The effect of credit risk transfer on financial stability[*]

Dirk Baur[†]
Trinity College Dublin and Joint Research Centre, EU Commission, Ispra
Elisabeth Joossens[‡]
Joint Research Centre, EU Commission, Ispra, Italy

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Abstract

This paper shows under which conditions loan securitization, e.g. collateral debt obligations (CDOs) of banks can increase the systemic risks in the banking sector. We use a simple model to show how securitization can reduce the individual banks' economic capital requirements by transferring risks to other market participants and demonstrate that systemic risks do not decrease due to the securitization. Systemic risks can increase and impact financial stability in two ways. First, if the risks are transferred to unregulated market participants there is less capital in the economy to cover these risks. And second, if the risks are transferred to other banks interbank linkages increase and therefore augment systemic risks. We analyze the differences of CDOs (true sale) and credit default swaps (synthetic) in contributing to these risks. An empirical analysis finds a significant relationship between systemic risk and CDO issuance for monthly data for the years 2000 until 2005.

JEL Classification: G21, G28

Keywords: CDOs, CDS, Systemic risk, financial stability, securitization, economic capital

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[†]College Green, Dublin 2, Ireland, Email: baurd@tcd.ie

[‡]Via Fermi, 21020 Ispra (VA), Italy, Tel: +39 0332 785056, Fax: +39 0332 785733, Email: elisabeth.joossens@jrc.it

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1 Introduction

Asset-backed securities such as collateral debt obligations (CDOs) showed a remarkable growth during recent years. In the European Union, securitization is still growing and CDO issuance reached its highest quarterly total ever in 2005. One of the reasons for this growth is the fact that debt securitization reduces the economic capital requirements of banks and offers new investment opportunities.

The market for synthetic securities such as credit default swaps (CDS) is also growing. The difference to true-sale securitization (e.g. CDOs) is that CDS stay on balance sheet. They offer an insurance against default but do not lower economic capital requirements. This suggests that the growth of synthetic or true-sale securitization has also another underlying cause. Both CDOs and CDS constitute a risk transfer from the originating bank to the buyers of these securities. CDO issuance is a direct (true-sale) risk transfer while a credit default swap is a contractual (synthetic) risk transfer.

From an economy-wide perspective, this risk transfer poses also risks by itself. If the risk is unevenly distributed so that the transfer leads to a concentration of risk with some market participants, there is a risk for the financial system as a whole. Furthermore, when linkages (correlations) among market participants rise, systemic risks do also rise.

The paper is motivated by the observation that the number and diversity of innovative or alternative financial products is increasing steadily but the number of financial crises has not clearly declined in recent years. Another observation is that unregulated market participants such as hedge funds are large investors in these relatively new financial products (see Issing, 2005). Therefore, we seek to analyze the effect of credit risk transfer on the allocation of risks in the economy with a focus on extreme risks, that is, systemic risks. In other words, does credit risk transfer result in a spread of risks or in a concentration of risks?

This can be measured directly or through an analysis of the linkages in the financial system. The higher the degree of correlation, the higher is the concentration.

This paper focusses on the risk transfer through securitization and shows that extreme risks in the financial system do not decrease due to securitization and can even increase when the linkages among banks and other market participants increase. We show that the linkages can increase if CDOs and CDS are not only sold but also bought by financial intermediaries. Our empirical results illustrate that there is a link between the issuance of CDOs and extreme equity movements for a sample of European banks and insurance companies.

There are numerous papers analyzing systemic risks in the banking sector[1] and an equal number of contributions explaining debt securitization[2]. The importance of loan securitization and derivatives in relation to other financial products is analyzed in contributions by the Bank for International Settlements and the European Central Bank among others.[3]. A broad analysis of credit risk transfer can be found in BIS 2005 and Bank of England 2002. A study by Franke and Krahnen (2005) focusses on the reaction of a bank's beta around the announcement of a CDO issuance while this study aims to study the macro-effects of credit risk transfer with a focus on the relation of securitization and systemic risks.

The paper is structured as follows. First, we present a model to demonstrate the economic risk transfer obtained through debt securitization and show that extreme risks do not decrease but can increase under certain conditions. The difference of true-sale and synthetic securities with regard to credit risk transfer and financial stability is illustrated and discussed. Section 3 contains an empirical analysis and finds a relationship of CDO

[1] e.g. see Bartram, Brown and Hund (2005), Gropp and Moerman (2004); Hartmann, Straetmans and de Vries (2005) and Schröder and Schöler (2002).

[2] e.g. see Jobst (2002a,b,c)

[3] e.g. see BIS (2005), European Central Bank (2004)

issuance and bank and insurance equity returns. In section 4 we summarize our findings and conclude.

2 Risk Transfer Through Securitization

There are many reasons to engage in securitization. One of these reasons for banks is that a significant amount of debt and thus risk is transferred to the market and then off the balance sheet of the originating bank. We focus on this risk transfer and use a simple model to quantify the effect for the bank and the market.[4]

Assume we have an index set, $I = \{1, \ldots, m\}$, referring to loans of a portfolio. The easiest case possible is to assume that the complete portfolio is selected for securitization. The loans are transferred to a SPV (Special Purpose Vehicle) which is a company set-up especially for the purpose of this transaction.[5]

Based on this collateral portfolio, an equity piece and one or more mezzanine and senior pieces are sold to different investors. The equity piece, often called the first loss piece (FLP), receives interest and principal payments only if all other investors received their promised payments. Often the issuing bank is obliged to invest in the equity piece.

Applying Monte-Carlo simulations we can model the cash flows in case of securitization given a value for the first loss piece. But we start with a more theoretical approach. For simplicity the loss given default (LGD) is taken equal to 100% which is equal to putting the recovery rate equal to zero. The loss statistic for the portfolio I is given by $(L_1, \ldots, L_m)$. Hence the total loss in case there is no securitization is equal to

$$L = \sum_{i=1}^{m} L_i.$$

[4]The basic equations of the model can be found in Bluhm et al. (2003).

[5]An important condition is that the SPV's own bankruptcy risk is minimized and that it will not default on its own obligations because of bankruptcy or insolvency of the originator.

For the securitization we assume that no Interest Coverage tests (IC) or Overcollateralization tests (OC) are used, also no cash reserve account is available and the model horizon is one year. We also suppose that the bank manages to sell all the senior tranches and keeps the equity piece itself. The bank is hence protected against losses exceeding the first loss piece and its loss is equal to the loss of the equity piece. It will be denoted with L_{eq}. Since the equity piece absorbs all the losses up to a certain level (FLP) its loss is given by

$$L_{\text{eq}} = \min(\sum_{i=1}^{m} L_i, FLP).$$

The change (denoted by Δ) in expected loss $E(L)$ from the bank that securitizes its debt is given by

$$\Delta EL = E(L) - E(L_{\text{eq}}).$$

The required economic capital (denoted with EC_α) is defined as the difference of the $\alpha\%$-quantile (q_α) and the expected loss. Hence the difference in economic capital due to the securitization is

$$\begin{aligned} \Delta EC_\alpha &= EC_\alpha(L) - EC_\alpha(L_{\text{eq}}) \\ &= q_\alpha(L) - E(L) - (q_\alpha(L_{\text{eq}}) - E(L_{\text{eq}})) \\ &= \Delta q_\alpha - \Delta EL \qquad (1) \end{aligned}$$

with $\Delta q_\alpha = q_\alpha(L) - q_\alpha(L_{\text{eq}})$, the change of the $\alpha\%$-quantile. In this case without tests and without a cash reserve account the losses of the portfolio with and without securitization will be increasing functions of percentages of defaults in the collateral pool. The mezzanine and senior pieces that are sold to the market have a total loss which is denoted with L_{sp}. Since no extra money is transferred, the sum of the loss of the equity piece L_{eq} and the loss of the senior pieces L_{sp} will always be equal to the loss in case there is no securitization L. This leads to

$$E(L) = E(L_{\text{eq}}) + E(L_{\text{sp}}). \qquad (2)$$

Table 1: **Example for securitization**

		loss of A		
		0	100	Σ
loss of B	0	$1-\pi_1$	$\pi_1-\pi_2$	$1-\pi_2$
	100	0	π_2	π_2
	Σ	$1-\pi_1$	π_1	1

It holds the equality $L = L_{\text{eq}} + L_{\text{sp}}$. However, for quantiles the relationship is less clear. In general sub-additivity does not hold for quantiles.[6]

In the case of securitization, there is a strict relationship between the loss of the securitized portfolio and the loss of the senior pieces. Assume that A is equal to the equity piece and B equal to the whole group of senior pieces. Due to the (default sequence) structure B can only default if A has defaulted as well. Equal default probabilities for A and B will lead to either a total loss of 200 or no loss, the intermediate case of a loss of 100 is not possible. Then the additivity certainly holds. More general, if we have a probability π_1 for a loss of 100 for the equity piece A and a probability π_2 for a loss of 100 for B we get the following cases shown in table 1.

Naturally, the condition $\pi_1 > \pi_2$ has to be satisfied to guarantee non-negative probabilities. Given the structural constraint, there are three cases of interest: (i) no defaults, (ii) only A defaults and (iii) A and B defaults. Here sub-additivity will hold. For example, for $\pi_1 = 0.06$ and $\pi_2 = 0.02$, we get $q_{95}(A) = 100$, $q_{95}(B) = 0$ and $q_{95}(A+B) = 100$. Assume alternatively that $\pi_1 = 0.08$ and $\pi_2 = 0.06$, we get $q_{95}(A) = 100$, $q_{95}(B) = 100$ and

[6] The standard counterexample for sub-additivity is a portfolio with two identical bonds A and B. Each defaults with probability 0.04 with a loss of 100 and no loss otherwise. Hence, the 95%-quantile of the loss for each bond is zero: $q_{95}(A) = q_{95}(B) = 0$. In case A and B are independent, losses of A and B occur as follows: a loss of 0 occurs with probability $0.96^2 = 0.9216$, a loss of 200 happens with probability $0.04^2 = 0.0016$ and a loss of 100 with probability $1 - 0.9216 - 0.0016 = 0.0768$. It follows that $q_{95}(A+B) = 100$. Hence, sub-additivity does not hold since $q_{95}(A+B) > q_{95}(A) + q_{95}(B)$.

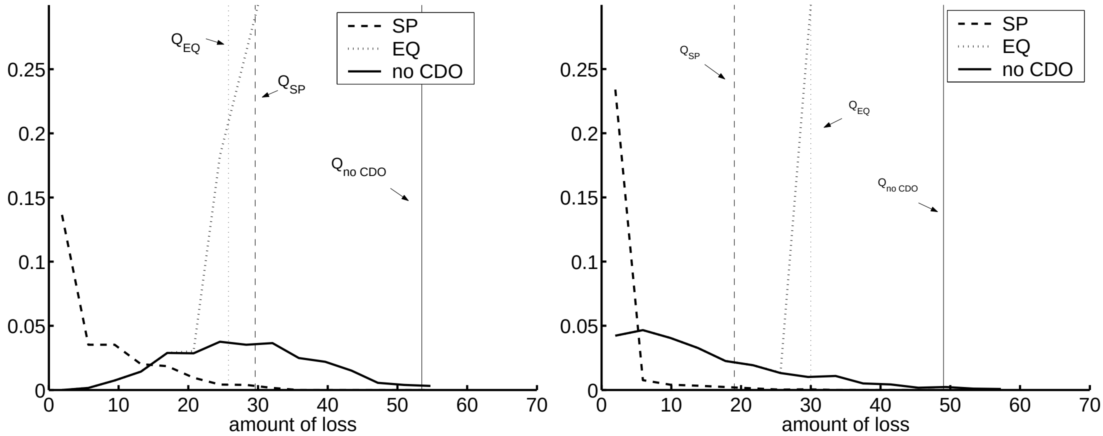

Figure 1: *Probability density functions for the total loss, the loss of portfolio with securitization (= loss of the equity piece) and the loss of the loss of the senior pieces, and the corresponding 99%-quantiles.* ***left panel*** *using a 7-year maturity ;* ***right panel*** *using a 1-year maturity.*

$q_{95}(A + B) = 200$.

Obviously this cannot be considered to be a proof since not the whole range of partial losses is analyzed in the above example but only two values, that is, no loss or a total loss (equal to a loss of 100).

We will show in the following that the strict constraint that losses on the senior pieces only occur when the equity piece is totally lost will force the quantiles to be sub-additive:

$$q_\alpha(L) \leq q_\alpha(L_{\mathbf{eq}}) + q_\alpha(L_{\mathbf{sp}}). \tag{3}$$

To illustrate this, we use an example with a collateral pool of total size 100. It consists of 50 loans with variable default probabilities. Using a first loss piece of size 30 and only one senior piece of size 70, a Monte-Carlo simulation constructs empirical distribution functions for the loss functions and finds the corresponding quantiles. A visualization of them is given in Figure 1. In this particular case, recovery rates are chosen randomly between 0% and 50% for the collateral pool and the maturity is 7 years. The 99%-quantiles are: $q_{99}(L) = 53.48$, $q_{99}(L_{\mathbf{eq}}) = 25.77$ and $q_{99}(L_{\mathbf{sp}}) = 29.60$. For a one year maturity we find the 99%-quantiles to be: $q_{99}(L) = 49.03$, $q_{99}(L_{\text{eq}}) = 30$ and $q_{99}(L_{\text{sp}}) = 19.03$.

If we only consider the one year period from the launch of the deal until one year later it is possible to proof (see Appendix for details):

$$q_\alpha(L) = q_\alpha(L_{\text{eq}}) + q_\alpha(L_{\text{sp}}). \tag{4}$$

Using this finding, the reduction of economic capital ΔEC_α can be calculated. In other words, it is the regulatory capital relief obtained by securitization. The proof also shows that securitization does not automatically augment or lower the economic capital in the financial system. Due to the additivity of the risks of the tranches (and the additivity of the expected losses), the economic capital remains unchanged. If additivity did not hold, economic capital could decrease or increase thereby compensating or amplifying the risk transfer effect.

In other words, extreme risks can be sold and thus transferred to one or more market participants but the aggregate of extreme risks in the economy is not reduced and remains unchanged.

There is another potential risk of securitization. It is the search for higher yields. These can be realized by selling senior pieces and investing in new assets with a higher yield and a higher risk. Consequently, the risk of the bank increases.

2.1 Credit Default Swaps

Not only CDOs but also credit derivatives such as credit default swaps (often called synthetic securities) are useful instruments to transfer credit risk. They are designed to isolate risk of default on credit obligations. The holder of the credit obligation issues the CDS through an SPV (similar as for CDOs) so that she is able to buy an insurance against default of the reference entity on its debt. They are typically used when long term maturity bonds face short-term default risk (e.g. one year maturity for the CDS). The buyer makes payments to the seller of the security. These payments are continuous until maturity of the contract or until default occurs. If a default occurs, the buyer of the CDS delivers a bond of the underlying asset in exchange for its face value. Hence, by using CDS, buyers aim to reduce their amount of securities they hold physically.

The difference to a CDO is that the debt remains on the balance sheet and that there is a regular (e.g. monthly) payment to the buyer of the CDS that provides the insurance. Similar to the CDO, the issuer often takes the first losses for his account (first-loss piece). To do so she will keep a reserve account up to a certain value. Since the debt is not actually sold (true-sale) there is no liquidity effect, that is, there is no extra cash available to be invested which implies that there is no additional systemic or systematic risk as in the CDO case.

As an example we assume a CDS based on one underlying bond of size 100 with a default probability of π. Assume that the bank holding this bond (say A) wants to buy a security for this. Suppose a second bank (say B) offers to sell this security. For this bank A gives a continuous payment α to B and keeps a reserve account of 50. In case of total default of the underlying bond, banks A and B both take 50 of the loss. In case there is no default bank A paid bank B over a period of time a value α but kept the bond for itself during the time. We can refer again to table 1 for the loss structure. In case there is only a partial loss bank A will not use the security unless the loss exceeds the reserve account (in this case of size 50). Clearly, the risk for this extreme loss is transferred.

The next section discusses the effect of credit risk transfer not from an individual bank's perspective but from a broader, economy-wide, aspect.

2.2 Effect of Risk Transfer

The previous sections described the effect of a credit risk transfer using CDOs or CDS from an individual banks perspective. The question remains now whether the new structure, that is, the distribution of credit risks in the market requires a higher or lower amount of economic capital. For this to answer, we analyze two cases of credit risk transfer through securitization.

First, the tranches are sold to unregulated market participants (e.g. hedge funds) in or outside the financial system and second, the tranches are sold to other, regulated, financial intermediaries within the financial system.

In the first case, the overall amount of capital put aside can be lower than before the securitization since market participants are unregulated and do not face any capital requirements. In that case, the positive effect of the risk transfer, that is, the distribution of risk, can be compensated to a certain degree.[7] In the second case, banks invest in the same underlying collateral pool which increases their linkages (the issuing banks keep the equity piece and other banks invest in the less risky mezzanine pieces or senior pieces). In this case, the amount of capital put aside stays constant but can be insufficient from a system-wide perspective due to the increased interbank linkages. We will show below that these stronger linkages increase systemic risks and therefore require an augmented amount of capital. A simple example for two banks aims to clarify the mechanism of increased linkages through securitization.

Assume there are two banks A and B that face default if all assets are lost with a probability of $p = 0.1$. The possible losses and its probabilities are given in table 2.

Two events can create or constitute linkages. Either banks A and B invest in each

[7] Krahnen (2005) argues that senior tranches placed outside the financial system reduces the risk of contagion among banks.

Table 2: **Two banks no diversification**

		loss of A	
		0	100
loss of B	0	0.9^2	$0.1 \cdot 0.9$
	100	$0.1 \cdot 0.9$	0.1^2

others assets (e.g. CDO tranches) or they invest in the same assets in the market rendering them dependent on one or more common factors[8]. Here we assume that both events happen at the same time. Suppose now that the two banks diversify their risks so that both hold 50 percent of the other banks assets. In case of the CDS we can interpret this like both banks insure 50% of their default risk. It follows that each bank can now also lose 50 if either A or B defaults. Introducing linkages between A and B, measured by a positive correlation coefficient ρ yields table 3. The table shows that any positive correlation coefficient ρ increases the extreme cases, i.e. no losses or joint losses, while the probability for the intermediate case decreases. For example, the 95 (98) percent quantile for $\rho = 0$ is 100 (100) but jumps up to 200 for $\rho = 0.5$ ($\rho = 0.25$). This example clarifies that increased linkages can increase extreme events and thus require a larger amount of economic capital.

This simple example also demonstrates that periods in which no banks default or in which there are no financial crisis do not imply that the financial system is more stable than in other periods in the past. This can be a result of increased linkages with a higher potential for extreme risks.

There is also a third possibility of increased risks. If banks use the new capital obtained by securitization to expand their loan business they incur more systematic risk (see

[8]Assume a factor model as follows: $r = \beta r_m + \gamma CDO + \theta \boldsymbol{X} + \epsilon$ where r is the banks asset return, r_m the market return, CDO a common factor related to securitization and $\boldsymbol{X}$ a vector of other potential factors. The higher the loading of the factors, e.g. γ, the higher are the linkages.

Table 3: **Two banks with diversification with a linkage**

		loss of A		
		0	50	100
loss of B	0	$0.9^2 + \rho \cdot 0.1 \cdot 0.9$	0	0
	50	0	$2 \cdot 0.1 \cdot 0.9 \cdot (1-\rho)$	0
	100	0	0	$0.1^2 + \rho \cdot 0.1 \cdot 0.9$

Franke and Krahnen (2005)). Since systematic risk is different to systemic risk we will not investigate this case in the paper. [9]

Concerning the CDS, the banks are insuring each others risks which links them directly through contracts. In the CDO case, the linkage is not through contracts but through sold or bought tranches. They may not invest directly in the same underlying bonds or loans but they try to secure each other for extreme cases. We hypothesize that true-sale securitization increases correlations among banks by more than synthetic instruments which would imply that from a financial stability perspective synthetic structures are superior.

A survey from the European Central Bank from May 2004 (European Central Bank, 2004) studies the transfer of risk between several European banks. A summary of the transfer of the credit derivatives and structured products (Asset-backed securities and synthetic collateral debt obligations) is given in Table 4 and shows that this last risk is non negligible since up to 30% (see Portugal) of a banks capital can be invested in CDO's from other banks.

3 Empirical Analysis

In this section we aim to analyze empirically the hypothesis that credit risk transfer of banks increases systemic risks in the financial sector. We focus on CDO issuance as a

[9]Here, systematic risk means the market risk and systemic risk means a risk due to the system per se.

Table 4: **Summary of the transfer of structured products (ABS and synthetic CDO's)**

	protection buying % of total assets	protection selling % of total assets	number of institutions surveyed
Germany[1.]	7.8% credit derivatives	8.7% credit derivatives	10
Greece	0.02%	0.2%	3
Spain	3 – 15% structured products	n.a.	4
France[2.]	0.6 – 12.9% credit derivatives 0.2 – 1.5% structured products	0.3 – 9.6% credit derivatives 0.1 – 8.5% structured products	3
Ireland	0.13 – 4%credit derivatives 1 – 10% structured products	0.6 – 7%credit derivatives 0.2 – 0.6% structured products	protection buying: 6 protection selling: 9
Italy	0.5 – 5%credit derivatives 0 – 6.5% structured products	0.1 – 5%credit derivatives 0.2 – 7.5% structured products	4
Luxembourg	0.5%credit derivatives 0.5 – 1% structured products	1.7%credit derivatives 1.5 – 2.5% structured products	estimate for entire national banking sector
Austria	0.7% credit derivatives	3.4%	8
Portugal	5 – 30%structured products	2 – 3%credit derivatives	4

1. protection buying and selling as an average of the ten surveyed banks.

2. Data as at end–June 2003.

measure for credit risk transfer. Systemic risk is measured with coexceedances introduced by Bae, Karolyi and Stulz (2003). Coexceedances are joint exceedances of asset returns above a given threshold. We assume that this value better reflects systemic risks than correlations because it focusses on extreme linkages and not on normal linkages. In addition, the correlation coefficient is only a bivariate measure and not straightforward to compute through time. On the contrary, coexceedances measure the joint movement of N returns and are easy to model through time (see also Baur and Schulze (2005) for an alternative approach based on quantile regression.).

It is also important to note that we focus on systemic risks and not on systematic risks. Das and Uppal (2004) define systemic risks as infrequent and extreme while systematic risk is assumed to be frequent and not extreme. This difference is important not only for the econometric model but also with respect to the essence of the paper. The paper focusses on extreme risks through increased bank linkages. It does not analyze in which

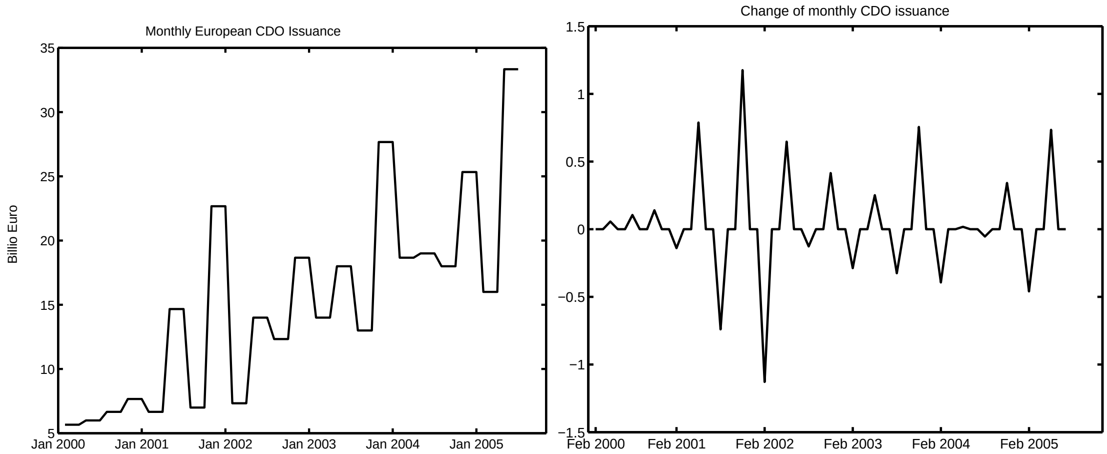

Figure 2: *Monthly European CDO issuance derived from quarterly data*

way banks use the "new money" obtained from debt securitization to invest in financial products thereby potentially increasing systematic risk.

3.1 The Data

We use quarterly data of European CDO issuance obtained from the European Securitization Forum (ESF (2005)). The quarterly numbers are split in equal values to obtain monthly figures from January 2000 until June 2005 in order to match them with the monthly asset return data of financial intermediaries. The computed monthly CDO issuance data and the changes are shown in figure 2. Changes are computed as the difference of the natural logarithms between this months' and last months' CDO issuance. The splitting is done due to the non-availability of monthly data for CDO issuance. Monthly data for asset-backed securities issuance obtained from the monthly bond market notes of the European Commission (DG ECFIN) showed that there was a drop at the end of every quarter. This structure is not changed by the splitting.

In order to analyze the impact of credit risk transfer (CRT) on the systemic risk within the financial sector, we analyze monthly (continuously compounded) equity returns of ten European banks and insurance companies for the same time period as for the CDO is-

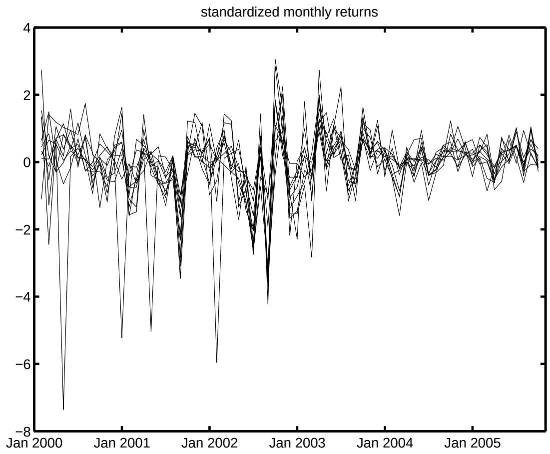

Figure 3: *Standardized monthly returns of European banks and insurance companies*

suance data, i.e. January 2000 until June 2005. The banks are ABN Amro, BBVA, BNP Paribas, Deutsche Bank, Intesa BCI, San Paolo, Societe Generale, Unicredito and the insurance companies are Allianz and AXA.

Figure 3 shows the returns of all banks and insurance companies and table 5 provides the descriptive statistics. The graph illustrates that there is a clear co-movement of returns and that there are also extreme joint movements, more on the downside than on the upside. The descriptive statistics also show that the minimum is larger in absolute values than the maximum of the returns in the sample period. The cross-correlations presented in the table show that correlations vary considerably but are positive without exception and above 0.5 for most of the equity return pairs.

In order to compute the coexceedances it is necessary to determine a threshold. For this we standardized the returns and chose a threshold of one standard deviation with respect to the mean to compute the coexceedances. The obtained coexceedances are shown in figure 4.

The evolution of the coexceedances shows that extreme coexceedances vary consider-

Table 5: **Descriptive statistics of the monthly asset returns (standardized)**

	mean	std. dev.	min	max	skewness	kurtosis
ABN Amro	-0.0002	0.0985	-0.4055	0.2915	-0.8732	7.0254
BBVA	-0.0006	0.0856	-0.2807	0.2410	-0.5258	4.9000
BNP Paribas	-0.0055	0.1122	-0.6559	0.1995	-3.5053	20.0056
Deutsche Bank	-0.0027	0.0996	-0.3191	0.1853	-0.7153	3.7524
Intesa BCI	0.0021	0.1098	-0.3817	0.2416	-1.3041	6.0788
San Paolo	-0.0011	0.1095	-0.3978	0.2942	-0.7264	5.4672
Société Générale	-0.0137	0.1805	-1.3038	0.1815	-5.8044	41.6658
Unicredito	0.0011	0.0585	-0.1748	0.1162	-0.5314	3.5110
Allianz	-0.0194	0.1301	-0.4204	0.3332	-0.4988	4.9616
AXA	-0.0495	0.2718	-1.4274	0.4171	-3.8235	19.8260

correlations between the banks and insurance companies as given above

ABN Amro	1.0000	0.7555	0.5529	0.6189	0.7095	0.7098	0.2617	0.5911	0.6654	0.2140
BBVA	0.7555	1.0000	0.5213	0.6802	0.6148	0.7192	0.3454	0.5862	0.7210	0.2816
BNP Paribas	0.5529	0.5213	1.0000	0.5162	0.5645	0.3941	0.1780	0.3471	0.4654	0.1471
Deutsche Bank	0.6189	0.6802	0.5162	1.0000	0.6809	0.7061	0.1769	0.4775	0.5012	0.1085
Intesa BCI	0.7095	0.6148	0.5645	0.6809	1.0000	0.8266	0.2800	0.6257	0.6121	0.2469
San Paolo	0.7098	0.7192	0.3941	0.7061	0.8266	1.0000	0.2841	0.5377	0.6254	0.2756
Société Générale	0.2617	0.3454	0.1780	0.1769	0.2800	0.2841	1.0000	0.1072	0.3814	0.1168
Unicredito	0.5911	0.5862	0.3471	0.4775	0.6257	0.5377	0.1072	1.0000	0.5826	0.3174
Allianz	0.6654	0.7210	0.4654	0.5012	0.6121	0.6254	0.3814	0.5826	1.0000	0.3677
AXA	0.2140	0.2816	0.1471	0.1085	0.2469	0.2756	0.1168	0.3174	0.3677	1.0000

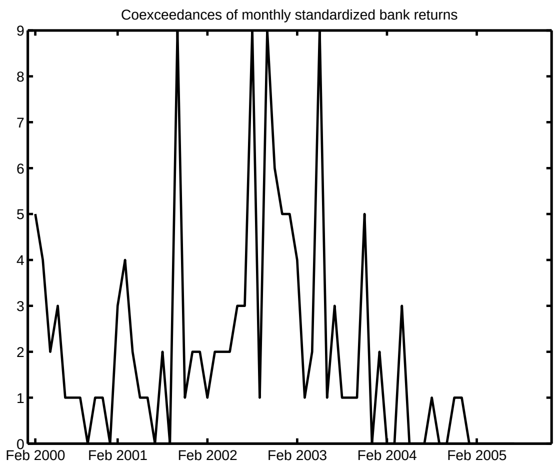

Figure 4: *Coexceedances of monthly standardized bank and insurance companies returns*

ably, dropping from five to zero in the beginning of the sample period, then peaking in the middle with nine markets simultaneously exceeding the defined threshold and finally again dropping to zero in the end of the sample period.

3.2 Econometric Specification

The analysis aims to analyze the effect of CRT on systemic risk. This implies that the CRT variable is defined as the independent variable and the systemic risk component as the dependent variable. We consider three different models for the estimation of the effect. First, ordinary least squares (OLS), second a multinomial logit model analyzing coexceedances as categories and a probit model in order to compute the probability of an coexceedance without distinguishing how many markets exhibit an extreme return.

The basic model is written as follows:

$$rcoexc_t = \alpha + \beta rCDO_t + \boldsymbol{\gamma} \boldsymbol{trend} + \boldsymbol{\theta} \boldsymbol{X}_t + \epsilon_t \tag{5}$$

The variables $rcoexc$, $rCDO$, $\boldsymbol{trend}$ and $\boldsymbol{X}$ are the return coexceedances at t, the change of CDO issuance activity, a trend specified with an additional squared term in order to account for the inverted u-shape of the coexceedances as shown in the figure above and other variables ($\boldsymbol{X}$) such as the returns of the banks underlying the coexceedance measure. We are most interested in the estimate for β since this coefficient measures the impact of CDO issuance on systemic risk, i.e. the number of coexceedances. A positive estimate for β implies that higher CDO issuance activity increases the number and severity of coexceedances. The trend variables that aim to capture the inverted u-shape of the coexceedances are specified in order to isolate the true CDO issuance effect. This should avoid the likelihood to obtain spurious results due to a common trend in both dependent and independent variables.

3.3 Empirical Results

The OLS regression is estimated in different specifications from a restricted version only including a constant and the CDO variable as regressors and then augmenting the model including the trend variables and the returns of the banks. The results show that β is positive for all different specifications but not significant. The trend variables replicate the inverted u-shape evolution of the coexceedances. Significant estimates for β are only obtained with the trend variables and negative bank returns. It seems to be very important to account for the negative realizations of returns. The estimate for β is 1.13 with a t-statistic of 1.67. The variables explain 52.1% of the coexceedances. Restricting the number of coexceedances and only focussing on all coexceedances with three or more banks involved increases the significance of β. Obviously, OLS is not the most adequate model to estimate the effect of CDO issuance on coexceedances. This is because OLS does not account for the categorial nature of the dependent variable, i.e. the number of coexceedances which ranges from two to ten. Hence, we consider the OLS result as an initial step only.

A more natural approach in modelling coexceedances is the use of a multinomial logit model estimating the impact of the exogenous variables on the categories (here the number of coexceedances) explicitly. Results show the same result as obtained by the OLS regression. CDO issuance has a positive impact ($\beta > 0$) but is not significant. The number of coexceedances had to be restricted in order to obtain estimates. Coexceedances larger than four (five) were considered to be one category.

Finally, we estimate an unordered probit model where coexceedances with five (four) or more returns are treated as one category. Results for specifications with the CDO issuance, a trend, its square and the negative values of the financial asset returns are shown in table 6. Results show that the impact of the CDO issuance is positive and despite the rather low number of observations also significant for both specifications. The estimates for the

Table 6: **results of the regression analysis**

Regressors: CDO issuance, trend and negative asset returns		
all absolute returns larger than one standard deviation (for standardized returns)		
$coexc = (coexc \geq 5)$		
McFadden R-squared	0.3059	
Estrella R-squared	0.2545	
LR-ratio, 2*(Lu-Lr)	15.9946	
LR p-value	0.2494	
Log-Likelihood	-18.1432	
Variable	Coefficient	t-statistic
constant	-2.304334	-2.544981
CDO issuance	1.362243	1.856872
trend	0.063843	1.086094
trend squared	-0.001110	-1.210961
$\boldsymbol{X}$		
...		
$coexc = (coexc \geq 4)$		
McFadden R-squared	0.4248	
Estrella R-squared	0.4109	
LR-ratio, 2*(Lu-Lr)	26.4154	
LR p-value	0.0149	
Log-Likelihood	-17.8831	
Variable	Coefficient	t-statistic
constant	-2.671182	-2.492746
CDO issuance	1.526216	2.143433
trend	0.083864	1.269347
trend squared	-0.001474	-1.448816
$\boldsymbol{X}$		
...		

Model: $rcoexc = \alpha + \beta rCDO + \boldsymbol{\gamma trend} + \boldsymbol{\theta X} + \epsilon$

returns are not significant and are therefore not reported due to space considerations. Since the estimates in a probit model cannot be interpreted directly, we computed the true impact which confirmed the intuition that the sign of the estimate for β is positive. This is also true for alternative specifications such as no trend, dynamics explicitly modelled by including lagged coexceedances and by including asset returns without accounting for the sign. All these specifications lead to similar results, that is, a positive and significant estimate for the CDO issuance variable. A logit model was also estimated which did not qualitatively change the results.

4 Conclusions

This paper shows how banks can reduce their capital requirements by transferring risks to other market participants. We focus on the case that these risks are transferred to other banks thereby increasing the interbank linkages. These increased linkages can augment the systemic risk which is shown with a simple model.

The hypothesis is also tested empirically by analyzing the impact of European CDO issuance on the extreme joint movements of financial sector equity returns. Results show that CDO issuance is positively correlated with these extreme simultaneous movements. This is an indication that systemic risks do increase with the issuance of CDOs. Interestingly, systemic risks are not persistent. This means that lower amounts of issued CDOs decrease systemic risks. This seems to suggest that only the newly securitized debt is important and not the aggregate amount.

Future research could extend the number of financial assets and the time period analyzed. In addition, the relation between systematic risk and systemic risk and the impact of synthetic in comparison to true sale CDOs could be further investigated.

5 Appendix

For longer maturity dates it is more complicated since the losses depend as well on the time of default. Here we have a similar situation as in a reinsurance company. All claims up to a certain level d are covered by the insurance company. The reinsurance company will only play a role in the case that the claim sizes exceed the given level. Then the payout of the insurance company will be d and the reinsurer will pay the part to which the claim exceeds the level. More formally, let X denote the random variable for the claim size with a distribution function f_X. The part the reinsurer takes for his account Y will be equal to zero in case $X \leq d$ and will be $X - d$ otherwise. For the distribution function we get

$$f_Y(y) = \begin{cases} F_X(d) & \text{if} \quad y = 0 \quad \text{or} \quad x \leq d, \\ f_X(y+d) & \text{if} \quad y > 0 \quad \text{or} \quad x > d. \end{cases} \tag{6}$$

Similar here we could say that X is the loss in case we have no securitization. If the boundary value d is equal to the first loss piece, the senior piece will only be affected by the losses if they exceed a certain level d and the senior piece will have a distribution function like Y. The loss of the securitized portfolio can be seen as the part the insurance company has to take for his account. It is denoted by Z and has a distribution function

$$f_Z(z) = \begin{cases} f_X(z) & \text{if} \quad z < d \quad \text{or} \quad x < d, \\ 1 - F_X(d) & \text{if} \quad z = d \quad \text{or} \quad x \geq d. \end{cases} \tag{7}$$

Using the above distribution function the α-quantiles can be calculated to prove the additivity.

We need to distinguish two cases. The case where the probability to have losses greater or equal then d is smaller than $1 - \alpha\%$ or the case where this probability is greater or equal than $1 - \alpha\%$. The construction of the proof is the same for both cases. Hence we only consider the second case $\Pr(X \geq d) \geq 1 - \alpha\%$ which can be written as $\Pr(X < d) < \alpha\%$.

For the total loss X we can only say that the α-quantile is equal to an unknown value

$q_\alpha(L)$ such that $q_\alpha(L)$ is the smallest possible value for which

$$F_X(q_\alpha(L)) \geq \alpha\% \tag{8}$$

holds. For the securitized portfolio or the equity piece we look for the smallest value which is not exceeded with a probability greater or equal than $\alpha\%$. Given only the second case is considered, we have

$$\Pr(Z < d) < \alpha\%$$

and $\Pr(Z \leq d) = 1$. Since d is the smallest possible value for which the loss of the equity piece is not exceeded with a probability greater or equal than $\alpha\%$, $q_\alpha(L_{eq}) = d$.

For the senior piece we need to use the definition of the quantile function once again. The quantile is so that $F_Y(q_\alpha(L_{sp})) \geq \alpha\%$. Given that Y has a distribution function as in (6) this can be written as

$$\begin{aligned} F_Y(q_\alpha(L_{sp})) &= \Pr(Y \leq q_\alpha(L_{sp})) = \Pr(Y = 0) + \Pr(0 < Y \leq q_\alpha(L_{sp})) \\ &= F_X(d) + \int_{0+}^{q_\alpha(L_{sp})} f_Y(y)\,dy = F_X(d) + \int_{0+}^{q_\alpha(L_{sp})} f_X(y+d)\,dy \\ &= F_X(d) + \int_{d}^{q_\alpha(L_{sp})+d} f_X(t)\,dt = F_X(d + q_\alpha(L_{sp})) \geq \alpha\%. \end{aligned} \tag{9}$$

The values $q_\alpha(L)$ in equation (8) and $d + q_\alpha(L_{sp})$ in equation (9) are both the smallest possible values for which $F_X(*) \geq \alpha\%$ holds. Since F_X is an increasing function, it can be concluded that $q_\alpha(L) = d + q_\alpha(L_{sp})$. This proves that $q_\alpha(L) = q_\alpha(L_{eq}) + q_\alpha(L_{sp})$.

References

BAE, K.-H., KAROLYI, G. and STULZ, R. (2003). A New Approach to Measuring Financial Contagion. *Review of Financial Studies* **16** 717–63.

BANK OF ENGLAND (2002). Financial Stability Review .

BARTRAM, S. M., BROWN, G. W. and HUND, J. (2005). Estimating Systemic Risk in the International Financial System. *FA 2005 Philadelphia Meetings Paper; EFA 2004 Maastricht Meetings Paper* 4449.
URL http://ssrn.com/abstract=559402

BAUR, D. and SCHULZE, N. (2005). Coexceedances in Financial Markets - A Quantile Regression Analysis of Contagion. *Emerging Markets Review* **6** 21–43.

BIS (2005). Credit Risk Transfer. *Basel Committee on Banking Supervision, The Joint Forum* .

BLUHM, C., OVERBECK, L. and WAGNER, C. (2003). *An introduction to : Credit Risk Modelling*. Chapman & Hall/CRC financial mathematics series.

DAS, S. and UPPAL, R. (2004). Systemic Risk and International Portfolio Choice. *Journal of Finance* **59** 2809–2834.

ESF (2005). ESF Securitization Data Report. Summer 2005 .

EUROPEAN CENTRAL BANK (2004). Credit Risk Transfer by EU Banks: Activities, Risks and Risk Management .

FRANKE, G. and KRAHNEN, J. P. (2005). Default Risk Sharing Between Banks and Markets: The Contribution of Collateralized Loan Obligations. *Working Paper Series CFS No.* 2005/06.

GROPP, R. and MOERMAN, G. (2004). Measurement of Contagion in Banks' Equity Prices. *Journal of International Money and Finance* **23** 405–459.

HARTMANN, P., STRAETMANS, S. and DE VRIES, C. (2005). Banking System Stability: A Cross-Atlantic Perspective. *Working Paper Series* 527.

ISSING, O. (2005). Opening Remarks at the 4th Joint Central Bank Research Conference on Risk Measurement and Systemic Risk in cooperation with the Committee on the Global Financial System. *ECB* .

JOBST, A. (2002a). Collateralized Loan Obligations (CLOs): A Primer. *CFS working Paper No.* 2002/13.
URL http://www.ifk-cfs.de/homepages/h-veroeffentlichungen.htm

JOBST, A. (2002b). Loan Securitisation: Default Term Structure and Asset Pricing Based on Loss Prioritisation. *FMG Discussion Paper Series Financial Markets Group, LSE dp* 422/02.

JOBST, A. (2002c). The Pricing Puzzle: The Default Term Structure of Collateralised Loan Obligations . *CFS working Paper No.* 2002/14.
URL http://www.ifk-cfs.de/homepages/h-veroeffentlichungen.htm

KRAHNEN, J. P. (2005). Der Handel von Kreditrisiken: Eine neue Dimension des Kapitalmarktes. *Working paper series: Finance & Accounting* .

SCHRÖDER, M. and SCHÖLER, M. (2002). The Systemic Risk Potential in European Banking - Evidence from Bivariate GARCH Models. *ZEW Working Paper No.* 03–11.