BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers
No 289

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Monetary and Economic Department

September 2009

JEL classification: D82, D86, G21, G28.

Keywords: Retention requirements, Screening incentives, Securitisation, Tranching.

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Bank for International Settlements
Communications
CH-4002 Basel, Switzerland

E-mail: publications@bis.org

Fax: +41 61 280 9100 and +41 61 280 8100

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)

ISBN 1682-7678 (online)

Incentives and Tranche Retention in Securitisation: A Screening Model

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First draft: November, 2008‡
This version: September, 2009

Abstract

This paper examines the power of different contractual mechanisms to influence an originator's choice of costly effort to screen borrowers when the originator plans to securitise its loans. The analysis focuses on three potential mechanisms: the originator holds a "vertical slice", or share of the portfolio; the originator holds the equity tranche of a structured finance transaction; the originator holds the mezzanine tranche, rather than the equity tranche. These mechanisms will result in differing levels of screening, and the differences arise from varying sensitivities to a systematic risk factor. Equity tranche retention is not always the most effective mechanism, and the equity tranche can be dominated by either a vertical slice or a mezzanine tranche if the probability of a downturn is likely and if the equity tranche is likely to be depleted in a downturn. If the choice of how much and what form to retain is left up to the originator, the retention mechanism may lead to low screening effort, suggesting a potential rationale for government intervention.

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‡The views expressed in this paper remain those of the authors and do not necessarily reflect those of the BIS or the NBB. The usual disclaimer regarding errors and omissions applies. We would like to thank Ulrike Neyer, Patrick Legros, and Rafael Repullo for helpful comments, together with seminar participants at the joint Bundesbank-CEPR-CFS conference "Risk transfer: challenges for financial institutions and markets", the RTF/Banco de España workshop "Challenges in banking research", the BIS, and the NBB.

1 Introduction

In the summer of 2007, following an extended period of ample liquidity provision and tight credit spreads, large-scale valuation losses on US subprime mortgages and an associated collapse in investor risk appetite triggered broad-based distress in markets for securitised instruments. Subprime-related securitisations, in particular, had experienced severe credit quality deterioration and downgrades of their credit ratings. Losses were magnified by increasingly dysfunctional markets for many types of structured products, triggering sharp corrections in secondary market prices that eventually spilled over into other asset markets.[1]

As the crisis unfolded, it became increasingly clear that investor concerns were focused not—or not exclusively—on subprime mortgages or any other particular segment of the credit market. Instead, the crisis was driven by concerns about securitisation markets as such and by the way the more widespread use of structuring technology and off-balance sheet finance had reshaped the financial sector. Securitisation volumes plummeted in response, from a combined annual amount for the United States and Europe of more than \$3.5 trillion over the 2005-2007 period to just over \$2 trillion in 2008 (see Graph 1). Reflecting the generalised loss of investor confidence, most of this remaining issuance was in the US agency sector and in European securitisations used for refinancing activities with the European Central Bank. The US subprime and alt-A market, which had peaked at some \$815 billion in 2006, vanished completely, as did markets for many other securitised instruments.

One issue gaining particular attention in this context was the securitisation chain and its influence on incentives. This was because, by putting some distance between originators and investors, the process of securitisation can weaken incentives for proper screening and due diligence along the chain. This, in turn, can contribute to a lowering of lending standards and a gradual deterioration in the credit quality of assets included in the collateral pools of securitised instruments.[2]

Concerns like this are not new. It has long been recognised that securitisation, while adding economic value through features such as the tranching of risk, can also give rise to incentive incompatibilities and other information

[1] See chapter VI in BIS (2008) for a detailed account of financial market developments during the early stages of the credit crisis of 2007/08. Fender and Scheicher (2009) review the performance of subprime mortgage securitisations and related derivatives.

[2] See, for example, Ashcraft and Schuermann (2007), Keys et al (2008), and Mian and Sufi (2008). Gorton (2008) offers a somewhat contrarian view.

problems.[3] In particular, compared to the relationship between individual borrowers and lenders, securitisation relies on a diverse group of originators, servicers, arrangers and investors who are linked through a complex network of relationships. The efficiency of these relationships depends importantly on whether the institutional setup of the securitisation process preserves the disciplinary power of market forces. Indeed, market participants have sought to devise contractual features and institutional arrangements to address these issues. Still, events leading into the crisis suggest that, despite these efforts, incentive problems can accumulate within the securitisation process and that adjustments may have to be made to avoid similar problems in the future.

One proposal that has gained recent attention in this context is tranche retention. Under such an arrangement, the originator or arranger of a securitised instrument would be required to have some "skin in the game" in order to maintain the appropriate incentives to screen and monitor borrowers. Equity tranche retention, in particular, has been advanced as a measure to revitalise securitisation markets in the wake of the financial crisis.[4]

The public sector has also taken note. The International Organisation of Securities Commissions (see IOSCO, 2009) has recommended that regulators should "consider requiring originators and/or sponsors to retain a long-term economic exposure to the securitisation." The European Union has adopted a proposal requiring originators to hold at least 5% of the securitised portfolio, where the form of retention may be chosen from among a list of options, including a percentage share, or "vertical slice".[5] The U.S. is also considering

[3]The tranching process creates classes of securities with different levels of credit quality from the underlying collateral asset pool. This is accomplished through the use of credit support specified within the transaction structure, with the priority ordering of payments being a key example: the equity/first-loss tranche absorbs initial losses up to the level where it is depleted, followed by mezzanine tranches which absorb some additional losses, again followed by more senior tranches. See Fender and Mitchell (2005) and CGFS (2005) for details.

[4]See Franke and Krahnen (2008) and Hellwig (2008) for recent examples. In fact, in early securitisations, originators would routinely hold on to the equity piece of their transactions. Over time, however, investors appeared—rightly or wrongly—to become more comfortable with securitised instruments, leading to an active market in equity tranches.

[5]The options include: "5% of the nominal value of each of the tranches sold or transferred to the investors" (i.e., vertical slice); "retention of randomly selected exposures, equivalent to no less than 5% of the nominal amount of the securitised exposures, where these would otherwise have been securitised in the securitisation provided that the number of potentially securitised exposures is not less than 100 at origination"; "retention of the first loss tranche and, if necessary, other tranches having the same or more severe risk profile and not maturing any earlier then those transferred or sold to investors, so that the retention equals in total not less than 5% of the nominal value of the securitised exposures." (See Article 122a, European Parliament, 2009)

a retention proposal (see U.S. Treasury, 2009).

This paper aims to contribute to these ongoing discussions. In particular, it examines the power of different contractual mechanisms to influence an originator's choice of costly effort to screen borrowers when the originator plans to securitise its loans. The question addressed is whether some mechanisms lead to more screening than others, and under what conditions. We focus on three potential mechanisms: the originator holds the equity tranche of a structured finance transaction; the originator holds a "vertical slice" of the portfolio (a share of the entire portfolio without subordination features); and the originator holds the mezzanine tranche rather than the equity piece of a securitisation. The analysis illlustrates that the type of contract used to align incentives will affect the amount of screening that the originator will undertake.

The differing screening incentives generated by different mechanisms derive in large part from the varying sensitivities of the retention mechanisms to a systematic risk factor, which plays an important role in the determination of borrowers' default probabilities and asset values. In fact, the equity tranche can be shown to be more sensitive to the realisation of systematic risk than the entire portfolio.[6]

When the probability of an unfavourable realisation of the systematic factor is high, and when the equity tranche would be exhausted if this unfavourable realisation were to occur, the originator holding the equity tranche may have less incentive to exert screening effort than the originator holding a mezzanine tranche of equal "thickness" (i.e., identical percentage of overall pool size) or a vertical slice of the loan portfolio.[7] We nevertheless show that, whereas a vertical slice may dominate the equity tranche in this case, the slice would generally have to be quite "thick" to dominate both the equity and the mezzanine tranches. Hence, in our setting it is rather unlikely that retention schemes relying on vertical slices would give rise to an optimal incentive mechanism. Until now it has not been common practice to observe the originator holding the mezzanine tranche, as the equity tranche, which imposes the most risk on the originator, was generally believed to be more "high-powered" in influencing incentives.

If the probability of a favourable realisation of the systematic factor is high, then having the originator hold the equity tranche will tend to result in

[6] See Krahnen and Wilde (2006) for a discussion of this point. Fender et al (2008) make a similar point in the context of ratings for collateralised debt obligations.

[7] The result regarding the vertical slice contrasts somewhat with the idea that the tranching of asset-backed securities can help to solve problems of adverse selection (see, e.g., DeMarzo, 2005). Indeed, going into the crisis, structured finance transactions were much more commonly observed than "pass-through" securitisations with no tranching.

greater effort than with either a mezzanine tranche or a vertical slice. In this respect, the equity tranche appears to be a good "fair weather" device. If, in addition, the costs of screening are not too high or if the unfavourable state of the world is unlikely to be severe enough to exhaust the equity tranche, then having the originator hold the equity tranche provides very high-powered incentives. Namely, in this case the originator will exert the first-best level of effort; i.e., the same level as it would if it were to hold the entire portfolio on its balance sheet.

Finally, we ask whether allowing the originator to choose the retention mechanism in the absence of any constraints would lead to a choice of mechanism that results in screening effort lower than the first-best level. The originator's choice of mechanism will be influenced by the monetary benefits the originator receives from securitisation. Some of these benefits are indirect and "private", and we show they can indeed lead to a choice of retention mechanism that results in lower than first-best screening effort. This suggests a potential role for regulation in influencing the choice of retention.

The rest of this paper is organised as follows: Section 2 provides a brief overview of the related literature. Section 3 sets out the model and compares the effort choices associated with differing retention mechanisms. Section 4 discusses the results and provides numerical examples which illustrate the impact of various parameters on the outcomes. Section 5 analyses the originator's choice of retention mechanism. Section 6 concludes.

2 Related literature

The two papers most closely related to ours are Chiesa (2008) and Innes (1990). Chiesa analyses the impact of optimal credit risk transfer (CRT) activity at the portfolio level on a bank's monitoring of its borrowers and on the size of the bank's loan portfolio. In her setup, information conveyed by different portfolio cash flows can be used to determine if the bank has monitored or not. The realisation of a systematic risk factor plays an important role in communicating this information. Chiesa finds that a particular form of CRT contract − namely, one where the bank sells the portfolio together with a put option on the portfolio to outside investors − maximizes the size of the loan portfolio for which the bank finds it incentive compatible to monitor. While this paper provides a unique view of the potential role of CRT for banks in alleviating incentive problems, it does not focus on questions relating to typically observed forms of CRT contracts or on recent concerns about portfolio securitisation that have preoccupied many observers.[8]

Chiesa's result that a CRT contract, rather than debt, is optimal for the bank stands in contrast to the optimality of the standard debt contract found by Innes (1990), who formalizes intution in Jensen and Meckling (1976) and analyzes the optimal form of external finance when an entrepreneur with limited liability can exert effort to increase its profit. Innes finds that when the payout to the investor is constrained to be monotonically nondecreasing in the firm's profit, then having the entrepreneur issue a standard debt contract is optimal. Part of the explanation for the difference in Chiesa's results from Innes' is related to the question of whether the profit distribution satisfies the monotone likelihood ratio property (MLRP), which Innes (1990) assumes.[9]

The model of our paper resembles in certain respects that of Innes. Having the originator in our model hold the equity tranche of a securitisation would be similar to having the entrepreneur in Innes' model hold equity and obtain outside financing through debt. Similarly, having the originator in our model hold a mezzanine tranche would be analogous to the entrepreneur in Innes' model holding debt, with the outside investors holding equity. Unlike Innes (but similarly to Chiesa), our return distribution does not satisfy MLRP.[10] This feature gives rise to situations where the originator will exert less screening effort when it holds the equity tranche than when it holds the mezzanine tranche. At the same time, certain private benefits obtained through securitisation can encourage the originator to use retention schemes that result in too little screening effort. This provides a justification for asking whether an improvement could be achieved by using regulation to influence the originator's choice of retention scheme.

Another paper dealing with the optimality of debt contracts in the context

[8] Several previous authors have found potentially negative effects of instruments of credit risk transfer (single-name, rather than portfolio) on the incentives of loan originators. See, for example, Gorton and Pennacchi (1995), Morrison (2005), Parlour and Plantin (2007), and Parlour and Winton (2007). Kiff et al (2003) present a general discussion of the ways in which CRT instruments alter problems of asymmetric information and incentives between loan originators and borrowers.

[9] MLRP implies that the relative likelihood of a high realisation of revenue given a high effort increases with the level of revenue (i.e., the likelihood ratio increases with the level of revenue). Assuming MLRP, it can be shown that Innes' result regarding the optimality of debt financing also survives in more complex dynamic settings that allow for contract renegotiation under risk aversion. See Dewatripont et al (2003).

[10] The role of the systematic risk factor in our model leads to the outcome that, although higher levels of effort will lead to higher expected revenue realisations *given* the state of nature, high systematic factor realisations can lead to high realisations of revenue even for low levels of effort. MLRP is thus violated. This outcome highlights the potential lack of realism, at least in some settings, of assuming MLRP (which would essentially rule out multi-modal return distributions).

of asset securitisation is that of DeMarzo and Duffie (1999), who consider a situation where a financial institution would like to sell asset-backed securities to raise cash but where the institution has private information regarding the assets' cash flows. These authors find that, under some rather general technical conditions, the institution will choose to securitise by issuing a standard debt contract to outside investors; i.e., the originator will hold the equity "tranche" of the securitisation.[11]

In a spirit similar to that of our model, Duffie (2008) cites results from a numerical simulation illustrating the impact of equity tranche retention on an originator's monitoring/screening effort, when the originator uses securitisation to raise cash and when the monitoring effort reduces borrowers' default probabilities. The originator chooses the thickness of the equity tranche as well as the level of effort. Thicker equity tranches result in higher effort, and therefore, in a higher value for the senior tranches ("debt") that are sold to outside investors. On the other hand, thicker equity tranches reduce the amount of asset-backed securities that can be sold and, consequently, the extent to which the originator can generate cash. We explicitly model this tradeoff and find that in certain cases the originator may prefer thin equity tranches, or even no tranche retention at all, to holding thicker equity tranches. However, the thin tranche or no tranche retention will lead to levels of effort that are below the first-best level.

3 Model

Our model focuses on an originating institution that extends loans, while having the option to either carry these loans on balance sheet or pass them on to competitive, third-party investors in the form of a securitisation. Suppose that the originator has an amount Z in funds and extends Z loans of value one unit each.[12] The risk-free rate of interest is normalized to zero, and outside investors as well as the originator are assumed to be risk-neutral. If

[11] Mitchell (2005) provides a review of the literature on financial contracting and security design and its implications for the economics of structured finance markets, including questions relating to the optimality of pooling and tranching the cash flows from asset-backed securities.

[12] Because we are concerned with the originator's incentives to screen borrowers for a given portfolio size, we do not model the originator's choice of size of the loan portfolio. Note also that, although the model focuses on the incentives of originators in screening to-be-securitised assets, it could also apply to the incentives of arrangers with regard to their screening of the activities of the originators and the quality of the securitised assets.

a loan does not default, it repays $R > 1$ to the originator.[13] If a loan defaults, recovery is zero.

Borrowers are assumed to be of two types: good (G) and bad (B), where the types are distinguished by differing probabilities of default. The proportion of type-G borrowers in the population is given by θ and the proportion of type-B borrowers is $(1 - \theta)$. The loans of type-B borrowers are assumed to have negative present value. Therefore, if the originator believes that it is facing a borrower of type B, it will not extend a loan.

The originator cannot distinguish G from B types without screening. At the same time, screening does not allow the originator to identify borrower types with certainty. Instead, effort (unobservable to outsiders) exerted by the originator in screening borrowers is assumed to reduce Type II errors (i.e., accepting a type-B borrower) and, therefore, the proportion of B borrowers in the loan portfolio relative to no screening. The per-loan cost of screening to the originator is given by a function $c(e)$, where $e \in [0, 1]$, with $c(0) = 0$, $c'(e) > 0$, and $c''(e) > 0$.[14]

Screening effort is assumed to alter the composition of the portfolio as follows:

Proportion of type-B borrowers: $\alpha_B(e) = \max[(1 - \theta) - e, 0]$
Proportion of type-G borrowers: $\alpha_G(e) = \min(\theta + e, 1)$.

Note that $\partial\alpha_B(e)/\partial e = -1$ and $\partial\alpha_G(e)/\partial e = 1$ for $e \in [0, 1 - \theta]$. Given that screening effort is costly, the originator will never choose an effort level that exceeds $1 - \theta$.

Borrowers' PDs are affected by the realisation of a systematic risk factor $Y \in \{H, L\}$, where H denotes a "high" or favourable state of the world and L denotes a "low" or unfavourable state. $Y = L$ with probability p_L and $Y = H$ with probability $p_H = (1 - p_L)$. Probabilities of default for each type of borrower depend upon the state of the world in the following ways. In the low state, type-B borrowers default with certainty and type-G borrowers default with some probability $PD_G(L) > 0$. In the high state, no type-G borrowers default; however, type-B borrowers default with some probability $PD_B(H) > 0$. Like Chiesa (2008), we assume that the loan portfolio is

[13] We assume that there is imperfect competition among originators and that they can extract enough rent from borrowers to give the originator an expected return greater than the risk-free return.

[14] Screening cost functions are often specified as costs per loan applicant. Here, since the size of the loan pool is fixed, we can specify the cost function as cost per loan. For example, when screening effort is very low, Type-II errors are high; therefore, fewer type-B loan applicants are rejected. As screening effort increases, more type-B loan applicants are rejected; therefore, more loan applicants must be screened in order to achieve the fixed loan portfolio size, which is more costly.

highly granular (i.e., portfolio size Z is high enough), so that idiosyncratic risk is fully diversified away. Outcomes are then centered on the means, which depend upon the realisation of the systematic risk factor.

Our framework allows for the PDs for good and bad borrowers to vary across states of the world. An indication of the value of screening in a given state of the world is given by the differences in the PDs of bad and good borrowers in that state. Define these differences as $\Delta_L = 1 - PD_G(L)$ and $\Delta_H = PD_B(H) - 0$. A value of $\Delta_L > \Delta_H$, for example, would indicate that screening effort has a greater impact in the low than in the high state. For realistic values of $PD_G(L)$ and $PD_B(H)$, Δ_L is likely to exceed Δ_H. One can think of Δ_L and Δ_H as being similar to a measure such as the difference between the spreads of broad indices of BBB and AAA bonds. This measure, which tends to increase in downturns, is sometimes used in empirical work as an indicator of systematic risk.[15]

In this section we compare the choice of effort by an originator when it holds the entire loan pool on its balance sheet with the effort levels that would be chosen when the originator securitizes the loans but retains a portion of the securitisation through differing retention mechanisms. The question addressed is: given a particular form of retention mechanism, what effort level will the originator choose? This question implicitly supposes that the choice of retention scheme has been made at some prior point, either by the originator in the absence of any constraints on that choice, or as a result of regulation or pressure by market participants to use a particular form of retention scheme. We use the results of this analysis to investigate in Section 5 the originator's ex ante choice among retention schemes in the absence of any constraints on that choice.[16]

3.1 Holding the entire pool

Suppose that the originator holds the entire loan pool Z on its balance sheet. Assume, further, that the originator has assets other than this loan portfolio on its balance sheet and that, even if a portion of the loan portfolio defaults, the losses would not be high enough to lead to default by the originator on any debt finance that it has. The originator's expected return will be given

[15] See, among others, Fama and French (1989, 1993).

[16] The analysis of the originator's ex ante choice requires the results of this section, as it is necessary to know the ex post effects of each type of retention mechanism in order to be able to choose between the mechansisms ex ante.

by

$$\begin{aligned}\pi_{pool}(e) &= p_L\left[(1-PD_G(L))R\alpha_G(e)\right]Z \\ &\quad +p_H\left[R\alpha_G(e)+(1-PD_B(H))R\alpha_B(e)\right]Z \\ &\quad -c(e)Z-Z \qquad (1)\end{aligned}$$

The first expression in brackets on the RHS of (1) gives the originator's return if the low state occurs. In this state, all type-B borrowers default with certainty, and the proportion $PD_G(L)$ of G-type borrowers are expected to default. Loan returns will be zero for all defaulters. The proportion $(1-PD_G(L))$ of type-G borrowers is expected not to default, in which case the bank's loan returns equal $(1-PD_G(L))R\alpha_G(e)Z$, where $\alpha_G(e)$ represents the proportion of good borrowers in the pool. The second expression in brackets gives the originator's return if the high state occurs. In this state no type-G borrower defaults; therefore the return associated with these borrowers is $R\alpha_G(e)Z$. A proportion $(1-PD_B(H))$ of type-B borrowers does not default, which implies a return of $(1-PD_B(H))R\alpha_B(e)Z$.

Using the definitions of Δ_L and Δ_H, Eqn (1) can be reexpressed as

$$\pi_{pool}(e) = R\left[p_L\Delta_L\alpha_G(e)+p_H-p_H\Delta_H\alpha_B(e))\right]Z-c(e)Z-Z.$$

The originator chooses screening effort to maximize its expected return. This effort will be given by the F.O.C. of (1), which gives

$$c'(e_p) = R\left[p_L\Delta_L+p_H\Delta_H\right] \qquad (2)$$

The effort specified by the F.O.C. (2) represents the first-best effort choice, which will be used as the benchmark throughout our analysis. Note that the size of the loan pool Z does not appear in this expression. As this value plays no role in our analysis of effort choice, we normalize it to 1 from this point onward.

3.2 Securitising the entire pool

Securitisation provides the originator with cash prior to maturity of the loans. This cash may be valuable to the originator for any number of reasons, including extending new loans, meeting liabilities and the like. Note that in perfect financial markets, the originator would be able to borrow against the future cash flow from the loan portfolio. Therefore, there would be no extra benefit to using securitisation to generate cash. However, in the presence of imperfections such as asymmetric information, bankruptcy costs, and the separation of ownership and control, originators may find it costly to raise external funds, in which case it will be valuable to the firm to be able to generate cash.[17] To capture the monetary benefits from securitisation in the model, we multiply the cash generated from securitisation by a parameter Ω, whose value is greater than one. We expect the value of Ω to be institution as well as instrument-specific.

One of the reasons for the variation of Ω across institutions and instruments is that, in addition to the cash generated directly from the sale of the portfolio (or some portion of it), securitisation can generate other, indirect monetary benefits for the originator; for example, freeing up capital or increasing reported profits. Some of these are in fact "private" benefits for the originator. We explore the implications of the indirect benefits of securitisation in Section 5, where we take explicit account of the potential variation in the value of Ω across instruments in our analysis of the originator's choice between differing retention schemes. In the current section, however, the results are unaffected by any variation of Ω across instruments; therefore, we keep the analysis simple and hold Ω constant for all retention schemes.

In terms of timing, we assume in this section that the originator has already decided at the point of loan origination whether the loan portfolio will be securitised and in what form. Before origination of the loans, the originator issues securities backed by the portfolio.[18] It then chooses its screening effort, originates the loans, and conducts the securitisation transaction. We assume that outside investors are competitive: the price they will pay for any securitisation will just equal the expected value of their payments from the securitisation. We also assume that investors cannot observe the originator's screening effort, nor can the state of the world be legally "verified". Hence, neither effort nor the state of the world can be contracted upon. However, in computing the expected payments from the securitised portfolio, the investors take into account the effort level they know the originator had the incentive to choose.

Suppose now that the originator securitises the entire loan portfolio. Since no loans are held on balance sheet, the only source of revenue will be the cash from the securitisation. Denote this revenue by S_{sec}. The originator's

[17] See, for example, the discussion in Froot et al (1993).

[18] Equivalently, one could think of the originator setting up a special purpose vehicle to which its loans will be sold, and the SPV begins issuing securities of a certain form. See, for example, the discussion in Fender and Mitchell (2005). As in DeMarzo and Duffie (1999) and DeMarzo (2004), it is important that the originator commits to the form of the asset-backed securities before it originates the loans. The form of the securities that will be backed by the loans will influence the level of effort that the originator will choose to screen borrowers.

expected profit will then be given by

$$\pi_{\text{sec}}(e) = \Omega S_{\text{sec}} - c(e) - 1. \tag{3}$$

Since there is no recourse and investors cannot contract on effort, the originator has no incentive to exert any effort. It therefore chooses an effort level of zero. As a result, securitisation with no retention by the originator causes a lowering of the quality of its credit portfolio.[19]

Investors, anticipating this outcome, will be willing to pay a price equal to the expected return from the portfolio, given the zero effort level. This implies that S_{sec} will be given by:

$$\begin{aligned} S_{\text{sec}} &= p_L \left[(1 - PD_G(L)) R\alpha_G(0)\right] \\ &\quad + p_H \left[R\alpha_G(0) + (1 - PD_B(H)) R\alpha_B(0)\right]. \end{aligned} \tag{4}$$

As we will show in the next subsections, mechanisms involving some retention of the portfolio by the originator will generally lead to positive screening effort.

3.3 Originator holds a proportion v of the portfolio

Suppose that the originator securitises its loans but holds a proportion v (i.e., a vertical slice) of the portfolio on its balance sheet. This implies that for any given amount Y of cash flows from the portfolio, the originator will receive vY. Denote by S_v the amount that investors will pay for the $(1 - v)$ proportion of the return on the portfolio. The originator's expected payoff is now given by

$$\begin{aligned} \pi_v(e) &= \Omega S_v + v p_L \left[(1 - PD_G(L)) R\alpha_G(e)\right] \\ &\quad + v p_H \left[R\alpha_G(e) + (1 - PD_B(H)) R\alpha_B(e)\right] \\ &\quad - c(e) - 1 \end{aligned} \tag{5}$$

which can be rewritten as

$$\pi_v(e) = \Omega S_v + vR\left[p_L \Delta_L \alpha_G(e) + p_H - p_H \Delta_H \alpha_B(e)\right] - c(e) - 1.$$

[19] Note that this extreme, no-screening result is a consequence of our assumption that this is a one-shot game. In practice, for example, reputation risk might be expected to exert a level of discipline on the originator, especially if it plans to undertake repeated securitisations. Yet, it is also clear that the self-disciplining role of reputation does not necessarily always work, as documented in Frankel (2009) on the basis of a case study of New Century Financial.

On this basis, the originator's effort will be determined by the F.O.C.:

$$c'(e_v) = vR\left[p_L\Delta_L + p_H\Delta_H\right]. \tag{6}$$

Comparison of (6) and (2) together with the convexity of $c(\cdot)$ reveals that $e_v < e_p$. Thus, the originator exerts less effort when it holds a share of the pool than when it holds the entire pool.[20]

3.4 Originator holds equity tranche

Now suppose that the originator issues a tranched securitisation. Assume for simplicity that there are three tranches: an equity tranche, a mezzanine tranche, and a senior tranche. Assume that the originator holds the equity tranche with a thickness t. In other words, the originator will bear all losses up to a proportion t of the portfolio, above which the mezzanine tranche begins to suffer losses.

The originator will receive a payment S_{eq} from the sale of the mezzanine and senior tranches. Upon maturity of the loans, the mezzanine and senior tranche holders will together receive pre-contracted payment in the total amount of $B_1(t)$, where $B_1(t) = (1-t)R$, unless loan losses are so high that the portfolio cash flows are less than $B_1(t)$, in which case all of the portfolio cash flows will be paid to the mezzanine and senior tranche holders. Note that the payment $B_1(t)$ depends upon the thickness of the equity tranche: the thicker is the equity tranche, the lower will be B_1 and S_{eq}. The originator's expected payoff is now given by

$$\begin{aligned}\pi_{eq}(e) &= \Omega S_{eq} + p_L \max\left\{\left[(1-PD_G(L))R\alpha_G(e) - B_1\right], 0\right\} \\ &\quad + p_H \max\left\{\left[R\alpha_G(e) + (1-PD_B(H))R\alpha_B(e) - B_1\right], 0\right\} \\ &\quad - c(e) - 1 \end{aligned} \tag{7}$$

where the dependence of B_1 on t has been suppressed. Note that when the low state occurs, as long as $(1-PD_G(L))R\alpha_G(e) - B_1 > 0$, the originator receives some positive payment. If, however, $(1-PD_G(L))R\alpha_G(e) - B_1 \leq 0$, the equity tranche will be "exhausted" in the low state; i.e., the payment to the originator will be zero. Similarly, if the high state occurs and $R\alpha_G(e) + (1-PD_B(H))R\alpha_B(e) - B_1 < 0$, the equity tranche will be exhausted.

It will be useful to define the conditions under which the equity tranche is exhausted in the low and the high states of the world, respectively, as follows:

[20] The intuition for this outcome is similar to that of Jensen and Meckling (1976) and Innes (1990). Like Innes, the model here uses an ex ante choice of effort, as opposed to Jensen and Meckling's ex post choice of perquisites.

Condition LowEx: $(1 - PD_G(L))R\alpha_G(e) - B_1 \leq 0$

Condition HighEx: $R\alpha_G(e) + (1 - PD_B(H))R\alpha_B(e) - B_1 \leq 0$

Note that the value of e chosen by the originator will play a role in determining whether conditions LowEx and HighEx hold. In particular, the lower the value of e, the more likely these conditions are to hold. At the same time, it is straightforward to see that there will be values of e for which condition HighEx no longer holds but LowEx continues to hold. In other words, if both conditions hold for low values of e, as e is increased, the equity tranche will begin to pay out increasingly positive returns in the high state while it is still exhausted in the low state.

In order to reduce the number of cases that need to be considered in the exposition, and without loss of generality, we make the following assumption.

Assumption 1: When $e = 0$, condition HighEx does not hold but condition LowEx does hold. I.e.,

$$(1 - PD_G(L))R\alpha_G(0) - B_1 \leq 0 < R\alpha_G(0) + (1 - PD_B(H))R\alpha_B(0) - B_1.$$

This assumption implies that, even if the effort level is zero, the equity tranche will not be exhausted in the high state; however, it will be exhausted in the low state.[21]

Define $\widehat{e}$ as the threshold level of effort such that condition LowEx will hold for all levels of effort less than $\widehat{e}$ but will not hold for effort levels greater than this value. I.e., $\widehat{e}$ satisfies

$$(1 - PD_G(L))R\alpha_G(\widehat{e}) - B_1 = 0. \tag{8}$$

For all values of effort below $\widehat{e}$, the equity tranche will be exhausted in the low state, and for all values above $\widehat{e}$, the equity tranche holder's expected

[21] In principle, there are three possible cases to consider: (1) low effort levels cause the equity tranche to be exhausted in both the low and the high states; (2) medium effort levels cause the equity tranche to be exhausted in the low state but not in the high state; (3) high effort levels imply that the equity tranche will not be exhausted in either state. Assumption 1 effectively rules out the need to consider the first case, which simplifies the exposition without changing any of the results. This assumption allows us to ignore parameter values for which the equity tranche holder would not receive a payout in either the high or the low state and is without loss of generality. In practice, rating agency (or "market") requirements on minimum subordination levels would also effectively rule out the first case.

payment in the low state will be positive. This has the following implications for the marginal effect of a change in effort:

$$\frac{\partial \pi_{eq}(e)}{\partial e} = p_H \Delta_H R - c'(e), \text{ for } e \in [0, \widehat{e}] \quad (9)$$
$$= R\left[p_L \Delta_L + p_H \Delta_H\right] - c'(e), \text{ for } e > \widehat{e}.$$

In words, for values of $e < \widehat{e}$, an increase in e will have no impact on the originator's payment in the low state, but it will affect the payoff in the high state. For values of $e > \widehat{e}$, an increase of effort has an effect on the payoff in both states of the world.

The expressions above indicate that the marginal impact of effort on the originator's revenue is discontinuous at the value $\widehat{e}$. Whether the originator's optimal choice of effort will lie in the range $[0, \widehat{e}]$ or the range $e > \widehat{e}$ will ultimately depend upon the value of $c'(\widehat{e})$. In particular, if $c'(\widehat{e}) > R\left[p_L \Delta_L + p_H \Delta_H\right]$, then the originator will choose an effort less than $\widehat{e}$. It is only in the case where $c'(\widehat{e}) < R\left[p_L \Delta_L + p_H \Delta_H\right]$ that the originator will choose an effort greater than $\widehat{e}$. This effort choice, then, will determine whether the equity tranche will be exhausted in the low state.

The originator's effort choice can thus be described by two possible cases.

Case E1: Condition LowEx holds at optimal effort.

Suppose that $c'(\widehat{e}) > R\left[p_L \Delta_L + p_H \Delta_H\right]$. Then the optimal effort is given by

$$c'(e) = p_H \Delta_H R. \quad (10)$$

Define this level of effort as $e_{eq.}$ Note that the originator's effort in this case is determined solely by the the likelihood that the high state occurs and the impact of effort in the high state (as measured by Δ_H).

Case E2: Condition LowEx does not hold at optimal effort.

This condition can only hold if $c'(\widehat{e}) < R\left[p_L \Delta_L + p_H \Delta_H\right]$. It follows that

$$c'(e) = R\left[p_L \Delta_L + p_H \Delta_H\right]. \quad (11)$$

Note that this level of effort is the first-best level e_p. In this case $e_p > \widehat{e}$ and the equity tranche will have a positive expected payoff in the low state.

Note that equity tranche thickness t does not enter into the first-order condition in either of the two above cases; equity tranche thickness has no direct effect on the originator's effort choice. It does, however, have an indirect effect. The thicker is the equity tranche t, the smaller will be the promised payment $B_1 = (1-t)R$ and the lower will be the threshold effort $\widehat{e}$. Therefore, the thicker is the equity tranche, the less likely is Case E1 to hold at the optimum.[22]

The following proposition characterizes the optimal effort with the equity tranche.

Proposition 1: (i) *If Case E2 holds, then the originator exerts the same amount of effort with the equity tranche as it would if it held the entire portfolio on balance sheet*; (ii) *If Case E1 holds, then the originator's effort with the equity tranche will be lower than if the originator were to hold the entire portfolio on balance sheet*; (iii) *If Case E1 holds, having the originator hold a share v of the portfolio, with the value of v equal to equity tranche thickness t, will lead to greater effort than having the bank hold the equity tranche if*

$$t > \frac{p_H \Delta_H}{p_L \Delta_L + p_H \Delta_H};$$

(iv) *Equity tranche thickness has an indirect impact on the originator's choice of effort: an increase in tranche thickness will lower the likelihood that Case E1 holds.*

Condition (i) of the above proposition reflects the prevailing wisdom regarding the equity tranche: this tranche, which would represent a much smaller claim on the portfolio than the entire portfolio itself, provides high-powered incentives and gives rise to the first-best effort.

However, condition (ii) of the proposition suggests that the equity tranche may not always provide such high-powered incentives. If, in equilibrium, the equity tranche will be exhausted in the low state of the world, then the originator will exert less effort with the equity tranche than with the entire portfolio. Condition (iii) then suggests that the originator's effort choice may be higher if it holds a vertical slice of the portfolio rather than the equity tranche. Comparison of the F.O.C. (10) associated with the equity tranche and the F.O.C. (6) for a vertical tranche shows that a slice of size v will result in higher effort than will the equity tranche if the following inequality holds:

$$v > \frac{p_H \Delta_H}{p_L \Delta_L + p_H \Delta_H}. \tag{12}$$

This inequality suggests that if p_L is high relative to p_H, or if Δ_L is large relative to Δ_H, the critical value of v needed for the vertical slice to dominate the equity tranche may be fairly small. Setting the left-hand side equal to t

[22] Indeed, if the equity tranche were thick enough (e.g., close to 1), then condition LowEx would not hold even for an effort level of zero.

and checking whether the inequality holds will indicate whether having the originator hold a vertical slice of size t would lead to a higher effort than having the originator hold the equity tranche of thickness t.

3.5 Originator holds the mezzanine tranche

Now suppose that rather than holding an equity tranche of thickness t, the originator holds a mezzanine tranche of the same thickness.[23] What will the choice of effort be relative to the choice when the originator holds the equity tranche? Having the originator hold the mezzanine tranche means that outside investors now hold the senior and the equity tranches. The originator will now have to make a payment $B_2 = (1 - 2t)R$ to the senior tranche holder. Then the originator will pay itself a payment B_{mezz}, and the equity tranche holder, who holds a tranche of thickness t, will receive the residual. If revenue is not sufficient to make the payment B_2 to the senior tranche holder, then the originator will receive no payment. If revenue is sufficient to make the payment B_2 to the senior tranche holder but not sufficient to make a payment of B_{mezz} to the originator, then the originator will receive the residual of revenue minus B_2, and the equity tranche holder will receive no payment. The originator's expected payoff is now given by

$$\begin{aligned} \pi_{mezz}(e) &= \Omega S_{mezz} + p_L \min\left\{\max\left[(1 - PD_G(L))R\alpha_G(e) - B_2, 0)\right], B_{mezz}\right\} \\ &\quad p_H \min\left\{\max\left[R\alpha_G(e) + (1 - PD_B(H))R\alpha_B(e) - B_2, 0)\right], B_{mezz}\right\} \\ &\quad -c(e) - 1. \end{aligned} \tag{13}$$

Given that the payment structure for the various tranche holders is the same as in the previous subsection (i.e., only the identities of the holders of the tranches have changed), then $B_{mezz} + B_2 = B_1$. This implies that the threshold effort $\widehat{e}_{mezz}$ below which the equity tranche is exhausted; i.e., for which $(1 - PD_G(L))R\alpha_G(\widehat{e}_{mezz}) - B_2 = B_{mezz}$, is equal to the previous threshold effort $\widehat{e}$, for which $(1 - PD_G(L))R\alpha_G(\widehat{e}) = B_1$. Note also that the originator will now never choose an effort greater than $\widehat{e}$, since for any effort greater than $\widehat{e}$, its payoff does not increase with effort and will be equal to B_{mezz}.

In order to characterize the optimal effort we need to distinguish between three potential cases.

Case M1: At the optimal effort, Case E1 from the previous section holds (i.e., equity tranche is exhausted) but the mezzanine tranche is not completely exhausted (i.e., $(1 - PD_G(L))R\alpha_G(e_{mezz}) - B_2 > 0$).

[23] The assumption of the same thickness for the mezzanine tranche is made to allow a more direct comparison between the alternatives of having the originator hold the equity tranche and having the originator hold the mezzanine tranche.

Given that the originator will never choose an effort greater than $\widehat{e}$ (since the mezzanine tranche holder always receives the constant payment B_{mezz} in the high state of the world), the condition which implies that Case E1 holds at the optimal effort is that $c'(\widehat{e}) > p_L \Delta_L R$. In this case the optimal effort $e_{mezz} < \widehat{e}$, and

$$c'(e_{mezz}) = p_L \Delta_L R. \tag{14}$$

Case M2: Case E1 holds at optimal effort and the mezzanine tranche is exhausted.

This case will occur if $c'(\widehat{e}) > p_L \Delta_L R$ and if at the value e for which $c'(e) = p_L \Delta_L R$, $(1 - PD_G(L)) R \alpha_G(e) - B_2 \leq 0$. Given that losses are so high with this level of effort that the mezzanine tranche will be exhausted in the low state of the world, the optimal effort will be $e = 0$.

Case M3: $c'(\widehat{e}) < p_L \Delta_L R$.

In this case, if the originator were to hold the equity tranche, it would choose an effort high enough so that the condition LowEx does not hold (i.e., Case E2 would characterize the optimum). When the originator holds the mezzanine tranche, it will choose the effort $\widehat{e}$, and it will receive B_{mezz} in both the low and the high states. Note, however, that in this case the equity tranche is still exhausted in the low state.

We may now state the following proposition.

Proposition 2: (i) *Suppose that condition (ii) of Proposition 1 holds; i.e., the originator, if it holds the equity tranche, would choose an effort low enough so that the equity tranche will be exhausted in the low state. Then the originator, when it holds the mezzanine tranche, will also choose a level of effort such that the equity tranche will be exhausted in the low state, and this effort may be greater than the effort that the originator would choose if it held the equity tranche.*
(ii) *Suppose the originator holds the mezzanine tranche and that Case M1 holds. Then having the originator hold a share v of the portfolio, with the value of v equal to mezzanine tranche thickness t, will lead to greater effort than having the bank hold the mezzanine tranche if*

$$t > \frac{p_L \Delta_L}{p_L \Delta_L + p_H \Delta_H}.$$

(iii) *Suppose that the originator holds the mezzanine tranche and that Case M3 holds. Then the originator's effort will always be less than the effort it would have chosen if it were holding the equity tranche.*

Proof: (i) When $c'(\widehat{e}) > R\left[p_L \Delta_L + p_H \Delta_H\right]$, condition (ii) of Proposition 1 holds. That $c'(\widehat{e}) > R\left[p_L \Delta_L + p_H \Delta_H\right]$ implies also that $c'(\widehat{e}) > p_L \Delta_L R$.

So, the effort chosen by the originator holding the mezzanine tranche will be strictly less than $\widehat{e}$. The effort will be strictly positive and will satisfy $c'(e_{mezz}) = p_L \Delta_L R$, as long as the mezzanine tranche is not exhausted in the low state at this level of effort. Comparison of the F.O.C. for e_{mezz} with that for e_{eq} reveals that $e_{mezz} > e_{eq}$ if $p_L \Delta_L > p_H \Delta_H$. This condition will hold if the likelihood of the low state occurring is high or if the impact of screening is high in the low state relative to the impact in the high state.

(ii) The effort with a share v of the portfolio will exceed the effort with the mezzanine tranche if

$$p_L \Delta_L R < v \cdot R \left[p_L \Delta_L + p_H \Delta_H \right]$$

or

$$v > \frac{p_L \Delta_L}{p_L \Delta_L + p_H \Delta_H}. \tag{15}$$

(iii) In this case $c'(\widehat{e}) < p_L \Delta_L R$, and the originator holding the mezzanine tranche will choose $e_{mezz} = \widehat{e}$. Given that $c'(\widehat{e}) < p_L \Delta_L R < R \left[p_L \Delta_L + p_H \Delta_H \right]$, then if the originator were to hold the equity tranche, it would choose the first-best effort e_p such that $c'(e_p) = R \left[p_L \Delta_L + p_H \Delta_H \right]$. This implies that the originator's effort with the mezzanine tranche is lower than it would be with the equity tranche. $\|$

4 Discussion and numerical examples

The analysis above has derived conditions under which one type of mechanism may dominate another in providing the incentive for originators to exert screening effort. Under what conditions might one of the mechanisms dominate both other alternatives? Statement (i) of Proposition 1 provides a partial answer to this question. When the equity tranche is thick enough so that it will not be exhausted in the low state in equilibrium, then the equity tranche will result in the first-best effort. However, if the equity tranche would be exhausted in the low state in equilibrium (as in statement (ii) of Proposition 1), then the effort chosen by the originator will be less than first-best, and the mezzanine tranche or a vertical slice may yield higher effort than the equity tranche.

4.1 Ilustration and discussion

The intuition for these results can be illustrated via Graph 2. The coloured lines depict the payment profiles across different retention mechanisms from the investor's and the originator's perspectives. When the originator retains the equity tranche of a securitisation (indicated by the red line in the right-hand panel), he becomes the residual claimant with respect to the cash flows from the underlying portfolio. The investor (for simplicity, the graph assumes that there is only one combined mezzanine/senior tranche), in turn, holds a claim that has the familiar properties of a standard debt contract (the red line in the left-hand panel). That is, the investor will receive the entire cash flow from the underlying pool of assets up to the point where this cash flow equals the promised payment to the mezzanine tranche holder. Only from that level of cash flow onwards will the originator begin to receive payouts. Mezzanine tranche retention by the originator works in a similar fashion (with the payoff profiles in the two panels reversed, as indicated by the blue lines), while a share in the overall pool generates a linear payoff profile for both the originator and investor (as suggested by the brown lines).

If a downturn is likely (p_L is high) and the equity tranche is thin enough to be depleted if the downturn materialises, then cash flows generated by the asset pool will imply tranche payouts to the left of points A and B in both panels of the graph. (This is our case E1 in Section 3.4.) In this region of cash flows, an increase in the originator's effort would have no impact on its payoff in the low state (although it would increase the payoff in the high state). This reduces the incentive to exert screening effort. In contrast, if the originator holds the mezzanine tranche, an increase in effort will increase the payout in the low state (although it will have no impact on the payoff in the high state). If the originator holds the vertical slice, an increase in effort will increase the payout in both the low and the high states. Hence, depending upon parameter values, either the mezzanine tranche or the vertical slice may dominate equity tranche retention.

The more standard case of equity tranche domination arises for relatively high cash flow realisations to the right of A and B, which correspond to situations where the equity tranche is "thick" enough not to be exhausted in the downturn (which corresponds to Case E2 in Section 3.4).

Note that these results contrast with the main result of Innes (1990), which would imply in our context that it should always be optimal to have the originator hold the equity tranche. The reason for this difference is that the return distribution in our model does not satisfy the monotone likelihood ratio property (MLRP). This property is assumed to hold in Innes' model, as in much of the financial contracting literature.

The violation of MLRP for the return distribution in our model is due to the role of the systematic risk factor. Whereas in our model the loan portfolio return distributions in the low state and in the high state each satisfy MLRP individually, when these two return distributions are "linked" via the systematic risk factor, the resulting distribution does not satisfy MLRP. Stated differently, a high return on the portfolio can arise from a favourable realisation of the systematic factor rather than high effort. Hence, in principle, a low effort combined with a favourable realisation of the systematic factor can result in higher portfolio returns than a high effort combined with an unfavourable realisation of the systematic factor.[24] The fact that MLRP does not hold in this setting suggests that the assumption of MLRP as a technical regularity condition for return distributions (at least on loan portfolios) may actually be too strong.

We investigate below the conditions for which one retention mechanism would dominate the other two. The condition for a vertical slice to dominate the equity tranche is given by Eqn. (12) and allows us to define a threshold value v_{equity} as follows:

$$v_{equity} = \frac{p_H \Delta_H}{p_L \Delta_L + p_H \Delta_H}.$$

When the equity tranche will be exhausted in the low state of the world, all vertical slices of size v_{equity} or greater will result in higher levels of effort than will the equity tranche.

Similarly, equation (15) provides the condition for which a vertical slice would dominate the mezzanine tranche. Define the threshold value v_{mezz} by

$$v_{mezz} = \frac{p_L \Delta_L}{p_L \Delta_L + p_H \Delta_H}.$$

All vertical slices of size v_{mezz} or greater will yield higher effort than the mezzanine tranche.

A vertical slice of size v will then dominate both the equity tranche and the mezzanine tranche (assuming that the equity tranche would be exhausted in the low state) only if

$$v > \max\left[v_{equity}, v_{mezz}\right].$$

This condition suggests that in our setting it is rather unlikely that a vertical slice will dominate both the equity tranche and the mezzanine tranche, unless v represents a relatively high proportion of the portfolio.

[24] Our results can be illustrated in the context of Innes' model as follows. Consider the firm's profit distribution and the optimal (monotonic) debt contract of Innes. Now assume that a systematic risk factor exists and that the current profit distribution is the distribution that would hold in the High state. Suppose, further, that the Low state is severe enough so that the equity the entrepreneur holds will have a zero payoff in this state (i.e., the maximum realisation of profit is too low to repay the investor in full). Then, it is possible to show that having the entrepreneur issue equity instead of debt to the outside investor, with the entrepreneur holding a standard debt contract, may result in a higher level of effort than having the entrepreneur issue a debt contract and retain equity.

We may also ask when the mezzanine tranche would dominate the equity tranche (still assuming that condition LowEx holds). Comparison of the F.O.C.s (10) and (14) reveals that the mezzanine tranche would dominate the equity tranche if

$$p_L \Delta_L > p_H \Delta_H.$$

It is straightforward to verify that this inequality is also implied by the ratio $v_{mezz}/v_{equity} > 1$. Hence, comparison of the values of v_{mezz} and v_{equity} will reveal whether the mezzanine tranche would dominate the equity tranche.

4.2 Numerical examples

Tables 1-3 provide numerical illustrations of important parameters and relationships in our model. We have chosen a set of baseline parameter values and we examine the impact of successively varying some of the parameter choices. Our baseline parameter values are as follows: $p_H = p_L = 0.5$; $\theta = 0.6$; $PD_G(L) = PD_B(H) = 0.05$; $t = 0.15$; $B_1 = (1-t)R$; $B_2 = (1-2t)R$; $B_{mezz} = tR$.

Table 1 illustrates the relationship between equity tranche thickness and the critical effort $\widehat{e}$, below which the equity tranche would be exhausted in the low state. The level of $\widehat{e}$ relative to the maximum level of effort the originator would ever choose gives some indication of the relative likelihood that in equilibrium the equity tranche will be exhausted in the low state.

The table reports the critical value $\widehat{e}$ in the following way. Given that an effort level of 0.4 is the maximum effort level that the originator would ever choose (since $\theta = .6$ in this example, and the originator will never choose an effort greater than $(1-\theta)$), if the value of $\widehat{e}$ exceeds 0.4, we simply report it as 0.4, since any higher value is irrelevant. In the first column of this table, all parameter values are held at their baseline values except equity tranche thickness t. The entries in the first column show that thin tranches (i.e., of thickness less than or equal to 0.05) would result in a value of $\widehat{e} = 0.4$. Thus, very thin equity tranches would generate an outcome where the equity tranche is always exhausted in the low state. As equity tranche thickness increases, the value of $\widehat{e}$ decreases, implying that for choices of effort level high enough, the equity tranche would not be exhausted in the low state. For very thick equity tranches (of 0.43 and higher in our example), the critical effort falls to zero. Hence, for these very thick tranches the equity tranche will never be exhausted in the low state, and the originator's optimal effort will always be the first-best level.

Examination of equation (8), which defines the critical effort $\widehat{e}$, shows that the PD of good borrowers in the low state, $PD_G(L)$, also plays a role in determining $\widehat{e}$. Namely, as $PD_G(L)$ increases, the value of $\widehat{e}$ also increases. An increase in $PD_G(L)$ can be interpreted as an increase in the severity of the low state of the world. (Recall that bad borrowers default with certainty in the low state.) Furthermore, an increase in $PD_G(L)$ translates into a decrease in the difference Δ_L between the PDs of the bad and the good borrowers in this state. In other words, an increase in the severity of the low state will imply that screening effort has less of an "impact", since the PDs of good borrowers are now closer to those of bad borrowers. The diminished impact of screening will imply that more screening effort will now have to be exerted in order for the equity tranche not to be exhausted; i.e., the value of $\widehat{e}$ increases.

Table 1 also illustrates the impact of a change in $PD_G(L)$ on $\widehat{e}$. The rise in $\widehat{e}$ as $PD_G(L)$ increases (subject to the maximum effort level of 0.4) is readily visible. However, the table also illustrates that as $PD_G(L)$ rises, increasingly thicker equity tranches will be needed to ensure that the equity tranche is not always exhausted in the low state; i.e., to ensure that $\widehat{e}$ is less than 0.4. Consider, for example, the baseline values of $t = 0.15$ and $PD_G(L) = 0.05$. These values result in a value of $\widehat{e}$ equal to 0.295. If $PD_G(L)$ is increased to 0.15, then $\widehat{e}$ rises to 0.4. Tranche thickness would have to be increased in order to ensure that there are any effort levels for which the equity tranche would not be exhausted. For instance, increasing tranche thickness from 0.15 to 0.20 would lower the value of $\widehat{e}$ from 0.4 to 0.343.

Table 2 illustrates how the critical values v_{equity} and v_{mezz} change as the probability of the high state, p_H, changes. Table 3 in turn shows the impact of changes in the probabilities $PD_G(L)$ and $PD_B(H)$ on these critical values. These tables can be used to determine when a vertical slice or a mezzanine tranche would dominate the equity tranche, assuming that the baseline equity tranche of 0.15 results in a choice of effort low enough to exhaust the equity tranche in the low state.

In particular, Table 2 indicates that a vertical slice of less than 15 percent will begin to dominate the equity tranche for values of p_L that are rather low. Indeed, for a value of p_L equal to 0.25 ($p_H = 0.75$), a vertical slice of about 13 percent of the portfolio will dominate the equity tranche of 15 percent. On the other hand, the size of the vertical slices needed to dominate a mezzanine tranche of 15 percent are very high for all possible values of p_H and p_L. This implies that only very thick vertical slices would ever dominate both the equity and mezzanine tranches.

We can also examine the ratio v_{mezz}/v_{equity} to determine whether the mezzanine tranche would dominate the equity tranche. Comparison of v_{mezz} and v_{equity} reveals that the mezzanine tranche would dominate the equity tranche for all values of $p_H \leq 0.95$.

Table 3 reports the values of v_{mezz} and v_{equity} as $PD_G(L)$ and $PD_B(H)$ vary. To keep the example tractable, we have set $PD_G(L) = PD_B(H)$. As these values increase, the difference between Δ_L and Δ_H decreases. For example, when $PD_G(L) = PD_B(H) = .05$, $\Delta_L - \Delta_H = .9$, and when $PD_G(L) = PD_B(H) = .5$, $\Delta_L - \Delta_H = 0$. The table also shows that when Δ_L is significantly greater than Δ_H (i.e., when $PD_G(L)$ and $PD_B(H)$ are very low), a very thin vertical slice can dominate the 15 percent equity tranche. When $PD_G(L)$ and $PD_B(H)$ are at their baseline levels of 0.05, then a vertical slice of five percent of the portfolio would dominate the 15 percent equity tranche. On the other hand, when $PD_G(L) = PD_B(H) = .5$, it would take a vertical slice of 50 percent to dominate the equity tranche.

Finally, examination of the value of v_{mezz} in Table 3 reveals that a vertical slice of 15 percent or less would dominate a mezzanine tranche of 15 percent only for very high values of $PD_G(L)$ and $PD_B(H)$. As in Table 2, vertical slices would generally have to be very thick to dominate a mezzanine tranche. With respect to the question of whether a mezzanine tranche would dominate the equity tranche, comparison of the values v_{mezz} and v_{equity} in Table 3 suggests that the equity tranche would dominate only for relatively high values of $PD_G(L)$ and $PD_B(H)$, above 0.5.

These results illustrate that, as the probability of the low state rises and as the impact of screening in the low state (Δ_L) increases, either the vertical slice or the mezzanine tranche becomes more likely to dominate the equity tranche. The more likely is a downturn to occur and the more valuable is screening in the downturn, the less desirable will be equity tranche retention relative to an appropriate share of the portfolio or to the mezzanine tranche (if the equity tranche is likely to be exhausted in the downturn). The more likely is an upturn, the more desirable is equity tranche retention relative to the mezzanine tranche or the share of the portfolio. In this respect, we may say that the equity tranche is an effective "fair weather" device. Thus, we have a seeming paradox: the more likely is screening to be valuable, the less desirable it may be to have the originator hold the equity tranche, or the thicker the equity tranche must be in order for adequate screening incentives to be created.

5 Originator's choice of retention mechanism

In this section, we examine the originator's choice of retention mechanism. The aim is to determine whether the originator would ever choose a mechanism that would yield a level of screening effort below the first-best level.

This is important, in that to the extent that the originator would prefer retention mechanisms that lead to low levels of effort, there may be a role for regulation to play in restricting the choice of mechanisms.

As discussed in Section 3, the value Ω of monetary benefits of securitisation is assumed to vary across institutions and instruments. In particular, because of the indirect ("private") benefits linked to factors such as capital savings or compensation schemes, the value of Ω can be expected to increase as more of the portfolio is securitised (i.e. as the retained portion of the securitisation diminishes).

For example, holding less of the loan portfolio on balance sheet frees up capital, which can be re-employed in other activities. This adds to the direct benefits the originator obtains from the cash generated by the securitisation. Another possible source of indirect benfits is related to the design of compensation schemes. If the compensation of managers is linked to short-term profits (or revenues), then managers may prefer securitisation over loans held on balance sheet, due to differences in the accounting or regulatory treatment of securitisations versus loans. Securitisations typically involve front-loaded recognition of revenues, including origination fees, while similar revenues for loans held on balance sheet are typically recognized over the life of the loan.[25] This may thus provide an impetus to securitise and to minimise retention.[26]

For these reasons, the value the originator attributes to Ω is assumed to be higher for full securitisation of the portfolio than for a transaction where the originator retains a portion of the securitised assets, but in ways that will depend on the nature of the securitising institution, the type of assets in the collateral pool and the design of the securitisation.

Our analysis proceeds as follows. We define a "thick" equity tranche as a tranche with a thickness sufficient to give rise to the first-best effort e_p from Section 3. (In other words, a thick equity tranche yields an outcome that corresponds to Case E2 considered in Section 3.4.) Similarly, we define a "thin" equity tranche as a tranche which gives rise to an effort $e_{eq} < e_p$ (or an outcome corresponding to Case E1 in Section 3.4).

We first note that, given that cash from securitisation has greater value than cash paid at maturity of the loan portfolio and given that the originator's effort with a thick equity tranche is the same as when it holds the entire loan portfolio on balance sheet, the originator will always prefer se-

[25] See, for example, the discussion in Goldman Sachs (2009).

[26] Even within a given institution, the value of generating benefits through securitisation (and, therefore, the incentive to securitise loans) can vary as a result of the accounting and regulatory rules applied at the departmental level (e.g., investment banking versus commercial banking division) or as a result of the compensation schemes of the individuals making the lending or securitisation decisions.

curitisation with a thick equity tranche to holding the portfolio on balance sheet. What must be determined is whether the originator would ever prefer securitisation of the entire portfolio to securitisation with a thin equity tranche or securitisation with a thin equity tranche to securitisation with a thick equity tranche. If the answer to either of these questions is yes, then there is a potential role for regulation.[27]

In order to answer these questions, we proceed as follows. We first identify the originator's preferred tranche thickness among all "thick" equity tranches, then the originator's preferred tranche thickness among all "thin" equity tranches. We then compare the originator's profit when it holds the preferred thick tranche versus the profit with the preferred thin tranche. Finally, we compare the originator's profit with the preferred thin tranche to the profit with securitisation of the entire portfolio.

5.1 Optimal tranche thickness for a thick equity tranche

Suppose that the originator is constrained to hold an equity tranche with sufficient thickness so that the tranche will not be exhausted in the Low state; i.e. such that Case E2 from Section 3.4 will hold in equilibrium and the originator will choose the first-best effort e_p. Given that the monetary benefit of a unit of cash from securitisation is greater than one, the originator will want to securitise as much (i.e., to retain as little) as possible. Therefore, the optimal tranche thickness for the originator will be the lowest thickness (i.e., the thinnest tranche) for which effort e_p is still optimal. In addition, given any tranche thickness t, the originator has an interest in promising the mezzanine and senior tranche investors as high a payment as possible (within the confines of the definition of the equity tranche). This, too, helps to maximise cash from securitisation. The maximum amount B_1 that can be promised to the mezzanine and senior investors when the originator holds the equity tranche with thickness t will be the amount $R(1-t)$.

Denote the originator's preferred thickness of a thick equity tranche by t^T. We can find the value of t^T as follows. Recall from our discussion of the condition LowEx in Section 3.4 that for any given tranche thickness t, a

[27]Note that, in order to determine whether the originator would ever prefer a mechanism that yields less than first-best effort to holding the thick equity tranche (and therefore whether there is a rationale for regulatory intervention), it is sufficient to show that there are situations in which the originator would choose either securitisation of the entire portfolio or securitisation with a thin equity tranche. It is not necessary in addition to consider the mezzanine tranche or a vertical slice, since both of these mechanisms yield levels of effort below first-best.

critical effort level $\widehat{e}(t)$ can be defined by

$$(1 - PD_G(L))R\alpha_G(\widehat{e}(t)) - R(1-t) = 0. \tag{16}$$

For any effort $e \leq \widehat{e}(t)$ condition LowEx will hold and the originator's optimal effort will be below the first-best level of e_p, while for any effort $e > \widehat{e}(t)$, condition LowEx will not hold and effort will be e_p. As discussed in Section 3.4, the value of $c'(\widehat{e})$ will determine whether the effort chosen by the originator with the tranche t will be higher or lower than $\widehat{e}$.

Consider a tranche thickness $\widetilde{t}$ such that

$$c'(\widehat{e}(\widetilde{t})) = R\left[p_L\Delta_L + p_H\Delta_H\right].$$

The fact that $c'(\widehat{e}(\widetilde{t}))$ just equals $R\left[p_L\Delta_L + p_H\Delta_H\right]$ implies that $\widehat{e}(\widetilde{t}) = e_p$ and suggests that the originator's optimal effort with an equity tranche of thickness $\widetilde{t}$ will be e_p. However, given that $e_p = \widehat{e}(\widetilde{t})$ and by the definition of $\widehat{e}$, we know that the equity tranche holder can never expect to receive any income in the Low state if the effort chosen is $\widehat{e}$. So, with a level of effort e_p in this case, the originator will only have a positive payout in the High state, and its expected profit with the equity tranche $\widetilde{t}$ and an effort of e_p would be

$$p_H\left\{R\alpha_G(e_p) + (1 - PD_B(H))R\alpha_B(e_p) - R(1-\widetilde{t})\right\} - c(e_p),$$

which can be reexpressed as

$$p_H\left[R - R\Delta_H \cdot \alpha_B(e_p)\right] - p_H R(1-\widetilde{t}) - c(e_p).$$

As in Section 3.4, define e_{eq} such that $c'(e_{eq}) = p_H\Delta_H R$. The effort e_{eq} is the optimal effort choice when the equity tranche is exhausted in the Low state but recieves a positive payout in the High state. By the definition of e_{eq}, therefore, we know that the value of the above expression would be higher with an effort level of e_{eq} than with e_p (or higher with $e = 0$ if $R\alpha_G(e_{eq}) + (1 - PD_B(H))(R\alpha_B(e_{eq})) - R(1-\widetilde{t}) < 0$). Assume the former, so that e_{eq} would be the optimal effort in this case. In other words,

$$\begin{aligned}
& p_H\left\{R\alpha_G(e_{eq}) + (1 - PD_B(H))R\alpha_B(e_{eq}) - R(1-\widetilde{t})\right\} - c(e_{eq}) \\
> \; & p_H\left\{R\alpha_G(e_p) + (1 - PD_B(H))R\alpha_B(e_p) - R(1-\widetilde{t})\right\} - c(e_p) \\
= \; & p_L\left\{(1 - PD_G(L))R\alpha_G(e_p) - R(1-\widetilde{t})\right\} \\
& + p_H\left\{R\alpha_G(e_p) + (1 - PD_B(H))R\alpha_B(e_p) - R(1-\widetilde{t})\right\} - c(e_p).
\end{aligned}$$

The above inequality shows that $\widetilde{t}$ is not a tranche thickness that yields e_p as the optimal effort. Hence, this tranche is too thin to qualify as a "thick" tranche. In order to find the thinnest tranche that can be classified as a "thick" tranche (i.e., the preferred tranche thickness t^T), we need to increase tranche thickness above $\widetilde{t}$ (i.e., reduce promised payment below $R(1-\widetilde{t})$), to the point where the originator has the incentive to actually choose effort e_p. It suffices to increase tranche thickness to the point where the originator is just indifferent between choosing e_{eq} and e_p.

To see thisn, note that any value of $t > \widetilde{t}$, $\widehat{e}(t) < \widehat{e}(\widetilde{t})$; hence, $c'(\widehat{e}(t)) < c'(\widehat{e}(\widetilde{t})) = R\left[p_L \Delta_L + p_H \Delta_H\right]$. The minimum thickness such that the originator would just be indifferent between choosing e_{eq} and e_p will be the value t^T such that

$$\begin{aligned}
& p_H \left\{R\alpha_G(e_{eq}) + (1 - PD_B(H))R\alpha_B(e_{eq}) - R(1-t^T)\right\} - c(e_{eq}) \\
= \; & p_L \left\{(1 - PD_G(L))R\alpha_G(e_p)\right\} \\
& + p_H \left\{R\alpha_G(e_p) + (1 - PD_B(H))R\alpha_B(e_p)\right\} - R(1-t^T) - c(e_p).
\end{aligned}$$

The tranche thickness t^T thus represents the preferred "thick" tranche for the originator.

To simplify notation, denote $p_H \left\{R\alpha_G(e) + (1 - PD_B(H))R\alpha_B(e)\right\}$ by $p_H \{e\}$. (In other words, $p_H \{e\}$ represents the cash flow from the portfolio in the High state when the originator chooses an effort level of e.) Similarly, denote $p_L \{1 - PD_G(L))R\alpha_G(e)\}$ by $p_L \{e\}$. Then we can rewrite the expression for the optimal thickness t^T as follows:

$$p_L \{e_p\} + p_H \{e_p\} - R(1-t^T) - c(e_p) = p_H \{e_{eq}\} - p_H R(1-t^T) - c(e_{eq}). \quad (17)$$

This expression will be useful in the comparison of the originator's profit with the preferred thick tranche versus the preferred thin tranche.

5.2 Optimal tranche thickness for a thin equity tranche

Suppose now that the originator is constrained to hold an equity tranche which is sufficiently thin so that the tranche will be exhausted in the Low state; (i.e., so that Case E1 from Section 3.4 holds) and the effort will be $e_{eq} < e_p$. As before, given the monetary benefits of securitisation the originator will want to securitise as much as possible; therefore, the preferred "thin" tranche will be the thinnest tranche for which effort e_{eq} is optimal. In order to find this tranche, first consider a tranche thickness t^* such that

$$R\alpha_G(e_{eq}) + (1 - PD_B(H))R\alpha_B(e_{eq}) = R(1-t^*).$$

The tranche t^* is so thin that the expected cash flow from the loan portfolio in the High state, even with an effort e_{eq}, is just sufficient to cover the promised payment to the senior tranche holders. In this case, the payoff to the equity tranche will be zero in both the Low and the High states; therefore, the originator's profit with the equity tranche t^* would actually be $-c(e_{eq})$. In this case, the originator would choose an effort of zero. Hence, the equity tranche t^* is too thin to elicit positive effort by the originator.

In order to find the preferred tranche thickness among thin tranches, we must increase tranche thickness above t^* to the point where the originator is just indifferent between exerting zero effort and the effort e_{eq}. This tranche thickness is given by t^t such that

$$p_H \left\{ R\alpha_G(e_{eq}) + (1 - PD_B(H))R\alpha_B(e_{eq}) \right\} - p_H R(1 - t^t) - c(e_{eq}) = 0$$

or

$$p_H \left\{ e_{eq} \right\} - c(e_{eq}) = p_H R(1 - t^t). \tag{18}$$

5.3 Comparison of the originator's payoff with the optimal thin and thick equity tranches

Now that we have found the preferred thicknesses among all "thick" and all "thin" tranches for the originator, we can identify whether the originator would prefer retention of a thin tranche or a thick tranche by comparing the originator's profit with the preferred thin tranche and the preferred thick tranche. Define Ω^T as the value to the originator of generating cash through securitisation where the orignator holds a thick equity tranche. The originator's expected profit with the preferred thick equity tranche will be

$$\Omega^T R(1 - t^T) + p_L \left\{ e_p \right\} + p_H \left\{ e_p \right\} - R(1 - t^T) - c(e_p).$$

Let Ω^t be the value of securitisation benefits with a thin equity tranche. In accordance with our discussion of the differences in Ω across instruments, we assume that $\Omega^t > \Omega^T$. The originator's expected profit with the optimal thin equity tranche will be

$$\Omega^t p_L \left\{ e_{eq} \right\} + \Omega^t p_H R(1 - t^t) + p_H \left\{ e_{eq} \right\} - p_H R(1 - t^t) - c(e_{eq}).$$

These two expressions illustrate the potential trade-offs in choosing between the thick tranche and the thin tranche. All else equal (i.e., given some fixed level of effort e), the thin tranche will generate more cash, since the originator retains a smaller proportion of the portfollio with the thin than with the thick tranche. In addition, the thin tranche yields higher total monetary benefits for each unit of cash earned through securitisation than does the thick tranche, which further reinforces the advantage of the thin tranche.

However, the originator will not choose the same effort with each retention mechanism: a higher level of effort will be chosen with the thick tranche than the thin tranche. The higher effort level with the thick tranche will result in higher expected cash flows from the loan portfolio, which will increase cash earned from securitisation. The thick tranche will yield greater profit for the originator if the higher cash flows due to the higher effort are sufficient to compensate for the higher monetary benefits generated from the thin tranche, all else equal.

The originator will prefer the thick tranche if the profit with the thick tranche is higher (i.e., if the following expression is positive).

$$\begin{aligned} &\Omega^T R(1-t^T) - \Omega^t p_L \{e_{eq}\} - \Omega^t p_H R(1-t^t) \\ &+p_L \{e_p\} + p_H \{e_p\} - R(1-t^T) - c(e_p) \\ &-p_H \{e_{eq}\} + p_H R(1-t^t) + c(e_{eq}) \end{aligned} \tag{19}$$

By Eqn. (18), the third line of (19) equals zero. We can also use Eqn. (17) to rewrite the second line of (19):

$$\begin{aligned} &\Omega^T R(1-t^T) - \Omega^t p_L \{e_{eq}\} - \Omega^t p_H R(1-t^t) \\ &+p_H \{e_{eq}\} - p_H R(1-t^T) - c(e_{eq}). \end{aligned}$$

Using (18) and rearranging gives

$$\begin{aligned} &\Omega^T p_L R(1-t^T) - \Omega^t p_L \{e_{eq}\} \\ &+(1-\Omega^t)\left[p_H R(1-t^t)\right] - p_H R(1-t^T) \end{aligned} \tag{20}$$

The second line of (20) is negative for all values of $\Omega^t > 1$. With respect to the first line of (20), it is straightforward to show, by using (17), that $p_L R(1-t^T) > p_L \{e_{eq}\}$; therefore, the first line will also become negative for a high enough difference in the values of Ω^t and Ω^T. So, for a value of Ω^t high enough relative to Ω^T, the originator will prefer the thin equity tranche to the thick equity tranche.[28]

5.4 Comparison of optimal thin equity tranche with full securitisation of portfolio

Let Ω^f be the value of Ω when the full portfolio is securitised; i.e., when none of the securitisation is retained. The originator will prefer the thin equity

[28] It can be shown that for values of Ω^T and Ω^t close to one, the thick tranche dominates the thin tranche.

tranche to full securitisation of the portfolio if the difference in profit between these two options is positive, or if

$$\Omega^t p_L \{e_{eq}\} + \Omega^t p_H R(1-t^t) + p_H \{e_{eq}\} - p_H R(1-t^t) - c(e_{eq})$$
$$-\Omega^f \{p_L \{0\} + p_H \{0\}\} > 0. \tag{21}$$

Eqn. (17) implies that $p_H \{e_{eq}\} - p_H R(1-t^t) - c(e_{eq}) = 0$; therefore, the above inequality will hold if

$$\Omega^t p_L \{e_{eq}\} + \Omega^t p_H R(1-t^t) - \Omega^f \{p_L \{0\} + p_H \{0\}\} > 0.$$

which can be rewritten as

$$\Omega^t p_L \{e_{eq}\} - \Omega^f p_L \{0\} + \Omega^t p_H R(1-t^t) - \Omega^f p_H \{0\} > 0. \tag{22}$$

We observe that $p_L \{e_{eq}\} > p_L \{0\}$. If we can show that $p_H R(1-t^t) > p_H \{0\}$, then we can conclude that (22) holds for a small difference between Ω^f and Ω^t; however, for a difference $\Omega^f - \Omega^t$ high enough, the inequality will no longer hold, and the originator will prefer full securitisation to the thin equity tranche.

Claim: $p_H R(1-t^t) > p_H \{0\}$.

Proof: Suppose that $p_H R(1-t^t) \leq p_H \{0\}$. Then, by Eqn. (17),

$$p_H \{e_{eq}\} - c(e_{eq}) \leq p_H \{0\}$$

or

$$p_H \{e_{eq}\} - p_H \{0\} \leq c(e_{eq}). \tag{23}$$

Straightforward algebra shows that $p_H \{e_{eq}\} - p_H \{0\} = p_H R \Delta_H \cdot e_{eq}$. Using this in the above inequality gives

$$p_H R \Delta_H \cdot e_{eq} \leq c(e_{eq}).$$

However, the convexity of the cost function $c(\cdot)$, together with the fact that $c'(e_{eq}) = p_H R \Delta_H$, implies that $c(e_{eq}) < p_H R \Delta_H \cdot e_{eq}$. Hence, the assumption that $p_H R(1-t^t) \leq p_H \{0\}$ leads to a contradiction. Q.E.D.

The fact that the originator may choose to hold a thin equity tranche rather than a thick equity tranche, or to undertake full securitisation of the portfolio rather than holding a thin equity tranche, demonstrates that in the absence of any constraints on the originator's choice, retention mechanisms may be chosen that lead to effort levels below the first-best level. This provides a potential rationale for regulation.

6 Conclusion

Proper alignment of incentives in securitisation is likely to remain of key interest in the coming years for market practitioners, policy makers, and academics alike, as markets struggle to recover from the fallout of the financial crisis. With incentives now under increased scrutiny, it is likely that practitioners and regulators will demand that originating institutions retain some exposure to the assets that they securitise, or demand disclosure about such retentions, in order to help align their incentives with those of investors. It is important to note that this is not a new development. In the past, originators often retained subordinated classes of securitised asset pools, while facing the risk that investors might shy away from their loans if these were deemed to be underwritten with lower standards than those of their competitors. Retention practices, however, have changed across market segments and time, and disclosures about those retentions have been informal at best, limiting the availability and reliability of such information.

Importantly, tranche retention does not in and of itself assure that the associated risk exposures are going to be retained. To the extent that liquid secondary or derivatives markets exist, originators may be able (basis and counterparty risk aside) to hedge part or all of the exposure from retained tranches, or to sell these tranches altogether.[29] This, then, can undermine the incentive alignment that proponents of tranche retention are seeking, unless reputation effects or warehouse risk (i.e., the risk from retention of exposures until they are sold or hedged) act in a counterbalancing fashion. As a result, it may be desirable to keep any retention requirements flexible or simply require disclosure of all relevant information regarding retention (e.g., size and position in the capital structure as well as any changes over time), possibly combined with a third-party mechanism to validate such disclosures.

Keeping all this in mind, the model presented in this paper suggests that retention of a stake in the securitisation is likely to improve the incentives of those who are originating to-be-securitised assets or who are arranging securitisations. Retention may thus represent a viable option to help restart depressed securitisation markets. However, if the choice of how much to retain and in what form is left up to the originator, the retention mechanism chosen may well lead to suboptimal screening effort. Whether or not retention should be imposed by regulators or be left for the markets to sort out is, nevertheless, a question that cannot be directly answered with our simple model. Yet, what the model can do is to alert those supporting tranche reten-

[29] Note that the amended European Capital Requirements Directive will require that retained positions be maintained on an ongoing basis, i.e. without being "subject to credit risk mitigation, short positions or other hedge"; see European Parliament (2009).

tion that care must be taken in designing such retention schemes. Wrongly designed retention requirements can inadvertently destroy the economics of securitisations, at least in some market segments, which would further depress (rather then restart) activity in these markets. Again, this is an issue that we do not address directly. However, we do show that the "dominant" form of retention (i.e., the form yielding the highest screening effort) is likely to depend crucially on the specific nature and characteristics of the securitisation in question, as well as the state of the credit cycle. In other words, there is no "one-size-fits-all" solution to tranche retention.[30]

Allowing investigation of some of the key factors driving tranche dominance, our model suggests a number of simple "rules of thumb": First, equity tranche retention is not necessarily the most effective way to align incentives. Retention mechanisms such as a mezzanine tranche or a vertical slice of the portfolio can in some conditions generate higher screening effort. Second, in order for equity tranche retention to be likely to dominate the retention of other tranches, the equity tranche needs to be relatively unlikely (across various levels of screening effort) to be completely depleted in unfavourable states of nature; i.e., in downturns. Third, in order for this to be the case, equity tranches need to be relatively thick and the probability of favourable states of nature needs to be relatively high. Consequently, equity tranches might be dominated by other retention schemes in economic downturns—a reflection of the "fair weather" feature of the equity tranche discussed in the previous sections. Finally, although a vertical slice may dominate either the equity tranche or the mezzanine tranche, it is unlikely that a vertical slice will dominate both of these alternatives unless the vertical slice is very thick.[31]

While our analysis has considered a range of realistic retention schemes, we have not dealt with certain possibilities, such as covered bonds or representations and warranties. Since covered bond exposures remain on balance sheet and since the originator must use its other assets to cover any shortfalls in promised cash flows from the covered bond exposures to outside investors, the originator's screening effort with covered bonds should be identical to its

[30] This result is important, as much of the existing literature on tranche retention (by both academics and industry) has focused almost exclusively on retention or disclosure schemes based on the equity tranche. See, for example, FitchRatings (2008) and Moody's (2008) for industry examples, in addition to the academic papers mentioned in Section 2.

[31] One of the motivations for the proposal of a vertical slice is to balance the originator's interests with those of investors across all tranches. Investors in different tranches do indeed have conflicting interests in certain dimensions. For example, equity tranche holders prefer assets with higher default correlations and more backloaded default profiles than do senior tranche holders. We nevertheless believe that these conflicts are likely to be of second-order importance relative to the determinants of overall asset pool quality, which is the focus of our model.

effort if it were to hold its loans on balance sheet. At the same time, using covered bonds allows the institution to generate some up-front cash, although the ultimate amount generated would depend upon regulatory (capital and other) requirements linked to covered bond issuance. We would expect that covered bonds (given the lack of credit risk transfer) would be more likely to be used by institutions with relatively low values of the "securitisation value" parameter Omega, as the indirect monetary benefits from covered bonds are likely to be lower than those from other securitisation mechanisms.

Representations and warranties, which can include promises to repurchase loans in default, are likely to have an effect that is similar to that of having the originator hold an equity tranche, since the originator bears the default risk on a certain proportion of the loans. One difference, however, is that representations and warranties introduce counterparty risk, which investors do not face when the originator actually holds the equity tranche. This may discourage investors from accepting representations and warranties in lieu of equity tranche retention by the originator.

Finally, retention mechanisms – even when supported by mandatory disclosure requirements – may not be sufficient to guarantee that incentives are aligned along the securitisation chain. As illustrated by our parameter Omega, which captures the monetary benefits of securitisation for the originator, a host of factors can influence the economics of securitisation from the originator's perspective. Accounting and regulatory features of securitisation, together with remuneration systems in financial institutions, have tended to generate "indirect benefits" to securitisation (going beyond those related to funding) relative to holding loans on balance sheet. These indirect benefits are often "private" rather than "social" and can encourage originators to favour mechanisms with low (or zero) amounts of retention in order to maximise these private benefits.

On this basis, our model provides some indirect support for initiatives that are currently under discussion to modify banks' remuneration systems and to adjust regulatory and accounting measures that have the effect of making securitisation artificially more attractive than other sources of funding. This could include, for example, changes to accounting standards that would eliminate immediate recognition of gain on sale by originators at the inception of securitised instruments. Similarly, capital regulation might be adjusted to cover all originating institutions and to grant capital relief to originators only to the extent that true third-party risk transfer has taken place, for instance, reducing incentives to "sell" securitisations to vehicles such as SIVs with their implicit recourse to originators.

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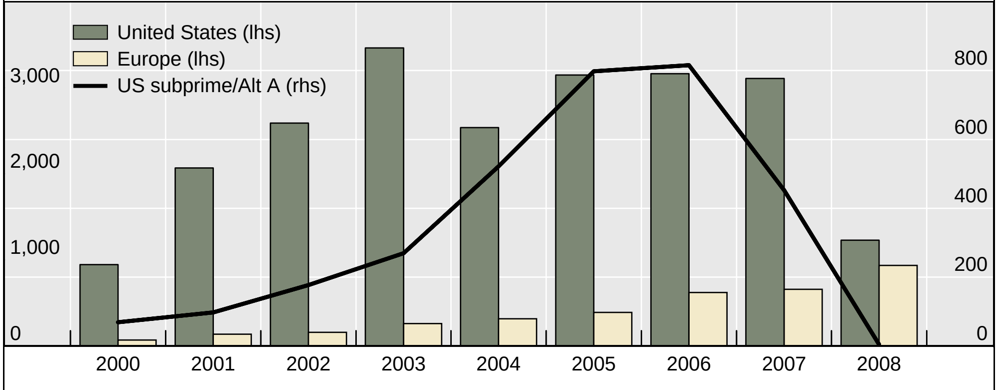
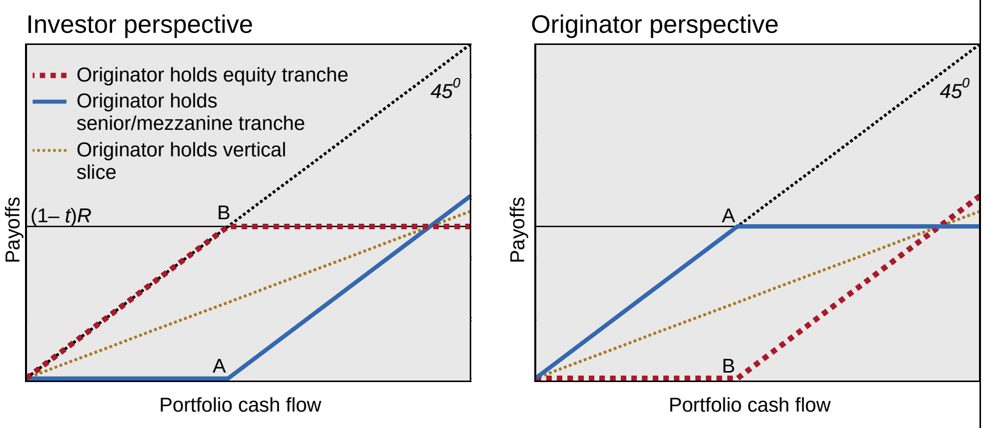
European and US securitisation volume

In billions of US dollars



Sources: SIFMA; UBS. Graph 1

Retention mechanisms: payoff profiles



Source: Authors. Graph 2

Table 1: Numerical examples—critical levels of effort (e)

Baseline results for different combinations of tranche width (t) and probabilities of default ($PD_G(L) = PD_B(H)$), keeping all other assumptions unchanged[1,2]

Tranche width	Probability of default: $PD_G(L) = PD_B(H)$				
	0.05	**0.15**	**0.25**	**0.35**	**0.45**
0.01	0.400	0.400	0.400	0.400	0.400
0.05	0.400	0.400	0.400	0.400	0.400
0.10	0.348	0.400	0.400	0.400	0.400
0.15	0.295	0.400	0.400	0.400	0.400
0.20	0.243	0.343	0.400	0.400	0.400
0.25	0.190	0.283	0.400	0.400	0.400
0.30	0.138	0.225	0.335	0.400	0.400
0.35	0.085	0.165	0.268	0.400	0.400
0.40	0.033	0.108	0.200	0.325	0.400
0.45	0.000	0.048	0.135	0.248	0.400

[1] Baseline assumptions: $p_H = (1 - p_L) = 0.5$; $\theta = 0.6$; $PD_G(L) = PD_B(H) = 0.05$; $PD_G(H) = 0$; $PD_B(L) = 1$; $B_1 = (1 - t)R$; $B_2 = (1 – 2t)R$; $B_{mezz} = tR$; and $t = 0.15$. [2] Numerical results for the critical (highest) effort level e at which the equity tranche is going to be exhausted in the low state of the world (ie, for which condition **LowEx** is just going to hold), given different values of tranche width.

Table 2: Numerical examples—critical values of v_{equity} and v_{mezz}

Baseline results for different state probabilities (p_H = 1 - p_L), keeping all other assumptions unchanged[1]

Probability p_H	v_{equity}[2]	v_{mezz}[2]	**Probability p_H**	v_{equity}[2]	v_{mezz}[2]
0.01	0.001	0.999	**0.50**	0.050	0.950
0.05	0.003	0.997	**0.55**	0.060	0.940
0.10	0.006	0.994	**0.60**	0.073	0.927
0.15	0.009	0.991	**0.65**	0.089	0.911
0.20	0.013	0.987	**0.70**	0.109	0.891
0.25	0.017	0.983	**0.75**	0.136	0.864
0.30	0.022	0.978	**0.80**	0.174	0.826
0.35	0.028	0.972	**0.85**	0.230	0.770
0.40	0.034	0.966	**0.90**	0.321	0.679
0.45	0.041	0.959	**0.95**	0.500	0.500

[1] Baseline assumptions: $p_H = (1 - p_L) = 0.5$; $\theta = 0.6$; $PD_G(L) = PD_B(H) = 0.05$; $PD_G(H) = 0$; $PD_B(L) = 1$; $B_1 = (1 - t)R$; $B_2 = (1 - 2t)R$; $B_{mezz} = tR$; and $t = 0.15$. [2] Numerical results for the critical (highest) level of vertical slice size v at which the equity/mezzanine tranche is not going to be dominated by a vertical slice of size v.

Table 3: Numerical examples—critical values of v_{equity} and v_{mezz}

Baseline results for different probabilities of default ($PD_G(L) = PD_B(H)$), keeping all other assumptions unchanged[1,2]

$PD_G(L) = PD_B(H)$	v_{equity}[3]	v_{mezz}[3]	**$PD_G(L) = PD_B(H)$**	v_{equity}[3]	v_{mezz}[3]
0.01	0.01	0.99	**0.50**	0.50	0.50
0.05	0.05	0.95	**0.55**	0.55	0.45
0.10	0.10	0.90	**0.60**	0.60	0.40
0.15	0.15	0.85	**0.65**	0.65	0.35
0.20	0.20	0.80	**0.70**	0.70	0.30
0.25	0.25	0.75	**0.75**	0.75	0.25
0.30	0.30	0.70	**0.80**	0.80	0.20
0.35	0.35	0.65	**0.85**	0.85	0.15
0.40	0.40	0.60	**0.90**	0.90	0.10
0.45	0.45	0.55	**0.95**	0.95	0.05

[1] Baseline assumptions: $p_H = (1 - p_L) = 0.5$; $\theta = 0.6$; $PD_G(L) = PD_B(H) = 0.05$; $PD_G(H) = 0$; $PD_B(L) = 1$; $B_1 = (1 - t)R$; $B_2 = (1 – 2t)R$; $B_{mezz} = tR$; and $t = 0.15$. [2] As $PD_G(L) = PD_B(H)$ rises, the difference of Δ_L and Δ_H will decline monotonically. [3] Numerical results for the critical (highest) level of v at which the equity/mezzanine tranche is not going to be dominated by a vertical slice of size v.