How much to retain? Theory and Evidence From Structured Finance Transactions

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Abstract

This paper presents a moral hazard problem between a loan originating bank and outside investors in the context of systemic risk. The bank can extend loans to individual borrowers and has the option to create a structured product based on the loan portfolio. Contrary to traditional moral hazard models, we introduce accounting related frictions and allow the bank to value upfront payments relating to the sale of more senior tranches at a premium to its notional amount. It turns out that most of the time equity tranche retention generates the highest possible screening level but at the same time profits might be maximized under mezzanine tranche retention due to the otherwise high loan screening costs and capital charges. Furthermore, in case of a bright economic outlook, banks would prefer mezzanine tranche retention although effort levels are clearly below those implied by retaining the first loss piece. As a regulator it is thus important to have a good estimate of both loan screening and opportunity costs as well as the economic outlook before giving active policy advice. Finally, empirical evidence shows that average retention rates since 2001 equal 1.5% but fell by roughly one third in the years preceeding the outbreak of the financial crisis. Investigating the determinants of the retention decision, we find that deal complexity and retention are positively related.

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1 Introduction

In the aftermath of the global financial crisis, both the U.S. Government and the European Union Parliament have been pushing to force securitizers to retain economic exposure in securitized assets in order to better align their interests with those of investors. As a first step, the United States have signed the Dodd-Frank Bill into law in June 2010 which forsees at least a 5 percent retention rate for the sale of asset backed securities. While the bill provides some guideline on how to force securitizers to retain skin in the game, it still leaves some open questions regarding the preferred form of the actual retention decision.

Fender and Mitchell (2009) build a moral hazard model in the spirit of Innes (1990) in which a loan originating institution can extend loans to borrowers and then has the option of securitizing the loan portfolio by selling different tranches to individual investors. While the initial proportion of "good" and "bad" borrowers is given exogenously, the originator can exert costly screening effort before the loan is made to increase his expected return. Because the setup includes a systemic risk component, debt financing is not necessarily the optimal contract - a result which has been also found in Chiesa (2008). Specifically, the optimality of debt depends on the systemic outlook, the quality of the loan pool, idiosyncratic default probabilities and on how much credit exposure the loan originating institution retains.

This paper compares the benefits and drawbacks of both equity and mezzanine retention and thereby contributes to recent public discussions and academic research on two fronts. First, contrary to existing moral hazard models we specifically introduce accounting related frictions into the principal agent problem. Specifically, we allow the bank to maximize expected profits by choosing both the optimal amount of loan screening as well as the optimal retention size. The actual retention decision is driven by a tradeoff between accounting related benefits of securitization and both capital charges and adverse selection costs. Results show that most of the time equity retention best incentivizes diligent loan screening but at the same time a profit maximizing bank is likely to retain the mezzanine tranche due to lower loan screening and capital costs. The negative effect of capital charges gets exacerbated the higher the promised return on a loan because of the higher opportunity costs of retaining funds. Also, in case the economic outlook is positive, mezzanine retention would be the preferred choice although the level of screening effort is clearly below the one implied by equity retention. Thus, policymakers need a good estimate of potential screening and opportunity costs before designing any regulation because otherwise they run the danger of shutting down securitization markets. Besides, retention advice should be given contingent on the state of the economy. Second, using a dataset of more than 18,000 structured finance transactions provided by Dealogic, we empirically investigate how much

credit exposure was actually retained. It turns out that average retention rates since 2001 equal 1.5% but fell by approximately one third in the years preceeding the financial crisis. Deals securitzed with Residential Mortages involve the lowest retention rates whereas for Auto Loans retention rates are highest. Finally, we find that deal complexity and retention are positively related.

This paper relates to literature dealing with the interaction between credit risk transfer (CRT) and moral hazard. Keys et al. (2010) investigate whether securitization lead to lax screening and show that conditional on being securitized, there is a positive relation between the ease of securitization and observed defaults. From a theoretical perspective, this paper is most closely related to Innes (1990) and Fender and Mitchell (2009). Innes (1990) models a principal-agent problem between a risk-neutral entrepreneur with access to an investment project who makes an unobservable effort choice influencing the probability of success and an outside investor who provides the necessary funding for the project. Given limited liability of the entrepreneur, Innes (1990) shows that debt financing is the optimal contract in the context of unobservable and noncontractable effort choice. Chiesa (2008) models a loan originating bank which needs outside financing and extends the setup to allow for a systemic risk component. Because a high return does not necessarily mean that the bank has engaged in monitoring but instead can be the result of a favorable realization of the systemic risk factor, Chiesa (2008) is able to show that a pure debt contract is not optimal whereas CRT with limited credit enhancements enhances loan monitoring and expands financial intermediation. Fender and Mitchell (2009) adapt their setting to the case of asset securitization and develop a simple screening model in which a loan originating institution can screen borrowers, for a cost, and has the option to securitize its loan portfolio. Using a dynamic model, Hartman-Glaser et al. (2010) focus on the optimal contract for mortgage backed securities beween an originator and outside investors. Under some assumptions, they are able to show that the optimal contract consists of a one time payment to the originator after having a observed a default-free waiting period.

More generally, the paper also relates to the literature on informational asymmetries. The "lemons problem", as coined by Akerlof (1970), shows that markets may break down in the context of informational asymmetries. Leland and Pyle (1977) use a signaling model to show how agency costs can be mitigated in the context of a partial firm sale. They model an entrepreneur with superior information regarding future prospects of assets in place who wants to sell part of his holdings to diversify risk. The entrepreneur can signal quality by retaining a larger fraction of the asset and thereby mitigate the agency problem. Gorton and Pennacchi (1995) focus on the subsequent adverse selection problem a bank faces if it engages in loan sales. However, they show that implicit contract features such as the retention of part of the loan and or implicit guarantees against default can make loan sales possible and

thereby reduce agency problems. Focusing on CRT mechanisms, Morrison (2005) shows that credit derivatives may destroy the signaling value of debt and thereby cause disintermediation and lower welfare. On the other hand, Niccolo and Pelizzon (2006) demonstrate that even in the context of credit risk transfer, banks may signal their own types by using first-to-default contracts. Also, DeMarzo (2005) shows that if assets are not only pooled but also tranched into different risk categories, banks can signal the quality of the sold loan portfolio by retaining interest in the equity tranche, thereby confirming optimality of a (standard) debt contract.

The paper proceeds as follows. Section [2] introduces the model and Section [**??**] presents some numerical examples. Section [4] investigates how much credit exposure has been retained in structured product transactions and it also analyzes the main empirical determinants of the retention decision. Section [5] concludes and elaborates on the main policy implications.

2 Optimal Retention and Screening Policy

Similar to Fender and Mitchell (2009), we model a bank which extends loans to borrowers for the total amount of Z and which then has the option of securitizing the loan portfolio and selling different tranches to individual investors.[1] Outside investors and the bank are assumed to be risk-neutral and the risk-free interest rate is set to zero. A performing loan returns $R > 1$ while there is zero recovery for a defaulting loan.

The simplified economy consists of a continuum of good and bad borrowers who differ in their ability to repay the loan. The proportion of "good" borrowers is captured by the parameter θ which is given exogenously. The bank can exert costly screening effort e to increase the probability of lending to a good quality borrower. Denoting α_G and α_B as the revised probabilities of lending to good and bad borrowers, we can see that

$$\alpha_G(e) \quad = \quad (\theta + e) \tag{1}$$

$$\alpha_B(e) \quad = \quad (1 - \theta - e) \tag{2}$$

Screening borrowers is costly, which is captured by the cost function $c(e)$ which is assumed to be increasing in e and convex, i.e. $c(0) = 0$, $c'(e) > 0$ and $c''(e) > 0$. Similar to Carletti (2004) and Duffie (2008), we assume a quadratic cost function, i.e. we set $c(e) = \frac{\phi}{2}e^2$ to account for the convexity in effort costs. It is further assumed that at the time when the loans are extended, the originator has already decided if and in what form the loan portfolio will be securitized. Effort level is chosen accordingly and then different tranches of the portfolio are sold to outside investors. Outside investors are only willing to make payments equal to the expected value of future cash flows conditional on the optimal effort level of the originator.

Finally, following Chiesa (2008) and Fender and Mitchell (2009) we introduce a systemic risk factor and assume that the economy can be either in a high or a low state and that the corresponding probabilities are given by p_L and p_H. The state of the economy has a distinct impact on each borrower. In the high state, the good borrower is always able to repay the loan while the bad borrower may default with a probability PD. In the low state, the bad borrower always defaults with probability one while the good borrower only does so with a probability of PD. Table [1] summarizes the assumption.

[1] Z can be normalized to one without loss of generality.

	Good Borrower	Bad Borrower
High State	0	PD
Low State	PD	1

Table 1: Default Probabilities in the context of systemic risk

Summing up, we can now define the expected cash flows of the entire loan portfolio in the low and the high state of nature of the economy.[2]

$$P_L(e) \equiv [(1 - PD)(\theta + e)] R \tag{3}$$

$$P_H(e) \equiv [(\theta + e) + (1 - PD)(1 - \theta - e)] R \tag{4}$$

It follows that the expected cash flow of the entire portfolio is given by $P(e) = p_L P_L(e) + p_H P_H(e)$. The bank has the option to create a structured product and sell different tranches to outside investors. For simplicity, it is assumed that the structured product consists of a senior tranche, a mezzanine tranche and an equity tranche and that equity and tranche holders retain a fraction t of the loan portfolio. In this case, promised payments to more senior tranche holders are given by $R(1 - t)$. For the case of mezzanine tranche retention, it is assumed that equity and mezzanine tranche are of the same size t such that payments to more senior tranche holders are given by $R(1 - 2t)$.

Due to the systemic risk component, the monotone likelihood ratio property does not always hold which is why debt financing, i.e. equity tranche retention, is not necessarily the optimal contract. While the non-optimality of debt also depends on the systemic outlook and the idiosyncratic default probabilities, the thickness of the respective tranches is most relevant as has been demonstrated by Kiff and Kisser (2010). However, from an intuitive level, the systemic outlook, the quality of the loan pool and individual default probabilities are exogenous to the bank while retention size is not and would be chosen by the bank.

We therefore introduce a second dimension into the principal agent problem and also allow the bank to choose how much credit exposure it wants to retain. To make this decision practically relevant, some market friction is needed. DeMarzo (2005) assumes that the source of market friction is superior valuation ability of banks which is why they profit from increasing volume, i.e. buying undervalued assets and selling them at market prices. However, if banks sell everything then they face a lemons problem as they are not able to signal the quality of their assets for sale. Alternatively, Fender and

[2]Note that due to having assumed that there is a continuum of good and bad borrowers with corresponding sub-continua depending on their idiosyncratic default probabilities, it follows that expected and realized cash flows of the individual states of nature coincide.

Mitchell (2009) argue that banks can benefit from accounting loopholes as an upfront sale of the loan portfolio allows for early recognition of profits. This effect may even get exacerbated if managerial compensation is linked to short-term profits. To capture this intuition, we assume that whenever the bank sells more senior tranches and those tranches are expected to be fully paid back, then it may be able to value the corresponding upfront payments at a premium to its notional amount. On the other hand, if the bank sells more risky tranches (i.e. sells equity and keeps the mezzanine tranche), then no premium can be realized with respect to the more risky tranche.

Assumption 1 *If the bank retains an equity tranche of thickness t which is not expected to be exhausted, then it is able to value upfront payments for selling a total of $(1-t)R$ mezzanine and senior tranches at $S_E = (1-t^2)R$.*

While the choice of the specific functional form is somehow ad-hoc, it allows us to capture the benefits of securitization and to also consider agency costs due to informational asymmetries in a reduced form approach.[3] This effect can be seen in Figure [1].

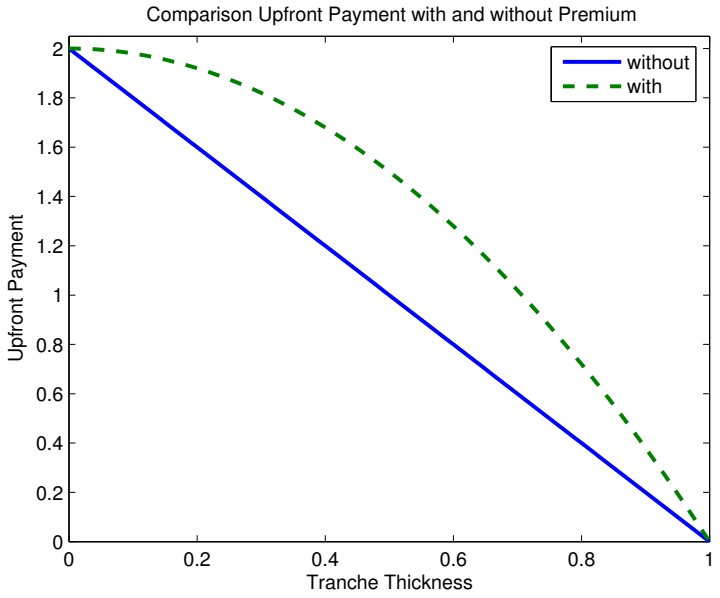

Figure 1: Visualizing the Intuition of Assumption [1]

The solid blue line plots the fixed upfront payment $R(1-t)$ for different values of t where R is set to 2. The dashed green line displays values corresponding to the concave function $(1-t^2)R$. It can

[3]Besides, the intuition is similar to Jensen and Meckling (1976) who illustrate a trade-off between agency costs of equity and agency costs of debt in the capital structure choice of a single firm.

be seen that starting with a fully retained loan portfolio, i.e. $t = 1$, the initial marginal benefit of securitizing is very high and it subsequently decreases the more of the loan portfolio is sold to outside investors. We can also see that if the entire portfolio is sold to outside investors, i.e. $t = 0$, the net benefits from securitization are zero such that the originator is only able to value the upfront payment at its notional value. The assumption thus captures the intuition that initially securitizing is beneficial to the bank but the less credit exposure is retained, the more agency costs relating to asymmetric information dominate and eliminate the marginal gain from securitizing an additional unit. We follow a similar intuition for the upfront payment relating to the case when the bank retains the mezzanine tranche which is formalized in Assumption [2].

Assumption 2 *If the bank retains a mezzanine tranche of thickness t which is not expected to be exhausted, then it is able to value upfront payments for selling a $(1-2t)R$ senior tranche at $S_M = (1-4t^2)R$.*

It should be made clear that although the functional forms captures the trade-off between accounting related benefits of securitization and costs due to adverse selection, the framework presented is not a signaling model a la Leland and Pyle (1977) and DeMarzo (2005). Instead, the model is still in the spirit of Innes (1990) and thus deals with the moral hazard problem between the bank and outside investors. However, the bank can choose how much credit exposure to retain and this decision is driven by the above mentioned trade-off.

From a practical perspective, banks face also costs of regulatory capital charges depending on how much credit exposure they retain. We therefore specifically introduce capital charges into the model and assume a linear cost function for capital requirements.

Assumption 3 *To capture the various capital charges associated with each of the retention mechanisms, we assume the following linear cost function*

$$k(t) = k_i \cdot t \tag{5}$$

where k_i captures capital charges, conditional on the specific retention mechanism. Specifically we assume that $k_i = 0.08 \times RW_i \times (R-1)$ where RW_i denotes the risk weight under equity or mezzanine retention and $(R-1)$ captures the opportunity costs of the capital charges.[4]

[4]The intuition for this assumption is as follows. As the bank is required to retain capital in its balance sheet it does not lose the entire amount but only the option to originate even more loans. Thus, the true costs of capital requirements are foregone profits or opportunity costs.

Combining above, we are now able to write down the following general maximization problem.

$$\max_{e,t} \Pi(e,t) = S(t) + F(e,t) - c(e) - k(t) - 1 \tag{6}$$

where $F(e,t)$ denotes the cash flows of the retained credit exposure. The subsequent analysis investigates how optimal screening effort and tranche size differ depending on whether the bank retains the equity or the mezzanine tranche.

Retaining interest in the equity tranche is similar to holding a call option on the performance of the loan portfolio with a strike price equal to the promised payments to senior and mezzanine tranche holders. Specifically, expected profits of the retained credit exposure are given by

$$F(e,t) = p_L \max\{P_L(e) - B_1(t), 0\} + p_H \max\{P_H(e) - B_1(t), 0\} \tag{7}$$

where $B_1 = (1-t)R$ denotes the promised payments to mezzanine and senior tranche holders. The bank can either choose screening effort and tranche size such that it never defaults on its promised payments or it can make use of its limited liability option.

Proposition 1 *If the bank does not allow the equity tranche to be exhausted in both states of nature, then the maximization problem is as follows*

$$\begin{aligned}
\max_{e,t} \Pi_{E1}(e,t) &= (1-t^2)R + p_L\left[P_L(e) - B_1(t)\right] + p_H\left[P_H(e) - B_1(t)\right] \\
&- \frac{\phi}{2}e^2 - k_E t - 1 && (8)\\
s.t.\ B_1(t) &\leq P_L(e) && (9)\\
e &\leq 1-\theta && (10)\\
e &\geq 0 && (11)
\end{aligned}$$

where [9] is the positive payoff constraint of equity tranche holders in the low state of nature and the minimum and maximum effort constraints [11] and [10] consider the fact that the probability of making a good loan is bounded by zero and one.

We can see that under equity retention, the bank is able to benefit from market imperfections for the entire fraction of the loan portfolio sold to outside investors in case it does not make use of its limited liability option. However, once it allows the equity tranche to get exhausted in the low state of nature, then it will only partly benefit from market imperfections as can be seen in Proposition [2].

Proposition 2 *If the bank makes use of its limited liability option in the low state of nature, the maximization problem is as follows*

$$\begin{aligned}
\max_{e,t} \Pi_{E2}(e,t) &= p_L P_L(e^*) + p_H(1-t^2)R + p_H\left[P_H(e) - B_1(t)\right] - \frac{\phi}{2}e^2 \\
&- k_E t - 1 \qquad (12)\\
s.t.\ B_1(t) &\leq P_H(e) \qquad (13)\\
e &\leq 1-\theta \qquad (14)\\
e &\geq 0 \qquad (15)
\end{aligned}$$

Depending on whether expected profit is higher by enforcing a non-negative payoff in the low state of nature or by making use of its limited liability option, the bank will choose effort and tranche size accordingly.[5] However, our ultimate interest lies in answering whether mezzanine retention induces higher screening effort than equity retention and whether this outcome is practically feasible. The payment structure when investing into the mezzanine tranche of a structured product is similar to holding subordinated or junior debt. Specifically, the claim is given by

$$\begin{aligned}
F(e,t) &= \min\left[\max\left\{P_L(e) - B_2(t), 0\right\}, tR\right] p_L \\
&+ \min\left[\max\left\{P_H(e) - B_2(t), 0\right\}, tR\right] p_H
\end{aligned} \qquad (16)$$

where $B_2(t) = (1-2t)$ denotes promised payments to senior tranche holders. Because the maximum payment mezzanine tranche holders can receive is capped at tR, they will only exert so much screening effort as to guarantee this payoff in the low state of nature. At the same time, this implies that the equity tranche will be exhausted in this case. Combining above together with the fact that the payoff in the high state of nature is always larger than the payoff in the low state, i.e. $P_H(e) > P_L(e)$, the expected value of the equity tranche is given by

$$C(t) = 0 + p_H\left(P_H(e^*) - B_1(t)\right) \qquad (17)$$

as long as it does not get exhausted in the high state of nature. Using this together with Assumptions [2] and [3], Proposition [3] is as follows.

[5] In principle, one would also need to check whether it is optimal for the bank to make use of the limited liability option in the high state of nature. For presentational simplicity and due to the fact that this scenario almost never becomes relevant in the numerical analysis, we abstract from this case here.

Proposition 3 *Under mezzanine tranche retention, if the equity tranche is not expected to be exhausted in the high state of nature, the maximization problem of the bank is given by*

$$\begin{aligned}
\max_{e,t} \Pi_M(e,t) &= C(t) + (1-4t^2)R + p_L\left(P_L(e) - B_2(t)\right) + p_H tR \\
&- \frac{\phi}{2}e^2 - k_M t - 1 \qquad (18) \\
s.t.\ B_2(t) &\leq P_L(e) \qquad (19) \\
P_L(e) &\leq B_1(t) \qquad (20) \\
e &\leq 1-\theta \qquad (21) \\
e &\geq 0 \qquad (22)
\end{aligned}$$

where [19] is the positive payoff constraint of mezzanine tranche holders in the low state of nature, [20] is the maximum payoff constraint of mezzanine tranche holders in the low state of nature and the minimum and maximum effort constraints [22] and [21] consider the fact that the probability of making a good loan is bounded by zero and one.

Clearly, the different maximization problems provide different incentives to screen loans and although we obtain the optimal screening effort and tranche size as closed form solutions, it is practially impossible to judge which retention mechanism dominates the other due to the various kinks in the payoff functions. The next section will therefore present numerical examples using the solutions to Propositions [1] to [3] which are provided in the Appendix.

3 Numerical Analysis

This section presents numerical examples based on the solutions to the maximization problem introduced in the previous section to judge whether equity or mezzanine tranche retention results in higher screening effort. To make matters practically interesting, we focus on the stylized case of a market with high systematic and idiosyncratic risk which can be thought of as a proxy for the subprime market.

It is therefore assumed that three out of 10 borrowers in the economy can be classified as good ($\theta = 0.3$) and that the probability of entering a downturn is equal to 80 percent. Furthermore, the gross return R is set to 1.1 and ϕ is equal to 1. Following the Basel II framework, risk weights for equity retention are set to 1250 percent while those of mezzanine tranche retention are assumed to be 100 percent. Results will be presented for idiosyncratic default probabilities between zero and one. All effort levels will be displayed relative to the amount of effort the bank would exert in case it retained the entire loan portfolio.

We first present results according to the baseline scenario before then performing various robustness checks by varying the fraction of good quality borrowers, the systemic risk component, screening costs and the gross return of the individual loans.

3.1 Baseline Scenario

We start our analysis by calculating implied screening effort and retention size in case the bank retains the equity tranche. Focusing on Figure [2], it can be seen that for idiosyncratic default probabilities of up to 40% equity tranche retention generates the same amount of screening as if the entire loan portfolio was retained. Most interestingly, for default probabilities between 40% and approximately 80% the bank would even screen individual loans more intensively than for the benchmark case. Intuitively, this can be explained by the fact that holding the equity tranche is more risky than retaining the entire loan portfolio and the bank is willing to increase the amount of screening in order to avoid costly default and to benefit from the accounting related value premium. However, if default probabilities are close to 90% then screening effort drops precipitously which is due to the fact that it becomes optimal for the bank to make use of its limited liability option in the low state of nature.

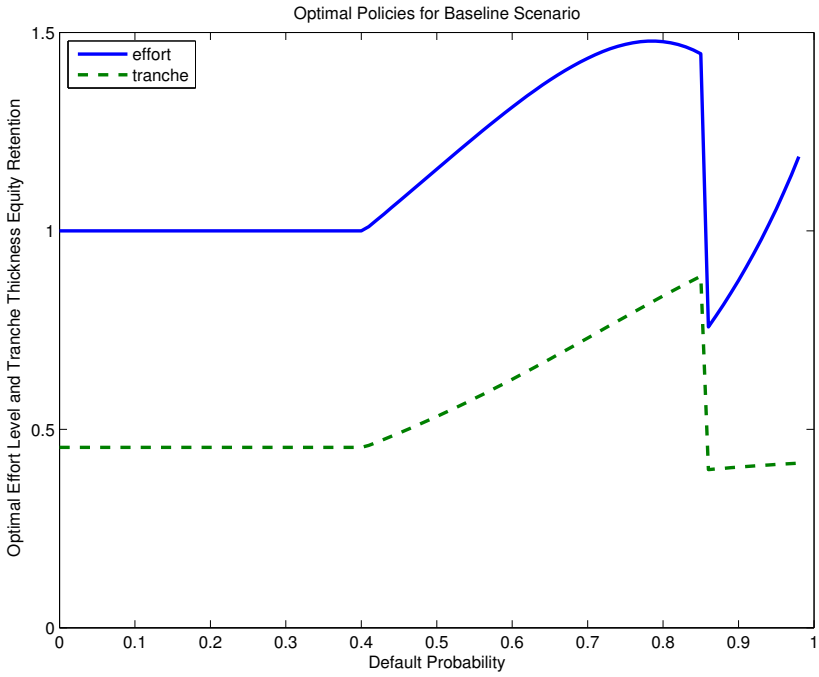

Figure 2: Screening Effort and Optimal Retention under Equity Tranche Retention

Figure [2] also shows that implied retention levels are very high and range between 44% and 92%. Thus, in order to maximize expected profits the bank will optimally exert a high level of screening effort

if it is able to choose retention size optimally and increase it to roughly 90 percent in case idiosyncratic default probabilities are high. From a policymaker's perspective it is therefore important to identify situations in which a bank is not able to choose retention size optimally as these are precisely the circumstances in which incentives might be distorted and which require active policy intervention. Practical examples which come to mind are internal rules limiting a bank's credit exposure to different geographic areas, borrower types ore certain demographic constraints which might be outside of the model.

The main interest lies in analyzing whether equity or mezzanine tranche retention leads to higher loan screening and which approach would be preferred by a profit maximizing bank in the context of systemic risk. Figure [3] therefore displays optimal screening effort and tranche size for the case of mezzanine tranche retention. It can be seen that most of the time mezzanine tranche retention generates a lower level of loan screening than if the bank retained the entire loan portfolio. The intuition is that the mezzanine tranche is less risky due to the fact that it is not the first to suffer losses and this in turn allows the bank to optimally reduce its screening efforts. Nevertheless, it can be also seen that the bank is able to sell a larger fraction of the loan portfolio as it never retains more than 50% of the issue

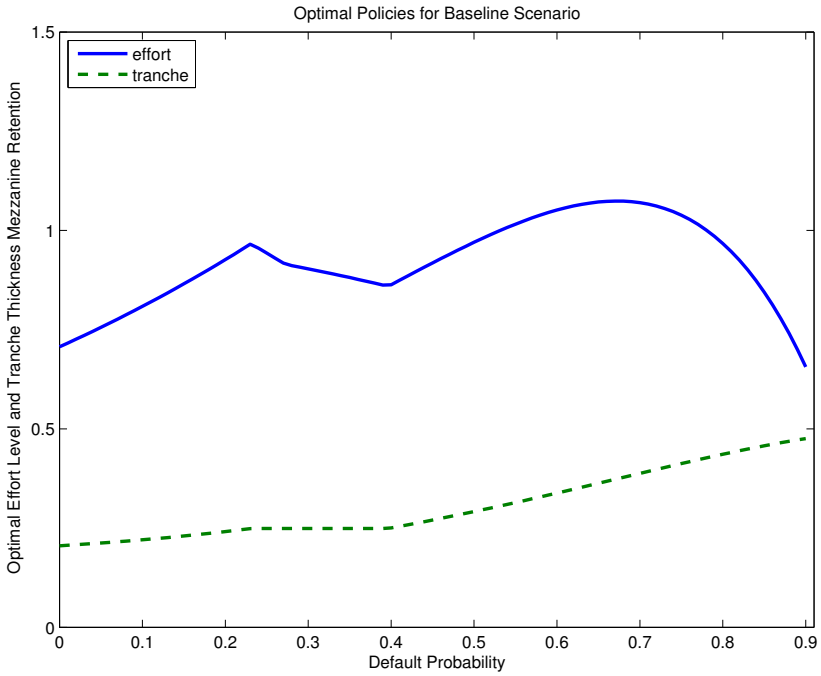

Figure 3: Screening Effort and Optimal Retention under Mezzanine Tranche Retention

Comparing expected profits under equity and mezzanine tranche retention, it turns out that financing the loans only has a positive net present value (NPV) for projects with default probabilities of less than 12%. Thus, due to the high systematic risk only projects with relatively low default probabilities would receive financing. Out of those, a bank would choose equity retention as long as the default probability is less than 6% and mezzanine tranche retention otherwise. At the same time, we can see that equity retention generates the same amount of screening effort as if the bank retained the entire loan portfolio and it clearly dominates mezzanine retention.

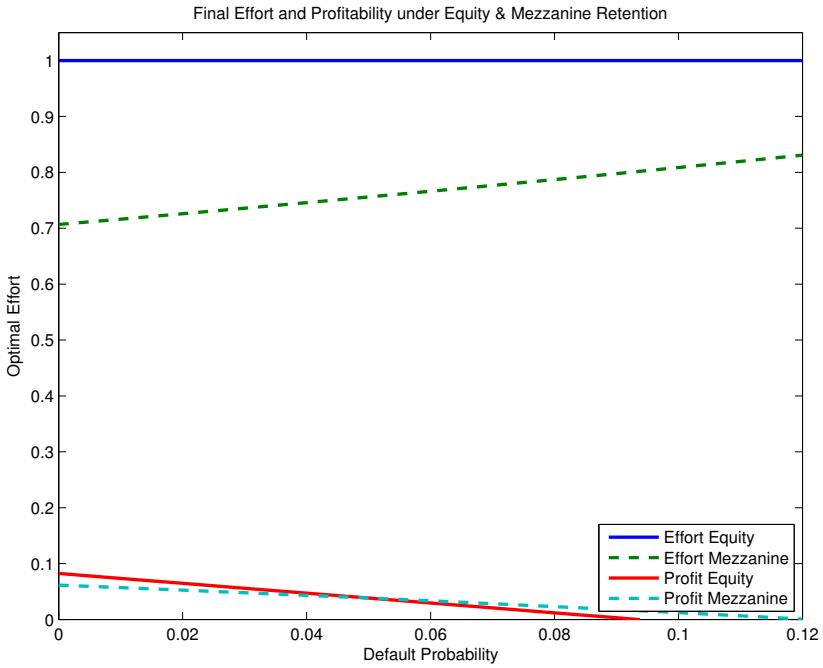

Figure 4: Comparison Equity versus Mezzanine Tranche Retention

The simple example shows that for the stylized case of a low quality market, i.e. high fraction of bad borrowers and high chances of economic downturn only a small fraction of projects would receive financing and that equity retention leads to higher screening effort than mezzanine tranche retention. However, a profit maximizing bank would not necessarily choose to retain the equity tranche. Before discussing any potential policy implications, it is important to know how results change if different parameter values are assumed. The next section will therefore first investigate the drivers of expected profits and then analyze the impact of assuming a different macroeconomic environment.

3.2 Robustness Checks

This section aims to obtain an understanding of how expected profits and implied loan screening are interrelated. We therefore start by varying the magnitude of capital costs, screening costs and the gross return of the individual loan and assess its implications for expected profits and screening level. Then, we investigate the influence of the macroeconomic environment, as measured by the fraction of good and low quality borrowers and the systemic risk component on retention policy.

3.2.1 The Profit Drivers

As a first step, we illustrate the effect of capital costs by reducing their monetary impact in the profit function to one tenth of its actual value. Doing so, this allows us to understand the impact of capital costs on the retention decision. Figure [5] displays the corresponding results. It can be seen that the region for which projects are financed using equity tranche retention more than doubles to default probabilities of up to 14% whereas there is basically no impact on the profitability under mezzanine tranche retention. This is due to the fact that capital costs are rather small than in case the first loss piece is retained which makes its impact negligible. Most importantly, equity retention delivers both the highest expected profit and the highest level of loan screening activity.

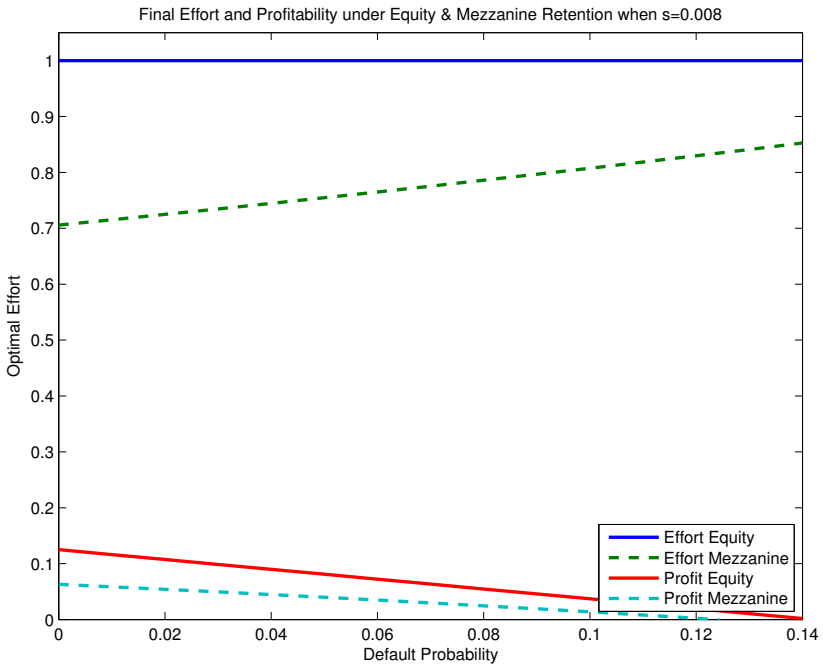

Figure 5: Comparison Equity versus Mezzanine Tranche Retention for low Capital Charges

Another possibility is that profits under mezzanine tranche retention are driven by the magnitude of loan screening costs which is captured by the parameter ϕ. Instead of setting ϕ equal to one, we assume a value of 5% which is common in the Corporate Finance literature relating to agency costs of free cash flow. For more details see for example Eisfeldt and Rampini (2007). Figure [6] shows that securitization becomes more profitable as projects with default probabilities of up to 40% would receive financing. It turns out that equity retention generates higher expected profits than mezzanine tranche retention for default probabilities of up to 15%. At the same time, given that screening is relatively cheap the bank will exert maximum screening effort under both equity and mezzanine tranche retention for default probabilities of 15% and higher

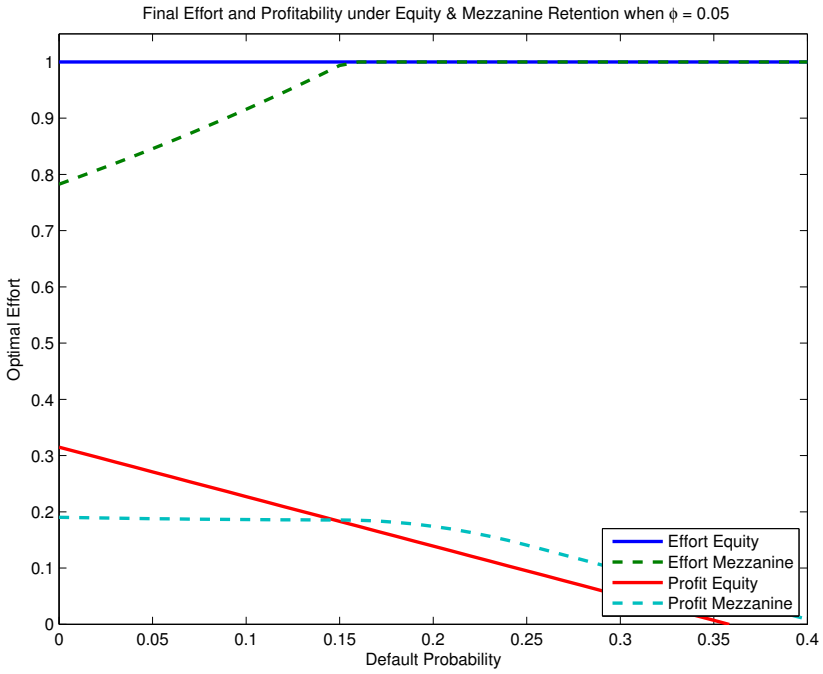

Figure 6: Comparison Equity versus Mezzanine Tranche Retention for low Screening Costs

Finally, we can analyze the effect of the gross return on relative profitability and screening levels. Setting R equal to 1.5 and leaving the other parameters unchanged, it turns out that mezzanine tranche retention generates higher profits than retaining the equity tranche. The reason is that equity retention becomes increasingly costly as the opportunity cost of capital charges are positively related to the gross return R. Focusing on the relative amount of screening effort, it can be seen that for default probabilities of approximately 20%, mezzanine tranche retention leads to a lower amount of loan screening than retention of the equity tranche. This is because when investing into the mezzanine tranche of a structured product, maximum payoffs are capped such that for low levels of default

probabilities there is no incentive to screen loans more diligently.

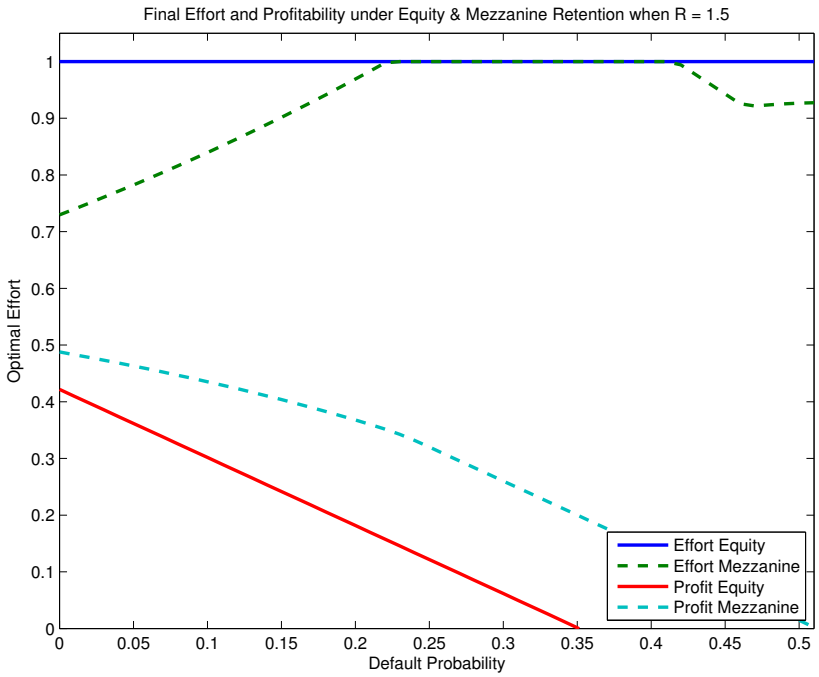

Figure 7: Comparison Equity versus Mezzanine Tranche Retention for High Gross Return

Summing up, we have seen that capital charges have a strong impact on the incentives to diligently screen loans and borrowers. This can be explained by the fact that in order for equity retention to be effective, a profit maximizing bank has to ensure that the next risky tranche is safe and this is achieved by increasing the thickness of the equity tranche. While this leads to the highest possible screening effort, it also reduces expected profits compared to the case of mezzanine retention due to the comparably much higher capital charges. This feedback effect even gets more pronounced in case gross profit is high as the opportunity costs of retaining funds become increasingly expensive in this case. While we do not argue that capital costs should be reduced to restore banks incentives to retain the equity tranche, it is important to be aware of this negative feedback effect and account for it when giving regulatory advice.

Another factor influencing the retention decision is the magnitude of loan screening costs. We have seen that once it becomes cheaper to screen, more projects receive financing. However, at the same time this makes high screening effort under mezzanine tranche retention also much more likely. Finally, it was shown that in the context of high opportunity costs, i.e. a high gross return, equity retention would lead to the highest screening level but is not the preferred choice for a profit maximizing bank.

As a policymaker it is therefore important to be aware of the above mentioned interrelations. Specifically, it is crucial that regulators have a good estimate of loan screening costs and the relative profitability of the different credit markets. If both screening costs and profitability are high and an equity retention rule was implemented, the one runs the danger of shutting down segments of securitization markets.

3.2.2 The Effect of the Macroeconomic Environment

The results presented so far have focused on one stylized credit market which is characterized through a large fraction of low quality borrowers and a high chance of an economic downturn. We now relax this assumption and present results for different levels of systematic risk and varying fractions of good and low quality borrowers.

Figure [8] displays profit levels and optimal screening activity for equity and mezzanine retention under different economic scenarios. Under the first one, we assume that the economy will enter a recession with 90% probability, under the second one we assume equal chances of entering economic up- and downturns and finally we set the probability of entering an upturn equal to 80 percent. It can be seen that if one expects an economic downturn, then only projects with default probabilities of up to 7% would receive financing and equity tranche retention would be the preferred choice both in terms of screening effort and profitability. On the other hand, if chances of an economic upturn are 50% or higher, then more projects would receive financing and banks would choose to retain the mezzanine tranche. The reason is that the combination of lower screening and opportunity costs together with a higher expected upfront payment increase profits under mezzanine tranche retention.

Alternatively, one can change the fraction of high quality borrowers in the economy. Figure [9] displays relative profitability and optimal effort levels when the parameter θ is set to 50% or 80%. We can see that for both cases, equity tranche retention delivers the highest screening effort but that it would only be the preferred choice for default probabilities of less than approximately 15%. One can thus observe a similar pattern as for the benchmark case.

So far, the robustness checks we have presented displayed results by only changing one parameter whereas the others have been left unchanged at the level of the baseline scenario. As a last step, we therefore display optimal policies and profit levels for the case of a high quality market, i.e. we set the parameter θ equal to 60% and assume that the chances of entering an economic up- or downturn are equal. Figure [10] displays corresponding results. It can be seen that for nearly all levels of default probability, a profit maximizing bank would choose to retain the mezzanine tranche. At the same time,

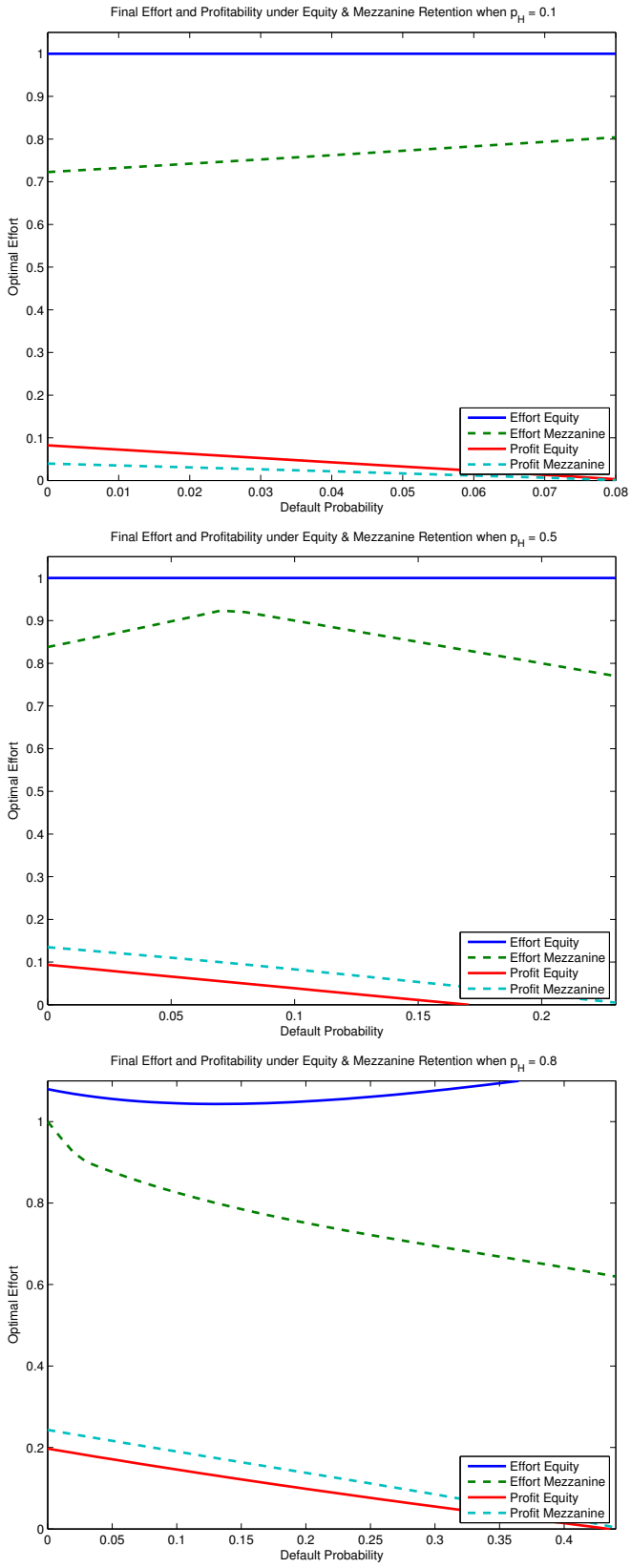

Figure 8: Optimal screening effort and tranche thickness for different economic scenarios.

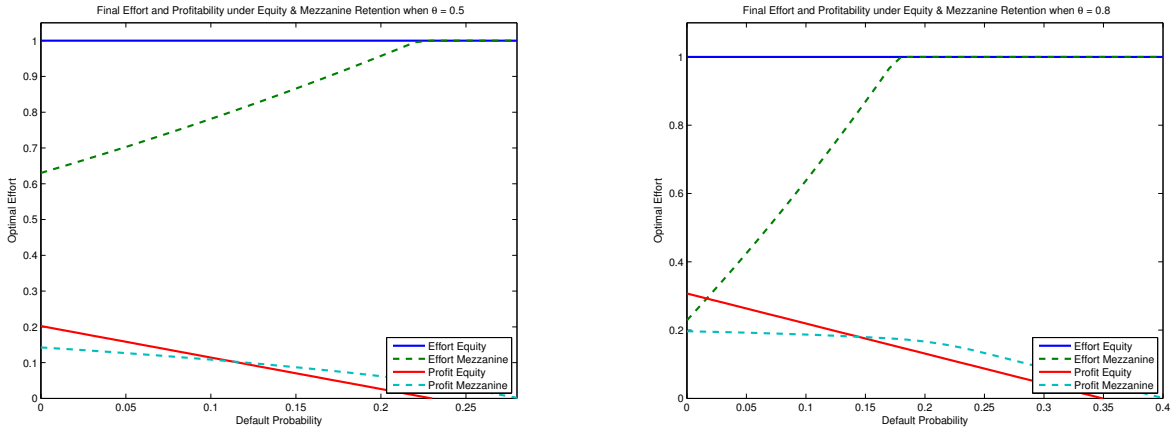

Figure 9: Optimal screening effort and tranche thickness for different fractions of high and low quality borrowers.

the implied screening level is considerably below the one obtained if the equity tranche was retained. Besides, it can be seen that optimal retention size under mezzanine retention is considerably lower than under equity retention as visualized in the right panel of Figure [10]. Thus it seems again that once the expected outlook is of neutral to good quality, mezzanine retention would be the preferred choice due to lower screening costs and capital charges.

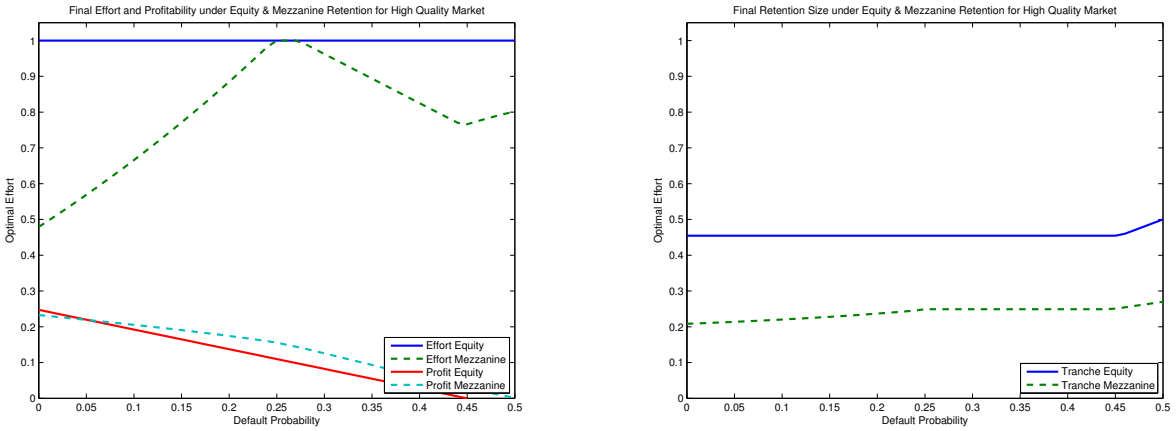

Figure 10: Optimal Policies under High Quality Market

3.3 Intermediate Summary

We have seen that when banks can choose both screening effort and optimal tranche size, retention of the equity tranche best aligns incentives with outside investors. At the same time, a profit maximizing bank might choose to retain the mezzanine tranche, specially when opportunity and screening costs are high and the economic outlook promising. From a policymaker's perspective, it is therefore important to have a good estimate of the magnitude of both a bank's loan screening and opportunity costs. If those are too high an equity tranche retention rule was implemented, one runs the danger of unnecessarily shutting down securitization markets.

Moreover, a policymaker should also focus attention on identifying situations in which a bank is not able to choose retention size optimally as these are precisely the circumstances in which incentives are distorted and which require active policy intervention. Practical examples which come to mind might be internal rules limiting a bank's credit exposure to different geographic areas, borrower types or certain demographic constraints which might be outside of the model.

Finally, we have seen that banks generally prefer mezzanine tranche retention in case an economic downturn is unlikely. This is due to the fact that when the economic outlook is reasonably good, the bank can save on screening and capital costs by retaining the less costly mezzanine tranche. Thus any active policy recommendation concerning whether banks should retain interest in the equity or mezzanine tranche should take the business cycle into account. This could result in countercyclical regulation in which securitizers are forced to retain the equity tranche in case an economic upturn is likely and otherwise retain the flexibility of choosing between equity and mezzanine retention, thereby aligning incentives with investors and most importantly avoiding procyclical liquidity effects.

4 Empirical Analysis

This section aims to provide a link between the theoretical analysis of the previous section and practical retention issues. The theoretic model has shown that equity tranche retention best aligns incentives with outside investors, but at the same time, mezzanine retention might be the preferred choice of a profit maximizing bank. In any case, the model implies that banks retain interest in the structured products they sell in order to reduce the moral hazard problem. We are now interested in how much credit exposure has actually been retained in structured credit transactions across different deal types, countries and time. As a second step, we then investigate the determinants of the retention decision.

4.1 Data Description

Our analysis is based on a dataset from Dealogic, a third party data provider, recording more than 90,000 securitization deals since 2001 from a variety of different countries. Deals are classified according to the deal type (Asset Backed Securities versus Mortgage Backed Securities), the number of tranches created for the specific deal, the country of origin, the date of issuance and the type of collateral (Collateral Debt Obligation, Residential Mortgages, Home Equity Loans, Auto Loans, Credit Card Receivables and Other Collateral) among others.

Since we do not have data on the actual retention numbers, we define the difference between the total transaction amount and the sum of the reported notional amounts of the constituent tranches as retained credit exposure.[6] The final dataset includes 18,732 observations and indicates that on average 1.5% of a loan portfolio has been retained in a structured credit transaction. Most observations stem from the United States (75.5%), the Cayman Islands (4.5%), South Korea (2.7%), the United Kingdom (2.5%) and Argentina (2.5%).

Focusing first on deals originated in the United States, it can be seen that the average retention rate equals only 0.9% and that approximately 45% of the deals have involved Asset Backed Securities whereas rougly 55% involved Mortgage Backed Securities. The majority of the deals has been collateralized by Residential Mortgages, followed by Home Equity Loans and CDOs. Finally, it can be seen in Table [2] that most deals are structured with one tranche (55.2%), two tranches (11.9%) or more than ten tranches (11.4%). In other words, transactions seem to be either extremly simple or very complex.

When only deals involving Asset Backed Securities are considered, it turns out that the retention number is higher (2.5%) and that most deals are backed by Home Equity Loans (33.8%) and Collateral Debt Obligations (28.8%). Finally, deals are structured in a more complex way as indicated by the fact that 17% of the deals contain more than 10 tranches. The picture is different for Mortgage Backed Securities. Average retention is lower at 0.3%, most deals are backed by Residential Mortgages (88.6%) and more than 80% of the deals involve only one or two tranches. Complete summary statistics for deals involving Asset Backed Securities (ABS) and Mortgage Backed Securities (MBS) can be found in the Appendix.

As a next step, we investigate whether retention rates have changed over the time and therefore calculate average retention rates from 2001 until 2009. Figure [11] shows that retention has fallen by

[6] We are aware that this approach excludes the possibility of retention after public placement or the purchase via SIVs sponsored by the originator.

Variable	Mean	Std. Dev.
Retention	0.009	0.048
Asset Backed Securities	0.453	-
Mortgage Backed Securities	0.547	-
Collateral Debt Obligations	0.104	-
Residential Mortgages	0.496	-
Credit Card Receivables	0.056	-
Home Equity Loans	0.226	-
Auto Loans	0.017	-
Other Collateral	0.100	-
One Tranche	0.552	-
Two Tranches	0.119	-
Three Tranches	0.027	-
Four Tranches	0.028	-
Five Tranches	0.029	-
Six Tranches	0.035	-
Seven Tranches	0.037	-
Eight Tranches	0.023	-
Nine Tranches	0.02	-
Ten Tranches	0.017	-
More than Ten Tranches	0.114	-
N	14146	

Table 2: Summary Statistics for United States

roughly one third from 2003 to 2007, thereby confirming anecdotal evidence that in the years preceding the financial crisis structured credit transactions have become looser in the sense that originators retained less skin in the game. However, at the same time it seems that once the crisis became evident originators were forced to retain a higher fraction as indicated by the steep increase in retention between 2007 and 2009.

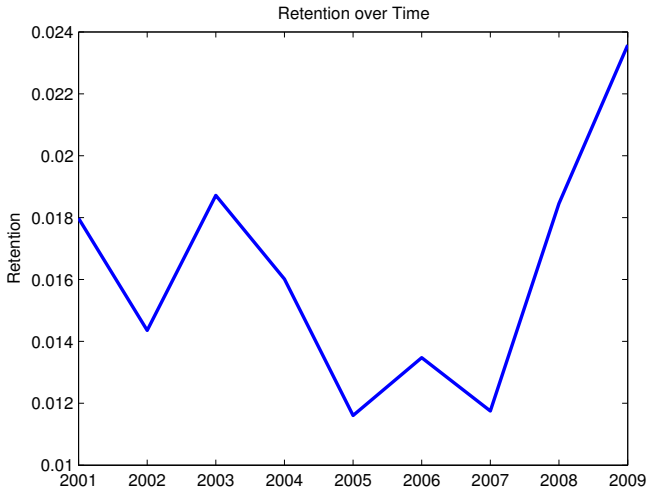

Figure 11: Retention over Time

We also decompose our sample with respect to collateral type. Figure [12] shows that the highest retention rate occurred for Auto Loans, Collateral Debt Obligations and Other Collateral, whereas for Residential Mortgages retention was basically nil.

As a last step, we can check whether retention rates differ across countries. It can be seen in Figure [13] that deals originated in the United States involved the lowest retention rates but that, with exception of South Korea, retention was only slightly higher in other countries.

4.2 The Determinants of the Retention Decision

From the perspective of a policymaker it is important to know the drivers of a bank's retention decision in oder to design regulation and to avoid designing an inefficient one size fits all approach. We therefore try to analyze what determines the retention decision in practice. Within the limits of our dataset, we estimate the following equation

$$y_t = \alpha + \beta_1 \text{mat}_t + \beta_2 \text{ABS} + \beta_3 \text{CDO} + \beta_4 \text{ResMtg} + \beta_5 \text{CCR} + \beta_6 \text{HEL} + \beta_7 \text{AL} + \beta_8 \text{X} + \epsilon_t \qquad (23)$$

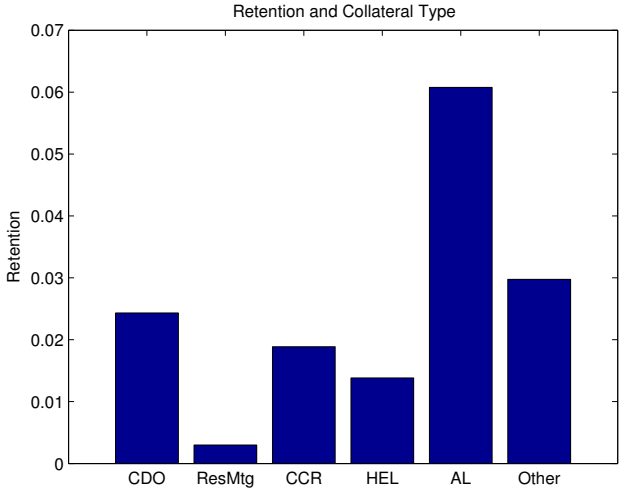

Figure 12: Retention for Different Collateral Types

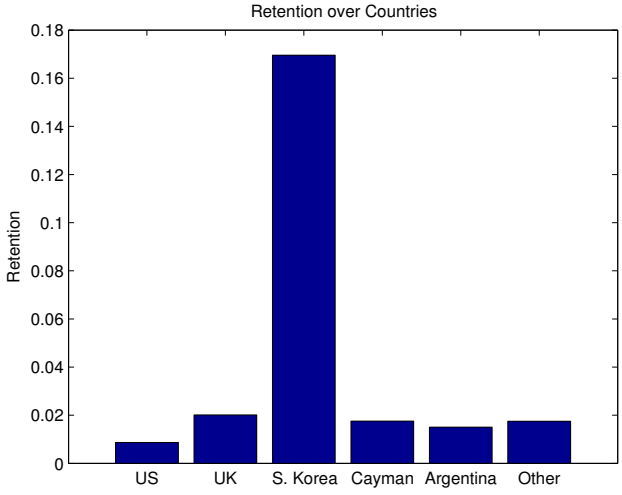

Figure 13: Retention across Countries

which will be referred to as the baseline regression. Note that y_t denotes retention size, mat_t is time to maturity and ABS, CDO, ResMtg, CCR, HEL and AL are dummy variables indicating the classification and collateral type of the underlying deal. Finally X is a vector summarizing the country of origin, including the United States, the United Kingdom, Cayman, Ireland, Argentina, Australia, Spain and Netherlands, and time dummies from 2001 until 2009. Estimation will be done using both linear (OLS) and nonlinear (Tobit) estimation techniques.

As a next step, we estimate an extended regression by also including the gross spread earned and the number of deal tranches as additional regressors. We are aware that both variables are open to the potential criticism that they are chosen endogenously such that they can not be included as exogenous regressors in the estimation. In the worst case, the coefficient of interest can only be interpreted as a sign of correlation rather than in terms of partial derivatives. In other words, we are not able to say that higher spreads imply higher or lower retention but only that spreads and retention are correlated. Due to data limitations, we have not (yet) been able to employ a reasonable instrumental variable approach to overcome this problem.

4.2.1 Results of the Baseline Regression

When estimating equation [23] results are supportive of the descriptive statistics provided in the previous section. One can see that if deals are backed by Mortgage Backed Securities, retention is reduced both under the OLS and Tobit estimation. The same negative effect can be observed for Credit Card Receivables as well as for the United States and Cayman Islands. Focusing on the Tobit estimates, we also see that for Residential Mortgages retention is further reduced while Home Equity Loans and Auto Loans imply higher retention rates. On the other hand, the coefficients of the time dummies turn out to be mostly insignificant in both regressions. It seems that the retention decision is thus mostly driven by the type of collateral and the country of origin.

While similar coefficients across OLS and Tobit regressions confirm a similar direction of the results, one can not simply compare them with each other. We therefore also compute the marginal effects under Tobit regression for the probability that the dependent variable is within the unit interval $P(a < y < b|x)$, the conditional expectation that the dependent variable is within the unit interval $E(y|a < y < b, x)$ and the final conditional expectation $E(y|x)$. The results confirm the general picture. Focusing on the third column in Table [4] we can see that retention drops by 1.1 percent if the deal is classified as a Mortgage Backed Security. Furthermore, if the underlying loan portfolio is backed by Residential Mortgages then retention decreases by another 0.7 percent whereas underlying Home Equity Loans increase retention by 1.4 percent. Similarly we can see that for deals structured in the

	(1)		(2)	
	OLS		TOBIT	
	Coefficient	T-Statistics	Coefficient	T-Statistics
Time to Maturity	0.000	0.40	0.002***	5.20
Mortgage Backed Securities	-0.028***	-8.13	-0.122***	-7.79
Collateral Debt Obligations	-0.010**	-2.71	0.045***	3.69
Residential Mortgages	-0.000	-0.23	-0.075***	-5.73
Credit Card Receivables	-0.015***	-3.36	-0.059**	-3.25
Home Equity Loans	-0.015***	-4.19	0.114***	9.11
Auto Loans	0.020*	2.49	0.085***	4.14
United States	-0.043***	-11.28	-0.221***	-18.14
United Kingdom	-0.033***	-6.56	0.005	0.29
Cayman Islands	-0.046***	-10.31	-0.218***	-13.08
Ireland	-0.041***	-7.54	-0.095***	-5.12
Argentina	-0.054***	-11.54	-0.106***	-6.36
Australia	-0.040***	-8.82	-0.028	-1.50
Spain	-0.049***	-11.21	-0.039	-1.78
Netherlands	-0.044***	-7.98	-0.083***	-4.01
Year 2002	0.001	0.26	-0.026	-1.56
Year 2003	0.005	1.60	0.029*	1.99
Year 2004	0.002	0.73	0.043**	3.20
Year 2005	-0.003	-1.28	0.029*	2.24
Year 2006	-0.002	-0.84	0.028*	2.16
Year 2007	-0.003	-1.08	0.018	1.34
Year 2008	-0.000	-0.09	0.049*	2.51
Year 2009	0.007	0.98	0.034	0.98
Constant	0.073***	13.93	-0.105***	-7.09
Sigma			0.225***	38.27
Observations	18253		18253	
R^2	0.074		0.284	

Table 3: Results for Baseline Regression

	(1) $\frac{\partial P(a<y<b\|x)}{\partial x}$	(2) $\frac{\partial E(y\|a<y<b,x)}{\partial x}$	(3) $\frac{\partial E((y\|x)}{\partial x}$
Time to Maturity	0.001***	0.000***	0.000***
Mortgage Backed Securities (d)	-0.090***	-0.020***	-0.011***
Collateral Debt Obligations (d)	0.036***	0.008***	0.005**
Residential Mortgages (d)	-0.053***	-0.012***	-0.007***
Credit Card Receivables (d)	-0.037***	-0.009***	-0.004***
Home Equity Loans (d)	0.104***	0.021***	0.014***
Auto Loans (d)	0.078***	0.016***	0.011**
United States (d)	-0.219***	-0.043***	-0.033***
United Kingdom (d)	0.003	0.001	0.000
Cayman Islands (d)	-0.087***	-0.028***	-0.010***
Ireland (d)	-0.052***	-0.014***	-0.006***
Argentina (d)	-0.057***	-0.015***	-0.007***
Australia (d)	-0.019	-0.004	-0.002
Spain (d)	-0.026*	-0.006	-0.003*
Netherlands (d)	-0.047***	-0.012***	-0.006***
Year 2002 (d)	-0.018	-0.004	-0.002
Year 2003 (d)	0.023	0.005	0.003
Year 2004 (d)	0.034**	0.007**	0.004**
Year 2005 (d)	0.022*	0.005*	0.003*
Year 2006 (d)	0.022*	0.005*	0.003*
Year 2007 (d)	0.014	0.003	0.002
Year 2008 (d)	0.040*	0.008*	0.005*
Year 2009 (d)	0.027	0.006	0.004
Observations	18253	18253	18253

Marginal effects

(d) for discrete change of dummy variable from 0 to 1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Marginal Effects for Baseline Tobit Regression

United States retention rates would fall by an additional 3.3 percent.

One word of caution is warranted at this point. It is well known that Tobit estimates might be severely biased in the presence of heteroskedasticity. However, Wooldridge (2006) argues that for moderate levels of heteroskedasticity, Tobit estimation is likely to provide good estimates of the partial effects on the conditional means. As our residuals reveal heteroskedasticity, one should interpret the coefficients of the partial effects with caution, even when a visual inspection of residuals and regressors looks reassuring. Nevertheless, the coefficients of OLS and Tobit estimation have the same sign and similar magnitude for most regressors and thus support our interpretation of the results.

4.2.2 The Extended Setup

While the results are intuitive and supportive of the preliminary descriptive analysis, they do not aid much in designing policy measures. We will therefore augment the baseline regression by also including the gross spread earned on the transaction and the number of deal tranches, i.e.

$$\begin{aligned} y_t &= \alpha + \beta_1 \text{mat}_t + \beta_2 \text{ABS} + \beta_3 \text{CDO} + \beta_4 \text{ResMtg} + \beta_5 \text{CCR} + \beta_7 \text{HEL} + \beta_8 \text{AL} \\ &+ \beta_9 \text{spread}_t + \beta_{10} \text{X} + \beta_{11} \text{tranches} + \epsilon_t \end{aligned} \tag{24}$$

where spread_t denotes the gross spread earned on the transaction and tranches is a vector of dummy variables indicating whether the transaction consists of one, two, three, ... , ten or more than ten tranches. We are aware of the potential criticism the two regressors might not be exogenous . Results should be interpreted with caution and in terms of correlation rather than causation.

The additional regressors change results substantially and increase the Pseudo R^2 of the Tobit regression from 28 to 60%. First, we can see that retention and gross spread are positively correlated under the Tobit specification. Besides, we also see that once deal complexity is controlled for, Residential Mortages as the underlying collateral type actually increases retention whereas for Home Equity Loans the effect becomes negative.

This is due to the introduction of the number of deal tranches which seem to capture most of the relation between retention and the right hand side variables. Specifically, we can see that if the deal only involves more than one tranche, retention has to be increased. The coefficients on the individual deal tranches dummies also indicate a positive relation between the number of deal tranches and retention, with some nonlinearities under the OLS specification. In other words, the more tranches a deal involves the more complex the security becomes which is why banks have to increase retention to mitigate informational asymmetries.

	(1)		(2)	
	OLS		TOBIT	
	Coefficient	T-Statistics	Coefficient	T-Statistics
Time to Maturity	-0.001**	-2.83	-0.001***	-5.92
Mortgage Backed Securities	-0.055***	-5.52	-0.178***	-26.53
Collateral Debt Obligations	-0.024*	-2.18	-0.055***	-12.08
Residential Mortgages	0.032**	3.08	0.046***	6.74
Credit Card Receivables	0.003	0.34	0.032***	6.58
Home Equity Loans	-0.083***	-7.21	-0.115***	-28.45
Auto Loans	-0.010	-0.81	0.009*	2.47
Gross Spread	-0.001	-0.14	0.038***	5.74
United States	-0.063***	-7.85	-0.323***	-79.25
United Kingdom	-0.065***	-6.37	-0.187***	-43.02
Cayman Islands	-0.019	-0.99	-0.032***	-6.35
Ireland	-0.058***	-3.79	-0.179***	-37.17
Argentina	-0.075***	-4.05	-1.503	.
Australia	-0.032***	-3.64	-0.166***	-25.60
Spain	-0.059***	-6.68	-0.144***	-31.50
Netherlands	-0.057***	-3.60	-0.168***	-34.32
Two Tranches	0.031***	4.64	1.559***	364.73
Three Tranches	0.039***	5.33	1.640***	404.86
Four Tranches	0.066***	7.21	1.727***	518.48
Five Tranches	0.073***	7.11	1.768***	537.16
Six Tranches	0.134***	6.90	1.863***	633.22
Seven Tranches	0.088***	7.85	1.832***	629.16
Eight Tranches	0.089***	5.47	1.845***	737.44
Nine Tranches	0.130***	8.97	1.937***	787.23
Ten Tranches	0.130***	5.54	1.874***	667.50
More than Ten Tranches	0.163***	11.80	2.024***	605.21
Sigma			0.227***	149.41
Observations	3049		3049	
R^2	0.223		0.596	

Table 5: Results for Extended Regression

What we have not yet addressed so far is the partial effect of the individual regressors. We therefore compute again the marginal effects under the Tobit estimation for the probability that the dependent variable is within the unit interval $P(a < y < b|x)$, the conditional expectation that the dependent variable is within the unit interval $E(y|a < y < b, x)$ and the final conditional expectation $E(y|x)$. Unfortunately, we are currently not able to calculate standard errors for the expected value calculations as the maximum likelihood computation does not converge. Thus while columns two and three of Table [6] confirm the positive relationship between deal complexity and retention, we do not know whether theses coefficients are statistically significant.

Summing up, banks must increase retention if they issue a structured product instead of a single claim on the performance of the entire loan pool. Finally, we can see that the type of collateral and the country of origin mostly loose all their economic and statistical significance in explaining the retention decision.

4.3 Intermediate Summary

The empirical section has shown that average retention rates in structured product transactions since 2001 equal approximately 1.5%. Nevertheless retention rates differ severly across collateral types. It turns out that deals collateralized by Residential Mortgages involve by far the lowest retention rates whereas retention could be as high as 6% for Auto Loans. We have also seen that retention rates dropped substantially in the period from 2003 to 2007. The decline in retention seems to confirm anecdotal evidence that in the years preceding the financial crisis, structured credit transactions have become looser in the sense that originators retained less skin in the game.

Finally, it seems that deal complexity has important implications for retention rates. Overall, results show a positive relation between retention and the number of deal tranches thereby indicating that more complex deals and skin in the game are positively related. Besides, we can also see that the type of collateral and the country of origin become rather economically insignificant determinants of the retention decision once the deal complexity is accounted for.

When comparing the results of the empirical section with the outcomes of our model, we can see that actual retention rates are extremely low and well below those implied by the different maximization problems. While a direct comparison of the figures is not meaningful as the theoretic results are not the outcome of a calibration, one might still wonder why this is the case. One potential explanation is given by the functional form for the valuation of the upfront payment which assumed that if a bank sells the entire issue it is not able to profit from the transaction due to costly informational

	(1) $\frac{\partial P(a<y<b\|x)}{\partial x}$	(2) $\frac{\partial E(y\|a<y<b,x)}{\partial x}$	(3) $\frac{\partial E((y\|x)}{\partial x}$
Time to Maturity	-0.000***	-0.000	-0.000
Mortgage Backed Securities (d)	-0.001**	-0.010	-0.000
Collateral Debt Obligations (d)	-0.000**	-0.003	-0.000
Residential Mortgages (d)	0.000*	0.003	0.000
Credit Card Receivables (d)	0.000*	0.002	0.000
Home Equity Loans (d)	-0.001**	-0.007	-0.000
Auto Loans (d)	0.000	0.001	0.000
Gross Spread	0.000	0.002	0.000
United States (d)	-0.007***	-0.022	-0.001
United Kingdom (d)	-0.000**	-0.010	-0.000
Cayman Islands (d)	-0.000**	-0.002	-0.000
Ireland (d)	-0.000**	-0.009	-0.000
Argentina (d)	-0.000**	.	.
Australia (d)	-0.000**	-0.009	-0.000
Spain (d)	-0.000**	-0.008	-0.000
Netherlands (d)	-0.000**	-0.009	-0.000
Two Tranches (d)	0.960***	0.525	0.586
Three Tranches (d)	0.896***	0.618	0.702
Four Tranches (d)	0.743***	0.701	0.817
Five Tranches (d)	0.625***	0.735	0.869
Six Tranches (d)	0.429***	0.777	0.928
Seven Tranches (d)	0.463***	0.770	0.920
Eight Tranches (d)	0.418***	0.778	0.931
Nine Tranches (d)	0.260***	0.806	0.964
Ten Tranches (d)	0.344***	0.791	0.948
More than Ten Tranches (d)	0.557***	0.762	0.892
Observations	3049	3049	3049

Marginal effects

(d) for discrete change of dummy variable from 0 to 1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Marginal Effects for Extended Tobit Regression

asymmetries. While this assumption is probably reasonable today and over a longer horizon it might not have been an adequate description of reality in the years preceding the financial crisis. In other words, it might simply be the case that outside investors did not force banks to retain some interest by paying a sufficiently lower price for close to zero retention products. If this true and investors are indeed overly optimistic over certain periods, this makes another case for active policy intervention.

5 Conclusion

This paper uses a moral hazard model to investigate the incentives of banks to screen loans once it knows that it sells the loan portfolio as a structured product to outside investors. Contrary to existing models, we specifically introduce accounting related benefits into the principal agent problem in order to pin down the optimal retention amount.

The analysis finds that equity retention most of the time generates the highest possible screening effort but at the same time, a profit maximizing bank might choose to retain the mezzanine tranche. The intuitive reason is given by the fact that both screening costs and capital charges are higher under equity retention which is why mezzanine retention is often the preferred choice. Most importantly, the higher the promised return on a loan, the stronger the negative impact on capital charges. From a policy perspective, it is therefore indispensable that a regulator has a good estimate of both loan screening and opportunity costs. An unanimous imposition of equity retention could otherwise lead to a shutdown of securitization markets if retention becomes too costly. Finally, it has been shown that banks favor mezzanine tranche retention in case the economic outlook is reasonably good due to lower screening costs and capital charges. Active regulation might address these conflicts of interest by actively considering the business cycle and advising equity retention in case of a positive economic outlook. Doing so, incentives with outside investors would be better aligned and countercyclical capital requirements would be guaranteed.

Using a dataset with 18,000 structured credit transactions we show that average retention rates equal 1.5% from 2001 until 2009. The total amount of retention depends strongly on the type of collateral with Residential Mortgages involving the lowest retention rates and Auto Loans the highest. However, once deal complexity is accounted for in the regressions we find basically no explanatory effect of the type of collateral nor the country in which the structured product was issued. In general, the more tranches a deal involves the higher are implied retention rates thereby implying that banks have to keep more skin in the game to reduce informational asymmetries.

References

G. Akerlof. The market for lemons: Quality uncertainty and market mechanism. *The Quarterly Journal of Economics*, 84:488–500, 1970.

Elena Carletti. The structure of bank relationships, endogeneous monitoring, and loan rates. *Journal of Financial Intermediation*, 13:58–86, 2004.

Gabriella Chiesa. Optimal credit risk transfer, monitored finance and banks. *Journal of Financial Intermediation*, 17:464–477, 2008.

Peter M. DeMarzo. The pooling and tranching of securities: A model of informed intermediation. *Review of Financial Studies*, 18:1–34, 2005.

Dareell Duffie. Innovations in credit risk transfer: Implications for financial stability. *BIS Working Paper*, 255, 2008.

Andrea Eisfeldt and Adriano Rampini. Financing shortfalls and the value of aggregate liquidity. *Working Paper*, 2007.

Ingo Fender and Janet Mitchell. Incentives and tranche retention in securitisation: A screening model. *Working Paper*, 2009.

Gary B. Gorton and George G. Pennacchi. Banks and loan sales marketing nonmarketable assets. *Journal of Monetary Economics*, 35:389–411, 1995.

Barney Hartman-Glaser, Tomasz Piskorski, and Alexei Tchistyi. Optimal securitization with moral hazard. *Working Paper*, 2010.

Robert D. Innes. Limited liability and incentive contracting with ex-ante action choices. *Journal of Economic Theory*, 52:45–67, 1990.

Michael Jensen and William Meckling. Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3, 1976.

Benjamin J. Keys, Tanmoy Mukherjee, Amit Seru, and Vikrant Vig. Did securitization lead to lax screening? evidence from subprime loans. *Quarterly Journal of Economics*, 125:307–362, 2010.

John Kiff and Michael Kisser. Asset securitization and optimal retention. *IMF Working Paper*, 10/74, 2010.

Hayne E. Leland and David H. Pyle. Informational asymmetries, financial structure, and financial intermediation. *Journal of Finance*, 32:371–387, 1977.

Alan D. Morrison. Credit derivatives, disintermediation, and investment decisions. *Journal of Business*, 78:621–647, 2005.

Antonio Niccolo and Loriana Pelizzon. Credit derivatives: Capital requirements and strategic contracting. *Working Paper*, 2006.

Jeffrey M. Wooldridge. *Introductory Econometrics*. Thomson Higher Education, 2006.

A Appendix

A.1 Proof of Proposition [??]

Proof.

[Proof] By assumption the entire loan portfolio is retained which implies that $t = 1$ such that the maximization problem is given by

$$\max_{e} \Pi(e) = p_L P_L(e) + p_H P_H(e) - \frac{\phi}{2}e^2 - k - 1 - \lambda_1 \left[e + \theta - 1\right] - \lambda_2(-e) \tag{25}$$

If $\lambda_1 \geq 0$ the solution is given by

$$e^* = \min\left[\left(p_L(1 - PD) + p_H PD\right)\frac{R}{\phi}, 1 - \theta\right] \tag{26}$$

Note that for reasonable parameter values, λ_2 is never binding.

■

A.2 Proof of Proposition [1]

Proof.

[Proof] The maximization problem is as follows

$$\begin{aligned} \max_{e,t} \Pi_{E1}(e,t) &= (1 - t^2)R + p_L\left[P_L(e) - B_1(t)\right] + p_H\left[P_H(e) - B_1(t)\right] \\ &- \frac{\phi}{2}e^2 - k_E t - 1 - \lambda_1\left[P_L(e) - B_1(t)\right] - \lambda_2\left[e + \theta - 1\right] - \lambda_3(-e) \end{aligned} \tag{27}$$

If $\lambda_1 = \lambda_3 = 0$ and $\lambda_2 \geq 0$, the solution is given by

$$\begin{aligned} e^* &= \min\left[\left(p_L(1 - PD) + p_H PD\right)\frac{R}{\phi}, 1 - \theta\right] \\ t^* &= \frac{1}{2} - \frac{k_E}{2R} \end{aligned} \tag{28}$$

If $\lambda_1 > 0$, $\lambda_2 \geq 0$ and $\lambda_3 = 0$, the solution is given by

$$
\begin{aligned}
e^* &= \min\left[\frac{k_E(1-PD)+R\left[2(1-PD)-p_H(1-2PD)-2(PD-1)^2\theta\right]}{\phi+2(PD-1)^2R}, 1-\theta\right] \\
t^* &= \max\left[\frac{\phi-k_E(PD-1)^2+(PD-1)(2PD-1)p_HR+(PD-1)\phi\theta}{\phi+2(PD-1)^2R}, PD\right]
\end{aligned}
\tag{29}
$$

Finally, if $\lambda_1 = \lambda_3 > 0$ and $\lambda_2 = 0$ then

$$
\begin{aligned}
e^* &= 0 \\
t^* &= 1-(1-PD)\theta
\end{aligned}
\tag{30}
$$

Note that $\lambda_2 = \lambda 3 \geq 0$ is not possible.

■

A.3 Proof of Proposition [2]

Proof.

[Proof] The maximization problem is as follows

$$
\begin{aligned}
\max_{e,t}\ \Pi_{E2}(e,t) &= p_L P_L(e^*) + p_H(1-t^2)R + p_H\left[P_H(e)-B_1(t)\right] - \frac{\phi}{2}e^2 \\
&- k_E t - 1 - \lambda_1\left[P_H(e)-B_1(t)\right] - \lambda_2\left[e+\theta-1\right] - \lambda_3(-e)
\end{aligned}
\tag{31}
$$

If $\lambda_1 = \lambda_3 = 0$ and $\lambda_2 \geq 0$, the solution is given by

$$
\begin{aligned}
e^* &= \min\left[p_H PD\frac{R}{\phi}, 1-\theta\right] \\
t^* &= \frac{1}{2} - \frac{k_E}{2Rph}
\end{aligned}
\tag{32}
$$

If $\lambda_1 > 0$, $\lambda_2 \geq 0$ and $\lambda_3 = 0$, the solution is given by

$$
\begin{aligned}
e^* &= \min\left[\frac{PD\left[k_E+2PDp_HR(1-\theta)\right]}{\phi+2PD^2p_HR}, 1-\theta\right] \\
t^* &= \max\left[\frac{PD(\phi(1-\theta)-k_EPD)}{\phi+2PD^2p_HR}, 0\right]
\end{aligned}
\tag{33}
$$

Finally, if $\lambda_1 = \lambda_3 > 0$ and $\lambda_2 = 0$ then

$$\begin{aligned} e^* &= 0 \\ t^* &= 1 - \theta - (1 - PD)\theta \end{aligned} \tag{34}$$

Note that $\lambda_2 = \lambda 3 \geq 0$ is not possible.

■

A.4 Proof of Proposition [3]

Proof. The maximization problem is given as follows.

$$\begin{aligned} \max_{e,t} \pi_M(e,t) &= C(t) + (1 - 2t^2)R + p_L \left(P_L(e) - B_2(t)\right) + p_H tR - \frac{\phi}{2}e^2 - ct \\ &- 1 - \lambda_1 \left[B_2(t) - P_L(e)\right] - \lambda_2 \left[P_L(e) - B_1(t)\right] - \lambda_3 \left[e + \theta - 1\right] - \lambda_4(-e) \end{aligned} \tag{35}$$

If $\lambda_1 = \lambda_2 = \lambda_4 = 0$ and $\lambda_3 \geq 0$, the solution is given by

$$e^* = \min\left[(1 - PD)p_L \frac{R}{\phi}, 1 - \theta\right] \tag{36}$$

$$t^* = \frac{1}{2} - \frac{k_M}{4R} \tag{37}$$

If $\lambda_1 > 0$, $\lambda_3 \geq 0$ and $\lambda_2 = \lambda_4 = 0$, the solution is given by

$$e^* = \min\left[\frac{k_M(1 - PD) + (1 - PD)R2(p_L - \theta(1 - PD))}{2(\phi + (PD - 1)^2 R)}, 1 - \theta\right] \tag{38}$$

$$t^* = \max\left[\frac{2\phi - k_M(PD - 1)^2 + (PD - 1)^2 p_H R - 2\theta(1 - PD)}{4(\phi + (PD - 1)^2 R)}, \frac{PD}{2}\right] \tag{39}$$

If $\lambda_1 = \lambda_4 > 0$ and $\lambda_2 = \lambda_3 = 0$, the solution is given by

$$e^* = 0 \tag{40}$$

$$t^* = \frac{1 - (1 - PD)\theta}{2} \tag{41}$$

If $\lambda_2 > 0$, $\lambda_3 \geq 0$ and $\lambda_1 = \lambda_4 = 0$, the solution is given by

$$e^* = \min\left[\frac{k_M(1-PD)+(PD-1)R\left[-4+2p_H+p_L+4\theta(1-PD)\right]}{1+4(PD-1)^2R}, 1-\theta\right] \tag{42}$$

$$t^* = \max\left[\frac{1-k_M(PD-1)^2+(PD-1)^2\left[2p_H+p_LR\right]-\theta(1-PD)}{1+4(PD-1)^2R}, PD\right] \tag{43}$$

If $\lambda_2 = \lambda_4 > 0$ and $\lambda_1 = \lambda_3 = 0$, the solution is given by

$$e^* = 0 \tag{44}$$

$$t^* = 1-(1-PD)\theta \tag{45}$$

Note that it is not possible that both $\lambda_1 = \lambda_2 > 0$. Otherwise, it would immediately follow that as $\hat{t}(e) = 0$ as $B_2(t) = P_L(e)$ and $P_L(e) = B_1(t)$. This in turn implies that

$$e^* = \frac{1}{1-PD} - \theta \tag{46}$$

Because $\lambda_2 = 0$, we need that $e^* < 1-\theta$ which only holds true if $PD = 0$. Excluding the economically uninteresting case where $PD = 0$, the contradiction finishes the proof.

■

Variable	Mean	Std. Dev.
Retention	0.025	0.092
United States	0.664	-
United Kingdom	0.020	-
Cayman Islands	0.084	-
South Korea	0.049	-
Argentina	0.047	-
Australia	0.006	-
Spain	0.007	-
Ireland	0.023	-
Netherlands	0.016	-
Other Country	0.085	-
Collateral Debt Obligations	0.288	-
Residential Mortgages	0.001	-
Credit Card Receivables	0.110	-
Home Equity Loans	0.338	-
Auto Loans	0.044	-
Other Collateral	0.219	-
One Tranche	0.267	-
Two Tranches	0.108	-
Three Tranches	0.092	-
Four Tranches	0.065	-
Five Tranches	0.060	-
Six Tranches	0.067	-
Seven Tranches	0.066	-
Eight Tranches	0.042	-
Nine Tranches	0.035	-
Ten Tranches	0.027	-
More than Ten Tranches	0.171	-
N	9665	

Table 7: Summary Statistics for Asset Backed Securities

Variable	Mean	Std. Dev.
Retention	0.003	0.031
United States	0.853	-
United Kingdom	0.031	-
Cayman Islands	0.003	-
South Korea	0.005	-
Argentina	0.001	-
Australia	0.034	-
Spain	0.010	-
Ireland	0.013	-
Netherlands	0.010	-
Other Country	0.041	-
Collateral Debt Obligations	0.000	-
Residential Mortgages	0.886	-
Credit Card Receivables	0.000	-
Home Equity Loans	0.000	-
Auto Loans	0.000	-
Other Collateral	0.114	-
One Tranche	0.728	-
Two Tranches	0.161	-
Three Tranches	0.027	-
Four Tranches	0.025	-
Five Tranches	0.016	-
Six Tranches	0.012	-
Seven Tranches	0.006	-
Eight Tranches	0.006	-
Nine Tranches	0.003	-
Ten Tranches	0.002	-
More than Ten Tranches	0.016	-
N	9067	

Table 8: Summary Statistics for Mortgage Backed Securities

	(1)		(2)	
	OLS		TOBIT	
	Coefficient	T-Statistics	Coefficient	T-Statistics
Time to Maturity	-0.000***	-3.46	-0.000***	-7.91
Mortgage Backed Securities	-0.018***	-5.41	-0.095***	-39.08
Collateral Debt Obligations	-0.025***	-6.50	-0.066***	-38.92
Residential Mortgages	0.005***	3.58	-0.019***	-7.44
Credit Card Receivables	-0.007	-1.63	0.010***	5.41
Home Equity Loans	-0.045***	-10.38	-0.121***	-76.57
Auto Loans	0.012	1.55	-0.009***	-6.35
United States	-0.041***	-11.40	-0.212***	-126.15
United Kingdom	-0.051***	-9.62	-0.133***	-85.88
Cayman Islands	-0.035***	-8.60	-0.171***	-98.75
Ireland	-0.043***	-8.17	-0.122***	-86.69
Argentina	-0.054***	-12.17	-0.128***	-54.96
Australia	-0.048***	-10.78	-0.074***	-33.63
Spain	-0.057***	-13.19	-0.104***	-60.53
Netherlands	-0.047***	-8.62	-0.111***	-72.20
Two Tranches	0.013***	7.63	1.124***	587.46
Three Tranches	0.022***	7.23	1.197***	754.94
Four Tranches	0.029***	8.64	1.245***	951.94
Five Tranches	0.042***	10.65	1.304***	1003.57
Six Tranches	0.049***	10.68	1.335***	1015.14
Seven Tranches	0.039***	12.55	1.322***	980.25
Eight Tranches	0.047***	10.79	1.355***	1200.96
Nine Tranches	0.071***	12.77	1.426***	1319.06
Ten Tranches	0.059***	9.71	1.417***	1333.22
More than Ten Tranches	0.076***	17.08	1.492***	1132.50
Sigma			0.187***	280.01
Observations	18253		18253	
R^2	0.142		0.672	

Table 9: Results for Extended Regression without Spread