



Munich Personal RePEc Archive

## **Securitization and Bank Stability**

Di Cesare, Antonio

Bank of Italy

February 2009

Online at <https://mpra.ub.uni-muenchen.de/16831/>  
MPRA Paper No. 16831, posted 18 Aug 2009 18:36 UTC

# SECURITIZATION AND BANK STABILITY

by Antonio Di Cesare\*

## Abstract

This paper analyzes the effects of CDO issuance on the risk of default of banks. Previous literature showed that the overall riskiness of a bank can increase when it sells part of the loans in its portfolio by issuing a CDO of which it retains the equity tranche. Using Monte Carlo simulations, this paper confirms previous results but also highlights that they can change substantially if one modifies the hypothesis regarding how the proceeds of securitizations are reinvested. The assessment of the effects of securitizations on bank stability is thus mainly a matter of empirical research. Using data for Italian banks I provide evidence that the securitization activity has been a relevant factor in changing the composition of the asset side of banks' balance sheets. Results also show that these changes have probably contributed to lower the average *ex-ante* riskiness of Italian banks. I also compare the riskiness of loans that have been securitized with that of new loans granted by the same securitizing banks using loan-by-loan data. Results show that new loans are on average riskier than loans that have been securitized, thus pointing to an increasing amount of risk to be born by banks as a consequence of the reinvestment of the proceeds of securitizations.

JEL classification: G21, G28.

Keywords: *Bank stability, CDOs, Value-at-Risk, bank capital structure, Monte Carlo simulations.*

---

\*Bank of Italy and Erasmus School of Economics. Corresponding address: Bank of Italy, Economic Outlook and Monetary Policy Department, Via Nazionale 91, 00184 Rome, Italy. Tel: +39 (06) 4792 3943, fax: +39 (06) 4792 3723, e-mail: antonio.dicesare@bancaditalia.it.

The views expressed in the article are those of the author and do not involve the responsibility of the Bank of Italy.

## Contents

1	Introduction.....	1
2	CDO issuance and bank stability .....	3
2.1	The basic model .....	3
2.2	The distribution of the returns of a portfolio of loans .....	7
2.3	The effects of securitization on bank stability.....	9
3	An empirical investigation on Italian banks.....	10
3.1	Analysis of Italian bank balance sheets.....	11
3.2	Comparing securitized loans and new loans.....	16
4	Conclusions .....	18
	References .....	20
	Appendix: The market of CDOs .....	22
	Tables and figures .....	25

## 1 Introduction

During the last few years there was a tremendous increasing use of new financial instruments for transferring credit risk, such as credit-linked notes (CLNs), credit default swaps (CDSs), indices on CDSs (CDXs), collateralized debt obligations (CDOs) and many others.<sup>1</sup> The exceptional growth of the market has been spurring an intense debate on the effects of credit derivatives on the entire economic system, especially after the starting of the ongoing financial crisis. The use of credit derivatives can have sizable beneficial effects on both single institutions and the overall financial system. Credit derivatives make the dispersion of credit risk among economic institutional sectors easier and more efficient and even sectors that overall are not net sellers of credit risk can benefit from a wider dispersion of the risk among their members. Moreover, the transferring of risks from the banking sector to less leveraged and more long-term oriented financial sectors, such as insurance companies and pension funds, could contribute to further strengthen the whole financial system (cf. Greenspan, 2005). However, as FitchRatings (2006) pointed out, and the current financial crisis confirmed, the extensive use of credit derivatives can also lead to an extremely high concentration of risks among a few primary dealers, with the consequence that the exit or the failure of one of them has the potential to harm market liquidity and can result in huge counterparty credit losses for market participants.<sup>2</sup>

Recently it has emerged (at least) one more source of concern for financial stability due to how credit derivatives can be used. During the last few years it has become common practice for banks, especially large banks, to use CDOs to transfer part of the credit risk associated with their loan portfolio to other investors. Collateralized debt obligations are securities issued in tranches with different seniority which are backed by the payoffs of the underlying assets.<sup>3</sup> If some of the underlying loans are not repaid at maturity, the

---

<sup>1</sup>For an overview of the techniques used for transferring credit risk and related issues, cf. Committee on the Global Financial System (2003). JPMorgan (1999) contains an admitted incomplete taxonomy of credit derivatives.

<sup>2</sup>In this regard, one of the main drawbacks in most available statistics on credit derivatives exposures is that only net notional value positions are available, at most. However, notional exposures can be rather misleading since they do not take into account real exposures to the underlying risk factors, that is the sensitivity of the value of the instruments to changes in the underlying risk factors (cf. Cousseran and Rahmouni, 2006). Apparently balanced positions in terms of notional amounts can hide very large risk exposures whereas apparently unbalanced positions can instead be the result of well hedged portfolios.

<sup>3</sup>Collateralized debt obligation is a generic term for this type of securities. Depending on whether the assets in the underlying portfolio are loans, bonds or CDSs, one can have *collateralized loan obligations* (CLOs), *collateralized bond obligations* (CBOs) or *collateralized synthetic obligations* (CSOs). CDOs of ABS and CDO<sup>2</sup> are also rather common: In the first case the underlying is made by other securities (asset backed securities) which are in turn backed by assets such as consumer loans or credit card debts, while in the second case the collateral is made by other CDOs. More details about the market of CDOs can be found in the Appendix.

corresponding losses are borne by the tranches with lower seniority, up to their notional values. The most senior tranches are only affected in case of very large losses, for which the provisions of the most junior tranches are not enough. In order to reduce moral hazard issues related to the fact that banks that transfer their risks could have less incentives to have sound credit standards and the efforts of banks in that regard cannot be easily verified by final investors in CDOs, it is common practice for banks that securitize loans to retain the equity tranche, which is the most junior and riskiest tranche. However, Krahn and Wilde (2006) show that selling loans by issuing CDOs and retaining the equity tranche can increase the risk that banks suffer extreme large losses, thus increasing the probability of banking failures.

In this paper I slightly modify the framework used by Krahn and Wilde (2006) and I show that even if their results hold under plausible assumptions they are nonetheless very sensitive to the initial hypotheses. My results show under which conditions the issuance of CDOs increases or reduces the risk for the issuer to incur large losses and highlight the fundamental role that the reinvestment of the proceeds of the securitization has in this regard. In particular, I show that the riskiness of a bank decreases when the proceeds of the securitization are reinvested in loans with individual default probability smaller than that of the loans that have been securitized. Similarly, securitization is beneficial for a bank when the loans that are securitized have a positive (negative) correlation with a common risk factor and the proceeds are reinvested in new loans with lower (greater) correlation with the same risk factor (i.e. securitization is used to increase the diversification on the portfolio). As a consequence of these results, the assessment of the effects of the issuance of CDOs on the risk of defaults for banks is mainly a matter of empirical research.

So far there have been two main streams of empirical research on the relationship between banks and securitization. The first one is concerned with the determinants of securitization. In this regard, Bannier and Hänsel (2007) use data on European banks and find that securitizations are more likely to be realised by larger, less liquid, less profitable and riskier banks. Affinito and Tagliaferri (2008) confirm those results for Italian banks and also find evidence of a role for regulatory capital relief as a determinant of securitization activity. Other works concentrated instead on the empirical effects of CDOs issuance on banking business. Altunbas et al. (2007) show that the use of securitization shelter banks' loan supply from the effects on monetary policy and strengthen the capacity of banks to supply new loans. Franke and Krahn (2005), using data from the stock market, find evidence that banks' betas rise around the announcement of a CDO issue, thus signalling an increased perception of systematic risk by the market. Jiangli et al. (2007) and Jiangli and Pritsker (2008) find that securitization has been beneficial to US

banks in terms of increased profitability and reduced risks.<sup>4</sup>

The second part of my paper is related to both streams of empirical research. First of all, using data for Italian banks I look for changes in the composition of the asset side of the balance sheets of the banks that securitized their loans and I provide evidence that the securitization activity has been a relevant factor in explaining those changes. Results also show that those changes have probably contributed to lower the average *ex-ante* riskiness of Italian banks, mainly because of the reduction of the share of bad loans over total assets. Then, I aim to verify whether banks use securitizations to modify the overall quality of their loan portfolio. In this regard, I use loan-by-loan data to directly compare default rates of loans that have been securitized with those of new loans granted in the same months by the banks that made the securitizations. Results show that new loans are on average riskier than loans that have been securitized, thus pointing to an increasing amount of risk to be born by banks as a consequence of the reinvestment of the proceeds of securitizations. To the best of my knowledge this is the first paper that attempts to measure directly the effects of securitization on the risks borne by the issuer using loan-by-loan data.

The paper is organized as follows. In Section 2 I introduce the model used to analyse the effects of CDOs issuance on bank stability and discuss the results. Section 3 focuses on the empirical investigation on the effects of securitization on the risks incurred by Italian banks and Section 4 concludes. An Appendix at the end of the paper provides further details on the market of CDOs.

## 2 CDO issuance and bank stability

Due to the growing importance that the CDO market had in the global financial system during the last few years, it is surprising that until now only the paper by Krahen and Wilde (2006) has studied the effects that issuing these instruments can have on the risk of defaults of the originators. Following the trail blazed by those authors, I use Monte Carlo simulations to generate the return distribution of a portfolio of loans and study how the risk of default of the originator can change according to different assumptions regarding the characteristics of the loans that are securitized and the characteristics of the new loans that are granted using the proceeds of the securitization.<sup>5</sup>

### 2.1 *The basic model*

I assume that a bank owns a portfolio of  $N$  loans granted to  $N$  different borrowers.

---

<sup>4</sup>The two papers use data up to the third quarter of 2006 and the second quarter of 2007, respectively, thus excluding the recent unfavourable developments for the banking industry.

<sup>5</sup>Those interested in more analytical CDO pricing techniques should take a look at Longstaff and Rajan (2006), and references therein.

The capacity of each borrower to pay back the loan at maturity is described by the variable

$$V_i = \text{sign}(\rho)\sqrt{|\rho|}X + \sqrt{1-|\rho|}\epsilon_i, \quad i = 1, \dots, N. \quad (1)$$

with  $\rho \in (-1, 1)$ .<sup>6</sup> The variable  $V_i$  can be interpreted as a normalized measure of the value of the assets of borrower  $i$  and depends on the return of a common risk factor  $X$  and an idiosyncratic risk factor  $\epsilon_i$  which is borrower specific. Both the common and the idiosyncratic risk factors are assumed to be standard normally distributed and pairwise independent. Due to these assumptions,  $V_i$  is also standard normally distributed with a correlation of  $\text{sign}(\rho)\sqrt{|\rho|}$  with the common risk factor and  $|\rho|$  with any other  $V_j$  with  $j \neq i$ . All loans are assumed to be equal as for notional value, coupon yield ( $CY$ ), individual default probability ( $DP$ ), and recovery ratio ( $RR$ ). The value of  $DP$  implicitly define the default level  $DL = \Phi^{-1}(DP)$ .<sup>7</sup> When the value of  $V_i$  goes below  $DL$ , borrower  $i$  is deemed to default and only the share  $RR$  of the notional value of the loan is paid back. I also assume a constant interest rate  $r$  for (continuously) discounting future payoffs. Finally, I assume that all loans have a maturity of one year and that default can only occur at the end of that year.

Without loss of generality, one can normalize the total notional value of the  $N$  loans to be equal to 1, so that the relative weight of any loan is  $1/N$ . The coupon yield on the loans is set equal to

$$CY = \frac{\exp(r) - DP \cdot RR}{1 - DP} - 1 \quad (2)$$

which is the value that makes the discounted expected value of any loan equal to its face value. More generally, I assume that any asset is priced in a risk-neutral way, thus getting rid of any issue related to investors' degree of risk aversion.

Let me now assume that the bank decides to sell  $n$  of the  $N$  loans by putting them in the underlying pool of a CDO. As in Krahnert and Wilde (2006) the CDO has 7 tranches whose size is defined by their default probabilities, which are set at the 1%, 2%, 5%, 10%, 20%, and 30% percentiles of the return distribution of the loan portfolio. That means that the first tranche only suffers some losses with a 1% probability, the second one with a probability of 2%, and so on. The default probability of the last tranche, that bears all initial losses and is retained by the bank, is not pre-defined but can be calculated given the previous assumptions on the characteristics of the loans. Immediately after the securitization the bank reinvests the proceeds of the sale of the six tranches in new loans. It turns out that the reinvestment strategy is the critical factor determining whether the overall riskiness of the bank is going to increase or to decrease after the securitization

---

<sup>6</sup>This definition of the model allows  $\rho$  to be negative and encompasses the model used by Krahnert and Wilde (2006) which requires  $\rho$  to be positive.

<sup>7</sup> $\Phi$  is the standard normal cumulative distribution function.

process has been completed (i.e. tranches are sold and proceeds are reinvested). Krahen and Wilde (2006) make the reasonable but simplifying assumption that new loans have the same characteristics (in terms of  $\rho$ ,  $DP$ , and  $RR$ ) of the loans that have been just securitized.<sup>8</sup> Under this hypothesis, they show that the probability that the bank face large losses increases substantially after the securitization.

The core of my exercise is to estimate the return distribution of the original portfolio (i.e. the portfolio of loans before the securitization process starts) and compare it with the return distribution of a new portfolio made of: 1) The loans in the original portfolio that have not been securitized; 2) The equity tranche of the CDO that has been issued; 3) The new loans that the bank has granted using the proceeds of the sale of the other tranches of the CDO. In order to better describe how the mechanism works, let me introduce some notation:

$$\left\{ \begin{array}{ll} P_{old} & \text{the total payoff of the original portfolio} \\ P_n & \text{the total payoff of the } n \text{ loans that are securitized} \\ P_{N-n} & \text{the total payoff of the } N - n \text{ loans that are not securitized} \\ P_{eqt} & \text{the payoff of the equity tranche of the CDO.} \\ P_{rnv} & \text{the total payoff of the loans in which the bank reinvests} \\ & \text{the proceeds of the securitization} \\ P_{new} & \text{the total payoff of the new portfolio.} \end{array} \right.$$

The returns associated to these payoffs can be calculated by dividing them by their initial fair values, and subtracting one, and are indicated by substituting  $R$ s to the previous  $P$ s (we thus have  $R_{old}$ ,  $R_n$ ,  $R_{N-n}$ ,  $R_{eqt}$ ,  $R_{rnv}$ , and  $R_{new}$ ).

All the probability distributions of the previous returns are estimated using the following steps:

- 1) Generate a random value for the common risk factor  $X$ ;
- 2) Generate  $N$  random values for the idiosyncratic risk factors  $\epsilon_i$ ,  $i = 1, \dots, N$ ;
- 3) For given  $\rho$ , compute  $V_i$ ,  $i = 1, \dots, N$ , as defined in equation (1);
- 4) Calculate total payoff and return of the original portfolio:<sup>9</sup>

$$P_{old} = \frac{1}{N} \left[ RR \cdot \sum_{i=1}^N \mathbf{1}_{\{V_i \leq DL\}} + (1 + CY) \cdot \left( N - \sum_{i=1}^N \mathbf{1}_{\{V_i \leq DL\}} \right) \right]$$

and

$$R_{old} = P_{old} - 1;$$

---

<sup>8</sup>Krahen and Wilde (2006) also make the less reasonable assumption that the bank securitizes all its loan portfolio, that is  $n = N$ .

<sup>9</sup>Remember that the initial value of the original portfolio has been normalized to one so that the initial value of any loan is  $1/N$ .



5) Calculate total payoff and return of the  $n$  loans that are securitized:

$$P_n = \frac{1}{N} \left[ RR \cdot \sum_{i=1}^n \mathbf{1}_{\{V_i \leq DL\}} + (1 + CY) \cdot \left( n - \sum_{i=1}^n \mathbf{1}_{\{V_i \leq DL\}} \right) \right]$$

and

$$R_n = NP_n/n - 1;$$

6) Calculate total payoff and return of the  $N - n$  loans that are not securitized:

$$P_{N-n} = \frac{1}{N} \left[ RR \cdot \sum_{i=n+1}^N \mathbf{1}_{\{V_i \leq DL\}} + (1 + CY) \cdot \left( N - n - \sum_{i=n+1}^N \mathbf{1}_{\{V_i \leq DL\}} \right) \right];$$

and

$$R_{N-n} = NP_{N-n}/(N - n) - 1;$$

7) Using  $P_n$ , calculate the detachment point of the equity tranche as the greatest value  $EDP$  such that  $\mathbf{P}(P_n \leq EDP) < 0.3$ ;

8) Calculate the payoff of the equity tranche:  $P_{equity} = \max(P_n - EDP, 0)$ ;

9) Reiterate previous steps  $M$  times to find out the empirical distribution of payoffs and returns.<sup>10</sup>

10) Using the distribution of  $P_{equity}$ , calculate the fair value of the equity tranche and its return

$$V_{equity} = \exp(-r) \cdot \mathbf{E}[P_{equity}]$$

and<sup>11</sup>

$$R_{equity} = P_{equity}/V_{equity} - 1;$$

11) Given that the CDO is priced in a risk-neutral framework, its total initial value is equal to that of the underlying loans, which is  $n/N$ . This implies that the proceeds of the sale of the CDO are equal to  $n/N - V_{equity}$ . That amount of money is reinvested by the bank in a portfolio of  $n$  new loans with characteristics potentially different from those of the loans in the original portfolio. The payoff of this reinvested portfolio,  $P_{rnv}$ , can be calculated in the same way as for  $P_{old}$ , steps 2 to 4, but setting  $N = n$ , and its distribution can be determined by reiterating the steps.

---

<sup>10</sup>Calculations are performed with  $M = 100,000$ .

<sup>11</sup>Given that  $P_{equity}$  has already been simulated  $M$  times, the distribution of  $R_{equity}$  can also be easily determined.

12) Finally, calculate the payoff and the return, and their distributions, of the portfolio that the bank owns after the reinvestment has been made:

$$P_{new} = P_{N-n} + P_{equity} + P_{rnv}$$

and

$$R_{new} = R_{N-n} + R_{equity} + R_{rnv} - 1.$$

## 2.2 The distribution of the returns of a portfolio of loans

In order to shed light on the effects of the securitization process on the risk profile of a bank one can take a look at the return distribution of the loan portfolio as a function of the underlying variables.

Figure 2.1 shows the return distributions for 5 portfolios which have the same characteristics except for the number of underlying loans. As in Krahen and Wilde (2006) I assume that all loans have a correlation coefficient  $\rho$  equal to 0.3, an individual default probability of 20% and a recovery rate of 47.5%. I further assume that the risk-free interest rate is equal to 4%. By equation (2) the coupon yield  $CY$  is equal to 18.2%. The figure clearly shows that the return distributions of 5 portfolios with a number of loans from 100 to 10,000 are rather similar, thus proving that a fairly high level of diversification can be achieved with a relatively small number of loans. Figure 2.2 shows the cumulative distribution functions for the returns of the 5 portfolios, that is the probability that returns are lower than given levels.<sup>12</sup> According to the figure, the probability of incurring a loss - a negative return - is equal to about 30% for all portfolios and the probability of having a loss greater than 20% is about 5%. Finally, Figure 2.3 reports the VaR for a probability level ranging from 0.1% to 10%.<sup>13</sup> The interpretation of the figure is that, for instance, there is a 2% probability that the loss can be greater than 30% and that with probability 0.1% the loss can be greater than about 55%. It is just the case to point out that all these figures contain the same information reported in slightly different ways.

More interesting things come out when one looks at portfolios with loans that differ in their individual default probability only.<sup>14</sup> Figure 3.1 reports the return distribution for 5 portfolios with loans that have default probability ranging from 10% to 50%. Portfolios with greater default probabilities have return distributions with extremely fatter tails than portfolios with smaller default probabilities. This is due to the fact that greater default

<sup>12</sup>Formally, the figure reports the function  $\mathbf{F}(x) = \mathbf{P}(R_{Port} \leq x)$ .

<sup>13</sup>Formally, the figure reports the function  $\text{VaR} = \mathbf{F}^{-1}(x)$ , where  $\mathbf{F}$  is the cumulative distribution function of Figure 2.2 and  $x$  is the probability level.

<sup>14</sup>Assumptions on the correlation coefficient, recovery rate and risk-free interest rate are the same as defined above. The number of loans is set to 1,000.

probabilities imply not only more chances of incurring large losses but also of having very large returns when there are no defaults (because loans with greater default probability also have higher coupon yields). From Figure 3.2 it can be seen that the probability of having losses greater than 10% can range from 5% to over 30% or, said in a slightly different way, Figure 3.3 shows that when the individual default probability increases from 10% to 50% one can expect to have losses greater than 10% and 45%, respectively, with the same 5% probability.

Finally, one can examine the case in which the correlation coefficient  $\rho$  varies across portfolios.<sup>15</sup> As shown by Figure 4.1, the effect of moving the correlation coefficient from zero - as in a perfectly diversified portfolio where all loans are independent of each other - to 50% is to transform the return distribution from a normal-like distribution to a distribution with very fat tails. Raising the correlation coefficient leads the return distribution of the portfolio to be more and more concentrated in the extremes and this effect is much greater than what can be seen in the previous case of increasing individual default probability. In the limit case in which  $\rho = 1$ , the loans either default all together or none defaults. In that case, there would be exactly a 20% probability that all loans default, with a return of the portfolio of -52.5% - since only the recovery rate would be received back - and a 80% probability that none of the loans defaults, so that there would be a return for the portfolio of 18.2% - the coupon yield.

To conclude this sub-section it is worth to point out that there is an important effect of the correlation coefficient on the return distribution that cannot be shown in the framework used until now, but that it is crucial for understanding the results I am just about to show on the effects of securitizing loans by issuing a CDO. Remember that in equation (1) I assumed  $\rho$  to be a real variable defined in the interval  $(-1, 1)$ . However, up to now I only analysed the effects of  $\rho$  on the return distribution of the portfolio for some positive values of that variable. This was done because I was assuming that all loans have the same  $\rho$ . The effects of  $\rho$  on the return distribution depend on how it affects the behaviour of the variable  $V_i$  in equation (1) and since the common risk factor  $X$  has a symmetric distribution with zero mean, my results would not change for, say,  $\rho = x$  and  $\rho = -x$ . However, in the following sub-section I am going to assume that the bank can reinvest the proceeds of the securitization in new loans that have a  $\rho$  different from the one of the old loans, thus creating a portfolio in which loans with different correlations with the common risk factor coexist. In that framework the sign of  $\rho$  is going to be relevant as, for instance, the effect of a negative return of  $X$  on the value of a firm which is positively correlated with it could be partially offset from the positive effects on a firm negatively

---

<sup>15</sup>The assumptions on recovery rate and risk-free interest rate are still the same as defined before and also the number of loans is kept fixed at 1,000. The individual default probability is equal to 20%.

correlated with it.

### *2.3 The effects of securitization on bank stability*

I take once again the assumptions of Krahnert and Wilde (2006) as the benchmark case. Hence, I assume  $\rho = 0.3$ ,  $DP = 20\%$ ,  $RR = 47.5\%$  and  $r = 4\%$ . The continuous line in Figure 5.1 shows the probability density function of the returns of a portfolio made of 1,000 loans with those characteristics. As shown by Krahnert and Wilde (2006), the risk for the bank of incurring large losses increases if the bank fully securitizes its portfolio by issuing a CDO of which it retains the equity tranche and reinvests the proceeds in loans with the same characteristics. This result can be seen from figures 5.2 and 5.3 through the comparison of the lines for the original portfolio with those of the case in which the loans in the new portfolio have also an individual default probability of 20%. However, if the bank reinvests the proceeds in loans of better quality, i.e. with smaller individual default probability, the overall riskiness of the bank can decrease significantly. For instance the 1% VaR goes from about -30% of the original portfolio to less than -20% of the new portfolio.

Results are even sharper if one assumes that the loans in which the proceeds of the securitization are reinvested have a different correlation coefficient  $\rho$ . Figures 7.1 to 7.3 shows that the bank can sharply reduce its VaR for any confidence level if it reinvests in loans with smaller  $\rho$ . In the case of reinvestment in loans with  $\rho = -0.1$ , for instance, the 1% VaR drop from about -30% to less than -5%. Reinvesting in loans that are negatively correlated with the common macro factor allows the bank to diversify the residual exposure to the initial portfolio, which is positively correlated with the risk factor, that it retains by holding the equity tranche of the CDO.

Given than assuming that a bank completely securitizes its portfolio is an extreme hypothesis, I also calculated what happens when only a fraction of the original portfolio is securitized. Figures 6.1 to 6.3 and 8.1 to 8.3 show that previous results still hold when 20% of the original portfolio is securitized but, as one would expect, new results are much less sharp. In fact, it interesting to notice in this more reasonable case that even if a bank reinvests the proceeds of securitization in loans with the same characteristics of the loans that it has sold, which is in some sense the worst thing it can do, the overall riskiness of the bank increases of only a negligible amount. These results provide support to the idea that CDO issuance is unlikely to increase the risks for the stability of the financial system. Even if this result is apparently at odds with the widely accepted opinion that the use of CDOs has been among the major drivers of the current turmoil, one should distinguish between the effects deriving from the securitization activity by its own, which are analysed in this paper, and the difficulties in correctly pricing and hedging these instruments, which the financial turmoil proved to be not an easy task. It is probably worth to point out once again that one major assumption in this section is that CDOs are correctly priced by

issuers and investors and that, of course, all results rely on the underlying assumptions.

Finally, tables from 1 to 4 report VaR changes for several hypotheses about the characteristics of the loans that have been securitized and the new loans that the bank has reinvested in. Table 1, for instance, reports that 0.1%, 1% and 5% VaR, would increase by (about) 10%, 15% and 30%, respectively, if a bank with loans with  $DP = 20\%$  securitizes them all and reinvests in loans with the same individual probability of default. However, the VaR at the same confidence level would decrease by (about) 10%, 15% and 15% if the bank reinvests in loans with  $DP = 10\%$ . As a general result, Tables 1 and 2 show that a bank can reduce its VaR if it reinvests in loans with better credit quality. At the same time, the bank can reduce its VaR also by investing in loans with the same credit quality but with a different degree of correlation with the common risk factor. In particular, the VaR generally decreases when a bank with a portfolio of loans positively (negatively) correlated with the common risk factor securitizes them all and reinvests in loans which are negatively (positively) correlated with the common risk factor. Tables 3 and 4 confirm that previous results still hold if only part of the original portfolio is securitized.

### **3 An empirical investigation on Italian banks**

In the previous section I showed that the overall riskiness of a bank can increase as well as decrease when it sells part of its loan portfolio by issuing a CDO of which it retains the equity tranche. The final results critically depend on the hypothesis one makes about the way in which the proceeds of the securitization are reinvested. The riskiness of a bank decreases every time it reinvests in loans with smaller individual default probability or in loans which are less (more) correlated with the common risk factor than the loans that have been securitized, when the correlation is positive (negative). The opposite results hold for the inverse assumptions. As a consequence of the previous analysis, it is not possible to assess the real effects of CDO issuance on banks' risk of default on a general basis but it is necessary a case-by-case study. In this Section I provide some empirical evidence on the effects that securitization is having on Italian banks' balance sheets and loan portfolios.

Securitization can effect the balance sheet structure of a bank either directly or indirectly. We have a direct effect when, as in the previous section, some assets are securitized and then replaced with different assets. For instance, the securitization of bad loans and the granting of new loans automatically tends to reduce the share of the first kind of loans over total assets and to increase the share of performing loans. The indirect effect is instead related to the potential effects that securitization might have on banks' balance sheets. As an example, a bank can decide to increase its share of loans

to particular categories of borrowers, or enter new markets, just because it knows that, if needed, it would be relatively easy to get rid of these new loans by securitizing them. This example is probably relevant for many American banks that in the last few years decided to increase their exposure to subprime loans.

My empirical analysis is twofold. In the first part I analyse whether the overall structure of banks' balance sheets has been changing due to securitization. I examine broad balance sheet items to verify whether their relative shares with respect to total assets have changed during the years due to the securitization activity of the banks. The second piece of empirical analysis is instead focussed on the characteristics of single loans, and is in some sense more in line with the theoretical framework provided in the previous section. For supervisory reasons, in Italy there are very detailed loan-by-loan databases. Using those data it is possible to compare the individual probability of default of the loans that have been securitized with that of the new loans that have been granted by the same banks during the same months. Unfortunately, for reasons that will be explained later, the information in the Italian databases is not suitable for estimating whether the probability of default of the new loans is more or less correlated with that of the loans that remained in the banks' portfolios than that of the loans that have been securitized.

### *3.1 Analysis of Italian bank balance sheets*

I analyse the evolution of Italian bank balance sheets between 1999, the year in which the Italian law on bank loan securitization was passed, and 2007. During that period Italian banks securitized assets for 170 billion euros. About 75% of that amount was made of performing loans, that is loans not considered as troublesome by banks. Out of the 218 banks that made at least one securitization, 140 securitized only performing loans, 40 only bad loans, and 38 both types of loans. The market was rather concentrated with about a half of the total amount of securitizations made by only 10 banks (this number further reduce to 5 if one takes into account that some of them merged during the period).

I use monthly data on balance sheet items and securitizations proceeds from the Supervisory Reports to the Bank of Italy. Supervisory Reports permit to distinguish between proceeds deriving from securitization of performing and bad loans. According to Italian regulations, banks are required to classify outstanding loans to borrowers that are not expected to meet their obligations as bad loans. Clearly, this definition allows banks some degrees of discretion in judging whether a loan is bad or not. I will return on this issue later.

In order to verify whether the main items of the Italian bank balance sheets have changed between 1999 and 2007 and whether there have been significant differences be-

tween banks that securitized their assets and banks that did not, I use a difference-in-difference approach. In particular, I estimate pooled equations of the following type for any asset item I am interested in:

$$y_{i,t} = \beta_0 + \beta_1 \delta_{t,2007} + \beta_2 \delta_{i,sec} + \beta_3 \delta_{i,sec} \delta_{t,2007} + \beta_4 x_{i,t} + \epsilon_{i,t} \quad (3)$$

where  $i = 1, \dots, N$  are the banks included in the sample,  $t \in \{1999, 2007\}$ ,

$$\delta_{t,2007} = \begin{cases} 0 & \text{if } t = 1999 \\ 1 & \text{if } t = 2007 \end{cases}$$

$$\delta_{i,sec} = \begin{cases} 0 & \text{if bank } i \text{ did not securitize at all between 1999 and 2007} \\ 1 & \text{if bank } i \text{ securitized at least once between 1999 and 2007} \end{cases}$$

and  $x_{i,t}$  are control variables such as size, capitalization and proprietary structure.

The balance sheet items I focus on are the amount of performing loans to non-bank customers (i.e. excluding interbank loans and deposits to monetary authorities), bad loans to non-bank customers, loans to other subjects (i.e. banks), and securities other than shares.<sup>16</sup> For any of those items I calculate the annual average of their monthly share over total assets. Given that these ratios are bounded between zero and one, I use the logistic transformation of them as dependent variable  $y_{i,t}$ .<sup>17</sup> Equation (3) is estimated using the weighted least-squares logistic regression for grouped data described in Greene (2003, pp. 686-689).

As in any difference-in-difference estimation the most interesting coefficients are those related to the dummy variables. In particular,  $\beta_1$  is a measure of the average common change of the dependent variable across all banks between 1999 and 2007,  $\beta_2$  is a measure of the average difference of the dependent variable between banks that securitized and banks that did not securitize, in both 1999 and 2007, and  $\beta_3$  is a measure of the average variation of the dependent variable between 1999 and 2007 for only those banks that securitized some of their assets. In other words,  $\beta_1$  captures structural changes in the overall Italian banking system between 1999 and 2007,  $\beta_2$  measures those differences that are intrinsic to banks that securitized some of their assets and that did not change

---

<sup>16</sup>Overall these items accounted for about 80% of total assets, in both 1999 and 2007. Other major items on the asset side of Italian banks' balance sheets are related to repo contracts, equity and other shares, and other assets. Those items are not included in the econometric analysis because repo contracts are only used by a minority of banks (although for some of them they represent an important investment), equity and other shares are subject to non-negligible variations due to evaluation effects, and other assets represent a miscellany of sub-items whose interpretation can be not always clear.

<sup>17</sup>The logistic transformation of  $x$  is  $\log(x/(1-x))$ .

between 1999 and 2007,<sup>18</sup> and  $\beta_3$  is a measure of how the capital structure of banks that securitized their assets has changed. The control variables that I use are the logarithm of the annual average of total assets, an indicator of capitalization defined as the logistic transformation of the annual average of the ratio between bank's its own capital and total asset, and a dummy variable indicating whether the bank is a mutual or cooperative bank or not.

Before running the regressions I performed a series of controls on the data. First of all, I drop data on branches of foreign banks. There are two reasons for this choice. The first one is that, due to the greater openness of the Italian banking system, there has been a huge increase of the role of foreign banks between 1999 and 2007, in terms both of numbers and total assets (from 50 to 80 and from 86 to 275 billion euros, respectively). This phenomenon is probably independent of the role of securitization in determining bank capital structures. The second reason is that for foreign banks the Italian law on securitization in 1999 did not probably represented a novelty, since for most of them it was already possible to securitize their assets in their home countries. Then, mergers and acquisitions are taken into account by considering all entities involved in these operations as a single entity for all the period taken into account (i.e. I summed the values of the corresponding balance sheet items for those banks that were involved in mergers or acquisitions). Since I use annual averages of monthly balance sheet data in my estimations, I also dropped those banks for which less than 6 monthly data are available, for either 1999 or 2007. Finally, to get rid of some outliers, I dropped 1% of observations from the dataset (best and worst 0.5% of all balance sheet ratios).<sup>19</sup> The final database is made of 537 banks, 80% of which are either local mutual or cooperative banks (cf. Table 5). At the end of 2007, the coverage of the sample was about 70% of all Italian banks in terms of number, total assets, loans to non-bank customers and proceeds from securitization (cf. Table 6).

The choice to restrict the analysis to just two years deserves some explanation. Indeed, it can be argued that more data with the same of higher frequency should be used. For instance one might think to use a panel of data with the time dimension being represented by all years between 1999 and 2007, and not just the first and the last year

---

<sup>18</sup>For instance, one may think that the banks that securitize their assets are also the banks that are technically more advanced and have better credit scoring systems. If this were true, it would be reasonable to expect that those same banks were also more prone to allow credit to non-bank customers and less to other banks or to buy less securities, since the last two types of investments generally need less sophisticated risk-management tools. Actually, in Italy the overall share of loans to non-bank customers was significantly higher for banks that securitized than for banks that did not securitize, in both 1999 and 2007.

<sup>19</sup>Keeping all observations does not modify signs and significance levels of the estimated coefficients, but measures of fit are sometimes lower than those reported here.



of the period. One might also think to use quarterly data instead of annual data. While these are reasonable choices I nevertheless prefer to perform a comparison over a longer period of time because what I am looking for in banks' balance sheets are structural changes only. By definition, those changes do not arise in the short-term and, more important, using higher frequency data would increase the relevance of short-term effects of the securitization process. In order to make this point clearer, one can consider the case of a bank that securitizes bad loans. In a long-term perspective, the one I am interested in, it is not obvious whether such a bank should have a lower share of bad loans, just because it securitizes them, or a higher share of them, since the bank can decide to invest in riskier activities as it knows that it can easily get rid of bad loans, if needed. By using shorter term data one would only gather the mechanical effect that securitizing bad loans lead to a decrease of their share over total assets.

Table 7 shows how the balance sheet items I mentioned above changed between 1999 and 2007. Italian banks considerably increased the average share of performing loans over total assets while decreasing their loans to other banks and their investments in securities other than shares. The increase of the relative size of performing loans was common to all types of banks but was larger for banks that specialized in securitizing bad loans. For those banks the share of bad loans in their portfolios decreased by about two thirds. Banks that securitized performing loans only were also the ones with the higher share of that kind of loans in their portfolios in both 1999 and 2007. They also decreased substantially the relative size of their investments in securities other than share.

Table 8 reports the results of the econometric analysis. For performing loans, as expected from the previous review of the data, the coefficients for the both the 2007-dummy and the sec-dummy are significantly positive. The first one reflects the fact that the share of performing loans over total assets grew markedly for all banks between 1999 and 2007 while the second one derives from the fact that banks that securitized had, on average, a higher share of performing loans than banks that did not securitize in both 1999 and 2007. The negative sign of the dummy variables interacting year and securitization highlights that banks that securitized had a lower growth of the share of performing loans. Negative signs on the control variables size and capitalization show that larger and more capitalized banks have lower shares of performing loans. Overall, banks that securitized some of their assets had in 2007 relatively smaller shares of both performing and bad loans and greater investments in loans to other banks and securities other than shares. These results provide support to the idea that banks that securitized their loans took that opportunity to diversify their investments in other categories of assets.

In tables 9 and 10 I add further dummy variables in the regressions, with the aim to verify whether the changes in the balance sheet composition are mainly due to a direct or to

an indirect effect of securitization. If the direct effect were predominant, one should observe greater changes for those banks that securitized greater amounts of their assets. It turns out to be the case that the greatest (in absolute value) and more significant coefficients are instead predominantly associated with levels of securitization inferior to the median value. My interpretation of these results is that the indirect effects of securitization seem to have played the larger role in determining the investment choices of Italian banks. Banks that verified that they had the possibility to securitize their assets started changing their investment policies, probably under the assumption that they could quickly revert to previous policies using the instrument of securitization, if needed. On the contrary, banks that made more use of securitizations were also those who changed relatively less their policies. They have used this innovative instrument mainly as a funding resource for financing the same kind of investments. This result is coherent with Affinito and Tagliaferri (2008) who find that one of the main motivations for Italian banks to securitize their assets is to have additional resources for financing their investments.

In order to verify whether the above mentioned changes to the composition of the balance sheets have increased or decreased the overall riskiness of Italian banks one can make the following exercise. First of all, using the results of previous regressions, it is possible to calculate the expected values of the balance sheet ratios.<sup>20</sup> Then, one can associate to any balance sheet item a given level of expected losses and calculate an overall level of expected losses as the weighted average of the expected losses for individual items with weights equal to the predicted values of the balance sheet ratios. Table 11 reports the result of this exercise for the case in which expected losses for performing loans, bad loans, loans to banks, and securities other than shares are equal to 1%, 50%, 0.2%, and 0.4%, respectively, and losses are independent across balance sheet items. Under these assumptions, between 1999 and 2007 the levels of expected losses decreased by more than one third for banks that securitized while remained broadly unchanged for banks that did not securitize. This result is mainly driven by the fact that the share of bad loans, which represents the riskiest part of the banks' balance sheets, dropped for banks that securitized while remaining constant for banks that did not securitize. It is interesting to note that the greatest beneficial effect is associated, once again, with banks that made less use of securitization. Those banks, in fact, were less prone to increase the share of performing loans by reducing the relatively safer investment in securities other than shares. Finally,

---

<sup>20</sup>Given that in a logistic regression for grouped data it is not possible to interpret the regression coefficients as partial derivatives of the expected value of the balance sheet ratio with respect to the independent variables, as in Bofondi and Gobbi (2006) I estimated the predicted values using the smearing estimator of Duan (1983) with the following steps: 1) calculate the residuals as the difference between the dependent variables and the linear predictions; 2) calculate the predicted values as the sum of the linear predictions evaluated at the mean values, except for the variable of interest, and the residuals; 3) calculate the inverse of the logistic transformation of the predicted values and take the mean.

it is easy to verify that these results do not change qualitatively as long as one assumes, as it is reasonable, that bad loans are by far the riskiest item and that loans to banks are the safest.

### 3.2 Comparing securitized loans and new loans

In this section I compare, for a sample of Italian banks, the individual risk of default of loans that have been securitized in each semester  $t$  between 2004 and 2007 with that of loans that have been granted by the same banks during the same semester. In particular, for any bank  $i$ , I calculate the rate of default in semester  $s$  for all loans that were securitized or granted in semester  $t$ , where  $s$  is any semester between  $t$  and the second half of 2007, included. The rate of default is defined as the ratio between the face value, at time  $s$ , of all loans that have been securitized or granted by  $i$  in  $t$  that run into default in  $s$  and the overall face value of loans that have been securitized or granted by  $i$  at time  $t$ . The definition of default that I use is based on the notion of bad loan as defined by Italian regulation and I consider a borrower to be in default on all the loans she received when at least one of those loans is classified as bad by one of her lenders.<sup>21</sup>

As already said, the definition of bad loans allows banks to have a certain degree of arbitrariness as they have to judge when the loan is likely not to be repaid. Actually, monthly default rates show a strong seasonality, probably reflecting the policies applied by major banks to review their credits. The choice to use semi-annual data relies on the need to mitigate the seasonality with which defaults are reported and also on the necessity to analyse a period of time that is long enough to allow banks to reinvest the proceeds of their securitizations but not too long to suppose that banks are doing their investments using other sources of financing only.

Section 3 showed that the characterizing features of loans for assessing riskiness of a bank are the individual probability of default and the correlation with other loans in the bank's portfolios. However, as mentioned at the beginning of this section, I am only able to provide some empirical evidence on the first characteristic. The main reason for why it is extremely difficult to say anything on the correlation between loans that have been securitized and loans that remained in the bank's balance sheet is the degree of arbitrariness with which Italian financial institutions can classify a loan as bad. A loan that is securitized is going to be defined as bad by the special purpose vehicle that bought it whereas loans that remain in the portfolio of the bank are going to be defined as bad by the bank itself. The fact that loans are classified as good or bad by different institutions,

---

<sup>21</sup>The reason for using this extended definition of default is based on the fact that Italian databases uniquely identify borrowers but not loans, thus making extremely difficult to keep track of the transferring of any specific loan among financial institutions.

potentially using different criteria, makes the calculations of any correlation coefficient among default strongly unreliable. One possibility to circumvent this problem would be to use a sufficiently large window, say six months, that is deemed to capture most of the possible differences in the timing with which loans are classified as bad by different institutions. However, with only four years of data and semi-annual windows one would end up with at most eight couples of default rates (eight default rates for securitized loans and eight default rates for loans that remained in the bank's portfolio), thus leading to estimated correlations with very high standard errors.

For my analysis I rely on two sources of data, both with loan-by-loan details. From the Italian Central Credit Register (Centrale dei Rischi) I gather data on defaults and on loans that have been securitized.<sup>22</sup> My second source of data is the Sample Survey of Active and Passive Rates (Rilevazione Campionaria dei Tassi Attivi e Passivi) which contains information on new loans, and corresponding borrowers, granted from a sample of Italian bank.<sup>23</sup>

Given that my primary interest is to know when a loan goes into default, I only take into account securitized loans that have been transferred to other institutions reporting to the Italian Central Credit Register, thus excluding foreign special purpose vehicles. I also use only data on securitizations of performing loans since, by definition, bad loans are already in default when they are transferred. Since particularly small or large loans can sometimes be treated in special ways by banks, I dropped from the dataset loans with an outstanding amount smaller than 75,000 or greater than 1,000,000 euros. Finally, for any given semester I only consider new loans granted by those banks that made at least one securitization during the same period. Overall, the final dataset includes about 493,000 new loans and about 346,000 securitized loans.

Figures 9 and 10 report the evolution over time of default rates, averaged across banks, for loans that have been securitized or granted in given semesters for the overall banking system. There are two interesting aspects in those figures. The first one is that the overall quality of new and securitized loans do not change significantly as a function of the semester in which they were granted or securitized. This result suggests the absence of an overall credit cycle during the sample period, at least when all kind of loans are taken into account and the analysis is limited to banks that used securitization to finance

---

<sup>22</sup>The Central Credit Register is a department of the Bank of Italy that collects data on borrowers from their lending banks. Reporting banks file detailed information for each borrower with total loans or credit lines of more than 75,000 euros. Banks are requested to report smaller exposures only in the case the borrower goes into default. Bad loans are defined on a customer basis and therefore include all the outstanding credit extended by a bank to a borrower considered insolvent.

<sup>23</sup>The survey covers about 70% of the total amount of new loans granted in the sample period.

their investments.<sup>24</sup> The second relevant aspect of the figures is that new loans are on average riskier than securitized loans, thus pointing to an increasing of risks for banks that securitized their assets. Overall, new loans have an average rate of default of 0.41%, significantly higher than the 0.28% of securitized loans. From the statistical point of view, the significance of the positive difference between default rates of new loans and loans that have been securitized is confirmed by Table 12, which also reports the averages of those differences across all banks for all semesters of inception (semester in which the loan was granted or securitized) and semesters of defaults. Almost all possible combinations inception/default have a positive value and many of them are statistically significant.

These results deserve a few last comments. It could be argued that one should control for other variables when comparing the riskiness of loans that have been securitized with that of new loans. Actually, it could be the case that the different riskiness of new loans with respect to securitized loans is due to the fact that the loans were granted to different sets of borrowers, with possible different credit worthiness, or had different characteristics in terms of yield (fixed or variable), maturity (shorter or longer), or whatever, that can influence the probability to run into default. It could also be argued that one should control for the time in which new and securitized loans were initially granted. In fact, Ioannidou et al. (2007) and Jiménez et al. (2008) show that loans that are granted when interest rates are low (high) have higher (lower) probability to run into default when interest rates increase (decrease). Hence, an explanation of my results could be that securitized loans are less risky just because they were granted when interest rates were higher. While these are very interesting issues they are nonetheless outside of the scope of this paper. As shown in Section 3, what matters for the stability of a bank that securitizes its assets is the difference between the riskiness of loans that are securitized and that of new loans, no matter where that difference comes from. Whatever the reason, securitizing good loans and substituting them with loans with lower quality is not a good deal for the stability of a bank.<sup>25</sup>

## 4 Conclusions

In this paper I analyse the effects of CDO issuance on the risk of default of a bank. Using Monte Carlo simulations I show that the current practice for a bank to securitize part of its loans using CDOs, of which it retains the equity tranches, and reinvest the proceeds of the securitization in other loans can increase as well decrease the risk that

---

<sup>24</sup>Bonaccorsi and Felici (2008) use a larger sample of banks to analyse mortgages to Italian households and find that default rates tend to rise during the same sample period.

<sup>25</sup>This last statement is of course subject the hypothesis that the liability side of the bank does not change. Greater losses would not affect the stability of the bank if the granting of riskier loans is associated with an increasing of own capital.

the bank faces large losses. The final result depends on the different characteristics of the loans that are securitized and the new loans in terms of individual probability of default and correlation with the loans that the bank did not securitize. Moreover, as long as the securitization involves only reasonable shares of the total portfolio of loans, the final effect on the VaR is generally almost negligible. I then focus on Italian banks and provide evidence that the presence of securitization activity has contributed to change the overall composition of the asset side of the balance sheet of the banks. Banks that securitized their assets have relatively lower shares of both performing and bad loans over total assets, while increasing their reliance on investments in the interbank market as well in securities other than shares. Securitization seems to have played mainly an indirect effect on the composition of the balance sheets of Italian banks, with banks that made little use of the instrument recording the greatest changes. Overall, the changes in the balance sheets involved by the securitization activity have probably reduced the expected credit losses of Italian banks. Finally, I examine loan-by-loan data to compare the risk of default of loans that have been securitized with that of new loans granted by the same banks at the same time. I show that Italian banks securitized loans with a better average quality than that of new loans, thus suggesting that the risks embedded in the loan portfolios of banks that securitized their loans have been increasing during the last few years.

## References

- Affinito, M. and E. Tagliaferri (2008), “Why do banks securitize their loans? An empirical analysis on Italian Banks”, mimeo.
- Altunbas, Y., L. Gambacorta and D. Marqués (2007), “Securitisation and the Bank Lending Channel”, Working Papers of the Bank of Italy, No. 653.
- Amato, J. D. and E. M. Remolona (2003), “The Credit Spread Puzzle”, BIS Quarterly Review, December.
- Bannier, C. E. and D. N. Hänsel (2007), “Determinants of banks’ engagement in loan securitization”, SSRN no. 1014305.
- Bofondi, M. and G. Gobbi (2006), “Informational Barriers to Entry into Credit Markets”, *Review of Finance*, Vol. 10, pp. 39-67.
- Bonaccorsi di Patti, E. and R. Felici (2008), “Il rischio dei mutui alle famiglie in Italia: evidenza da un milione di contratti”, (The risk of home mortgages in Italy: evidence from one million contracts), Occasional Papers of the Bank of Italy, No. 32 (in Italian).
- Carlstrom, C. T. and K. A. Samolyk (1995), “Loan Sales as a Response to Market-Based Capital Constraints”, *Journal of Banking and Finance*, Vol. 19, pp. 627-646.
- Committee on the Global Financial System (2003), “Credit Risk Transfer”, Bank for International Settlements, CGFS Publications, No. 20.
- Cousseran, O. and I. Rahmouni (2005), “The CDO Market. Functioning and Implications in Terms of Financial Stability”, Banque de France, Financial Stability Review, June.
- De Marzo, P. and D. Duffie (1999), “A Liquidity-Based Model of Security Design”, *Econometrica*, Vol. 67, pp. 65-99.
- Duan, N. (1983), “Smearing Estimate: A Nonparametric Retransformation Method”, *Journal of the American Statistical Association*, Vol. 78, pp. 605-610.
- FitchRatings (2006), “Global Credit Derivatives Survey: Indices Dominate Growth as Banks’ Risk Position Shifts”, *Special Report*, September 21.
- Franke, G. and J. P. Krahnert (2006), “Default Risk Sharing between Banks and Markets: The Contribution of Collateralized Debt Obligations”, in: *The Risks of Financial Institutions*, eds. M. Carey and R. Stulz, pp.603-633, University of Chicago Press.
- Greene, W. H. (2003), “Econometric Analysis”, Prentice Hall.

- Gorton, G. B. and G. G. Pennacchi (1995), “Banks and Loan Sales. Marketing Nonmarketable Assets”, *Journal of Monetary Economics*, Vol. 35, pp. 389-411.
- Greenspan, A. (2005), “Risk Transfer and Financial Stability”, Remarks to the Federal Bank of Chicago’s Forty-first Annual Conference on Bank Structure, Chicago, Illinois, USA.
- Jiménez, G., S. Ongena, J. L. Peydró, and J. Saurina (2008), “Hazardous Times for Monetary Policy: What do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?”, Social Science Research Network, Paper No. 1018960.
- Ioannidou, V., S. Ongena, and J. L. Peydró (2007), “Monetary Policy and subprime Lending: A Tall Tale of Low Federal Funds Rates, Hazardous Loan, and Reduced Loans Spreads”, mimeo.
- Jiangli, W., and M. Pritsker (2008), “The Impacts of Securitization on US Bank Holding Companies”, SSRN no. 1102284.
- Jiangli, W., M. Pritsker and P. Raupach (2007), “Banking and Securitization”, mimeo.
- Jones, D. (2000), “Emerging Problems with the Basel Capital Accord: Regulatory Capital Arbitrage and Related Issues”, *Journal of Banking and Finance*, Vol. 24, pp. 35-58.
- JPMorgan (1999), “The J. P. Morgan Guide to Credit Derivatives”, Published by Risk.
- Krahen, J. P. and C. Wilde (2006), “Risk Transfer with CDOs and Systemic Risk in Banking”, *CEPR Discussion Paper Series*, No. 5618.
- Longstaff, F. A. and A. Rajan (2006), “An Empirical Analysis of the Pricing of Collateralized Debt Obligations”, *NBER Working Paper Series*, No. 12210.
- Melenec, O. (2000), “Asset Backed Securities: A Practical Guide for Investors”, *The Securitization Conduit*, Vol. 1, pp. 8-17.



## Appendix: The market of CDOs

Collateralized debt obligations are securities backed by the cash flows of portfolios of different financial instruments. The main characteristic of CDOs is tranching. Any CDO is actually made by several different securities, each of one has a given seniority in terms of rights on the cash flow generated by the underlying assets. Senior, mezzanine, and junior tranches rank in a decreasing order. Risks and returns offered by these tranches vary accordingly. The splitting of CDOs into different tranches dictates a sequential allocation of the losses that the underlying portfolio can incur. The most junior tranche, called equity tranche, is the first to absorb the losses deriving from one or more defaults of the assets in the underlying portfolio. If losses exceed the notional value of the equity tranche, they are absorbed by other junior and mezzanine tranches. Only if the number and the significance of defaults in the underlying portfolio are large enough senior tranches are affected and sustain the remaining part of the losses that cannot be absorbed by other tranches. The structure of the CDOs guarantees that the holders of each tranche, with the exception of the equity tranche, are protected from the risk of incurring losses by one or more other tranches. Usually, senior and mezzanine tranches are also protected by other specific credit enhancement techniques, such as overcollateralization, reserve accounts and the trapping of excess spreads.<sup>26</sup>

Collateralized debt obligations are usually classified according to the aim of the transaction and the way in which the credit risk of the underlying portfolio is transferred. With respect to the first dimension, one can have *balance sheet* CDOs and *arbitrage* CDOs depending on whether the main purpose of the transaction is to modify in some respect the composition of the balance sheet of the seller (also named *originator*) or to carry out an arbitrage transaction by exploiting the potential differences between the returns required from investors on the tranches of the CDOs and the returns of the assets included in underlying pool.<sup>27</sup> In a balance sheet CDO the originator is usually a financial institution, most of the times a bank, that wants to get rid of some of its assets in order to have additional resources for other investments, increase the profitability, or reduce the regulatory capital.<sup>28</sup> Balance sheet CDOs determine a transferring of risks traditionally taken by the banking system to other investors. The aim of arbitrage CDOs is instead to carry out a market arbitrage by putting together a portfolio of assets to be used as collateral and a CDO structure such that the overall return of the underlying pool (the

---

<sup>26</sup>Melenec (2000) describes these and others credit enhancement techniques.

<sup>27</sup>Carlstrom and Samolyk (1995), Gorton and Pennacchi (1995) and DeMarzo and Duffie (1999) provide alternative explanations for the growth in securitization activity based on the fact that certain institutions have a natural comparative advantage in originating, but not holding, illiquid assets.

<sup>28</sup>Jones (2000) describe many securitization techniques used by banks to reduce their regulatory capital requirements.

arbitrageurs cash-in-flows) is greater than the overall return of the CDO's tranches (the arbitrageurs cash-out-flows).<sup>29</sup>

As for the ways in which credit risk can be transferred using CDOs, there are mainly two possibilities: Either through a true sale of the assets (*cash flow* CDOs) or using credit derivatives (*synthetic* CDOs). In a cash flow CDO the property rights on the assets in the underlying pool are actually transferred from the originator to a *special purpose vehicle* (SPV) which in turn finances the purchase using the proceeds of the issuance of the CDO. Synthetic CDOs have a more complex structure as the transferring of risk is not achieved by the true sale of risky assets but using credit default swap (CDSs).<sup>30</sup> In a synthetic CDO the originator get rid of some credit risk by buying protection from the SPV using credit default swap and the SPV buys protection from the holders of the CDO tranches. If some of the underlying assets default, the originator asks the SPV to be compensated for those losses. The SPV, in turn, transfers the losses to the final investors in the CDO, according to the tranching structure. Given that there is not any initial sale of assets from the originator to the SPV, there is not even the necessity for the SPV to raise cash when issuing the CDO. That means that the buyers of the tranches of the CDO can be required to pay nothing at the inception of the contract (*unfunded synthetic* CDO). They eventually pay what they due according to the tranching structure only in case of defaults in the underlying pool. It is clear that in an unfunded CDO the ability of the SPV to compensate the originator if a credit event occurs depends on the creditworthiness of the buyers of the CDOs only. On the other hand the fact that the buyers of the CDO have to pay nothing at inception also make this product more attractive for investors.<sup>31</sup> In a *funded synthetic* CDO, instead, final investors are required to pay the notional amount of their tranches to the SPV which in turn invests those proceeds in high-rated bonds (usually AAA-rated government bonds) and eventually use them to compensate the originator for any loss should it suffer in the underlying pool.

Usually the overall compensation paid to CDO investors is notably smaller than the returns on the underlying assets as the difference goes to pay all the professionals that are involved in the transaction, such as originators, security firms, asset managers, trustees, rating agencies, attorneys, and accountants. Hence, one might ask why investors should buy products that return to them much less than the underlying assets. The answer is that CDOs can create customized exposures that investors desire and cannot achieve in any other way. Using CDOs it is possible to fit into investors' various risk appetites

---

<sup>29</sup>Amato and Remolona (2003) exploit evidence from the market on arbitrage CDOs to support their explanation of the low level of credit spread based on the difficulty of fully diversify a credit portfolio.

<sup>30</sup>Roughly, in a credit default swap the seller of protection agrees to pay to the buyer of protection some amount of money in case of default of a reference entity, in exchange of a periodic fee.

<sup>31</sup>Tranches of CDS indices such as ITraxx or IBoxx are examples of unfunded synthetic CDOs.

and capital constraints. For instance less risk-adverse investors such as hedge-funds and investment banks could prefer to take an exposure in the more riskier tranches whereas pension funds and insurance companies would probably prefer to invest in more senior tranches. Collateralized debt obligations can slice the overall credit risk in the underlying portfolio into different tranches and sell each of them to the investors that feel mostly confident with the corresponding risk-return profile.

For what it has been just said, it should not be surprising if the rate of growth of CDOs issuance has been exceptionally high during the last few years, at least since the starting of the current crisis. Despite a strong decrease in the second half of the year, global issuance of CDOs in 2007 was about USD 500 trillion, more than three times greater than in 2004 (cf. Figure 1.1).<sup>32</sup> As in previous years, the bulk of the issues was represented by cash flow CDOs (about 70% of the total). A breakdown by purpose shows that arbitrage CDOs accounted for about 85% of total issues (cf. Figure 1.2). About 50% of total issues were backed by other structured products such as residential mortgage backed securities (RMBS), commercial mortgage backed securities (CMBS), other CDOs, CDSs, and other securitized/structured products, and 30% were backed by high yield loans.<sup>33</sup> New issues were mainly denominated in US dollars (70%) and euros (25%).

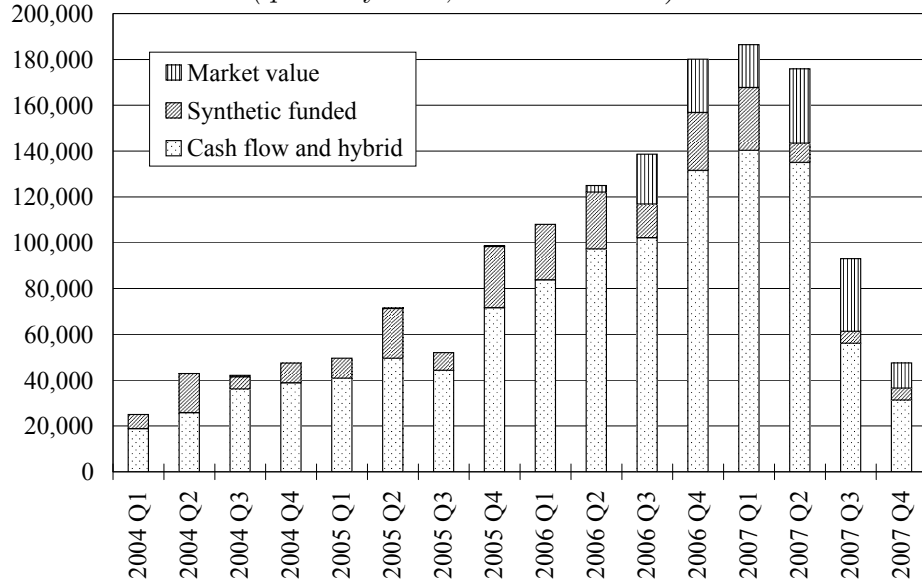
---

<sup>32</sup>Data are from the Securities Industry and Financial Markets Association (SIFMA), an organization born of the merger between The Securities Industry Association and The Bond Market Association which represents more than 650 member firms of all sizes, in all financial markets in the United States and around the world. Data do not include unfunded synthetic tranches.

<sup>33</sup>High yield loans are defined as transactions of borrowers with senior unsecured debt ratings below Baa3 from Moody's or BBB- from S&P.

## Tables and Figures

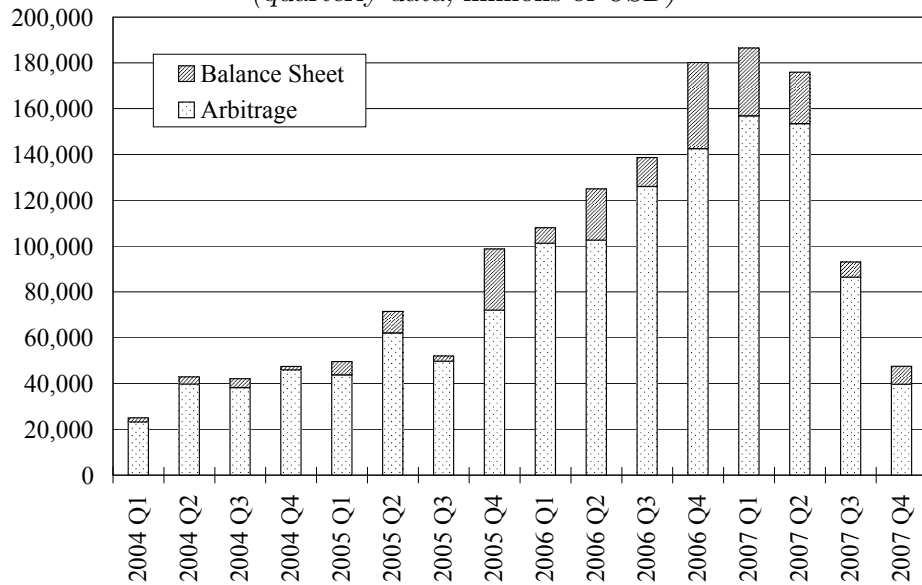
**Figure 1.1**  
**Global CDO market issuance data by structure (1)**  
*(quarterly data, millions of USD)*



Source: Securities Industry and Financial Markets Association (SIFMA).

(1) Data do not include unfunded synthetic tranches.

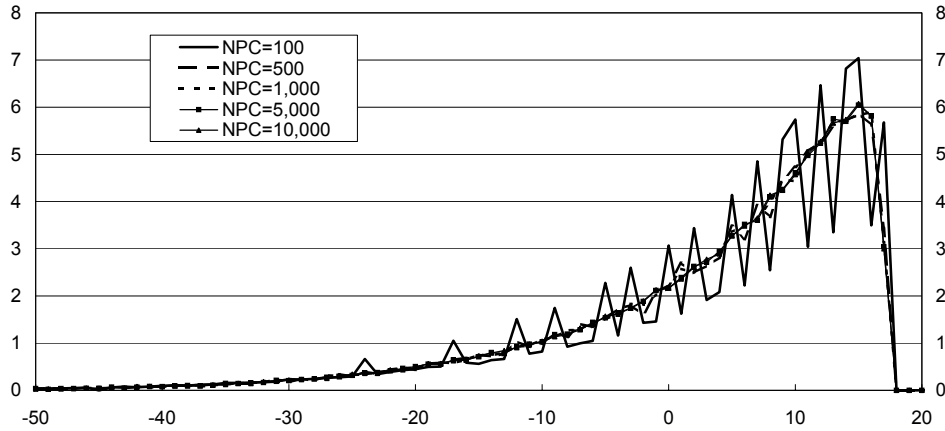
**Figure 1.2**  
**Global CDO market issuance data by purpose (1)**  
*(quarterly data, millions of USD)*



Source: Securities Industry and Financial Markets Association (SIFMA).

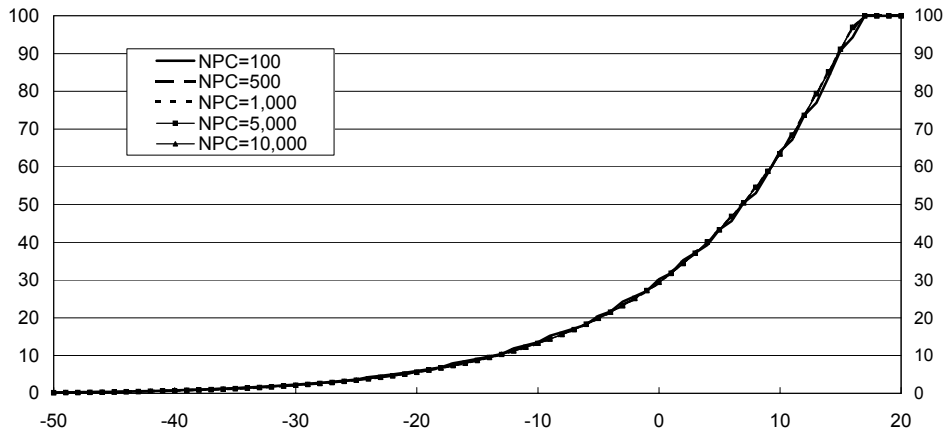
(1) Data do not include unfunded synthetic tranches.

**Fig. 2.1**  
**Probability density function of the returns of a loan portfolio**  
**for several values of the number of loans (1)**



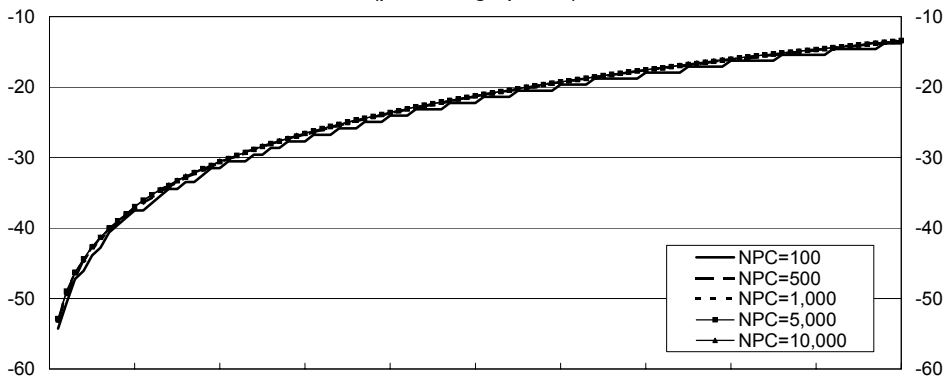
(1) The portfolio has a number of loans as specified in the legend with pairwise correlation equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04.

**Fig. 2.2**  
**Cumulative distribution function of the returns of a loan portfolio**  
**for several values of the number of loans (1)**



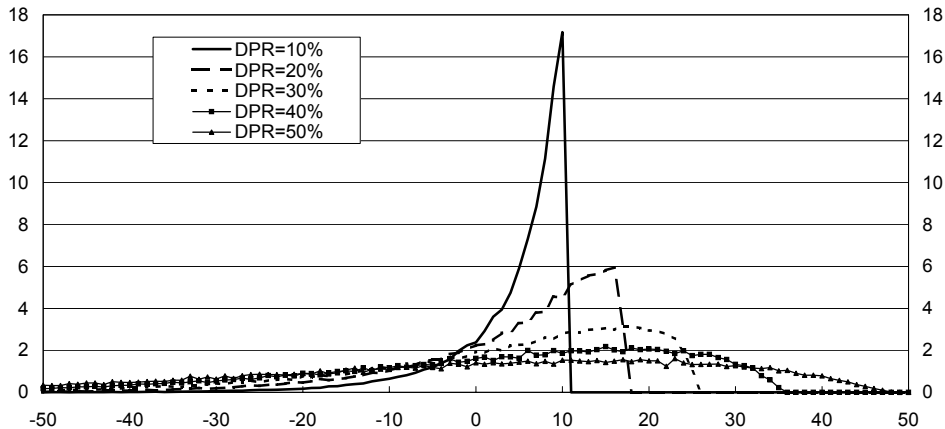
(1) The portfolio has a number of loans as specified in the legend with pairwise correlation equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04.

**Fig. 2.3**  
**Value-at-risk of a loan portfolio**  
**for several values of the number of loans (1)**  
*(percentage points)*



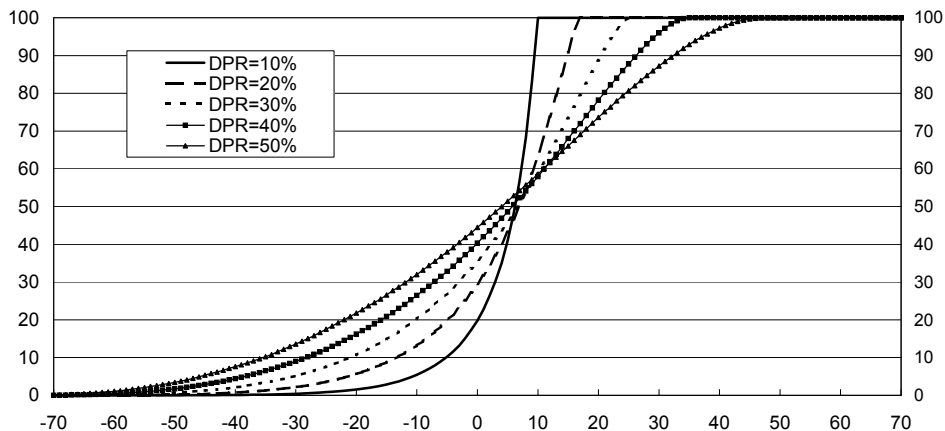
(1) The portfolio has a number of loans as specified in the legend with pairwise correlation equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The level of the VaR is reported in the abscissae axis in percentage points.

**Fig. 3.1**  
**Probability density function of the returns of a loan portfolio**  
**for several values of individual default probability (1)**



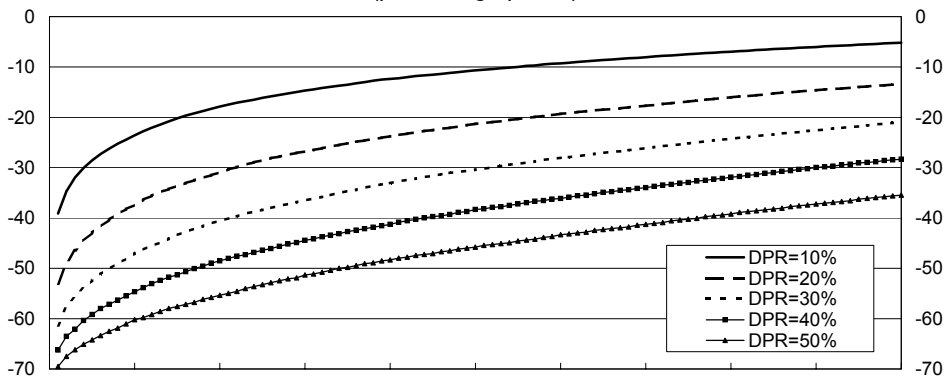
(1) The portfolio has 1,000 loans with pairwise correlation equal to 0.3 and individual default probability as specified in the legend. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04.

**Fig. 3.2**  
**Cumulative distribution function of the returns of a loan portfolio**  
**for several values of individual default probability (1)**



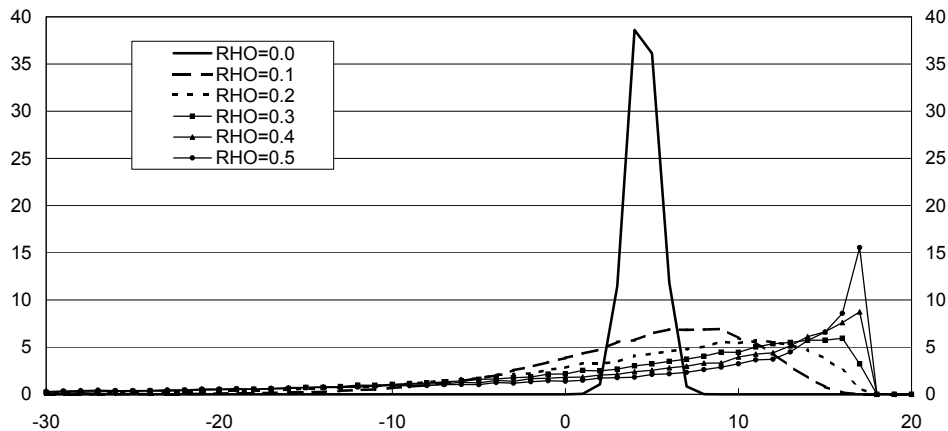
(1) The portfolio has 1,000 loans with pairwise correlation equal to 0.3 and individual default probability as specified in the legend. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04.

**Fig. 3.3**  
**Value-at-risk of a loan portfolio**  
**for several values of individual default probability (1)**  
*(percentage points)*



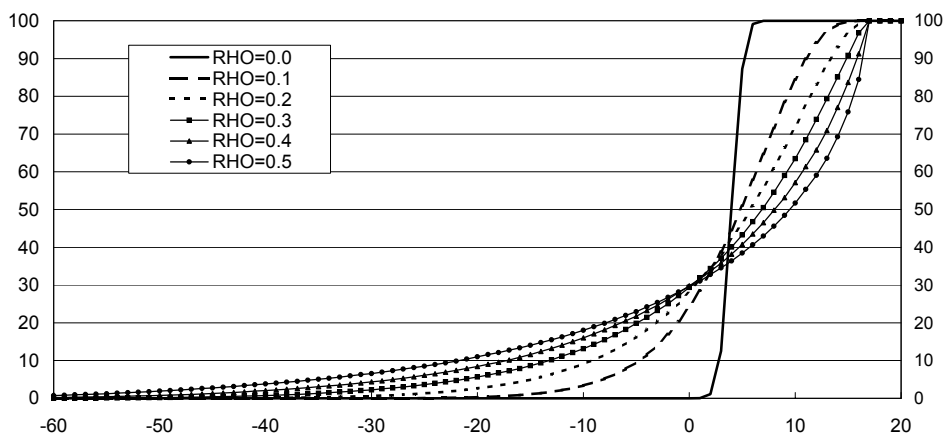
(1) The portfolio has 1,000 loans with pairwise correlation equal to 0.3 and individual default probability as specified in the legend. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The level of the VaR is reported in the abscissae axis in percentage points.

**Fig. 4.1**  
**Probability density function of the returns of a loan portfolio**  
**for several values of pairwise correlation (1)**



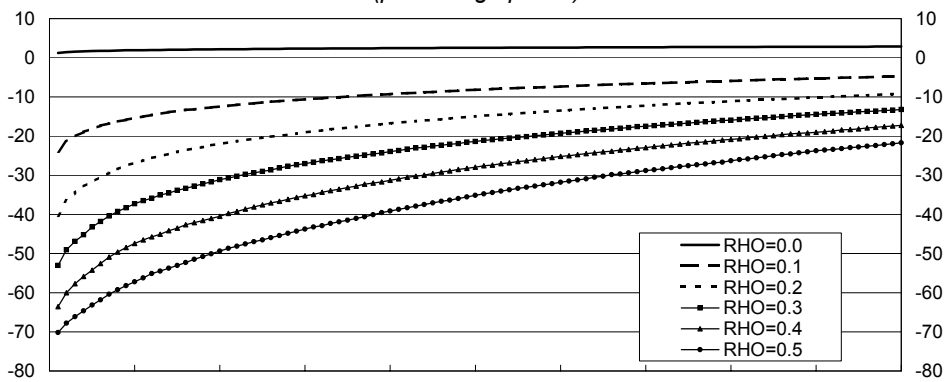
(1) The portfolio has 1,000 loans with pairwise correlation as specified in the legend and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04.

**Fig. 4.2**  
**Cumulative distribution function of the returns of a loan portfolio**  
**for several values of pairwise correlation (1)**



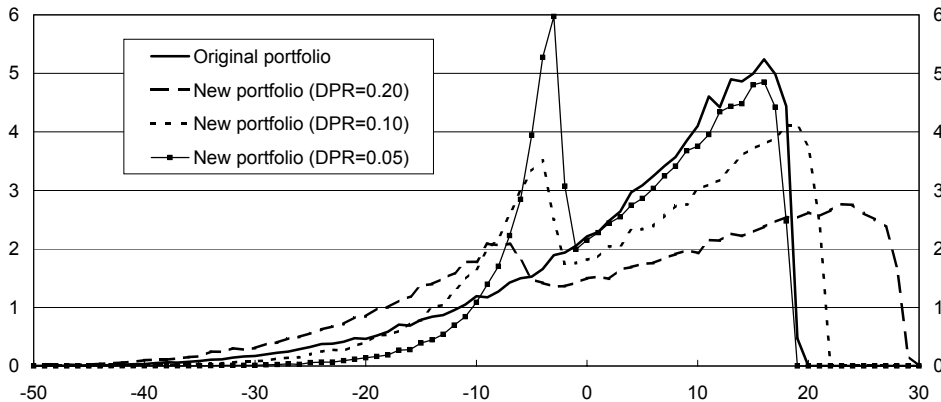
(1) The portfolio has a number of loans as specified in the legend with pairwise correlation equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04.

**Fig. 4.3**  
**Value-at-risk of a loan portfolio**  
**for several values of pairwise correlation (1)**  
*(percentage points)*



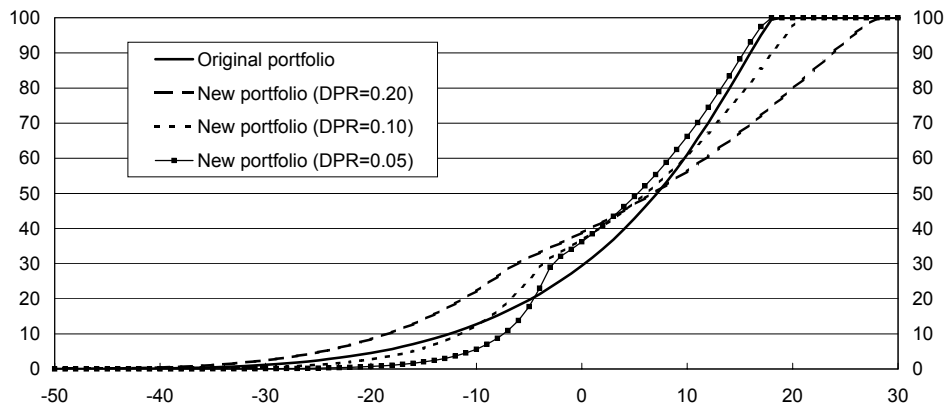
(1) The portfolio has a number of loans as specified in the legend with pairwise correlation equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The level of the VaR is reported in the abscissae axis in percentage points.

**Fig. 5.1**  
**Probability density function of the returns of a loan portfolio**  
**before and after a 100% securitization (1)**



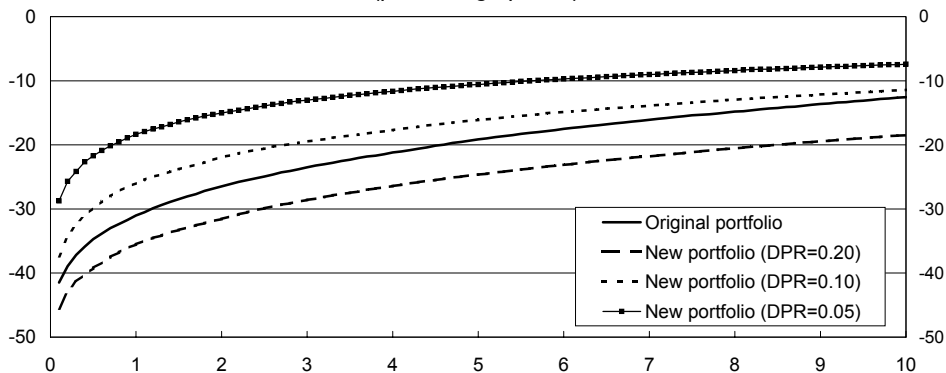
(1) The original portfolio has 1,000 loans with correlation coefficient  $\rho$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with an individual default probability as specified in the legend.

**Fig. 5.2**  
**Cumulative distribution function of the returns of a loan portfolio**  
**before and after a 100% securitization (1)**



(1) The original portfolio has 1,000 loans with correlation coefficient  $\rho$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with an individual default probability as specified in the legend.

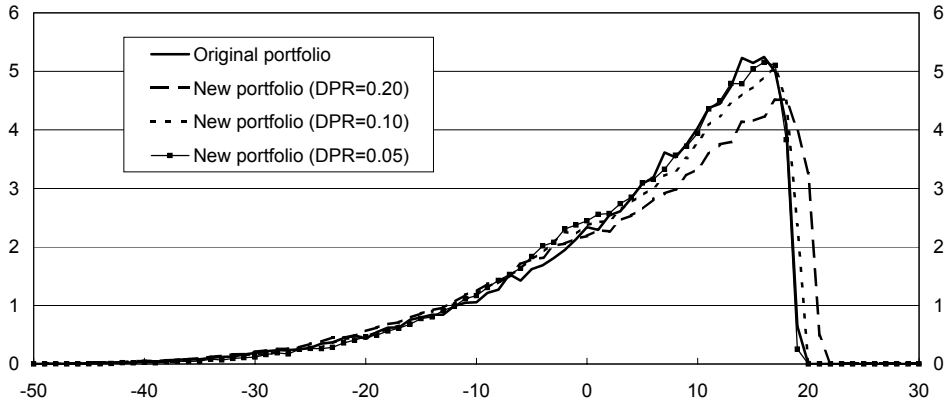
**Fig. 5.3**  
**Value-at-risk of a loan portfolio**  
**before and after a 100% securitization (1)**  
*(percentage points)*



(1) The original portfolio has 1,000 loans with correlation coefficient  $\rho$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with an individual default probability as specified in the legend. The level of the VaR is reported in the abscissae axis in percentage points.

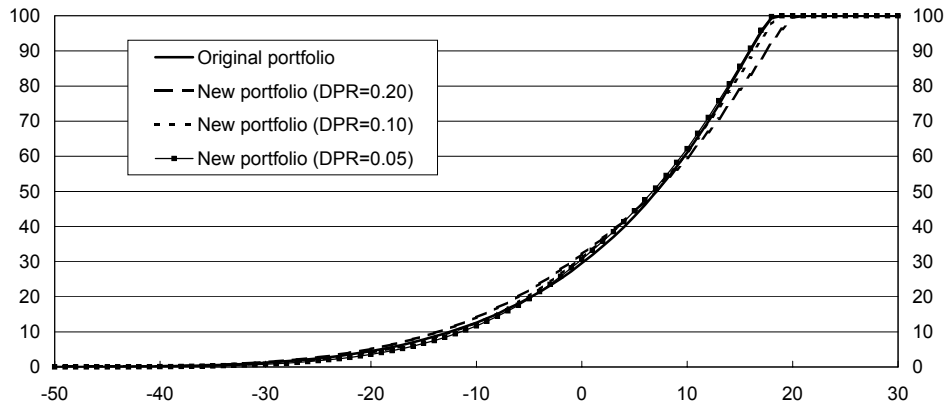


**Probability density function of the returns of a loan portfolio before and after a 20% securitization (1)** Fig. 6.1



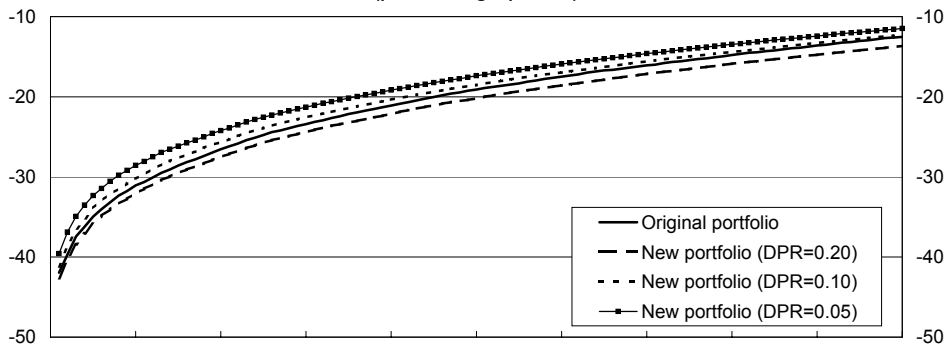
(1) The original portfolio has 1,000 loans with correlation coefficient  $\rho$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The 20% of the loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with an individual default probability as specified in the legend.

**Cumulative distribution function of the returns of a loan portfolio before and after a 20% securitization (1)** Fig. 6.2



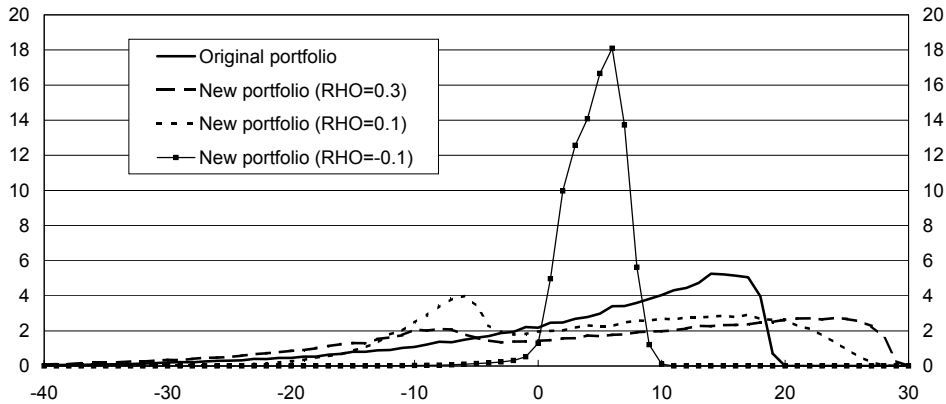
(1) The original portfolio has 1,000 loans with correlation coefficient  $\rho$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The 20% of the loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with an individual default probability as specified in the legend.

**Value-at-risk of a loan portfolio before and after a 20% securitization (1)**  
(percentage points) Fig. 6.3



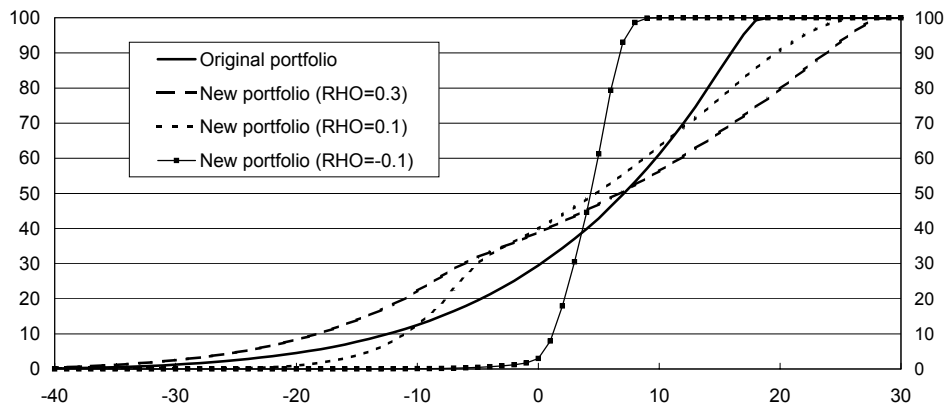
(1) The original portfolio has 1,000 loans with correlation coefficient  $\rho$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The 20% of the loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with an individual default probability as specified in the legend. The level of the VaR is reported in the abscissae axis in percentage points.

**Fig. 7.1**  
**Probability density function of the returns of a loan portfolio**  
**before and after a 100% securitization (1)**



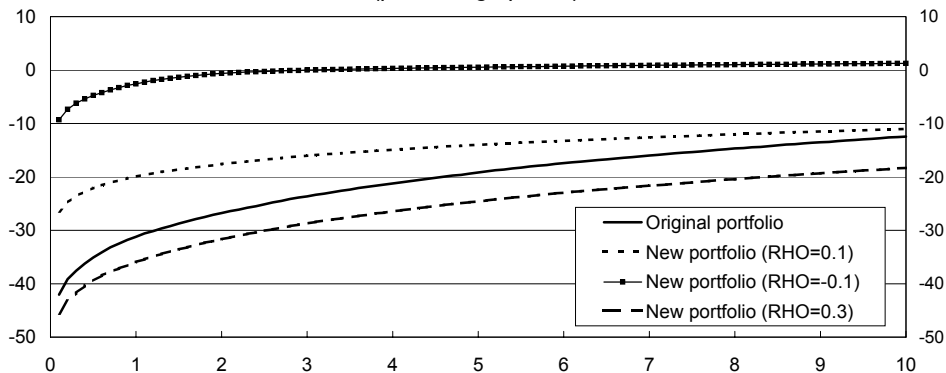
(1) The original portfolio has 1,000 loans with correlation coefficient  $RHO$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with a correlation coefficient  $RHO$  as specified in the legend.

**Fig. 7.2**  
**Cumulative distribution function of the returns of a loan portfolio**  
**before and after a 100% securitization (1)**



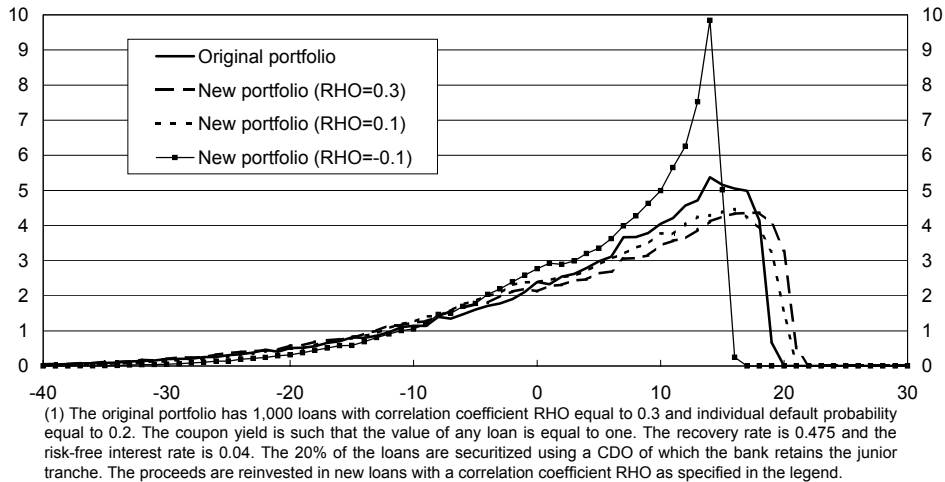
(1) The original portfolio has 1,000 loans with correlation coefficient  $RHO$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with a correlation coefficient  $RHO$  as specified in the legend.

**Fig. 7.3**  
**Value-at-risk of a loan portfolio**  
**before and after a 100% securitization (1)**  
*(percentage points)*

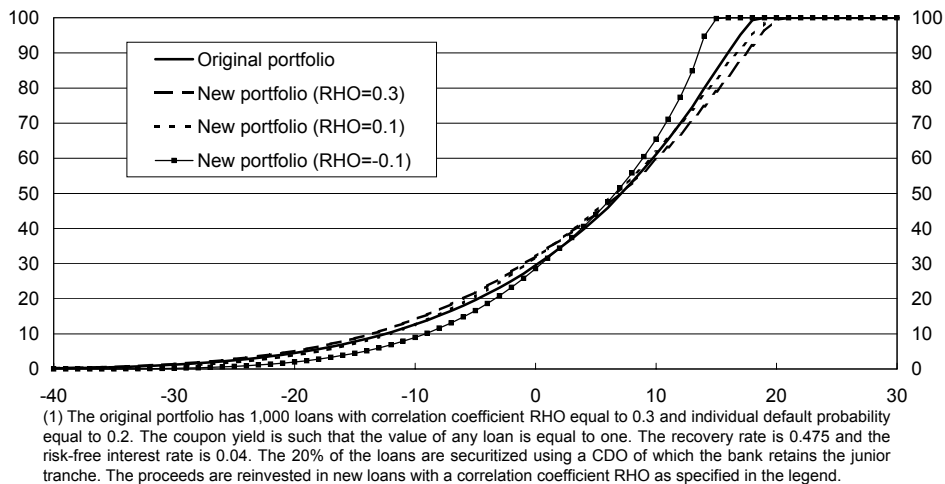


(1) The original portfolio has 1,000 loans with correlation coefficient  $RHO$  equal to 0.3 and individual default probability equal to 0.2. The coupon yield is such that the value of any loan is equal to one. The recovery rate is 0.475 and the risk-free interest rate is 0.04. The loans are securitized using a CDO of which the bank retains the junior tranche. The proceeds are reinvested in new loans with a correlation coefficient  $RHO$  as specified in the legend. The level of the VaR is reported in the abscissae axis in percentage points.

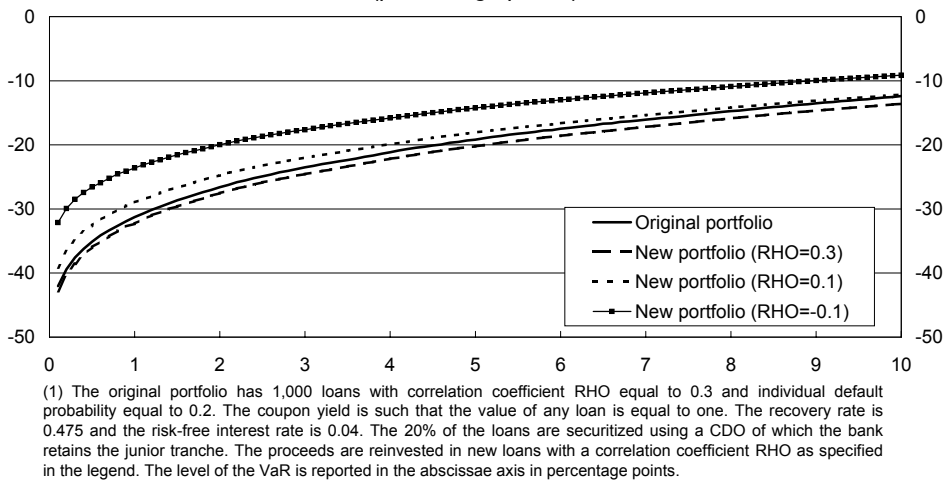
**Fig. 8.1**  
**Probability density function of the returns of a loan portfolio**  
**before and after a 20% securitization (1)**



**Fig. 8.2**  
**Cumulative distribution function of the returns of a loan portfolio**  
**before and after a 20% securitization (1)**



**Fig. 8.3**  
**Value-at-risk of a loan portfolio**  
**before and after a 20% securitization (1)**  
*(percentage points)*



**Table 1**  
**VaR changes in case of full securitization of the loan portfolio**  
**as a function of loans' individual default probability (1)**  
*(percentages)*

<i>DPR</i> <i>Port<sub>O</sub></i>	<i>DPR Port<sub>N</sub></i>										<i>Memo:</i> VaR <i>Port<sub>O</sub></i>
	5	10	15	20	25	30	35	40	45	50	
5	3.5	41.5	61.8	76.1	87.9	95.8	102.0	106.1	110.1	112.6	-23.8
	9.1	73.4	117.8	153.0	180.1	203.4	221.7	237.0	251.2	262.1	-12.7
	34.4	177.8	296.2	400.3	487.3	567.2	640.5	705.2	766.9	819.1	-4.1
10	-19.7	6.0	22.1	32.2	40.3	46.2	50.4	53.6	56.5	58.6	-32.6
	-26.9	11.3	38.1	58.4	75.2	88.0	99.5	108.7	117.1	124.1	-21.0
	-30.0	27.6	74.8	115.6	150.9	182.6	210.9	237.5	261.1	284.0	-10.1
15	-27.7	-5.9	7.7	16.7	23.5	27.7	31.2	34.1	36.8	38.3	-37.9
	-37.3	-7.5	13.1	29.0	41.6	52.0	60.4	67.7	73.9	79.2	-26.8
	-41.7	-4.2	27.6	54.0	77.2	98.1	116.7	134.2	149.7	164.8	-15.0
20	-30.1	-9.5	2.4	10.1	15.9	19.7	23.2	26.1	28.0	29.4	-41.2
	-40.6	-15.6	1.5	15.1	25.6	34.3	41.6	48.1	53.0	57.6	-31.1
	-44.5	-15.6	7.9	28.6	46.8	63.3	77.6	90.7	103.1	113.7	-19.1
25	-31.4	-11.8	-1.7	5.8	10.7	15.0	17.9	20.3	22.3	24.0	-44.0
	-41.7	-19.9	-4.5	7.1	16.5	24.0	30.4	35.9	40.4	44.7	-34.7
	-45.8	-22.2	-2.4	14.6	29.2	42.4	54.2	65.2	75.4	84.0	-22.8
30	-31.1	-13.6	-3.0	4.1	8.8	12.5	15.6	17.4	19.4	21.0	-45.9
	-41.6	-22.0	-8.4	2.2	10.4	17.6	23.4	28.5	32.4	36.0	-37.6
	-45.5	-25.2	-8.3	5.9	18.7	30.0	40.3	49.8	58.2	65.9	-26.1
35	-29.2	-12.6	-3.3	3.6	8.2	11.5	14.2	16.5	18.0	19.7	-47.2
	-41.2	-23.3	-10.6	-0.9	6.9	13.2	18.7	23.2	26.8	30.4	-40.1
	-44.8	-26.8	-12.2	0.5	11.5	21.4	30.2	38.5	46.2	52.6	-29.2
40	-28.1	-12.5	-3.4	3.1	7.4	10.3	13.2	15.2	16.8	18.0	-48.6
	-39.8	-23.0	-11.3	-2.0	5.0	10.9	15.7	20.0	23.6	26.6	-42.1
	-43.3	-27.2	-14.1	-2.9	7.1	15.9	23.8	31.2	37.8	44.2	-31.8
45	-25.7	-11.3	-2.3	3.4	7.9	11.3	13.5	15.5	17.1	18.3	-49.4
	-38.0	-22.1	-11.2	-2.8	4.1	9.6	14.2	18.1	21.4	24.3	-43.8
	-41.5	-27.0	-15.0	-5.0	3.7	11.9	19.0	25.7	31.9	37.1	-34.4
50	-23.6	-9.3	-1.3	4.8	8.7	11.9	14.5	16.1	17.5	18.8	-50.1
	-35.8	-21.2	-10.7	-2.6	3.8	8.9	13.4	17.1	20.0	22.7	-45.4
	-39.5	-26.2	-15.6	-6.2	2.1	9.4	16.1	22.0	27.4	32.4	-36.6

(1) The table shows the changes of the VaR - at 0.1%, 1.0% and 5.0% levels - of a bank that securitizes all its loan portfolio by issuing a CDO, of which it retains the equity tranche, and reinvests the proceeds of the sale in new loans. The individual default probabilities of the loans in the original portfolio and the new loans are in the left and top columns, respectively. Other assumptions are: number of loans equal to 1,000; recovery rate equal to 0.475; pairwise correlation of the loans equal to 0.3; risk-free interest rate equal to 0.04.

**Table 2**  
**VaR changes in case of full securitization of the loan portfolio**  
**as a function of loans' correlation with the macro factor (1)**  
*(percentages)*

<i>RHO</i> <i>Port<sub>O</sub></i>	<i>RHO Port<sub>N</sub></i>									<i>Memo:</i> VaR <i>Port<sub>O</sub></i>
	-40	-30	-20	-10	0	10	20	30	40	
-40	8.4	-2.1	-19.0	-41.6	-87.2	-80.9	-57.3	-40.7	-29.7	-47.3
	12.4	-3.8	-22.6	-45.3	-85.9	-92.5	-69.9	-51.1	-34.9	-37.9
	23.2	3.6	-16.3	-39.1	-81.3	-99.3	-87.9	-68.1	-48.7	-24.4
-30	22.0	9.7	-9.1	-36.5	-87.5	-79.3	-52.1	-33.5	-21.3	-41.8
	34.8	14.7	-8.4	-36.5	-85.6	-92.2	-64.5	-41.8	-21.5	-31.3
	52.8	27.8	2.1	-27.0	-80.6	-102.8	-84.4	-58.4	-33.9	-19.3
-20	49.8	34.7	11.3	-22.4	-87.8	-74.1	-40.7	-17.3	-1.2	-33.5
	76.4	48.9	18.5	-19.0	-85.7	-88.5	-51.5	-20.6	6.3	-23.5
	106.4	71.2	35.4	-5.6	-81.1	-107.7	-71.3	-35.7	-0.9	-13.8
-10	131.0	105.6	69.5	15.5	-88.3	-54.6	-1.4	36.7	61.4	-21.4
	184.4	138.2	87.3	24.3	-87.7	-69.3	-7.6	44.5	89.3	-14.2
	248.0	185.1	119.7	47.2	-87.2	-95.4	-24.4	40.4	102.0	-7.9
0	-3,847.0	-3,416.8	-2,735.3	-1,807.2	-30.4	-1,784.2	-2,710.9	-3,403.1	-3,828.1	1.3
	-2,009.5	-1,679.5	-1,286.6	-814.2	-16.1	-816.9	-1,281.9	-1,675.2	-2,014.8	2.0
	-1,031.4	-831.9	-631.7	-401.7	-9.6	-400.9	-628.1	-830.5	-1,025.1	2.6
10	62.0	36.4	-1.4	-53.9	-88.2	13.4	68.6	105.1	130.5	-21.4
	93.1	46.6	-5.2	-68.7	-87.3	25.9	89.3	143.6	188.1	-14.0
	104.4	40.5	-23.3	-95.7	-86.7	49.0	122.1	188.4	251.1	-7.8
20	1.1	-15.0	-38.6	-73.1	-87.6	-22.0	12.2	35.9	52.5	-33.0
	7.6	-19.4	-50.8	-88.2	-86.0	-19.3	18.6	49.6	76.1	-23.4
	-0.1	-35.1	-71.5	-107.7	-81.1	-6.2	34.9	70.7	106.0	-13.8
30	-20.4	-32.6	-51.6	-77.7	-87.3	-35.8	-9.1	9.3	22.0	-41.5
	-21.2	-41.0	-63.9	-92.1	-85.5	-35.9	-8.2	14.7	34.6	-31.1
	-33.0	-57.9	-83.8	-102.8	-80.1	-26.7	2.7	28.2	53.4	-19.1
40	-29.3	-40.4	-56.4	-80.1	-86.9	-42.0	-18.5	-2.3	8.5	-47.1
	-34.8	-50.7	-69.9	-92.5	-85.8	-45.6	-22.5	-4.1	12.7	-37.8
	-47.9	-67.7	-87.8	-99.0	-81.0	-38.9	-15.9	4.3	23.8	-24.2

(1) The table shows the changes of the VaR - at 0.1%, 1.0% and 5.0% levels - of a bank that securitizes all its loan portfolio by issuing a CDO, of which it retains the equity tranche, and reinvests the proceeds of the sale in new loans. The correlations with the macro factor of the loans in the original portfolio and the new loans are in the left and top columns, respectively. Other assumptions are: number of loans equal to 1,000; individual default probability equal to 0.2; recovery rate equal to 0.475; risk-free interest rate equal to 0.04.

**Table 3**  
**VaR changes in case of securitization of 20% of the loan portfolio**  
**as a function of loans' individual default probability (1)**  
*(percentages)*

<i>DPR</i> <i>Port<sub>O</sub></i>	<i>DPR Port<sub>N</sub></i>										<i>Memo:</i> VaR <i>Port<sub>O</sub></i>
	5	10	15	20	25	30	35	40	45	50	
5	0.1	7.7	12.4	15.2	16.5	18.2	18.8	20.4	21.5	21.8	-24.5
	1.4	14.8	24.0	30.6	36.5	40.5	45.0	47.8	50.8	53.2	-12.6
	5.0	33.9	57.5	77.7	95.5	111.2	124.8	138.2	150.3	161.2	-4.1
10	-4.0	1.3	4.9	6.8	8.2	8.8	10.0	10.7	11.4	11.7	-32.9
	-5.5	2.4	7.4	11.4	15.1	17.9	20.0	22.0	23.6	24.9	-20.9
	-6.6	5.2	14.1	22.6	29.3	36.2	41.0	46.7	51.8	56.2	-10.1
15	-5.6	-0.7	1.7	3.4	4.8	5.6	6.2	6.5	7.6	7.9	-38.4
	-7.4	-1.0	3.0	6.0	8.5	10.7	12.3	13.7	15.0	16.1	-26.7
	-8.6	-1.0	5.4	10.5	15.3	19.8	23.3	27.0	30.2	32.8	-15.0
20	-5.6	-1.9	0.6	2.2	3.0	4.4	4.9	5.3	5.6	5.7	-41.8
	-8.3	-3.4	0.2	2.9	5.0	6.5	8.3	9.2	10.6	11.5	-31.2
	-9.1	-3.3	1.4	5.5	8.9	12.1	15.0	17.8	20.1	22.7	-19.2
25	-6.0	-2.8	-0.5	1.4	2.1	2.9	3.4	3.8	4.2	4.6	-44.2
	-8.3	-4.3	-1.3	1.2	3.2	4.6	6.0	6.9	8.0	8.7	-34.7
	-9.4	-4.7	-0.7	2.6	5.7	8.2	10.8	12.8	14.8	16.7	-22.9
30	-5.8	-2.5	-0.6	0.8	1.9	2.5	3.3	3.5	3.8	4.1	-46.0
	-8.4	-4.3	-1.6	0.5	2.3	3.6	4.6	5.7	6.4	7.2	-37.7
	-9.3	-5.2	-1.8	1.0	3.5	5.9	7.7	9.6	11.4	13.0	-26.2
35	-5.9	-2.6	-0.9	0.5	1.5	2.0	2.7	3.1	3.3	3.7	-47.5
	-8.4	-4.6	-2.2	-0.2	1.3	2.5	3.8	4.5	5.4	6.0	-40.1
	-9.0	-5.3	-2.4	0.1	2.4	4.4	6.2	7.7	9.2	10.6	-29.1
40	-5.5	-2.4	-0.5	0.7	1.7	2.2	2.7	3.2	3.3	3.7	-48.6
	-8.2	-4.8	-2.2	-0.5	0.8	2.0	3.0	3.9	4.6	5.4	-42.2
	-8.8	-5.6	-2.9	-0.7	1.4	3.0	4.7	6.0	7.6	8.7	-31.9
45	-5.3	-2.2	-0.4	0.7	1.7	2.2	2.7	3.0	3.4	3.6	-49.4
	-7.8	-4.7	-2.6	-0.7	0.5	1.7	2.5	3.4	4.0	4.6	-43.9
	-8.4	-5.6	-3.2	-1.0	0.8	2.3	3.8	5.1	6.3	7.5	-34.3
50	-4.8	-2.2	-0.4	0.8	1.6	2.1	2.5	3.0	3.5	3.5	-50.3
	-7.3	-4.4	-2.2	-0.5	0.7	1.7	2.5	3.3	3.9	4.5	-45.4
	-8.1	-5.5	-3.3	-1.5	0.2	1.7	3.1	4.3	5.3	6.3	-36.7

(1) The table shows the changes of the VaR - at 0.1%, 1.0% and 5.0% levels - of a bank that securitizes all its loan portfolio by issuing a CDO, of which it retains the equity tranche, and reinvests the proceeds of the sale in new loans. The individual default probabilities of the loans in the original portfolio and the new loans are in the left and top columns, respectively. Other assumptions are: number of loans equal to 1,000; recovery rate equal to 0.475; pairwise correlation of the loans equal to 0.3; risk-free interest rate equal to 0.04.

**Table 4**  
**VaR changes in case of securitization of 20% of the loan portfolio**  
**as a function of loans' correlation with the macro factor (1)**  
*(percentages)*

<i>RHO</i> <i>Port<sub>O</sub></i>	<i>RHO Port<sub>N</sub></i>									<i>Memo:</i> VaR <i>Port<sub>O</sub></i>
	-40	-30	-20	-10	0	10	20	30	40	
-40	1.5	-0.9	-3.7	-8.6	-18.8	-23.3	-24.0	-24.1	-24.1	-47.3
	2.7	-0.7	-4.6	-9.3	-18.0	-23.1	-24.3	-24.7	-24.9	-37.7
	4.7	0.9	-3.3	-7.8	-16.9	-23.6	-25.7	-26.8	-27.4	-24.2
-30	4.2	1.6	-1.9	-7.0	-18.5	-23.9	-24.9	-24.9	-25.1	-41.8
	6.8	3.0	-1.6	-7.2	-18.1	-24.6	-25.9	-26.5	-26.7	-30.9
	10.7	5.5	0.6	-5.4	-16.9	-25.5	-28.1	-29.7	-30.4	-19.1
-20	10.2	7.1	2.7	-4.7	-18.8	-26.2	-26.8	-27.2	-27.2	-33.1
	15.4	9.9	3.8	-3.5	-18.7	-27.1	-28.8	-29.6	-29.6	-23.3
	21.2	14.3	6.9	-1.2	-17.4	-29.5	-33.0	-35.0	-36.3	-13.8
-10	26.3	21.4	14.1	2.8	-19.7	-30.9	-32.5	-32.8	-32.8	-21.3
	37.3	27.8	17.6	5.0	-19.7	-33.8	-36.7	-38.1	-38.6	-14.0
	49.3	37.2	24.3	9.5	-19.2	-40.8	-47.0	-50.6	-53.1	-7.8
0	-615.8	-526.9	-398.3	-230.1	-2.1	-236.2	-413.6	-537.6	-632.5	1.2
	-325.9	-261.6	-186.7	-103.9	-1.6	-104.8	-189.9	-265.2	-329.2	2.0
	-163.2	-127.2	-89.3	-49.3	-1.2	-49.2	-89.7	-127.3	-164.9	2.6
10	-31.5	-31.5	-31.2	-30.2	-19.6	2.8	12.9	20.4	25.9	-21.7
	-38.5	-38.0	-37.1	-34.1	-19.0	5.3	17.7	28.4	37.2	-14.2
	-52.6	-50.2	-46.7	-40.5	-19.0	9.6	24.3	37.2	49.7	-7.9
20	-26.6	-26.6	-26.2	-25.8	-19.1	-4.4	2.1	7.2	9.9	-33.3
	-29.5	-29.2	-28.6	-26.9	-18.4	-3.9	3.8	10.1	15.3	-23.6
	-36.0	-35.0	-33.1	-29.3	-17.5	-1.1	7.0	14.2	21.2	-13.9
30	-24.7	-24.7	-24.5	-23.6	-18.7	-6.8	-1.7	2.1	4.5	-41.8
	-26.5	-26.2	-25.8	-24.4	-18.2	-7.5	-1.9	2.9	6.7	-31.5
	-30.4	-29.7	-28.3	-25.8	-17.3	-5.7	-0.1	4.9	10.3	-19.3
40	-24.1	-24.1	-23.9	-23.2	-18.6	-8.5	-3.9	-0.7	1.6	-47.4
	-25.0	-24.9	-24.4	-23.5	-18.2	-9.5	-4.9	-0.8	2.3	-38.2
	-27.3	-26.8	-25.6	-23.8	-17.0	-8.0	-3.5	0.6	4.6	-24.4

(1) The table shows the changes of the VaR - at 0.1%, 1.0% and 5.0% levels - of a bank that securitizes all its loan portfolio by issuing a CDO, of which it retains the equity tranche, and reinvests the proceeds of the sale in new loans. The correlations with the macro factor of the loans in the original portfolio and the new loans are in the left and top columns, respectively. Other assumptions are: number of loans equal to 1,000; individual default probability equal to 0.2; recovery rate equal to 0.475; risk-free interest rate equal to 0.04.

**Table 5**  
**Number of banks in the dataset by type (1)**

Bank type	Number	%
Mutual banks	401	74.7%
Limited company banks	106	19.7%
Cooperative banks	30	5.6%
<b>Total</b>	<b>537</b>	<b>100.0%</b>

(1) Numbers take into account mergers and acquisitions. All banks involved in one of these operations are considered as one bank only. The type is defined according to the type of the resulting bank in 2007.

**Table 6**  
**Descriptive statistics of the banks in the dataset as a share of all Italian banks**

	1999	2007
No. of banks	81%	69%
Total assets	86%	70%
Loans to non-bank customers	89%	72%
Securitized (1)	72%	

(1) The data refer to the notional amounts of all securitizations between 1999 and 2007.



**Table 7**  
**Ratios of several asset items over total assets**  
*(averages across all banks)*

	Performing loans	Bad loans	Loans to banks	Securities other than shares
<b>All banks</b>				
1999	45.9%	3.0%	10.3%	29.6%
2007	63.1%	2.2%	7.6%	17.8%
Variation	+37.6%	-24.5%	-26.6%	-40.1%
<b>Banks that securitized</b>				
1999	49.8%	3.3%	9.3%	25.3%
2007	66.7%	1.9%	7.3%	14.1%
Variation	+34.0%	-42.7%	-22.3%	-44.3%
<i>Banks that securitized performing loans only</i>				
1999	53.0%	1.9%	7.8%	25.9%
2007	70.9%	1.6%	5.6%	12.9%
Variation	+33.8%	-13.5%	-28.3%	-50.2%
<i>Banks that securitized bad loans only</i>				
1999	37.4%	7.6%	15.2%	28.0%
2007	53.9%	2.5%	11.0%	21.8%
Variation	+44.2%	-66.9%	-28.0%	-22.1%
<b>Banks that did not securitize</b>				
1999	44.2%	2.8%	10.7%	31.4%
2007	61.7%	2.4%	7.7%	19.3%
Variation	+39.4%	-15.8%	-28.1%	-38.7%

**Table 8**  
**Effects of securitization on banks' balance sheets - 1**

	Performing loans	Bad loans	Loans to banks	Securities other than shares
$\delta_{2007}$	0.809 ***	0.061	-0.379 ***	-1.091 ***
$\delta_{sec}$	0.686 ***	0.880 ***	-0.886 ***	-0.152 **
$\delta_{2007}\delta_{sec}$	-0.658 ***	-0.958 ***	0.806 ***	0.224 ***
$\ln(assets)$	-0.152 ***	-0.007	0.269 ***	-0.069 ***
$\ln(cap)$	-0.275 ***	0.058	-0.223 ***	0.438 ***
$\delta_{mut}$	-0.069 **	-0.456 ***	0.103 **	0.357 ***
<i>constant</i>	0.326 **	-3.694 ***	-4.665 ***	0.104
$R^2$ ( <i>adjusted</i> )	0.405	0.448	0.524	0.480

*assets* is total assets, *cap* is a measure of capitalization defined as  $\frac{\text{equity}}{\text{assets}} / (1 - \frac{\text{equity}}{\text{assets}})$ , *mut* means mutual or cooperative bank.

**Table 9**  
**Effects of securitization on banks' balance sheets - 2**

	Performing loans	Bad loans	Loans to banks	Securities other than shares
$\delta_{2007}$	0.808 ***	0.053	-0.376 ***	-1.084 ***
$\delta_{sec\_low}$	0.713 ***	0.775 ***	-0.795 ***	-0.071
$\delta_{sec\_high}$	0.507 ***	0.884 ***	-0.895 ***	-0.132 *
$\delta_{2007}\delta_{sec\_low}$	-0.837 ***	-1.096 ***	0.907 ***	0.376 ***
$\delta_{2007}\delta_{sec\_high}$	-0.283 ***	-0.780 ***	0.681 ***	-0.037
$\ln(assets)$	-0.139 ***	0.021 *	0.244 ***	-0.096 ***
$\ln(cap)$	-0.154 ***	0.223 ***	-0.352 ***	0.325 ***
$\delta_{mut}$	-0.084 **	-0.445 ***	0.098 **	0.345 ***
<i>constant</i>	0.517 ***	-3.511 ***	-4.776 ***	0.052
$R^2$ ( <i>adjusted</i> )	0.452	0.469	0.534	0.502

*assets* is total assets, *cap* is a measure of capitalization defined as  $\frac{\text{equity}}{\text{assets}} / (1 - \frac{\text{equity}}{\text{assets}})$ , *mut* means mutual or cooperative bank. The dummies  $\delta_{sec\_a}$  take value 1 if bank *i* securitized loans for an amount *a* (low or high, i.e. below or above the median value) and 0 otherwise (i.e. when bank *i* did not any securitization).

**Table 10**  
**Effects of securitization on banks' balance sheets - 3**

	Performing loans	Bad loans	Loans to banks	Securities other than shares
$\delta_{2007}$	0.841 ***	-0.085	-0.459 ***	-1.067 ***
$\delta_{sec\_good\_low}$	0.609 ***	0.156 **	-0.666 ***	-0.225 ***
$\delta_{sec\_good\_high}$	0.449 ***	-0.110	-0.716 ***	-0.259 ***
$\delta_{sec\_bad\_low}$	0.048	0.709 ***	-0.201 **	0.259 ***
$\delta_{sec\_bad\_high}$	0.111	1.494 ***	-0.437 ***	0.118
$\delta_{2007}\delta_{sec\_good\_low}$	-0.590 ***	-0.232 **	0.564 ***	0.320 ***
$\delta_{2007}\delta_{sec\_good\_high}$	-0.113	0.021	0.362 ***	-0.059
$\delta_{2007}\delta_{sec\_bad\_low}$	-0.360 ***	-0.703 ***	0.542 ***	0.063
$\delta_{2007}\delta_{sec\_bad\_high}$	-0.135	-0.678 ***	0.478 ***	-0.082
$ln(assets)$	-0.124 ***	-0.002	0.246 ***	-0.112 ***
$ln(cap)$	-0.081 *	0.186 ***	-0.462 ***	0.320 ***
$\delta_{mut}$	-0.133 ***	-0.306 ***	0.161 ***	0.391 ***
<i>constant</i>	0.593 ***	-3.401 ***	-5.051 ***	0.147
$R^2$ (adjusted)	0.487	0.634	0.589	0.521

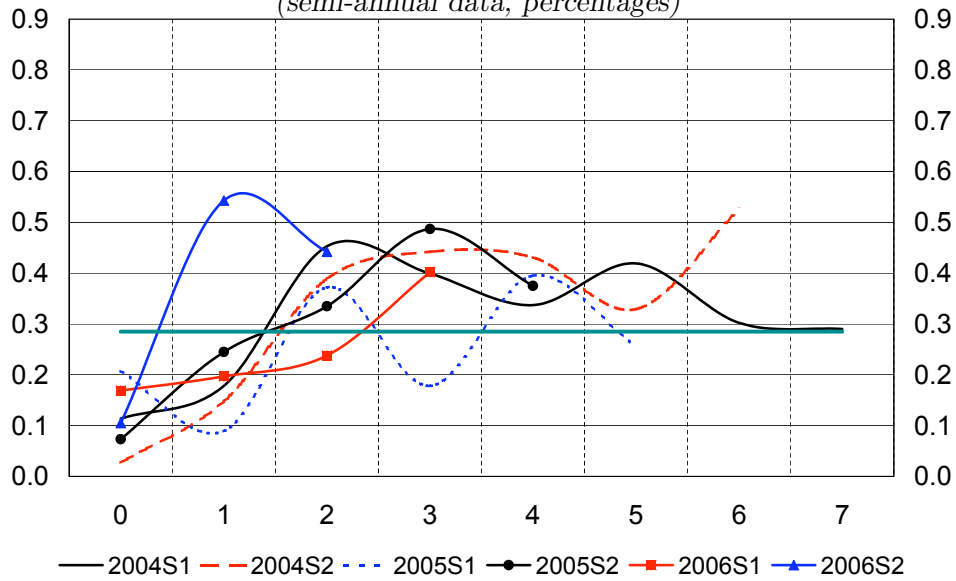
*assets* is total assets, *cap* is a measure of capitalization defined as  $\frac{\text{equity}}{\text{assets}} / (1 - \frac{\text{equity}}{\text{assets}})$ , *mut* means mutual or cooperative bank. The dummies  $\delta_{sec\_a\_b}$  take value 1 if bank *i* securitized loans of quality *a* (good or bad) for an amount *b* (low or high, i.e. below or above the median value) and 0 otherwise (i.e. when bank *i* did not any securitization).

**Table 11**  
**Economic significance of variations of banks' balance sheet**

	Performing loans	Bad loans	Loans to banks	Securities other than shares	Expected losses
<b>Banks that securitized</b>					
1999	58.6%	5.2%	5.8%	30.0%	3.3%
2007	62.0%	2.3%	8.5%	15.9%	1.8%
<i>Banks that securitized less than the median value</i>					
1999	59.5%	4.8%	6.2%	31.4%	3.2%
2007	58.8%	1.8%	9.9%	19.1%	1.6%
<i>Banks that securitized more than the median value</i>					
1999	54.8%	5.4%	5.7%	30.2%	3.4%
2007	66.3%	2.7%	7.5%	13.0%	2.1%
<b>Banks that did not securitize</b>					
1999	42.9%	2.3%	12.4%	33.1%	1.7%
2007	61.4%	2.4%	9.1%	15.0%	1.9%

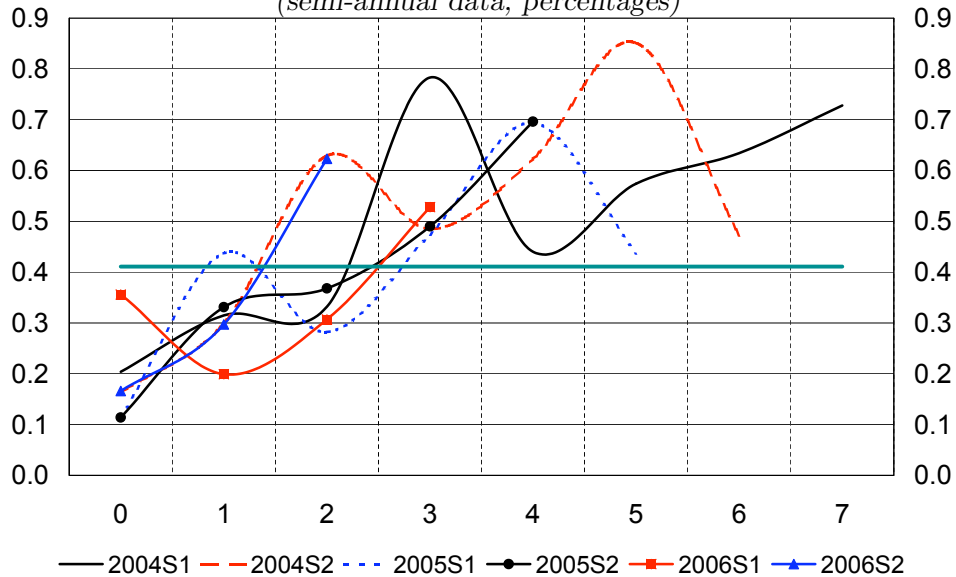
The table reports the estimated predicted values for the share of balance sheet items over total assets using the coefficients reported in tables 8 and 9. Given the non-linearities involved by logistic regressions, predicted values are calculated as the smearing estimates of Duan (1983). Expected losses are calculated using the estimated predicted values for balance sheet shares and assuming the following expected losses for the different asset items: performing loans, 1.0%; bad loans, 50.0%; loans to banks, 0.2%; securities other than shares, 0.4%. Losses across balance sheet items are assumed to be independent of each other.

**Figure 9**  
**Average default rates on securitized loans (1)**  
*(semi-annual data, percentages)*



— 2004S1 — 2004S2 - - - 2005S1 —●— 2005S2 —■— 2006S1 —▲— 2006S2  
 (1) Simple averages across all banks of semi-annual default rates. The legend reports the semesters in which the loans were securitized. The horizontal axes shows the number of semesters following the securitization. The horizontal line is the overall mean.

**Figure 10**  
**Average default rates on new loans (1)**  
*(semi-annual data, percentages)*



— 2004S1 — 2004S2 - - - 2005S1 —●— 2005S2 —■— 2006S1 —▲— 2006S2  
 (1) Simple averages across all banks of semi-annual default rates. The legend reports the semesters in which the loans were granted. The horizontal axes shows the number of semesters following the granting of the loans. The horizontal line is the overall mean.

**Table 12**  
**Comparison of the probability of default**  
**of new loans with that of loans that have been securitized**  
*(percentage points)*

	Semester	Semester+1	Semester+2	Semester+3	Semester+4	Semester+5	Semester+6	Semester+7	TOTAL
2004S1	0.090	0.137	-0.121	0.384 *	0.103	0.155	0.332 *	0.438 *	0.190 ***
2004S2	0.136 **	0.151 *	0.240	0.044	0.191	0.522 ***	-0.054	—	0.176 ***
2005S1	-0.094	0.348 **	-0.090	0.296 ***	0.299 *	0.181 *	—	—	0.157 ***
2005S2	0.040	0.086	0.033	0.003	0.321 *	—	—	—	0.097
2006S1	0.187	0.002	0.068	0.126	—	—	—	—	0.096
2006S2	0.061	-0.246	0.181	—	—	—	—	—	-0.002
2007S1	0.059	0.255 **	—	—	—	—	—	—	0.157 **
2007S2	-0.233	—	—	—	—	—	—	—	-0.233
<b>TOTAL</b>	<b>0.035</b>	<b>0.105 **</b>	<b>0.041</b>	<b>0.176 **</b>	<b>0.235 ***</b>	<b>0.257 ***</b>	<b>0.172</b>	<b>0.438 *</b>	<b>0.126 ***</b>

The table reports the averages across all banks of the differences between defaults rates of new and securitized loans by semester of inception (left column) and semester of default (top row). Significance levels at 1%, 5%, and 10% are denoted by \*, \*\*, and \*\*\*.