	0.6431	0.0978	0.5007	0.9377
Interest Margin	0.0218	0.0053	0.0056	0.0426
ROE	0.1366	0.0604	-0.0696	0.4429
ROA	0.0129	0.0097	-0.0041	0.0928
Risk Characteristics				
RWATA Ratio	0.7245	0.1248	0.3724	1.0204
NPL Ratio	0.0101	0.0074	0.0002	0.0404
Charge-Off Ratio	0.0047	0.0066	0.0000	0.0427
Loan Loss Provision Ratio	0.0057	0.0073	-0.0005	0.0515
Loan Loss Allowance Ratio	0.0143	0.0059	0.0023	0.0415
Z-Score	95.1717	69.5363	7.2231	327.8096
RAROA	11.3932	9.3022	-0.4005	43.4955
σ_{ROA}	0.0037	0.0037	0.0007	0.0331
RAROE	10.7410	8.7599	-0.3514	53.4815
σ_{ROE}	0.0717	0.0737	0.0133	0.4144
Securitisation Activity				
Securitisation Ratio	0.0755	0.2048	0.0000	1.5390
Retained Interest Ratio	0.0052	0.0159	0.0000	0.1032
Credit Enhancement Ratio	0.0021	0.0062	0.0000	0.0416
Credit-Enhancing Interest-Only Strip Ratio	0.0007	0.0025	0.0000	0.0206
Subordinated Security Ratio	0.0011	0.0040	0.0000	0.0272
Standby Letter of Credit Ratio	0.0006	0.0036	0.0000	0.0353
Liquidity Provision Ratio	0.0002	0.0010	0.0000	0.0100
Seller's Interest Ratio	0.0028	0.0121	0.0000	0.0817
NPL_{Sec} Ratio	0.0044	0.0082	0.0000	0.0466
Charge-Off$_{Sec}$ Ratio	0.0034	0.0086	0.0000	0.0416
Third-Party Credit Enhancement Ratio	0.00003	0.0001	0.0000	0.0012
Third-Party Liquidity Provision Ratio	0.00004	0.0003	0.0000	0.0033

Note: The table presents general descriptive statistics for the full sample of 197 banks covering the period from 2001 to 2007. 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. All variables are winsorised at the 1% level. For the definition and construction of the variables see Appendix A.

Table 2 Statistics on Securitisation Activity

Variable	Total Securitisation		Mortgage		HEL		Credit Card		Auto		Other Consumer		C&I		All Other	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Outstanding Securitisation																
Securitisation Ratio	**8.98**	22.43	**7.70**	18.83	**0.90**	0.95	**4.44**	6.90	**1.37**	2.15	**1.36**	1.90	**0.95**	0.87	**1.60**	2.16
Retained Interests																
Retained Interest Ratio	**0.60**	1.73	**0.16**	0.61	**0.12**	0.20	**1.78**	2.83	**0.08**	0.11	**0.08**	0.10	**0.08**	0.15	**0.11**	0.22
Retained Interest/Securitisation Ratio	**7.85**	18.21	**5.03**	17.18	**14.03**	14.54	**17.29**	22.66	**7.89**	6.17	**10.77**	8.90	**10.37**	14.54	**6.94**	10.33
Credit Enhancements																
Credit Enhancement Ratio	**0.26**	0.78	**0.16**	0.61	**0.06**	0.07	**0.20**	0.39	**0.07**	0.10	**0.06**	0.07	**0.01**	0.02	**0.04**	0.08
Credit Enhancement/Securitisation Ratio	**4.89**	14.61	**4.38**	15.05	**5.47**	4.76	**2.26**	2.83	**7.25**	5.75	**6.11**	4.49	**1.69**	2.39	**4.79**	7.42
Credit-Enhancing Interest-Only Strip Ratio	**8.00**	0.32	**0.06**	0.30	**0.02**	0.02	**0.06**	0.11	**0.04**	0.06	**0.04**	0.06	**0.00**	0.01	**0.01**	0.02
Credit-Enhancing Interest-Only Strip/Securitisation Ratio	**0.99**	2.65	**0.64**	2.51	**1.65**	1.66	**0.53**	0.65	**4.14**	3.81	**2.75**	2.42	**0.61**	1.33	**0.59**	1.35
Subordinated Security Ratio	**0.16**	0.49	**0.04**	0.12	**0.05**	0.10	**0.21**	0.34	**0.02**	0.03	**0.03**	0.06	**0.01**	0.02	**0.03**	0.08
Subordinated Security/Securitisation Ratio	**2.28**	6.71	**2.43**	9.04	**3.06**	3.30	**2.48**	2.49	**2.93**	3.81	**3.20**	4.83	**1.58**	2.01	**3.15**	5.07
Standby Letter of Credit Ratio	**0.08**	0.40	**0.08**	0.45	**0.00**	0.01	**0.00**	0.01	**0.02**	0.04	**0.00**	0.00	**0.00**	0.00	**0.01**	0.02
Standby Letter of Credit /Securitisation Ratio	**1.39**	6.19	**1.26**	5.42	**0.20**	0.36	**0.16**	0.43	**0.68**	1.26	**0.46**	0.89	**0.29**	0.68	**2.06**	6.41
Liquidity Provisions																
Liquidity Provision Ratio	**0.02**	0.12	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	**0.01**	0.03	**0.00**	0.00	**0.01**	0.04
Liquidity Provision/Securitisation Ratio	**0.39**	2.20	**0.07**	0.52	**0.08**	0.19	**0.00**	0.00	**0.00**	0.00	**2.63**	4.64	**0.00**	0.00	**0.35**	1.15
Seller's Interest																
Seller's Interest Ratio	**0.30**	1.26			**0.02**	0.03	**1.58**	2.60					**0.02**	0.04		
Seller's Interest/Securitisation Ratio	**1.72**	5.68			**4.87**	5.97	**15.65**	21.54					**6.23**	12.18		
Non-Performing Assets and Charge-Offs																
NPL$_{Sec}$ Ratio	**0.55**	0.96	**0.70**	1.51	**1.26**	1.44	**0.97**	0.88	**0.36**	0.41	**2.64**	2.20	**0.26**	0.39	**0.14**	0.26
Charge-Off$_{Sec}$ Ratio	**0.42**	0.99	**0.14**	0.56	**0.39**	0.43	**1.98**	1.78	**1.39**	1.91	**1.44**	1.75	**0.14**	0.25	**0.01**	0.03
No. of BHCs	197		147		27		36		34		22		26		44	

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. All variables are winsorised at the 1% level. The last raw reports the number of banks in the according sub-sample. For the definition and construction of the variables see Appendix A.

Table 3 Retained Interests and Bank Insolvency Risk

	(1)	(2)	(3)	(4)	(5)
log(Retained Interest Ratio$_{i,t-1}$)	-12.67***				
	(-3.109)				
log(Credit Enhancement Ratio$_{i,t-1}$)		-18.55**		-21.06**	-18.42**
		(-2.124)		(-2.425)	(-2.104)
log(Credit-Enhancing Interest-Only Strip Ratio$_{i,t-1}$)			-48.75**		
			(-2.555)		
log(Subordinated Security Ratio$_{i,t-1}$)			16.99		
			(0.815)		
log(Standby Letter of Credit Ratio$_{i,t-1}$)			-25.56***		
			(-2.689)		
log(Liquidity Provision Ratio$_{i,t-1}$)		12.00	-21.67	-6.98	12.98
		(0.240)	(-0.330)	(-0.161)	(0.240)
log(Seller's Interest Ratio$_{i,t-1}$)		-8.82**	-15.64**	-8.04*	-8.95**
		(-2.249)	(-2.042)	(-1.957)	(-2.250)
CredEnh x HighLiqProvDummy$_{i,t-1}$				89.40***	
				(3.308)	
LiqProv x HighCredEnhDummy$_{i,t-1}$				-41.12	
				(-0.580)	
log(Third-Party Credit Enhancement Ratio$_{i,t-1}$)					188.01
					(1.104)
log(Third-Party Liquidity Provision Ratio$_{i,t-1}$)					-8.54
					(-0.101)
log(Securitisation Ratio$_{i,t-1}$)	0.29	0.34	-0.02	0.37	0.35
	(0.659)	(0.763)	(-0.040)	(0.839)	(0.786)
Liquidity Ratio$_{i,t-1}$	0.87*	0.89*	0.59	0.91*	0.89*
	(1.847)	(1.870)	(1.225)	(1.928)	(1.858)
Loan HHI$_{i,t-1}$	-0.45	-0.48	-0.30	-0.45	-0.47
	(-1.167)	(-1.239)	(-0.686)	(-1.170)	(-1.207)
Trading Ratio$_{i,t-1}$	-5.95***	-5.94***	-5.22**	-6.18***	-6.01***
	(-2.940)	(-2.855)	(-2.439)	(-2.942)	(-2.916)
Capital Ratio$_{i,t-1}$	-0.41	-0.31	-1.33	-0.29	-0.30
	(-0.373)	(-0.285)	(-1.096)	(-0.266)	(-0.279)
Revenue HHI$_{i,t-1}$	-0.13	-0.08	0.19	-0.07	-0.08
	(-0.243)	(-0.157)	(0.322)	(-0.131)	(-0.152)
Asset Growth$_{i,t-1}$	0.88	0.80	0.16	0.75	0.84
	(0.981)	(0.910)	(0.144)	(0.857)	(0.944)
Asset Level 2$_{i,t-1}$	0.21	0.22	0.28	0.22	0.22
	(1.321)	(1.331)	(1.510)	(1.330)	(1.351)
Asset Level 3$_{i,t-1}$	0.36**	0.36**	0.36**	0.35**	0.36**
	(2.250)	(2.262)	(1.968)	(2.244)	(2.280)
Asset Level 4$_{i,t-1}$	0.29*	0.30*	0.40**	0.30*	0.30*
	(1.872)	(1.879)	(2.236)	(1.909)	(1.905)
Asset Level 5$_{i,t-1}$	0.52***	0.53***	0.39*	0.54***	0.54***
	(2.959)	(3.006)	(1.715)	(3.014)	(3.028)
Asset Level 6$_{i,t-1}$	0.39**	0.39**	0.31*	0.40**	0.40**
	(2.498)	(2.509)	(1.753)	(2.555)	(2.530)
Asset Level 7$_{i,t-1}$	0.63***	0.60***	0.54**	0.60***	0.60***
	(3.055)	(2.880)	(2.347)	(2.882)	(2.883)
Asset Level 8$_{i,t-1}$	0.55**	0.53**	0.51*	0.50*	0.52**
	(2.290)	(2.081)	(1.696)	(1.942)	(2.028)
Year$_t$	Yes	Yes	Yes	Yes	Yes
Constant	4.09***	4.05***	3.92***	4.02***	4.04***
	(10.297)	(9.923)	(8.998)	(9.933)	(9.925)
No. of Observations	900	900	573	900	900
No. of BHCs	197	197	181	197	197
R-Squared	0.137	0.140	0.169	0.150	0.141

Note: The table reports the results of regressions of bank insolvency risk on securitisation variables. The dependent variable is a logarithm of the z-score measuring a bank's distance to default. Securitisation variables include: (i) retained interests; (ii) credit enhancements; (iii) credit-enhancing interest-only strips; (iv) subordinated securities; (v) standby letters of credit; (vi) liquidity provisions; (vii) seller's interest; (viii) interaction between credit enhancements and a high liquidity provisions dummy; (ix) interaction between liquidity provisions and a high credit enhancements dummy; (x) credit enhancements provided to other institutions' securitisations; (xi) liquidity provisions to other institutions' securitisations; and (xii) outstanding securitisation. The balance sheet and income statement control variables include: (i) liquidity ratio; (ii) loan concentration; (iii) trading asset ratio; (iv) capital ratio; (v) revenue concentration; (vi) asset growth; and (vii) asset level dummies. Definition and construction of the variables are reported in Appendix A. All bank-specific variables are winsorised at the 1% level. Random effects regressions are run for the full sample of BHCs covering the period from 2002 to 2007, with exemption of Model 3 where the regression is run for 2004-2007. Year dummies are incorporated in all regressions. The t-statistics calculated using standard errors clustered at the BHC-level are reported in parentheses. *, **,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4 Retained Interests and Z-Score Components

	(1) Capital Ratio	(2) ROA	(3) σ_{ROA}
log(Credit Enhancement Ratio$_{i,t-1}$)	0.06	-0.06	0.06**
	(0.251)	(-1.048)	(2.242)
log(Liquidity Provision Ratio$_{i,t-1}$)	-0.23	0.13	0.02
	(-1.053)	(1.206)	(0.185)
log(Seller's Interest Ratio$_{i,t-1}$)	-0.70	0.14**	0.07*
	(-1.276)	(2.036)	(1.845)
log(Securitisation Ratio$_{i,t-1}$)	0.03**	0.01**	-0.00
	(2.196)	(2.388)	(-0.645)
Liquidity Ratio$_{i,t-1}$	0.04	0.00	-0.00*
	(1.596)	(0.078)	(-1.834)
Loan HHI$_{i,t-1}$	-0.02	-0.00	0.00
	(-1.221)	(-0.228)	(0.654)
Trading Ratio$_{i,t-1}$	0.04	-0.00	0.02*
	(0.383)	(-0.169)	(1.845)
Capital Ratio$_{i,t-1}$		0.08*	0.04***
		(1.700)	(3.798)
Revenue HHI$_{i,t-1}$	-0.01	0.00	-0.00
	(-0.223)	(0.104)	(-0.221)
Asset Growth$_{i,t-1}$	-0.05	-0.01	-0.01**
	(-0.847)	(-0.857)	(-2.369)
Asset Level 2$_{i,t-1}$	-0.00	0.00	-0.00
	(-0.369)	(0.583)	(-0.296)
Asset Level 3$_{i,t-1}$	-0.00	0.00	-0.00
	(-0.686)	(0.988)	(-0.447)
Asset Level 4$_{i,t-1}$	-0.00	0.00	-0.00
	(-0.485)	(0.955)	(-0.074)
Asset Level 5$_{i,t-1}$	-0.01*	0.00*	-0.00
	(-1.863)	(1.867)	(-0.224)
Asset Level 6$_{i,t-1}$	-0.01	0.00*	-0.00
	(-0.829)	(1.755)	(-0.572)
Asset Level 7$_{i,t-1}$	-0.01	0.00	-0.00
	(-0.903)	(0.756)	(-0.864)
Asset Level 8$_{i,t-1}$	-0.01	0.00	-0.00
	(-0.824)	(0.231)	(-1.059)
Year$_t$	Yes	Yes	Yes
Constant	0.10***	0.00	-0.00
	(6.014)	(0.485)	(-0.010)
No. of Observations	900	900	900
No. of BHCs	197	197	197
R-Squared	0.002	0.532	0.389

Note: The table presents the results of regressions of z-score components: (1) capital ratio; (2) return on assets; and (3) standard deviation of return on assets. Securitisation variables include: (i) credit enhancements; (ii) liquidity provisions; (iii) seller's interest; and (iv) outstanding securitisation. The balance sheet and income statement control variables include: (i) liquidity ratio; (ii) loan concentration; (iii) trading asset ratio; (iv) capital ratio; (v) revenue concentration; (vi) asset growth; and (vii) asset level dummies. Definition and construction of the variable are reported in Appendix A. All variables are winsorised at the 1% level. Random effects regressions are run for the full sample of BHCs covering the period from 2002 to 2007. Year dummies are incorporated in all regressions. The t-statistics calculated using standard errors clustered at the BHC-level are reported in parentheses. *, **,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 5 Retained Interests and Bank Insolvency Risk by Level of Securitisation

	(1) Low	(2) Medium	(3) High
log(Retained Interest Ratio$_{i,t-1}$)	536.72***	10.64	-13.59***
	(4.167)	(0.942)	(-4.153)
log(Securitisation Ratio$_{i,t-1}$)	90.87***	6.23**	0.06
	(2.996)	(2.394)	(0.166)
Liquidity Ratio$_{i,t-1}$	0.78	0.69	1.02
	(0.880)	(1.161)	(1.183)
Loan HHI$_{i,t-1}$	0.51	-1.35**	-0.62
	(0.627)	(-2.349)	(-1.237)
Trading Ratio$_{i,t-1}$	30.65**	-9.65***	-4.41**
	(2.298)	(-4.200)	(-2.150)
Capital Ratio$_{i,t-1}$	-0.25	-0.23	-0.25
	(-0.056)	(-0.156)	(-0.214)
Revenue HHI$_{i,t-1}$	-0.63	0.22	-0.42
	(-0.595)	(0.251)	(-0.422)
Asset Growth$_{i,t-1}$	-1.51	2.45	2.74*
	(-1.016)	(1.631)	(1.682)
Asset Level 2$_{i,t-1}$	0.28	0.15	-0.07
	(0.948)	(0.723)	(-0.235)
Asset Level 3$_{i,t-1}$	0.23	0.32	0.35
	(0.774)	(1.376)	(0.807)
Asset Level 4$_{i,t-1}$	0.49**	0.03	-0.32
	(2.107)	(0.102)	(-1.262)
Asset Level 5$_{i,t-1}$	0.44	-0.03	0.80***
	(1.447)	(-0.084)	(2.594)
Asset Level 6$_{i,t-1}$	0.22	0.04	0.64**
	(0.787)	(0.147)	(2.282)
Asset Level 7$_{i,t-1}$	-0.19	0.77**	0.55*
	(-0.377)	(2.526)	(1.736)
Asset Level 8$_{i,t-1}$		0.15	0.75**
		(0.426)	(2.078)
Year$_t$	Yes	Yes	Yes
Constant	3.88***	4.46***	4.29***
	(4.376)	(6.943)	(5.816)
No. of Observations	305	299	296
No. of BHCs	63	66	68
R-Squared	0.0985	0.245	0.308

Note: The table presents the results of regressions of the z-score by level of securitisation. Models (1)-(3) use sub-samples of banks with low, medium, and high level of securitisation, accordingly. The dependent variable is a logarithm of the z-score measuring a bank's distance to default. Securitisation variables include: (i) retained interests; and (ii) outstanding securitisation. The balance sheet and income statement control variables include: (i) liquidity ratio; (ii) loan concentration; (iii) trading asset ratio; (iv) capital ratio; (v) revenue concentration; (vi) asset growth; and (vii) asset level dummies. Definition and construction of the variable are reported in Appendix A. All variables are winsorised at the 1% level. Random effects regressions are run for the full sample period from 2002 to 2007. Year dummies are incorporated in all regressions. The t-statistics calculated using standard errors clustered at the BHC-level are reported in parentheses. *, **,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 6 Instrumental Variable Analysis

	I Stage log(Retained Interest Ratio$_{i,t-1}$)	II Stage Z-Score
log(Retained Interest Ratio$_{i,t-1}$)		-24.1856
		(-3.44)
log(Charge-Off$_{Sec}$ Ratio$_{i,t-1}$)	0.6489***	
	(3.72)	
log(Securitisation Ratio$_{i,t-1}$)	0.0329***	0.7446
	(2.9)	(1.6)
Liquidity Ratio$_{i,t-1}$	0.0019	0.8534*
	(0.32)	(1.86)
Loan HHI$_{i,t-1}$	0.0061	-0.3755
	(1.34)	(-0.97)
Trading Ratio$_{i,t-1}$	-0.0035	-5.9498
	(-0.14)	(-2.83)
Capital Ratio$_{i,t-1}$	0.0031	-0.1847
	(0.19)	(-0.16)
Revenue HHI$_{i,t-1}$	0.0053	-0.1132
	(0.74)	(-0.21)
Asset Growth$_{i,t-1}$	0.0146	1.0769
	(0.92)	(1.22)
Asset Level 2$_{i,t-1}$	-0.0002	0.206
	(-0.17)	(1.25)
Asset Level 3$_{i,t-1}$	0.0001	0.3586**
	(0.07)	(2.29)
Asset Level 4$_{i,t-1}$	0.0016	0.3219**
	(0.95)	(2.08)
Asset Level 5$_{i,t-1}$	-0.0009	0.549***
	(-0.7)	(3.15)
Asset Level 6$_{i,t-1}$	0.0035	0.4618***
	(1.37)	(2.85)
Asset Level 7$_{i,t-1}$	0.0023	0.6715***
	(1.44)	(3.22)
Asset Level 8$_{i,t-1}$	0.0046	0.6474***
	(1.3)	(2.69)
Year$_t$	Yes	Yes
Constant	-0.0099	4.0034***
	(-1.88)	(10.12)
No. of Observations	900	900
No. of BHCs	197	197
R-Squared	0.33	0.13
KP rk LM Statistic	8.35***	
KP rk Wald F Statistic	13.81	

Note: The table presents the results of the 2SLS estimation of the effect of retained interests on bank insolvency risk. The first column reports the results of the first stage, where retained interests are instrumented by a logarithm of net charge-offs on securitised assets as of total outstanding securitised assets. The second column reports the results of the second stage of the estimation. The t-statistics calculated using standard errors clustered at the BHC-level are reported in parentheses. *, **,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 7 Robustness Tests for Retained Interests and Bank Insolvency Risk

	(1) Z-Score(2.5%)	(2) Z-Score(5%)	(3) RAROA	(4) RAROE	(5) NPL Ratio	(6) 2002-2005	(6) 2006-2007
log(Credit Enhancement Ratio$_{i,t-1}$)	-17.66**	-16.84**	-165.37	-151.05***	0.10*	-16.32*	-37.81***
	(-2.180)	(-2.222)	(-1.381)	(-2.604)	(1.841)	(-1.840)	(-5.135)
log(Liquidity Provision Ratio$_{i,t-1}$)	11.41	12.02	267.89	168.92	-0.04	14.52	34.77
	(0.237)	(0.262)	(0.261)	(0.314)	(-0.378)	(0.273)	(0.520)
log(Seller's Interest Ratio$_{i,t-1}$)	-7.93**	-7.43**	-127.15***	-138.77***	0.08**	-10.71**	8.76
	(-2.199)	(-2.166)	(-3.502)	(-3.463)	(2.504)	(-2.280)	(1.450)
log(Securitisation Ratio$_{i,t-1}$)	0.30	0.30	4.06	9.14*	0.00	0.22	-0.03
	(0.716)	(0.776)	(0.638)	(1.827)	(0.016)	(0.456)	(-0.031)
Liquidity Ratio$_{i,t-1}$	0.84*	0.80*	5.50	-0.55	-0.00	0.87*	0.40
	(1.829)	(1.816)	(0.907)	(-0.107)	(-0.967)	(1.660)	(0.579)
Loan HHI$_{i,t-1}$	-0.46	-0.44	-4.74	-3.78	-0.00	-0.50	-0.34
	(-1.212)	(-1.185)	(-1.057)	(-1.020)	(-1.444)	(-1.213)	(-0.560)
Trading Ratio$_{i,t-1}$	-5.46***	-5.06***	-67.83***	-64.18***	0.03*	-7.41***	-4.92*
	(-2.811)	(-2.799)	(-3.370)	(-3.089)	(1.778)	(-3.498)	(-1.892)
Capital Ratio$_{i,t-1}$	-0.50	-0.67	-10.35	-7.36	-0.00	-0.36	-0.63
	(-0.478)	(-0.660)	(-1.211)	(-0.875)	(-0.348)	(-0.343)	(-0.322)
Revenue HHI$_{i,t-1}$	-0.05	-0.06	-2.97	1.91	0.00	-0.02	-0.05
	(-0.095)	(-0.116)	(-0.498)	(0.363)	(0.757)	(-0.037)	(-0.059)
Asset Growth$_{i,t-1}$	0.63	0.51	13.37	0.17	-0.00	0.58	-2.68
	(0.747)	(0.626)	(1.064)	(0.014)	(-0.519)	(0.575)	(-1.368)
Asset Level 2$_{i,t-1}$	0.21	0.21	3.05*	2.48	0.00	0.23*	-0.28
	(1.331)	(1.324)	(1.864)	(1.511)	(0.488)	(1.647)	(-0.630)
Asset Level 3$_{i,t-1}$	0.35**	0.34**	6.46***	6.06***	0.00	0.39**	-0.32
	(2.283)	(2.260)	(4.214)	(4.478)	(0.014)	(2.531)	(-1.049)
Asset Level 4$_{i,t-1}$	0.29*	0.27*	6.35***	5.73***	0.00	0.18	-0.04
	(1.853)	(1.789)	(4.529)	(3.794)	(0.558)	(1.029)	(-0.122)
Asset Level 5$_{i,t-1}$	0.52***	0.49***	12.59***	9.82***	-0.00	0.49**	-0.58*
	(3.024)	(2.938)	(5.315)	(5.067)	(-0.045)	(2.433)	(-1.674)
Asset Level 6$_{i,t-1}$	0.38**	0.36**	8.89***	8.66***	-0.00	0.52***	-0.52
	(2.499)	(2.468)	(4.853)	(5.173)	(-0.048)	(3.180)	(-1.615)
Asset Level 7$_{i,t-1}$	0.59***	0.56***	14.82***	13.87***	0.00	0.82***	-0.40
	(2.890)	(2.892)	(5.285)	(5.220)	(0.755)	(4.021)	(-1.117)
Asset Level 8$_{i,t-1}$	0.50**	0.45*	13.97***	12.74***	0.00	0.89***	-0.63
	(2.010)	(1.895)	(3.644)	(3.789)	(0.397)	(3.076)	(-1.370)
Year$_t$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.06***	4.09***	11.35**	10.15**	0.01***	4.00***	4.32***
	(10.270)	(10.726)	(2.451)	(2.526)	(3.264)	(8.954)	(6.244)
No. of Observations	900	900	900	900	900	663	237
No. of BHCs	197	197	197	197	197	191	126
R-Squared	0.137	0.136	0.144	0.150	0.104	0.135	0.211

Note: The table presents the results of robustness tests. Models (1)-(5) use different dependent variables, where Z-Score(2.5%) and Z-Score(5%) are z-scores winsorised at 2.5% and 5% levels, respectively; RAROA and RAROE are risk-adjusted return on assets and equity, respectively; NPL Ratio is a ratio of non-performing loans to total loans. Model (6) uses the z-score as the dependent variable breaking the sample period into two sub-periods: 2002-2005 and 2006-2007. Securitisation variables include: (i) credit enhancements; (ii) liquidity provisions; (iii) seller's interest; and (iv) outstanding securitisation. The balance sheet and income statement control variables include: (i) liquidity ratio; (ii) loan concentration; (iii) trading asset ratio; (iv) capital ratio; (v) revenue concentration; (vi) asset growth; and (vii) asset level dummies. Definition and construction of the variable are reported in Appendix A. All variables are winsorised at the 1% level. . Random effects regressions are run for the full sample of BHCs covering the period from 2002 to 2007, with exemption of model (6). Year dummies are incorporated in all regressions. The t-statistics calculated using standard errors clustered at the BHC-level are reported in parentheses. *, **,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Appendix A 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/Total Assets	(BHCK0081 + BHCK0395 + BHCK0397 + BHCK1754 + BHCK1773)/BHCK2170
Loan Ratio	Loans/Total Assets	BHCK 2122/BHCK2170
Trading Ratio	Trading Assets/Total Assets	BHCK3545/BHCK2170
Deposit Ratio	Deposits/Total Assets	(BHCK3517+ BHCK3404)/BHCK3368
Capital Ratio	Equity Capital/Total Assets	BHCK3210/BHCK2170
Asset Growth	Asset Growth Rate	
Loan Portfolio		
Real Estate Loan Ratio	Real Estate Loans/Total Loans	BHCK1410/(BHCK2122 + BHCK2123)
C&I Loan Ratio	Commercial and Industrial Loans/Total Loans	(BHCK1763 + BHCK1764)/(BHCK2122 + BHCK2123)
Consumer Loan Ratio	Consumer Loans/Total Loans	(BHCKB538 + BHCKB539 + BHCK2011)/(BHCK2122 + BHCK2123)
Other Loan Ratio	Other Loans/Total Loans	(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
Performance		
Interest Income/NOR	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 Equity (ROE)	Net Income/Equity Capital	BHCK4340/BHCK3519
Return on Assets (ROA)	Net Income/Total Assets	BHCK4340/BHCK3368

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

Appendix A Bank Holding Company Data Definition and Construction (continued)

Variable	Definition	Construction (FR Y-9C Data Items)
Risk Characteristics		
RWATA Ratio	Risk-Weighted Assets/Total Assets	BHCKA223/BHCK2170
NPL Ratio	Non-Performing Loans/Total Loans	(BHCK5525 + BHCK5526 - BHCK3506 - BHCK3507)/BHCK3516
Charge-Off Ratio	Net Charge-Offs/Total Loans	(BHCK4635 - BHCK4605)/BHCK3516
Loan Loss Provision Ratio	Quarterly Provision for Loan Losses/Total Loans	BHCK4230/BHCK3516
Loan Loss Allowance Ratio	Allowance for Loan Losses/Total Loans	BHCK3123/BHCK3516
Z-Score (Z)	Z-Score	
RAROA	Risk-Adjusted Return on Assets	
σ_{ROA}	Standard Deviation of Return on Assets	
RAROE	Risk-Adjusted Return on Equity	
Securitisation		
Securitisation Ratio	Securitised Assets/Total Assets	(BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711) /BHCK2170
Retained Interest Ratio	(Credit Enhancements + Liquidity Provision + Seller's Interest)/Total Assets	
Retained Interest/Securitisation Ratio	(Credit Enhancements + Liquidity Provision + Seller's Interest)/Securitised Assets	
Credit Enhancement Ratio	Credit Enhancements/Total Assets	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718 + BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399 + BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/ BHCK2170
Credit Enhancement/Securitisation Ratio	Credit Enhancements/Securitised Assets	(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)
Credit-Enhancing Interest Only Strip Ratio	Credit-Enhancing Interest-Only Strips/Total Assets	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718)/BHCK2170
Credit-Enhancing Interest Only Strip/Securitisation Ratio	Credit-Enhancing Interest-Only Strips/Securitised Assets	(BHCKB712 + BHCKB713 + BHCKB714 + BHCKB715 + BHCKB716 + BHCKB717 + BHCKB718)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)

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

Appendix A Bank Holding Company Data Definition and Construction (continued)

Variable	Definition	Construction (FR Y-9C Data Items)
Subordinated Security Ratio	Subordinated Securities/Total Assets	(BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399)/ BHCK2170
Subordinated Security/Securitisation Ratio	Subordinated Securities/Securitised Assets	(BHCKC393 + BHCKC394 + BHCKC395 + BHCKC396 + BHCKC397 + BHCKC398 + BHCKC399)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
Standby Letter of Credit Ratio	Standby Letters of Credit/Total Assets	(BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/ BHCK2170
Standby Letter of Credit/Securitisation Ratio	Standby Letters of Credit/Securitised Assets	(BHCKC400 + BHCKC401 + BHCKC402 + BHCKC403 + BHCKC404 + BHCKC405 + BHCKC406)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
Liquidity Provision Ratio	Liquidity Provision Commitments/Total Assets	(BHCKB726 + BHCKB727 + BHCKB728 + BHCKB729 + BHCKB730 + BHCKB731 + BHCKB732)/ BHCK2170
Liquidity Provision/Securitisation Ratio	Liquidity Provision Commitments/Securitised Assets	(BHCKB726 + BHCKB727 + BHCKB728 + BHCKB729 + BHCKB730 + BHCKB731 + BHCKB732)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
Seller's Interest Ratio	Seller's Interest/Total Assets	(BHCKB761 + BHCKB762 + BHCKB763 + BHCKB500 + BHCKB501 + BHCKB502)/BHCK2170
Seller's Interest/Securitisation Ratio	Seller's Interest/Securitised Assets	(BHCKB761 + BHCKB762 + BHCKB763 + BHCKB500 + BHCKB501 + BHCKB502)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
NPL_{Sec} Ratio	Past Due Securitised Assets/Securitised Assets	(BHCKB740 + BHCKB741 + BHCKB742 + BHCKB743 + BHCKB744 + BHCKB745 + BHCKB746)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
$ChargeOff_{Sec}$ Ratio	Net Charge-Offs on Securitised Assets/Securitised	(BHCKB747 + BHCKB748 + BHCKB749 + BHCKB750+ BHCKB751 + BHCKB752 + BHCKB753 - BHCKB754 - BHCKB755 - BHCKB756 - BHCKB757 - BHCKB758 - BHCKB759 - BHCKB760)/ (BHCKB705 + BHCKB706 + BHCKB707 + BHCKB708 + BHCKB709 + BHCKB710 + BHCKB711)
Third-Party Credit Enhancement Ratio	Credit Enhancements to Other Institutions' Securitisations/Total Assets	(BHCKB776+ BHCKB777+ BHCKB778 + BHCKB779 + BHCKB780 + BHCKB781 + BHCKB782)/ BHCK2170
Third-Party Liquidity Provision Ratio	Liquidity Provision Commitments to Other Institutions' Securitisations/Total Assets	(BHCKB783 + BHCKB784+ BHCKB785+ BHCKB786+ BHCKB787+ BHCKB788 + BHCKB789)/ BHCK2170

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

Appendix B Correlation Matrix

	Z-Score	Securitisation Ratio	Retained Interest Ratio	Credit Enhancement Ratio	Liquidity Provision Ratio	Seller's Interest Ratio	Third-Party Credit Enhancement Ratio	Third-Party Liquidity Provision Ratio
Z-Score	1							
Securitisation Ratio	-0.0917*	1						
Retained Interest Ratio	-0.1775*	0.4920*	1					
Credit Enhancement Ratio	-0.1592*	0.3976*	0.7652*	1				
Liquidity Provision Ratio	0.0419	0.026	0.1846*	0.0571*	1			
Seller's Interest Ratio	-0.1347*	0.4412*	0.8112*	0.3262*	0.008	1		
Third-Party Credit Enhancement Ratio	-0.0012	-0.025	0.017	-0.020	0.007	0.037	1	
Third-Party Liquidity Provision Ratio	-0.0301	0.012	0.2071*	0.042	0.1740*	0.2345*	0.4467*	1
Liquidity Ratio	0.0937*	-0.0975*	-0.030	0.0659*	0.033	-0.1080*	-0.018	0.045
Loan HHI	-0.0867*	0.1745*	0.0710*	0.0830*	0.008	0.030	-0.1173*	-0.0964*
Trading Ratio	-0.1626*	0.2219*	0.1739*	0.1107*	0.1303*	0.1455*	0.2075*	0.1363*
Capital Ratio	-0.0822*	0.0930*	0.1657*	0.1586*	-0.031	0.1480*	-0.027	-0.041
Revenue HHI	-0.0107	-0.1947*	-0.1646*	-0.1043*	-0.1133*	-0.1311*	-0.0889*	-0.0895*
Asset Growth	-0.0203	0.1104*	0.1192*	0.0607*	0.039	0.1286*	-0.049	-0.038
Asset Level 2	0.0271	-0.048	-0.1006*	-0.0825*	-0.052	-0.0710*	-0.0566*	-0.051
Asset Level 3	0.0209	-0.0942*	-0.0888*	-0.0596*	-0.052	-0.0715*	-0.026	-0.051
Asset Level 4	-0.0307	-0.051	0.018	0.033	-0.023	0.009	-0.0566*	-0.051
Asset Level 5	0.0207	-0.0635*	-0.0679*	-0.021	-0.052	-0.0712*	-0.0569*	-0.051
Asset Level 6	-0.0082	0.003	0.1058*	0.1103*	-0.052	0.049	-0.0566*	0.1056*
Asset Level 7	0.0947*	0.1242*	0.046	0.038	0.006	0.026	0.004	-0.051
Asset Level 8	-0.0576*	0.2125*	0.1975*	0.0825*	0.2757*	0.2021*	0.2471*	0.2014*
Charge-Off$_{Sec}$	-0.1188*	0.1694*	0.5189*	0.2809*	0.0583*	0.5427*	0.0079	0.2030*

Note: The table reports pairwise correlations between the main regression variables. * indicates significance at 10%. For the definition and construction of the variables see Appendix A.

Appendix B Correlation Matrix (continued)

	Liquidity Ratio	Loan HHI	Trading Ratio	Capital Ratio	Revenue HHI	Asset Growth	Asset Level 2	Asset Level 3	Asset Level 4	Asset Level 5	Asset Level 6	Asset Level 7	Asset Level 8
Liquidity Ratio	1												
Loan HHI	0.0763*	1											
Trading Ratio	-0.1689*	-0.1513*	1										
Capital Ratio	0.1180*	-0.1083*	-0.0827*	1									
Revenue HHI	0.1397*	0.2816*	-0.1998*	0.1407*	1								
Asset Growth	-0.0919*	0.1235*	0.0669*	-0.038	-0.003	1							
Asset Level 2	0.0813*	0.1063*	-0.1171*	-0.042	0.2238*	-0.029	1						
Asset Level 3	0.1510*	0.1250*	-0.1177*	-0.048	0.0880*	-0.0948*	-0.1429*	1					
Asset Level 4	-0.0718*	-0.0748*	-0.1163*	0.2029*	0.027	-0.014	-0.1421*	-0.1429*	1				
Asset Level 5	-0.0565*	0.1343*	-0.1099*	-0.0601*	-0.0664*	0.0591*	-0.1429*	-0.1436*	-0.1429*	1			
Asset Level 6	0.0729*	-0.020	-0.048	0.041	-0.0665*	0.0613*	-0.1421*	-0.1429*	-0.1421*	-0.1429*	1		
Asset Level 7	-0.025	-0.0920*	0.038	-0.0636*	-0.1035*	0.006	-0.1429*	-0.1436*	-0.1429*	-0.1436*	-0.1429*	1	
Asset Level 8	-0.1773*	-0.2544*	0.5887*	-0.0659*	-0.3508*	0.047	-0.1421*	-0.1429*	-0.1421*	-0.1429*	-0.1421*	-0.1429*	1
Charge-Off$_{Sec}$ Ratio	-0.1465*	-0.1158*	0.1682*	0.0957*	-0.2061*	-0.0139	-0.1208*	-0.1214*	-0.0499	0.046	0.1115*	0.0125	0.2442*

Note: The table reports pairwise correlations between the main regression variables. * indicates significance at 10%. For the definition and construction of the variables see Appendix A.

Appendix C Hausman Specification Test for Retained Interests and Bank Insolvency Risk

	Coefficients		Difference	SE
	FE	**RE**		
	(b)	(B)	(b-B)	SqRt(diag(V_b-V_B))
log(Retained Interest Ratio$_{i,t-1}$)	-9.3057	-12.6749	3.3692	3.4380
log(Securitisation Ratio$_{i,t-1}$)	1.1558	0.2855	0.8703	0.4633
Liquidity Ratio$_{i,t-1}$	1.1164	0.8676	0.2488	0.8019
Loan HHI$_{i,t-1}$	0.2400	-0.4451	0.6851	0.7085
Trading Ratio$_{i,t-1}$	0.9914	-5.9511	6.9425	4.3639
Capital Ratio$_{i,t-1}$	3.8240	-0.4070	4.2310	1.8568
Revenue HHI$_{i,t-1}$	-0.2821	-0.1299	-0.1522	0.6660
Asset Growth$_{i,t-1}$	1.0289	0.8782	0.1507	0.5007
Asset Level 2$_{i,t-1}$	-0.0357	0.2149	-0.2506	0.1921
Asset Level 3$_{i,t-1}$	0.0318	0.3552	-0.3235	0.2511
Asset Level 4$_{i,t-1}$	-0.0647	0.2938	-0.3585	0.3278
Asset Level 5$_{i,t-1}$	0.2056	0.5185	-0.3128	0.4424
Asset Level 6$_{i,t-1}$	-0.1566	0.3911	-0.5476	0.5011
Asset Level 7$_{i,t-1}$	-0.3658	0.6266	-0.9923	0.5821
Asset Level 8$_{i,t-1}$	-0.8306	0.5542	-1.3848	0.6948
Year 2	-0.1225	-0.1014	-0.0211	0.0212
Year 3	0.0354	0.0341	0.0013	0.0439
Year 4	0.1776	0.1395	0.0381	0.0484
Year 5	-0.0138	-0.0993	0.0855	0.0631
Year 6	-0.6511	-0.7169	0.0659	0.0749

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

chi2(20) = (b-B)'[(V_b-V_B)^(-1)](b-B)
chi2(20) = 26.70
Prob>chi2 = 0.1439

Note: The table report the results of the Hausman specification test for the regression of bank insolvency risk (equation (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 insignificant difference (H$_0$ is not rejected) is interpreted as evidence for applying the random effects model.

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