On the Design of Collateralized Debt Obligation-Transactions

by

Günter Franke*

Markus Herrmann**

Thomas Weber*

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Abstract

The strong growth in collateralized debt obligation transactions raises the question how these transactions are designed. The originator designs the transaction so as to maximize her benefit subject to requirements imposed by investors and rating agencies. We analyse a set of European transactions and find that the asset pool quality, measured by the weighted average default probability and the diversity score of the pool, plays a predominant role for the transaction design. Characteristics of the originator play a small role. A lower asset pool quality induces the originator to take a higher First Loss Position and renders a synthetic transaction less attractive. In these transactions the senior, least information sensitive tranche is not sold. The size of this tranche tends to decline with asset pool quality. Both, the weighted average default probability and the diversity score of the pool appear to positively affect the number of tranches and the credit spread of the lowest rated tranche.

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*University of Konstanz, department of economics, D-78457 Konstanz, POB D 147. E-mail: guenter.franke@uni-konstanz.de, thomas.a.weber@uni-konstanz,de.

** HSBC Bank, global research, London. E-mail: markus-herrmann@hsbcgroup.com

1. Introduction

Over the last 20 years the volume of securitizations has grown tremendously. The global volume of securitization issuance was estimated to be roughly 270 bn USD for 1997 and about 1600 bn USD for 2005 (HBSC (2006)). Securitizations are important for the management of default risks by financial intermediaries and may have positive effects on financial stability. A subset of these securitization-transactions are collateralized debt obligation (CDO)-transactions. They can be collateralized loan obligation (CLO)- or collateralized bond obligation (CBO)-transactions. In the former case a bank typically securitizes part of its loan portfolio. In the latter case the originator of the transaction, a bank or an investment manager, buys bonds, and sometimes in addition some loans, pools them in one portfolio and sells the portfolio to investors.

This paper analyses the design of CDO-transactions. In a perfect capital market securitizations would be useless. Therefore securitization research needs to focus on market imperfections to understand the design of securitization transactions. Information asymmetries, transaction and management costs, costs of financial distress, costs of equity capital, other regulatory costs and liquidity premiums appear to be important. If a bank, for example, securitizes the default risk of many loans granted to small and medium sized enterprises (SMEs), then investors know little about these obligors, relative to the bank. This provides room for adverse selection and moral hazard of the bank. Management costs of investors and of the bank including those of involved third parties also play a role in the securitization process. These costs include the costs of setting up the transaction (internal costs of the originator, fees of lawyers, rating agencies, custodians etc.) and the costs of managing the transaction after the setup. They are incurred by the originator and the investors buying the securities. By splitting the default risk of a portfolio into tranches of high and low default risk, sophisticated investors with strong risk management capacity and high management cost may buy high risk-tranches, while non-sophisticated investors with low management cost preferably buy low risk-tranches. Securitization, thus, induces management costs and costs to mitigate information asymmetries. Both pose a barrier to securitization. Therefore securitization makes sense only if these costs are overcompensated by some benefits. These benefits may come from better risk allocation across economic agents, a reduction of the bank's cost of required equity capital, other regulatory costs and refinancing costs. Moreover, the transfer of default risks in a securitization gives the bank the option to take other risks.

The purpose of this paper is to add to the understanding of the design of securitization transactions. The market imperfections mentioned above pose a challenge to the originator of a transaction. How should she design the transaction so as to maximize her net benefit? There are many degrees of freedom in setting up a transaction. For example, which loans/bonds should be selected as collateral for a transaction? Should the transaction be structured as a true sale- or a synthetic transaction? Should the originator retain a substantial fraction of the default risk of the underlying portfolio? These questions can only be answered taking into consideration not only the needs of the bank/originator, but also the needs of investors. They insist on a solid design of the transaction so as to protect them against potential losses due to information asymmetries, and on a tranching of securities to satisfy their needs of risk and return. We try to answer these questions by, first, looking at the optimization problem of the originator and deriving hypotheses about optimal design. Second, we investigate a European set of securitization transactions to test these hypotheses. To our best knowledge, this study is the first to analyse the interaction between the quality of the securitized asset pool, the other choice variables and originator characteristics.

The main findings of the paper can be summarized as follows. First, the quality of the securitized asset portfolio determines the default risk retained by the originator through the First Loss Position. This position increases when the portfolio quality declines. The quality of the securitized asset portfolio is measured by its weighted average default probability (WADP) and by Moody´s diversity score (DS). A lower WADP and/or a higher DS improve the asset pool quality. We interpret this as evidence that a lower portfolio quality reinforces problems of asymmetric information which are mitigated by a higher First Loss Position. Second, the attractiveness of a synthetic relative to a true sale transaction increases with the portfolio quality. A higher portfolio quality implies a lower default risk of the super-senior tranche, making it less attractive for the originator to sell this tranche. Retention of this tranche is in strong contrast to the literature which argues that the originator should sell the least information-sensitive tranche. Also the size of the super-senior tranche which the originator retains in a synthetic transaction, increases with the portfolio quality. Third, the number of tranches with different ratings increases with the diversity score and also with the weighted average default probability of the underlying portfolio. Thus, the number of tranches reacts differently to quality improvements measured by WADP and DS. The intuition for this finding is not clear. It might be that in accordance with signalling models a better diversity score is also signalled through a higher number of tranches, but a higher weighted average default probability allows for more differentiation of tranche quality so as to better satisfy different customer needs and extract a higher "comsumer rent". Fourth, the credit spread on the lowest rated tranche is much better explained by its rating than by the portfolio quality and the First Loss Position. This underscores the important role of the rating agencies.

Surprisingly, characteristics of the originator like her rating, her total capital ratio, Tobin´s Q and other variables which may proxy for her securitization motives, add little to the explanatory power of the regressions. This indicates that the design of securitization transactions depends little on these characteristics. Essentially, rating agencies and investors appear to be the dominant force. This strengthens the credibility of our findings since it mitigates endogeneity problems which might arise because all the elements of the transaction design are eventually chosen by the originator.

The paper is structured as follows. In section 2 the relevant literature is discussed. In section 3 we discuss the originator's optimization problem and derive hypotheses about her choice of the transaction design. The empirical findings are presented in section 4 and discussed in section 5. Section 6 concludes.

2. Literature Review

The design of a CDO-transaction is a complex task. In order to relate it to the literature, we first characterize CDO-transactions. Depending on her motives, the originator selects a set of loans or/and bonds[1] as the underlying asset pool of the transaction. In a static deal, this set is determined at the outset. In a dynamic (managed) deal, this set changes over time depending on the originator's policy. The originator decides on the share of default risk which she retains through the First Loss Position. Closely related is the decision whether to use a true sale or a synthetic transaction. In a true sale transaction, all loans/bonds are sold without recourse to the special purpose vehicle which issues various tranches of bonds to investors. The originator can freely use the proceeds from issuing the tranches. In a synthetic transaction the originator retains ownership of the loans/bonds and transfers part of the default risk through a credit default swap to the special purpose vehicle. Often the issued tranches cover only a small fraction of the nominal value of the underlying portfolio because the originator retains a large super-senior tranche and its associated default risk. Moreover, she does not receive the issuance proceeds. These need to be invested in AAA-securities or other almost default-free assets. Finally, in all transactions the originator decides about the tranching of the bonds to be issued. All these decisions are taken by the originator in close collaboration with the involved rating agencies and leading investors.

In the following we summarize the literature related to these issues. The optimality of first loss positions (FLP) has been demonstrated in a variety of settings. In the absence of information asymmetries, *Arrow* (1971) [see also *Gollier* and *Schlesinger* (1996)] analysed the optimal insurance contract for a setting in which the protection buyer is risk averse, but the protection sellers are risk neutral. If the protection sellers bound their expected loss from above, then a FLP of the protection buyer is optimal. This follows because optimal risk sharing entails an upper limit of the realized loss borne by the risk averse protection buyer. *Townsend* (1979) considers risk sharing between a risk averse entrepreneur and investors in the presence of information asymmetries about the entrepreneur's ability to pay. If the

[1] The bonds may include tranches of other securitization transactions or structured finance products.

entrepreneur fully pays the investor's claim, then she incurs no other costs. If she does not fully pay claiming that she lacks the necessary funds, then this claim needs to be verified. If the state verification cost is borne by the entrepreneur, the optimal contract is a standard debt contract: The entrepreneur fully pays the fixed claim when her company earns sufficient funds. Otherwise she prefers to pay the lower state verification cost and impose some loss on the investors. This is basically the same as taking a FLP.

In a related model of *Gale* and *Hellwig* (1985), both, the entrepreneur and investors, are risk neutral. However, the entrepreneur can only bear limited losses in order to stay solvent. Again, a standard debt contract turns out to be optimal implying a FLP of the entrepreneur.

In the previous two papers information asymmetries are resolved through state verification. The more recent literature distinguishes between information-sensitive and -insensitive securities. Information-insensitive securities are subject to little information asymmetries, in contrast to information-sensitive securities. *Boot* and *Thakor* (1993) argue that a risky cash flow should be split into a senior and a subordinated security. The senior security is information-insensitive and can be sold to uninformed investors while the subordinated security is information-sensitive and should be sold to informed investors. This allows the seller of the cash flow to raise the sales revenue. *Riddiough* (1997) extends this reasoning by showing that loan bundling allows for pool diversification which softens information asymmetries. Moreover, the holder of the junior security should control changes in the loan portfolio because she primarily bears the consequences.[2]

DeMarzo and Duffie (1999) analyse the security-design assuming a tradeoff between the retention cost of holding cash flows and the liquidity cost of selling information-sensitive securities. They also prove that a standard debt contract is optimal and that an issuer with very profitable investment opportunities retains little default risk in a securitisation transaction. In a recent paper *DeMarzo* (2005) shows that pooling of assets has an information destruction effect since it prohibits the seller to sell asset cash flows separately and, thereby, optimize asset specific sales. But pooling also has a beneficial diversification effect. Tranching then allows to sell the more liquid information-insensitive claims. This model is generalized to a dynamic model of intermediation. In a related paper, *Plantin* (2003) shows that sophisticated institutions with high distribution costs buy and sell the junior tranches leaving senior tranches to retail institutions with low distribution costs. *David* (1997) asks how many tranches should be issued. Tranches are sold to individual and institutional investors. The

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[2] *Gorton* and *Pennacchi* (1995) consider a bank which optimizes the fraction of a single loan to be sold and the optimal guarantee against default of the loan. This setup contrasts with a FLP of the bank.

latter buy tranches to hedge their endowment risk. Hence tranches should be differentiated so as to allow the different groups of investors an effective hedging.[3]

There are a few empirical studies related to securitizations. *Childs*, *Ott and Riddiough* (1996) investigate the pricing of Commercial Mortage-Backed securities and find the correlation structure of the asset pool and the tranching to be important determinants of the launch spreads of the tranches. *Higgins* and *Mason* (2004) find that credit card banks provide implicit recourse to asset-backed securities to protect their reputation. *Cebenoyan* and *Strahan* (2004) find that banks securitizing loans hold less capital than other banks and have more risky assets relative to total assets. *Franke* and *Krahnen* (2005) find that securitization tends to raise the bank's stock market beta indicating more systematic risk taking. *Cuchra* and *Jenkinson* (2005) analyse the number of tranches in securitizations and find that the number increases with sophistication of investors, with information asymmetry and with the volume of the transaction[4]. Finally, *Cuchra* (2005) carefully analyses the launch spreads of tranches in securitizations and finds that ratings are very important determinants besides of general capital market conditions. He also finds that larger tranches command a lower spread indicating a liquidity premium.

3. The Originator's Optimization and Hypotheses

When structuring a securitization transaction, the originator maximizes her net benefit. The gross benefit in a CLO-transaction may be summarized by the decline in the costs of required equity capital and other regulations, the decline in the expected costs of financial distress due to the reduction of default risk, and possibly the lowering of refinancing costs. Alternatively, the originator may reduce her default risk in order to take other new risks. Then the value of these new activities contributes to the gross benefit. The costs of securitization transactions include the credit spreads paid to investors, the setup and management costs, the costs of credit enhancements and reputation costs. The latter costs are incurred if investors suffer from default losses and attribute them to bad management of the originator. Investors would then charge higher spreads in future transactions.

In a CBO-transaction, the originator also maximizes her net benefit. However, often she purchases the asset pool and securitizes it simultaneously, retaining part of the risks through a FLP. Apart from these risks, the net benefit in such a transaction is an arbitrage profit. This explains why these transactions are often called arbitrage transactions. In the following we

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3 *Glaeser and Kallal (1997*) show that more information may increase information asymmetries. Hence limiting information disclosure may improve liquidity of asset-backed securities in the secondary market.

4 There are also various empirical studies about implied correlations of tranches in CDO^2-transactions.

discuss the originator's most important decisions in securitization transactions and derive testable hypotheses.

3.1 Choice of the Asset Pool

The originator selects the assets to be included in the underlying collateral pool. Since this paper only considers CDO-transactions, we restrict ourselves to loans and bonds. In the case of a loan transaction, the originating bank transfers part of the default risk of a subportfolio of its loans. The choice of this subportfolio relates to the number and the quality distribution of the loans, their maturity structure and its diversification within and across industries. One measure of the average quality of the loans is the weighted average default probability (WADP) of the loans. The intra- and interindustry-diversification of the loan portfolio can be summarized into a diversity score (DS) as it is done in Moody´s Diversity Score. This score can be interpreted as the diversification-equivalent number of equally sized loans whose defaults are uncorrelated. These two characteristics of the asset pool are the major determinants of the asset pool quality. Similarly to CLO-transactions, the originator decides about the quality of the bond portfolio in a CBO-transaction.

The first question is whether originators choose asset pools with homogeneous quality. Is a low WADP associated with a high DS and vice versa? As pointed out by *DeMarzo* (2005) and others, a high DS reduces information asymmetries because the idiosyncratic risks of the assets tend to be diversified away. Similarly, one may argue that information asymmetries are stronger for asset pools with higher WADPs because errors in estimating default probabilities tend to be higher. Given, for example, a claim with a communicated AAA-rating, the implied default probability is very low so that estimation errors should be small as well. Hence an originator being afraid of unfavourable investor reaction to strong information asymmetry would choose an asset pool with a low WADP and a high DS. But if the securitization motive in a CLO-transaction is to transfer default risk, then the originator may choose an asset pool with a high WADP. Yet, if investors appreciate a high diversity score, then it is easy for a bank with a large loan portfolio to pool a large number of loans. Given these conflicting conjectures, we refrain from a hypothesis about the joint choice of WADP and DS.

Information asymmetries tend to be stronger for CLO- than for CBO-transactions because loans are often given to small or medium sized firms whose identity is not revealed to investors while bond issuers are revealed and often are big firms or governments with publicly available information. Therefore CLO-tranches should meet with stronger investor-skepticism than CBO-tranches, controlling for WADP and DS. The originator can mitigate this problem by choosing a loan portfolio with a better quality[5]. If information asymmetries are smaller in CBO- than in CLO- transactions, in the latter transactions the originator should have a stronger incentive to mitigate investor scepticism by choosing an asset pool with better quality. This leads to

Hypothesis 1: *The quality of the asset pool, measured by the weighted average default probability of the asset pool and by pool diversification, is better in CLO- than in CBO-transactions.*

3.2 Choice of the First Loss Position

Investor scepticism can be reduced by an improvement of the quality of the asset pool, but also by a FLP taken by the originator. She may retain, for example, the most junior tranche of the securities which is most information-sensitive. The FLP can take different forms. It may be an initial FLP which is a fixed commitment of the originator to absorb the first default losses up to a given limit. The initial FLP may be supplemented by a reserve account which may build up over time due to interest surplus (interest revenue from the asset pool minus interest expense on tranches) and is used to absorb default losses. Hence an originator may substitute part of the initial FLP by a higher reserve account. This would reduce equity capital requirements. In the following, we discuss the choice of the size of the FLP.

The preferred size of the FLP depends on the benefits and costs of a FLP. First, consider the benfits. By retaining the most junior tranche, the originator saves a high mistrust premium and, perhaps, a complexity premium on this tranche. Owners may charge the latter premium because they incur high costs of sophisticated management. A substantial FLP may also strengthen investor confidence in the overall transaction so that they charge lower mistrust premia on all sold tranches. This is likely to be true because a higher FLP raises the originator's share in default losses. Hence adverse selection pays off less for her as does moral hazard in servicing and monitoring the asset pool. Therefore, investors may be more confident in the overall transaction, the higher is the FLP. Second, the cost of a high FLP is the associated default risk and the regulatory costs of this risk.

From the preceding analysis it appears that the benefits of a FLP increase with information asymmetry. This asymmetry is smaller if the quality of the asset pool is higher. The burden of the asymmetry is likely to be felt stronger by investors, the lower the quality of the asset pool

5 De Marzo (2005) argues that stronger diversification makes securitization of asset pools more attractive relative to liquidating assets separately because diversification reduces information asymmetries.

is. Hence investors would appreciate a higher FLP more, the lower is the quality of the asset pool. This leads to

Hypothesis 2: *The FLP is higher, the lower the quality of the asset pool.*

Hypothesis 2 does not differentiate between the two main determinants of the quality of the asset pool, WADP and DS. A decline in DS, holding WADP constant, can be perceived as a mean preserving spread in the loss rate distribution of the asset pool so that the two cumulative probability distributions intersect once. An increase in WADP, holding DS constant, can be perceived as a first order stochastic dominance shift in the loss rate distribution. Some implications of both changes are summarized in the following lemma which is proved in the appendix.

Lemma: *Consider a true sale transaction with a given size of the FLP.*

a) Then a mean preserving spread of the loss rate distribution, induced by a decline in asset pool diversification, implies a higher expected loss for the sold tranches altogether and a lower expected loss for the FLP.

b) Then an increase in the weighted average default probability of the asset pool, leading to a first order stochastic dominance shift in the loss rate distribution, implies a higher expected loss for the sold tranches and for the FLP.

The lemma shows for a true sale transaction that a decline in asset pool diversification redistributes expected losses from the FLP to investors while an increase in the weighted average default probability hurts both, the FLP and the investors. Therefore a decline in diversification may be in the interest of the originator, but hurt investors. Given this conflict of interest with respect to diversification, investors should be more sensitive to a decline in DS than to an increase in WADP. This may induce originators to offer FLPs, the size of which reacts stronger to a decline in DS than to an increase in WADP.

In a synthetic transaction, an originator retaining the super-senior tranche, would incur a higher expected loss on this tranche, given a decline in asset pool diversification. Hence the conflict stated in the lemma would be mitigated, but is unlikely to disappear since the probability is very small that the super-senior tranche incurs a loss. Therefore we state

Hypothesis 2a: *The relationship between the size of the FLP and asset pool diversification is stronger than that between size and asset pool-WADP.*

Hypothesis 2 is based on the conjecture that the size of the FLP is driven by the extent of information asymmetries. As argued above, these appear to be stronger in CLO- than in CBO-transactions. Therefore we state

Hypothesis 3: *Given the same communicated quality of the asset pool, the FLP is higher in CLO- than in CBO- transactions.*

The originator faces the choice between a static and a dynamic (managed) transaction. In a static transaction the original asset pool cannot be changed subsequently by the originator. In contrast, the originator may change the asset pool in a dynamic transaction subject to constraints specified in the offering circular. She may replenish the pool after repayment of some assets or substitute new for existing assets. This induces another moral hazard problem which can be mitigated by a higher FLP. This motivates

Hypothesis 4: *Given the same communicated quality of the asset pool, the FLP is higher in managed than in static transactions.*

A higher FLP retained by the originator reduces her opportunities for taking new risks. Therefore an originator with better investment opportunities should take a smaller FLP. As argued by *De Marzo* and *Duffie* (1999), she would transfer more default risks, the more valuable her real options are.

Hypothesis 5: *Banks with more valuable real options take a smaller FLP.*

3.3 The Choice Between a True Sale- and a Synthetic Transaction

The originator usually retains the most junior tranche as a FLP. In addition, the originator may consider the credit spread on a senior tranche as high relative to its default risk so that she prefers not to sell this tranche. Usually a synthetic transaction is partially funded, i.e. the volume of securities sold is only a (small) fraction of the volume of the asset pool. The originator usually retains a FLP *and* a large super-senior tranche. This is in strong contrast to some papers discussed in section 2 which argue that the originator should sell the least information-sensitive tranche because it suffers least from information asymmetries. This puzzle is usually observed in synthetic transactions.

The explanation of this puzzle may hinge on the refinancing aspect. In a true sale-transaction the originator uses the revenue from issuing securities at discretion for his own purposes while in a synthetic transaction this revenue must be invested almost free of default risk. Hence a true sale transaction also serves refinancing purposes while a synthetic transaction does not.

The choice between a true sale- and a synthetic transaction, thus, involves a choice between

- selling vs. not selling the super-senior tranche, and

- refinancing vs. no refinancing[6].

We hypothesize that banks with a very good rating have little incentive to use CDO-transactions for refinancing purposes since they can obtain funds at low credit spreads anyway. This is impossible for banks with a weak rating. For them it may be cheaper to refinance through a true sale transaction than through stand alone-borrowing. In a true sale transaction the strong collateralisation and the bankruptcy-remoteness of the special purpose vehicle render the bank's rating rather unimportant. This leads to

Hypothesis 6: *Synthetic [true sale] transactions are preferably used by banks with a strong [weak] rating.*

Another reason to retain the least information-sensitive super-senior tranche may be that the bank considers the credit spread to be too high[7]. This is plausible, in particular, if the bank regards the asset pool quality as very high, but is not able to communicate this credibly. Since information on asset pool quality is imperfect, investors may charge a credit spread in excess of the spread given perfect information. This effect is likely to be stronger, the better the "true" quality of the asset pool is. This leads to

Hypothesis 7*:* *Synthetic transactions are preferred to true sale transactions for asset pools with high quality.*

Related to this hypothesis is the decision on the size of the non-securitized super-senior tranche given a synthetic transaction. The risk of this tranche is inversely related to the quality of the asset pool. Hence, the bank can retain a larger super-senior tranche, the better is the asset pool quality, holding its risk constant. This motivates

Hypothesis 8: *In a synthetic transaction the size of the non-securitized super-senior tranche increases with the quality of the asset pool.*

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[6] Another aspect relates to balance sheet effects. Until 2004, in a true sale transaction the securitized assets disappear from the originator's balance sheet while they do not in a synthetic transaction. Thus, a true sale transaction allows to "improve" the balance sheet. The new accounting standards imply for most true sale transaction that the assets need to be shown on the originator´s balance sheet.

[7] The originator may buy protection against default losses of this tranche through a super-senior credit default swap. Casual observation suggests that banks often do not buy this protection because they feel that it is too expensive.

3.4 Tranching

The originator also decides about the tranching of the issued securities. Tranching serves the different needs of investors through “product differentiation”. This is done in close cooperation with the involved rating agencies and important investors. In a few transactions we see not only one but several AAA-tranches denominated in the same currency with strict subordination between these tranches. In other transactions, we see AAA-tranches of equal seniority, but denominated in different currencies. Sometimes, there is a wide spectrum of AAA, AA, A, BBB, BB, B-tranches while in others there is only one rated and one non-rated tranche[8].

The analysis of tranching is complicated by the hidden tranches. In a true sale transaction usually the nominal value of all tranches equals the nominal value of the underlying portfolio given only non-distressed underlying loans/bonds. But the market value of this portfolio is likely to be higher than the nominal value because securitized, liquid assets command a lower liquidity premium than illiquid assets. The originator captures the market value increase from securitization by supplementing the visible tranches with two invisible tranches which he owns. The first one is a First Profit Position which may be even senior to the visible senior tranche. Usually the originator collects servicing and other fees to cover her costs[9]. Beyond that the originator often charges the special purpose vehicle fees hidden in swaps and other servicing contracts. These claims may rank first and provide profits for the originator. In addition, the originator holds the subequity piece. In addition to the non-rated lowest tranche, the special purpose vehicle may collect a surplus on its accounts from interest excess spread after having paid all fees and having covered part of the default losses according to the offering circular. This surplus is eventually earned by the originator. It represents the subequity piece which alos exists in synthetic transactions.

It is difficult to evaluate the hidden tranches without knowing the loss rate distribution of the underlying portfolio and the details of the contracts between the originator and the special purpose vehicle. Therefore we analyse only the visible tranches. We address two issues, first, the number of rated tranches with different ratings, and, second, the determinants of the launch spread of the lowest rated tranche.

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8 We exclude here single tranche deals because they are driven by the needs of single investors and, therefore by different considerations than multi tranche deals.

9 Other involved parties like the trustee, the accountant and the custodian also collect fees.

a) The Number of Tranches

Looking at the number of tranches, we count the number of differently rated tranches. Strict subordination of tranches usually guarantees a different rating. Then increasing the number of subordinated tranches provides investors more information on the loss rate distribution of the underlying asset pool since the rating of each tranche is related to its expected default loss rate (using Moody's rating technology) resp. its default probability (using Standard & Poor's rating technology). Providing more information should reduce information asymmetry, and, thus, the mistrust premiums charged by all investors together. Therefore, the stronger the information asymmetry due to the underlying asset pool is, the stronger should be the potential for reducing the overall mistrust premium by offering more information through a higher number of tranches. This argument is consistent with a costly signalling equilibrium because the overall transaction costs of securitization increase with the number of tranches (see also *Cuchra* and *Jenkinson* [2005]). If information asymmetries are inversely related to asset pool quality, then this should also hold for the number of tranches. This leads to

Hypothesis 9: *The number of tranches is inversely related to the communicated quality of the asset pool.*

Due to economies of scale, a larger asset pool offers more potential for "product differentiation" through finer tranching [see also *Cuchra* and *Jenkinson* (2005)]. Hence we have

Hypothesis 10: *The number of tranches increases with the volume of the asset pool*.

Cuchra and *Jenkinson* (2005) also suggest that the more sophisticated and differentiated investors are in their management capacities, the more "product differentiation" should pay. More "product differentiation" allows the originator to tailor the tranches better to the needs of different investor groups and, thus, to extract more "investor rents". Since investor sophistication increases over time due to a learning process, we will test

Hypothesis 11: *The number of tranches increases over time.*

b) The Credit Spread of the Lowest Rated Tranche

The number of tranches depends on the quality of the lowest rated tranche. If, for example, it is rated B instead of BBB, then there is also room for a BB-tranche. The launch or initial credit spread (= credit spread at the issue date) of the lowest rated tranche offers a good opportunity to evaluate the importance of the rating agencies. This spread should be related inversely to the asset pool quality. Moreover, given the loss rate distribution of the asset pool, the FLP, or more generally, the hard credit support of the lowest rated tranche[10], determines the default risk of this tranche. Hence a higher hard credit support should reduce its credit spread. This motivates

Hypothesis 12: *The credit spread of the lowest rated tranche is inversely related to the quality of the underlying asset pool and to the size of the tranche´s hard credit support.*

Cuchra (2005) finds that credit spreads of tranches are strongly determined by their ratings relative to other factors like capital market conditions and type of collateral asset. In order to find out whether investors rely more on the measures of asset pool quality and hard credit support than on the rating of the lowest rated tranche, we test

Hypothesis 13: *The credit spread of the lowest rated tranche is better explained by its rating and its maturity than by the quality of the asset pool and the size of the tranche´s hard credit support.*

Cuchra (2005) also finds that the credit spread of a tranche is inversely related to its $-volume indicating an inverse relation between the tranche´s liquidity premium and its volume. Therefore we test

Hypothesis 14: *The credit spread of the lowest rated tranche is inversely related to its $-volume.*

4. Empirical Findings

The hypotheses stated above will be tested on a set of European CDO-transactions most of which have been completed in the years 2000 to 2004. We only consider multi tranche-transactions because single tranche-transactions are usually initiated by investors. Moreover, the quality of the asset pool plays a major role in our hypotheses. Therefore it is essential to have the same type of quality measures for all transactions. Moody’s uses two important measures of asset pool quality, one being the weighted average rating factor of the assets in the pool and the other one being their diversity score (DS). Moody’s assigns each asset a rating factor and then takes a weighted average. This rating factor equals 1 for all AAA-claims regardless of maturity. For claims with another rating, the rating factor depends on the maturity and denotes the idealized probability of default for this rating class divided by the idealized probability of default for AAA-claims of the same maturity. We use Moody’s tables

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[10] In some transactions, there exists more than one non-rated junior tranche. Then all these tranches provide hard credit support for the lowest rated tranche.

to translate the weighted average rating factor into the weighted average default probability (WADP). If Moody’s does not publish a weighted average rating factor, we use the published average rating of the asset pool and translate it into the WADP using Moody´s tables. Moody’s diversity score (DS) measures the diversification of the assets within and across industries, taking into account also variations in asset size. The diversity score ranges between 1 and 135. Thus, a DS of 1 indicates “no diversification” and a DS of 135 indicates “excellent diversification”.

We include in our data set all European CDO-transactions from the end of 1997 to the end of 2005 for which we know Moody’s DS and can derive the WADP[11]. This information is taken from offering circulars, from pre-sale reports issued by Moody’s and from transaction reports of the Deutsche Bank-Almanac. Our European CDO-sample of multi tranche deals includes 169 observations. This sample represents a fraction of about 50 % of all European CDO-transactions in the observation period.

4.1 Descriptive Statistics and Methodology

First, we present some descriptive statistics. The sample includes 169 transactions. The first table shows their distribution across CLO/CBO- and true sale/synthetic transactions and the distribution across years. In the sample 57 percent of the transactions are CBO-transactions, 54 percent are synthetic. Most transactions were completed between 2000 and 2004.

From the 169 transactions, 136 are arranged by banks and 33 by investment firms. The latter buy existing bonds and securitize them. In 15 CLO-transactions, the originating investment firms buy bonds and existing loans and securitize them. Since these transactions are, in spirit, very similar to CBO-transactions, we reclassify these 15 CLO-transactions as CBO-transactions. Thus, 33 CBO-transactions, i.e. 1/3 of the CBO-transactions, are originated by investment firms, all other transactions by banks.

	True sale	Synthetic	∑
CLO	30	43	73
CBO	48	48	96
∑	78	91	169

[11] We include a few transactions without a rating from Moody´s where the average quality of the underlying assets is known and also their diversification.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
number of transactions	1	1	12	26	40	42	16	19	12

Table 1: The upper part shows the number of transactions in the sample differentiating CLO- and CBO-transactions as well as true sale- and synthetic transactions. The lower part shows the distribution of transactions across years.

Table 2 presents the means and standard deviations of

-- WADP, the weighted average default probability of the assets in the pool,

-- DS, Moody's diversity score of the asset pool,

-- FLP, the initial size of the first loss position as a percentage of the volume of the asset pool,

-- NSP, the volume of the non-securitized senior tranche as a percentage of the volume of the asset pool, regarding synthetic transactions,

-- CSL, the initial (= launch) credit spread on the lowest rated tranche[12],

-- # TR, the number of tranches with different ratings.

The data are presented separately for true sale-/synthetic and CLO/CBO-transactions.

	CLO – ts	CLO – synth	CBO – ts	CBO – synth
WADP – mean WADP – std.	7.4 % 7.3 %	4.1 % 3.4 %	13.4 % 9.8 %	1.9 % 3.2 %
DS – mean DS – std.	87 46	89 30	33 11	56 26
FLP – mean FLP std.	5.9 % 5.0 %	2.8 % 1.5 %	10.8 % 6.0 %	3.4 % 2.5 %
NSP – mean NSP – std.	- -	80 % (86%) 23 % (7%)	- -	87% 7%

[12] Most tranches are floating rate notes. In the few cases of fixed rate notes we take the difference between the coupon and the swap rate of the same maturity as the credit spread.

#TR – mean #TR – std.	3.9 1.1	4.44 0.96	3.38 1.38	3.00 1.15
CSL– mean CSL – std.	248 bp 184 bp	479 bp 204 bp	334 bp 257 bp	281 bp 166 bp

Table 2: The table shows the means and standard deviations of transaction characteristics differentiating CLO and CBO-transactions as well as true sale (ts) and synthetic (synth) transactions. WADP and DS are the weighted average default probability and diversity score of the asset pool. FLP is the initial size of the FLP, NSP the non-securitized senior tranche as a percentage of the asset pool volume in synthetic transactions, CSL the launch credit spread of the most junior rated tranche, #TR the number of tranches with different ratings. The bracketed numbers for NSP in CLO-transactions are obtained if three fully funded Geldilux-transactions are excluded.

Table 2 indicates several interesting properties. The mean weighted average default probability is much higher for true sale than synthetic transactions. Also the mean is clearly higher for synthetic CLO– than synthetic CBO- transactions. On average, CLO-transactions are much better diversified than CBO-transactions. The average size of the FLP is higher for true sale than for synthetic transactions, and within these subsets the FLP is higher for CBO- than for CLO-transactions. The non-securitized senior tranche in synthetic transactions is, on average, about 86 % with a standard deviation of only 7 % for CLO **and** for CBO-transactions if we exclude three atypical Geldilux-transactions. These transactions are the only fully funded synthetic CLO-transactions, i.e. there is no NSP. Including these transactions lowers the average NSP of synthetic CLO-transactions to 80 %. The number of tranches with different ratings is higher for CLO- than for CBO-transactions. The credit spread of the lowest rated tranche is, on average, highest for synthetic CLO- and lowest for true sale CLO-transactions.

In the following we test the hypotheses derived in section 3. In principle, the originator decides about all the characteristics of a transaction. Since characteristics are regressors and regressands at the same time, this could raise a severe endogeneity problem. We try to take care of this problem by, first, distinguishing between banks and investment firms as originators, and, second, by including in the regressions various characteristics of originating banks. First, investment firms arrange transactions solely for arbitrage purposes. They select the assets for the underlying portfolio and the tranching so as to maximize the arbitrage profit. These choices are largely determined by market conditions imposed by investors and rating agencies. Characteristics of the investment firm should be largely irrelevant. Therefore the securitization decisions of the investment firm should be governed by market considerations, i.e. by exogenous forces. This should rule out the endogeneity problem for transactions originated by investment firms.

Second, banks pursue different objectives in their securitization activities creating endogeneity problems. A bank may want to reduce its default risk and, hence, the equity capital requirements. The need for such a transaction may depend on the level of its equity capital relative to its risk-weighted assets, on its profitability and on its options for taking other risks. Therefore these characteristics might govern various transaction decisions. Similarly, a bank may want to lower its refinancing costs through true sale-securitization. The need for doing this may be related to its refinancing opportunities using standard debt instruments. Since the costs of these instruments depend on the bank´s rating, this should also be true for the strength of the refinancing motive in securitizations.

In order to account for the impact on securitization decisions of these bank-internal considerations, in the regressions we include as additional regressors data on the originating banks which proxy for these considerations. These data are

- data on equity capital relative to risk weighted assets: the tier 1-capital ratio and the total capital ratio,
- capital structure data: equity/total assets,
- asset structure data: loans/total assets,
- profitability data: the return on average equity capital in the transaction year, the average return over the years 1994 to 2004, and the standard deviation of these returns as a proxy for profitability risk,
- Tobin´s Q to proxy for the bank´s profitability and also for its growth potential as evaluated by the capital market,
- the bank´s rating to proxy for its refinancing motive. The rating is captured by an integer variable which equals -1 for a AAA-rating and declines by 1 for every notch. Hence a higher integer indicates a better rating.

These bank characteristics are exogenous to securitization decisions and should explain the bank´s choices as far as they are driven by internal considerations. Thus, we hope to avoid endogeneity problems. The bank data are obtained from the Bank Scope Database.

Since these characteristics are not available for investment firms and also for some banks, for each characteristic we attach a residual dummy RD of 1 to those originators for whom the characteristic is not known and a residual dummy RD of 0 otherwise. Then the regression is of the type

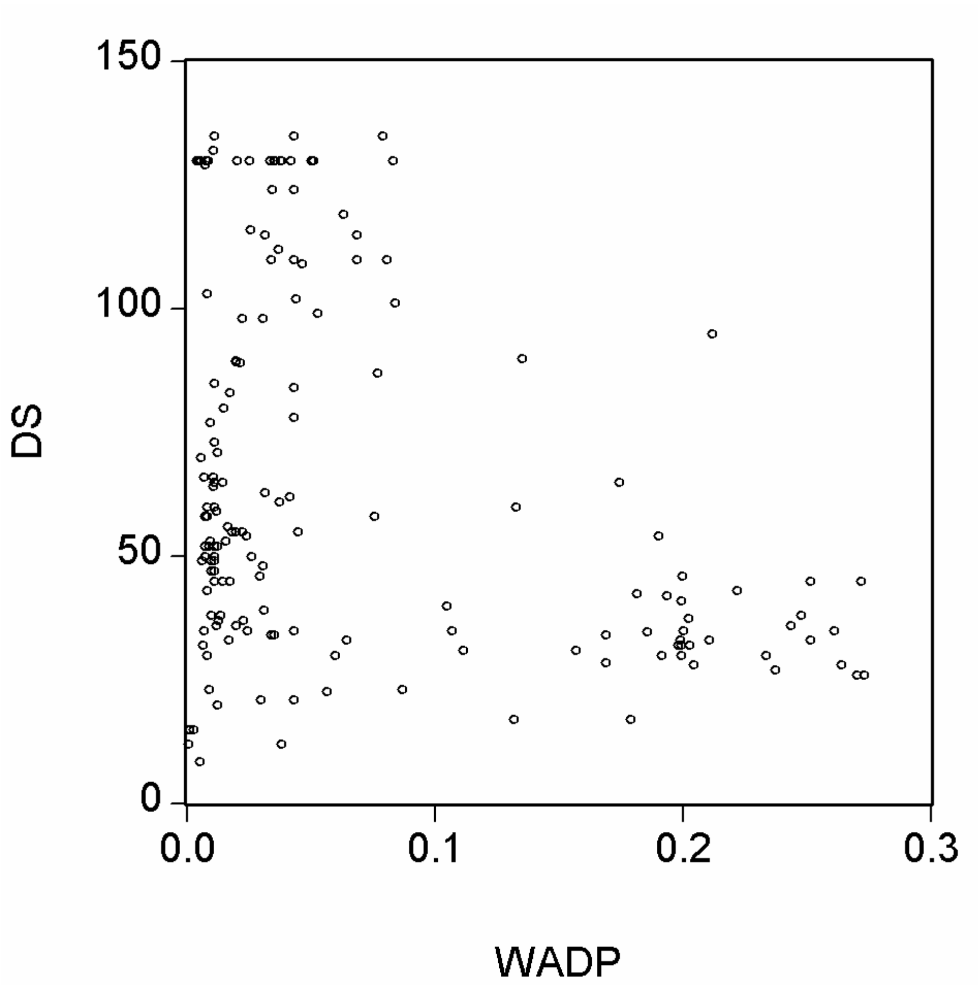
$$y = a + b\, x1 + c\,(1\text{-}RD)\,\Delta x2 + d\, RD + \varepsilon. \qquad (1)$$

x1 denotes the vector of explaining variables not being originator characteristics, b the vector of regression coefficients, $\Delta x2$ the bank characteristic minus its average in the sample and ε

the usual error term. This approach implies that for the banks with a known characteristic the variation in this zero-mean characteristic is taken into consideration while for the other originators no variation is assumed. d can be interpreted as the product of the average (unknown) characteristic and the corresponding “true” regression coefficient. Hence a higher average would be automatically compensated by a lower “true” regression coefficient and, thus, is irrelevant. If Δx2 or RD does not add to the explanatory power of the regression, then it is eliminated.

4.2 The Quality of the Asset Pool

Various hypotheses claim that the quality of the underlying asset pool has an impact on other securitization decisions. Therefore we, first, analyse whether the originator follows a homogeneous quality policy, that is whether he combines a low (high) weighted average default probability (WADP) with a high (low) diversity score (DS). Then, both quality indicators would be highly correlated. Regressing lnDS only on WADP shows a negative, highly significant regression coefficient. But the explanatory power, measured by R^2, is only 7.6 %. The reason is evident from Graph 1. It appears that for asset pools with WADP below 0.1 there is no relation between WADP and DS. For asset pools with WADP above 0.1, DS is rather low indicating low quality of the pool. Hence there is partial support for homogeneous quality choice.



Graph 1: The graph shows for 169 transactions Moody´s diversity score DS and the weighted average default probability WADP

Therefore, we now check what other factors determine WADP and DS. The first column of table 3 shows that WADP depends strongly on the originator type represented by a dummy of 1 if the originator is an investment firm and 0 otherwise. On average, investment firms clearly choose a higher WADP than banks. Possibly asset pools with a higher WADP offer more potential for arbitrage profits in a CBO-transaction. As shown in the second column, WADP tends to be lower in synthetic transactions represented by a dummy of 1 if the transaction is synthetic and 0 otherwise. This indicates that originators do not like high default risk in transactions in which they retain the super-senior tranche. Finally, WADP tends to increase with the bank´s total capital ratio indicating that banks with a strong equity buffer afford taking more default risks in the underlying asset pool. Tobin´s Q has no significant impact.

Looking at the factors explaining the diversity score, the third column of table 3 indicates that a substantial part of the variation in DS can be explained by WADP and by the CBO-dummy which is 1 for a CBO-transaction and 0 otherwise. CBO-transactions tend to be much less diversified as can be seen already in the descriptive statistics in table 2. This is not surprising

Explained variable	Weighted Default	Average probability	Ln	Diversity Score
Weighted average default probability of asset pool	-	-	-1.67 (0.0002)	-1.29 (0.0224)
Ln diversity score	-0.015 (0.0941)	-0.015 (0.0822)	-	-
Investment firm-dummy	0.11 (0.0000)	0.086 (0.0000)	-	-
CBO-dummy	-	-	-0.65 (0.0000)	-0.61 (0.0000)
Synthetic dummy	-	-0.053 (0.0000)	-	0.20 (0.1006)
ΔTotal capital ratio	-	0.015 (0.0004)	-	0.10 (0.0149)
ΔTobin´s Q	-	-0.013 (0.1261)	-	-
Adjusted R^2	0.376	0.492	0.346	0.412

Table 3: The table displays the coefficients (Newey-West heteroscedasticity adjusted p-values in brackets) of OLS-regressions explaining the weighted average default probability (WADP) and log diversity score of the asset pool. The investment firm-dummy is 1 if an investment firm is the originator and 0 otherwise. The CBO-dummy is 1 for a CBO-transaction and 0 otherwise. The synthetic dummy is 1 for a synthetic transaction and 0 otherwise. ΔTotal capital ratio is the total capital ratio of the originating bank in the transaction year minus the average total capital ratio in the sample (see equation (1)). The adjusted R^2 is shown in the last row.

since a bank with a large loan portfolio can easily achieve strong diversification by putting many loans into a CLO-transaction. Buying bonds in a rather illiquid market is fairly costly, so originators of CBO-transactions prefer to sell less diversified bond portfolios. This is independent of whether the originator is a bank or an investment firm. Therefore DS is not explained by the originator type. As indicated by the last column in table 3, high diversity scores tend to be observed in synthetic transactions indicating a fairly low risk of the super-senior tranche. But the regression coefficient is barely significant. Finally, DS tends to increase with the total capital ratio of the originating bank. The explanation of this finding awaits further research.

Other bank characteristics do not appear to affect the choice of WADP and DS. This indicates that the choice of the asset pool is largely driven by market considerations and not by internal considerations of the originator.

Regarding hypothesis 1, the diversity score turns out to be higher in CLO- than in CBO-transactions. But it appears that this is driven more by the ease to put together a large loan portfolio than by information asymmetries. With respect to the WADP of the asset pool, hypothesis 1 is not supported by the data.

4.3 The Choice of the FLP

Hypothesis 2 states that the size of the FLP is inversely related to the quality of the asset pool. First, we OLS-regress the size of the FLP on the WADP and 1/ln DS. The reason for including 1/ln DS is that the relationship between the FLP and diversification is likely to be nonlinear since the marginal benefit of diversification should decline. The first regression in Table 4 confirms this conjecture. The WADP of the asset pool has a strongly significant positive impact on the FLP while the impact of the diversity score is clearly negative. Given the high adjusted R^2 of almost 56 %, Hypothesis 2 is strongly supported.

Hypothesis 2a claims that the impact of the diversity score on the FLP is stronger than that of WADP. As the p-value of WADP is lower than that of the inverse ln DS, his hypothesis is not supported. In order to test hypotheses 3 and 4, we include in the regression the CBO- and the dynamic-dummy. The latter is 1 for a managed (dynamic) transaction and 0 otherwise. Results are not shown in Table 4. Both dummies turn out to be insignificant so that hypotheses 3 and 4 are falsified. The lack of significance of the dynamic-dummy may be due to the strict rules on replenishment/substitution of loans/bonds in offering circulars. Also it does not make any difference whether a bank or an investment firm is the originator.

Hypothesis 5 claims that originators with more valuable real options should prefer lower FLPs. Including Tobin´s Q as a proxy for the bank´s real options does not add to the explanatory power of the regression, thus falsifying the hypothesis. The same negative results are obtained for other bank characteristics except for the standard deviation of the bank´s return on average equity. It has a weakly significant, positive effect on the FLP. A higher standard deviation may be interpreted by investors as indicating higher asset pool risk relative to the communicated WADP and DS. This may enforce investor scepticism which the originator counteracts by a higher FLP.

Explained variable	First	Loss	Position
WADP of asset pool	35.77 (0.0000)	29.44 (0.0000)	27.78 (0.0000)
1/ln diversity score of asset pool	48.51 (0.0019)	43.50 (0.0036)	43.44 (0.0040)
Synthetic dummy	-	-2.14 (0.0028)	-2.23 (0.0020)
Δstandard deviation of return on average equity	-	-	0.23 (0.1065)
Adjusted R^2	0.557	0.583	0.599

Table 4: This table displays the coefficients (Newey-West heteroscedasticity adjusted p-values in brackets) of OLS-regressions explaining the size of the FLP. WADP is the weighted average default probability of the asset pool. The synthetic-dummy is 1 for a synthetic transaction and 0 otherwise. Δstandard deviation of return on average equity is the standard deviation of the originating banks´s return on average equity minus the average standard deviation of return on average equity of the banks in the sample (see equation (1)). The adjusted R^2 is shown in the last row.

4.4 The Choice Between True Sale- and Synthetic Transactions

As discussed in section 3.3, the choice between true sale- and synthetic transactions is a joint choice of a refinancing strategy and of selling/not selling the super-senior tranche. Hypothesis 6 claims that originators with a good rating are not interested in refinancing through securitization. A probit regression of the synthetic-dummy on the originator's rating supports this hypothesis. We include two regressors, the originator rating minus the average originator rating in the sample, and a dummy for those originators for which we do not have a rating. The first regression in table 5 shows that the originator rating has a significant, positive impact on the probability of synthetic transactions, while the originators without a rating clearly appear to prefer a true sale transaction. For them refinancing through true sale appears to be preferable. These findings provide strong support for hypothesis 6.

Hypothesis 7 states that synthetic transactions are preferred for high quality asset pools. This hypothesis is strongly supported as can be seen from the second regression in table 5. The explanatory power of the regression can be clearly improved by including also the originator rating and the corresponding dummy for those originators for which a rating is not known (third regression).

Explained variable	synthetic dummy			
Weighted average default probability	-	-10.89 (0.0000)	-9.31 (0.0000)	-10.79 (0.0000)
1/ln diversity score	-	-6.89 (0.0039)	- 7.09 (0.0062)	- 3.69 (0.1942)
ΔOriginator's rating	0.223 (0.0033)	-	0.21 (0.0124)	0.29 (0.0023)
Originator rating-dummy	-1.54 (0.0000)	-	-1.22 (0.0003)	-1.24 (0.0002)
ΔTobin´s Q		-	-	-0.92 (0.0011)
ΔTotal capital ratio				0.20 (0.0666)
McFadden R^2	0.190	0.263	0.353	0.413

Table 5: This table shows the coefficients (with p-values in brackets) of binary probit regressions explaining the synthetic-dummy, This variable is 1 for a synthetic transaction and 0 otherwise. ΔOriginator's rating is the originator´s rating minus the average originator rating in the sample (see equation(1)). ΔTobin´s Q and ΔTotal capital ratio are defined analogously. The originator rating-dummy is 1 for originators without a rating and 0 otherwise. The last row shows the McFadden R^2.

In the last regression we test for the effects of other variables. It turns out that the explanatory power can be improved by also including the originator´s Tobin´s Q and her total capital ratio. But now DS is no longer significant. This is explained by the correlations between ln DS and the new regressors Tobin´s Q (-0.19) and the total capital ratio (0.24). A high total capital ratio indicates a low cost to the originator of retaining the super-senior tranche. These variables take over part of the role of the diversity score. The negative regression coefficient of Tobin´s Q tells us that it may not pay for originators with attractive outside options to retain the risk of a super-senior position.

Explained variable	Size of the securitized	non-senior tranche
Weighted average default probability	- 1.43 (0.0000)	- 1.43 (0.0000)
Ln diversity score	0.15 (0.0000)	0.15 (0.0000)
1/log diversity score	1.66 (0.0003)	1.57 (0.0008)
Investment firm-dummy	-	-0.06 (0.0003)
Adjusted R^2	0.548	0.561

Table 6: This table displays the coefficients (Newey-West heteroscedasticity adjusted p-values in brackets) of OLS-regressions explaining the size of the non-securitized senior tranche in synthetic transactions. The investment firm-dummy is 1 if the originator is an investment firm and 0 otherwise. The adjusted R^2 is shown in the last row.

Next we analyse the size of the non-securitized senior tranche in synthetic transactions. Since we only look at synthetic transactions, the determinants of the non-securitized senior tranche are not necessarily the same as those of synthetic vs. true sale transactions. We exclude here the three fully funded Geldilux-transactions which are completely atypical. For two other transactions we do not know the non-securitized tranche leaving us with 86 observations. According to hypothesis 8, the non-securitized senior tranche increases with the quality of the asset pool. The WADP alone explains already 44 % of the variation in the size of the non-securitized senior tranche (not shown in table 6). Including DS clearly improves the explanatory power as shown in the first regression of table 6. The impact of ln DS is u-shaped. For small diversity scores the non-securitized portion declines with the diversity score, but for higher diversity scores it increases. This u-shape has to await further research. Thus, hypothesis 8 is strongly confirmed with respect to WADP, but not with respect to DS.

The explanatory power of the regression can be improved somewhat by including the investment firm-dummy (last column in table 6). The coefficient is negative indicating that investment firms tend to retain smaller non-securitized senior tranches.

4.5 Tranching

Regarding the optimal tranching, we look at the number of tranches and the credit spread of the lowest rated tranche. The hypotheses in section 3.4 claim that the number of differently rated tranches increases with lower asset pool quality, with the volume of the asset pool and with increasing issue calendar time. We check these hypotheses by an ordered probit regression. The first column in table 7 shows that the number of tranches increases with the weighted average default probability, but also with the diversity score of the asset pool. This supports hypothesis 9 with respect to the weighted average default probability, but falsifies it with respect to the diversity score. It could be that a high diversity score provides the originator with more opportunities to extract rents through a finer tranching. The hard credit support of the lowest rated tranche is defined as the volume of the FLP plus other junior, non-rated tranches in percent of the transaction volume. As shown before, the FLP and, hence, the hard credit support, is explained to a large extent by the asset pool quality. Therefore we replace the hard credit support by its residual taken from a OLS-regression of the hard credit support on WADP and inverse ln diversity score. This residual has a negative impact on the number of tranches. This could simply be a range effect. Since the hard credit support and the rated tranches add up to 100 % in true sale-transactions, a higher hard credit support reduces the range available for rated tranches. These findings need more intensive analysis and therefore will be investigated more carefully in a separate paper.

The first regression in table 7 also includes the ln volume of the transaction in the regression. Since an OLS-regression of the log volume on ln DS and hard credit support shows an R^2 of 42 %, we replace ln volume by the residual of this regression. This residual has a strongly significant, positive effect on the number of tranches, thus supporting hypothesis 10. Hypothesis 11 claiming an increase in the number of tranches over time is also supported. Both findings confirm those of *Cuchra/Jenkinson* (2005).The explanatory power of the regression can be improved somewhat by including the rating and Tobin´s Q of the originator (not shown).

We now analyse the launch credit spread of the lowest rated tranche. Usually the highest rated tranche has a AAA-rating. Therefore an increase in the number of differently rated tranches should be associated with a wider spectrum of tranche ratings implying a lower rating of the lowest rated tranche which in turn should imply a higher credit spread of this tranche. Therefore we expect that the same variables driving the number of tranches also drive the credit spread of the lowest rated tranche. Since we do not know the launch credit spread of the lowest rated tranche for all transactions, the sample shrinks to 136 observations. Comparing the first two regressions in table 7 supports this conjecture. The signs of the regression coefficients of WADP, DS and hard credit support are the same in both regressions, but the regression coefficient of DS turns insignificant. Apart from DS, the second regression also supports hypothesis 12 which claims that this spread should be inversely related to asset pool quality and, in particular, to the hard credit support of the lowest rated tranche. Since WADP depends on the maturity of the transaction, but the credit spread is paid annually, we include maturity as an additional explaining variable. Surprisingly, it does not matter. This might be explained by the strong negative impact of the hard credit support. The "net effect" of WADP and hard credit support may be insensitive to the maturity.

In addition, we include the issue date because the ratings determining the WADP are usually "through the cycle ratings", i.e. they do not change with the current phase of the business cycle. Therefore the date may proxy for this phase. Since the business phase moves up and down in the sample period, we include the date and its square in the regressions. The date is an integer variable equal to -4 for the last quarter of 1997 and increases by 1 for each successive quarter. The very strong impact of the issue date is given by a parabola with a maximum around 2002 which represents a trough in the business cycle. Hence, the credit spread should be very high. One would expect the IBOXX-spread, defined by the average yield of BBB-bonds over government bonds, to better reflect market sentiment than the mechanical date. Substituting for the date by the IBOXX-spread reduces the explanatory power of the regression considerably, however. Finally, according to hypothesis 14 we include the €-volume of the lowest rated tranche to check for a liquidity premium effect. This effect is strongly negative supporting a liquidity premium effect in line with the findings of *Cuchra* (2005). The explanatory power of the regression can be improved somewhat by including the originator´s Tobin´s Q (not shown in table 7).

Hypothesis 14 claims that the credit spread of the lowest rated tranche can be better explained by its rating and its maturity than by the characteristics analysed so far. This claim is strongly supported by the third regression of table 7. Rating and maturity explain almost 59 % of the variation in the credit spread. Now the maturity has a significant, positive coefficient as expected. As the last column in table 7 shows, explanatory power can be slightly improved by including the diversity score as an explaining variable. The coefficient is significant, negative. This is in contrast to the sign of the diversity score in the previous regressions and thus appears puzzling. The negative sign, however, is consistent with the notion that investors prefer high diversity scores because then information asymmetries are less of a problem. Maturity has lost its significance. Also, WADP and hard credit support lose their impact once

Explained variable	number of tranches	credit spread of the lowest rated tranche		
Weighted average default probability	3.93 (0.0005)	1185 (0.0000)	-	-
Ln diversity score	0.75 (0.0000)	12.5 (0.7459)	-	-47.6 (0.0677)
Hard credit support-residual	-0.05 (0.0153)	-14.2 (0.0022)	-	-
Ln volume transaction residual / of lowest rated tranche	0.45 (0.0001)	-87.4 (0.0000)	-	-
Rating of lowest rated tranche	-	-	-52.3 (0.0000)	-56.0 (0.0000)
Maturity	-	-	15.7 (0.0420)	10.9 (0.1401)
Date of issue	0.036 (0.0062)	30.7 (0.0004)	31.0 (0.0000)	31.1 (0.0000)
Date of issue squared	-	-1.31 (0.0006)	-0.95 (0.0000)	- 0.95 (0.0000)
Pseudo – R^2 (LR-index)/ Adj. R^2	0.105	0.297	0.586	0.595

Table 7: This table displays in the first column the coefficients from an ordered probit regression to explain the number of differently rated tranches, and in the other columns the results from OLS-regressions to explain the credit spread of the lowest rated tranche (p-values in brackets, heteroskedasticity adjusted in OLS regressions). Hard credit support residual is the residual from an OLS-regression of the hard credit support of the lowest rated tranche on weighted average default probability, ln diversity score and ln volume. Ln volume transaction residual is the residual from a OLS-regression of the ln volume of the transaction on WADP and ln diversity score. This variable is used to explain the number of tranches. Alternatively, the ln volume of the lowest rated tranche is displayed in the same row of the table to explain the credit spread of the lowest rated tranche. ΔTobin´s Q is the originator´s Tobin´s Q minus the average Tobin´s Q in the sample. The explanatory power of the ordered probit regression is measured by the pseudo-R^2 derived from the likelihood ratio statistic. For the OLS-regressions the adjusted R^2 is shown .

tranche rating is included. Again, these relationships need more careful analysis and therefore will be investigated in a separate paper.

4.6 Robustness Tests

A potential critique of OLS-regressions to explain the FLP and the NSP is that these variables are constrained to the (0;1)-range. The distribution of the regression residuals turns out to be fairly symmetric, with little excess kurtosis**.** As a robustness test we transform the FLP and the NSP so that the transformed variable varies between plus and minus infinity. The regression results basically stay the same.. Therefore we do not present the results of the transformation.

As mentioned before, there might exist an endogeneity problem regarding some explaining variables. This could exist, in particular, in the regressions which explain WADP through DS and vice versa. Therefore we check for endogeneity through a two stage least squares regression (2SLS). As shown before, the diversity score is much higher in CLO- than in CBO-transactions while WADP is similar in both types of transactions. Therefore, we use the CBO-dummy as an instrumental variable. In a 2SLS ln diversity score is regressed, first, on the CBO-dummy, the synthetic dummy, the investment firm dummy, ΔTobin´s Q and Δtotal capital ratio (see equation (1)). Second, WADP is regressed on the estimate of ln DS and the same other variables except for the CBO-dummy. The estimation results are

WADP = -0.018 ln DS + 0.085 Inv. Dummy – 0.053syn – 0.014ΔTobin´s Q + 0.015Δtot cap r.

(0.2718) (0.0000) (0.0002) (0.1202) (0.0008)

This result is very similar to that of the second regression in table 3 in which the WADP is OLS regressed on the same variables. Hence, even though the originator WADP and DS simultaneously, this does not appear to significantly affect the explanation of WADP.

Then we turn the exercise around to explain ln diversity score. As shown above, transactions originated by investment firms have a clearly higher WADP, without having a clear impact on the diversity score. Therefore we use the investment firm-dummy as an instrumental variable for WADP. Hence in a 2SLS, we first regress the WADP on the investment firm-dummy, the CBO dummy, the synthetic dummy and Δtotal capital ratio. Second, ln diversity score is regressed on the estimate of WADP and the same other variables except for the investment firm-dummy. The estimation results are

ln DS = -2.38 WADP – 0.59 CBO + 0.11 syn + 0.015Δtot cap ratio

(0.0514) (0.0000) (0.4184) (0.0053)

This result is very similar to that of the fourth regression in table 3 in which ln DS is OLS regressed on the same variables. Hence, the simultaneous choice of WADP and DS by the originator also does not appear to significantly affect the explanation of ln DS.

5 Discussion

The empirical findings “explain” securitization variables by regressing them on other variables part of which are also securitization variables chosen by the originator. The ensuing endogeneity problem is taken care of by including various bank characteristics as additional regressors which should proxy for the securitization motives of the banks. It turns out that some of these bank characteristics appear to affect some securitization choices, but the impact is rather limited (see Graph 2). Overall, the impact of originator characteristics on the findings is surprisingly small. This indicates that securitization decisions are to a large extent driven by market considerations and much less by originator considerations.

In almost all regressions explaining the First Loss Position, the choice between synthetic and true sale transactions, the size of the non-securitized senior tranche, the number of tranches and the credit spread of the lowest rated tranche, the asset portfolio quality, measured by the weighted average default probability and the diversity score, plays a strong role. The other choice variables play only a weak role if at all. We therefore take the two quality variables of the asset pool as the core variables which to a large extent determine the other choice variables. This motivates us to view these other variables as derived variables. In other words, we interpret the findings as strong support for the view that the originator, first, decides about the quality of the asset pool and, second, about the other variables. This interpretation can also be justified from a more theoretical perspective. Besides of transaction costs, market imperfections, important in securitization decisions, are primarily premiums of liquid versus illiquid assets and effects of information asymmetries. Both imperfections are closely related to the quality of the asset pool. If this quality is very good, then information asymmetries play a little role. Also, liquidity of high quality tranches is much better than that of low quality tranches since many investors are restricted to buy high quality tranches. Hence liquidity premiums should be lower for high than for low quality-asset pools. Therefore, the choice of the asset pool quality appears to be the dominant decision.

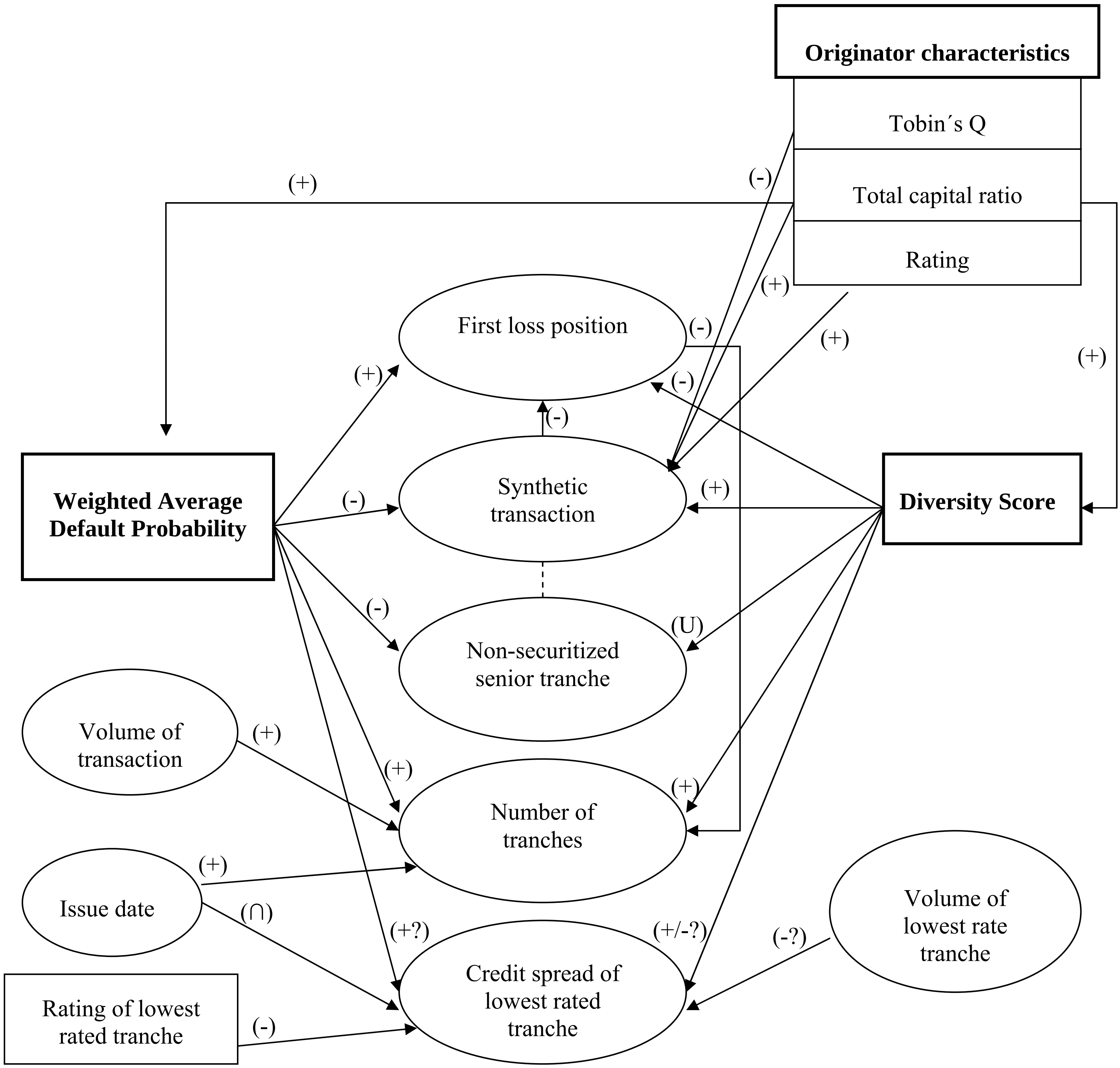
The two measures of asset pool quality show restricted coherence. Asset pools with a higher WADP tend to have a low diversity score. But this does not always imply that the impact of both quality variables on other originator choices is homogeneous in the sense that a higher WADP has the same impact as a lower diversity score. Therefore we need to discuss both quality measures separately.

The main results are summarized in Graph 2. The arc relating two variables indicates which variable has an impact on the other one. (+), (-) indicates a positive resp. a negative impact, U a u-shaped and ∩ an inversely-u shaped impact.

Asset pool quality has an impact on all choices shown in Graph 2. As stated in Hypothesis 2, bad asset pool quality makes it attractive for the originator to offer a high FLP to mitigate problems of information asymmetries. Strong asset pool quality makes a synthetic transaction more attractive relative to a true sale transaction. However, the effect of the two asset pool quality variables on the non-securitized senior portion is not homogeneous, thus partly supporting and partly invalidating hypothesis 8. A lower WADP induces the originator to take a higher non-securitized senior portion, but the impact of the diversity score is U-shaped. Surprisingly, both, WADP and DS, have a positive impact on the number of tranches, thus partly supporting and partly invalidating hypothesis 9. Similarly, WADP and DS have the same directional impact on the credit spread of the lowest rated tranche, again partly supporting and partly invalidating hypothesis 12. Clearly more research is needed to better understand the inhomogeneous effects of WADP and DS.

Regarding the interaction between other choice variables, the FLP is lower in synthetic transactions, controlling for the asset pool quality. This could indicate a substitution between taking the first and the last loss position (senior position). But the FLP is not higher in CLO- than in CBO-transactions even though information asymmetries appear to be stronger in CLO-transactions (hypothesis 3). This might be explained by the generally higher diversity score in CLO-transactions. Also the FLP is not higher in managed than in static transactions despite of stronger moral hazard concerns (hypothesis 4). Nor it is lower for originators with high Tobin´s Q who have valuable real options for risk taking (hypothesis 5). Since a higher FLP shifts part of the default risk from the lowest rated tranche to the originator, it is not surprising that its credit spread is inversely related to its hard credit support, holding the asset pool quality constant. This supports the last statement in Hypothesis 12. Also this spread is inversely related to tranche volume indicating a liquidity premium effect as found also by *Cuchra* (2005). Comparing for the credit spread the explanatory power of asset pool quality and hard credit support on one side and rating and maturity on the other side, the rating of this tranche and maturity clearly are much more powerful, supporting Hypothesis 13. Investors may feel that rating agencies have much better information for valuing this very information-sensitive tranche and, hence, attach a high significance to the rating. Nevertheless, since ratings are coarse, the DS retains some significance in explaining the credit spread. The issue date is quite important for this spread reflecting changing market sentiment and risk aversion. The hard credit support also negatively affects the number of differently rated tranches. This could be a range effect since in a true sale transaction the high credit support and the rated tranches usually add up to 100 % of the transaction volume. Not surprisingly, the number of tranches grows with the volume of the transaction and the calendar issue date, supporting hypotheses 10 and 11 and confirming the findings of *Cuchra/Jenkinson* (2005).

Finally, we discuss the impact of bank characteristics on choices. Originator rating clearly affects her choice between true sale and synthetic transactions due to the refinancing motive. Otherwise this rating appears irrelevant. A high Tobin´s Q appears to render synthetic transactions less attractive relative to true sale transactions. It might be that an originator with a high Q is not interested in retaining the senior tranche with low credit risk since she has attractive real options (hypothesis 5). The total capital ratio is positively related to the choice of the weighted average default probability, the diversity score and the choice of synthetic versus true sale. It may be that banks with a high total capital ratio can afford to take loans with high default probabilities and counteract the high default risk of such a loan portfolio by stronger diversification. Then the subset of securitized loans might share the same characteristics of high WADP and DS. A high total capital ratio raises the attractiveness of synthetic transactions, perhaps because the originators, not being plagued by capital regulation, consider the credit spread on the senior tranche too expensive. Also, the probability that the most senior tranche incurs a default loss, is very low so that the originator may not worry about its default risk. These considerations help to explain the puzzle that the least information-sensitive tranche is not sold to investors.



Graph 2: It summarizes the main empirical findings of the regressions. Asset pool quality is taken as a core variable which influences the other choices of the originator. These choices are depicted by ellipses. The arc denotes the direction of influence of one variable on the other variable. (+), (-) denotes a positive resp. negative regression coefficient. U (∩) denotes a u- (inverse u-) shaped impact.

6. Conclusion

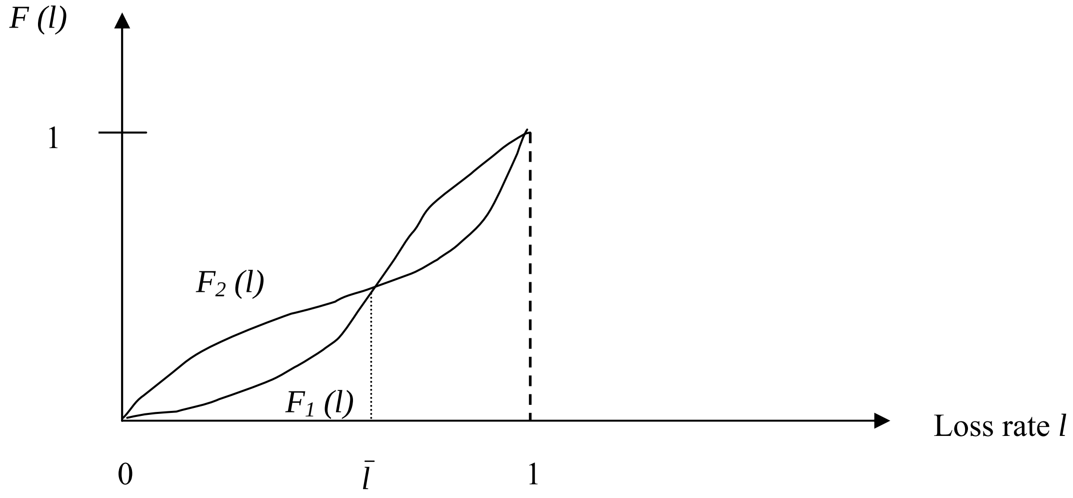
This paper investigates the design of collateralised debt obligations using a sample of European transactions. The design is governed by market imperfections. Information asymmetries, regulatory costs, refinancing costs, transaction costs and liquidity premiums are likely to play a major role in the transfer of default risks. The originator optimises the characteristics of the transaction so as to maximize her benefits. In particular, the originator chooses the underlying asset pool, the credit enhancements, the number of tranches and she chooses between a true sale and a synthetic transaction.

Bank characteristics have a surprisingly small impact on these choices. This indicates that choices are largely driven by market considerations including rating agencies and much less by originator motives for securitization. It appears that the quality of the underlying asset pool is the main determinant of other choices. Asset pool quality is measured by its weighted average default probability and its diversity score. A higher default probability lowers the quality, while a higher diversity score improves it. It appears that asset pool quality is inversely related to information asymmetry and, therefore, has a strong impact on the transaction design. Asset pool quality is strongly inversely related to the First Loss Position. This is in line with the argument that the originator should retain information-sensitive tranches. But asset pool quality also positively affects the originator´s preference for a synthetic transaction. More than half of the transactions are synthetic in which the originator does not sell the large information-insensitive super-senior tranche. This is in strong contrast to the literature which argues that the originator should sell the least information-sensitive tranche. Selling this tranche does not achieve a substantial risk transfer, but may involve transaction costs and relatively high credit spreads so that the originator may consider this refinancing mechanism as too expensive. This appears to be true in particular for originators with a good rating. Unfortunately, little is known on whether originators cover the default risk of the non-securitized super-senior tranche through a credit default swap.

Finally, the number of tranches poses a puzzle. This number increases with the weighted average default probability and the diversity score and declines with an increasing First Loss Position. The same is observed for the credit spread of the lowest rated tranche. Answering the economics behind these observations has to await further research. The findings of this paper should be considered a first step. Clearly more empirical research is needed to better understand the design of CDO-transactions.

Appendix: Proof of Lemma

a) A mean preserving spread is a second order stochastic dominance shift in the probability distribution of the loss rate, holding the mean constant. Let $F_1(l)$ and $F_2(l)$ denote the cumulative probability distribution before resp. after the mean preserving spread. A necessary and sufficient condition for a second order stochastic dominance shift is that $F_2(l)$ intersects $F_1(l)$ once from above. Let $\bar{l}$ denote the loss rate at the intersection. This is illustrated in Graph 3.



Graph 3: The cumulative probability distribution of the loss rate $F_2(l)$, obtained from $F_1(l)$ by a mean preserving second order stochastic dominance shift, intersects $F_1(l)$ once from above at $l = \bar{l}$.

First, we show that the expected loss of the FLP is higher under $F_1(l)$ than under $F_2(l)$. Suppose that the size of the FLP is smaller than $\bar{l}$. For $l \leq \bar{l}$, $F_1(l)$ first order stochastically dominates $F_2(l)$. Hence the expected loss of the FLP is higher under $F_1(l)$. Therefore the expected loss of the sold tranches must be lower, holding the mean constant.

Now suppose that the size of the FLP is higher than $\bar{l}$. Then, starting with the sold tranches, the same reasoning applies as before since for $l \geq \bar{l}$, $F_2(l)$ first order stochastically dominates $F_1(l)$.

b) A first order stochastic dominance shift in the loss rate distribution is characterized by $F_1(l) \geq F_2(l); \forall\, l$. This implies a higher probability of a complete loss of the FLP. Since a first order stochastic dominance shift is equivalently characterized by replacing $F_1(l)$

through $F_1(l+\varepsilon(l))$ with $\varepsilon(l)\geq 0$, it follows that the FLP and the sold tranches incur a higher expected loss□

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