

Did the Securitization Contribute to the Release of the Subprime Crisis? Empirical Investigation of American Banks

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ABSTRACT

In this paper we examine the hypothesis that the securitization, the act of converting illiquid loans into liquid securities, has largely contributed to an excess of risk taken by American banks on their subprime credit lending. Empirical investigation, conducted over a sample of 6775 US banks between 2003 and 2007, provides evidence to support this assumption. We additionally find that banks which securitize are also those experiencing a decreasing rate of profitability and a risk level higher than the average. Finally, this crisis seems to have a macroeconomic explication, also documented in previous studies, according to which the fall of the house price index since 2006 significantly deteriorates the US bank financial performance.

JEL Classifications: G01, G21, G33, G34

Keywords: subprime crisis; US banks; panel logistic regression; securitization

I. INTRODUCTION

The financial history was marked in the last decades by a succession of financial crises. Black Monday of Wall Street (1987), the Latin American crisis (1994-1995), the Asian financial crisis (1997) and, recently, the subprime crisis seem to have a periodic distribution. According to the 2009 Global Financial Stability report, the amount of the American assets for the whole financial institutions during the period between 2007 and 2010 may well exceed \$2.7 billion, compared to the expected level of \$2.2 billion in January 2009. According to the International Monetary Fund, the global amount of the loosed credits in the world is estimated at approximately \$4 billion, of which two-thirds belong to banks, and the remainder comes from insurance companies, hedge funds and other financial institutions. Since August 2006, various actions were undertaken by the world's leading central banks for the rescue of the financial markets. This has been materialized by the activation of the lender-of-the-last-resort functions and liquidity injections for several times. We note for example that the amount of liquidity injections by the European Central Bank to help eligible financial institutions experiencing financial difficulty or risking a probable default exceeded the sum of €500 billion. The Bank of England also injected, until April 2008, €63 billion for the repurchase of poor quality loans essentially in the forms of asset-backed securities and covered bonds. To the extent that the amount of banks' securitized credits rose substantially from \$1268.6 billion in January 2000 to about \$2523.4 billion in 2008 (or an increase of about 100%), some economists and finance professionals argued that securitization operations were the origin of the subprime crisis and did contribute to its worldwide propagation.

This paper attempts to empirically examine the role of the subprime mortgage-backed securitization in the release of the recent subprime crisis by checking the hypothesis of excessive risk-taking by financial companies in loan granting. This high risk is potentially supported by the possibility for American banks to transform their credits into negotiable evidences of indebtedness through securitization mechanism. Thus, our study joins the very recent literature that investigates the economic consequences of housing price appreciation (Goetzmann et al., 2009; Mian and Sufi, 2010a, 2010b) and the relationship between the securitization activity and the global financial crisis of 2007-2009 (Keys et al., 2010; Piskorski, 2010; Claessens et al., 2010). The main findings, obtained from econometric analysis for the sample of 6775 American banks between 2003 and 2007, indicate that credit securitization leads to an excessive risk-taking behavior of American banks on their subprime credit lending and to a significant increase in their probability of default.

The remainder of this paper is organized as follows. Section II provides an overview of the theoretical and empirical literature on the banking and subprime crisis, as well as some stylized facts related to the release of the subprime crisis in the United States. Section III proposes an empirical analysis of the securitization impacts on banks' probability of default. Section IV reports and discusses the results, and concluding remarks are provided in Section V.

II. SECURITIZATION AND SUBPRIME CRISIS

Before exposing an overview of the theoretical and empirical literature related to the role of the securitization in the subprime crisis in the United States, it is essential to recall some key concepts.

A. Some Basic Concepts

A mortgage loan is a standard debt contract between the borrower (i.e., the property purchaser) and the lender (i.e., the financial institution which grants the credit) whereby the credit is guaranteed by the bought property. The lender is entitled to the seizure of the property if the borrowers are unable to pay back their loans. We can distinguish three types of loans since all the mortgages have not the same credit risk: prime, subprime and Alt-A mortgage (or Alternative A-paper). The latter is commonly known as riskier than an A-paper (prime) loan which has the highest credit grade, but less risky than the subprime category. When selecting credit applications, banks have to construct a measurement scale about the borrowers' risk profile on the basis of (1) their past relations with the bank including, for example, their reimbursement of old loans granted, and the ratio of debt to personal income; (2) the credibility of the proofs provided by the borrowers to check their income; and (3) the "credit score" of the borrower which is firstly given by *The Fair Isaac and Company* or "FICO score" and secondly by the amount of the requested loan.

Therefore, according to the definition commonly accepted by the majority of banks, a mortgage loan is classified into subprime category if it is granted to a borrower having a *FICO* score below 620. Note that the *FICO* scores range from 300 and 850, and the highest score indicates the likelihood to have a credit under the best conditions in terms of interest rates, loan-to-value (LTV), and term of payment, etc. A *FICO* score exceeding 720 is generally considered as an excellent credit rating score and makes it possible to qualify the borrower "premium". When the borrower obtains a credit score between 620 and 720, the loan is considered as an Alt-A mortgage.

In their standard forms, mortgage loans are not easily exchangeable, and the lenders may face significant risks in case of non-payment by the borrowers. Banks and lending institutions have often recourse to asset securitization technique which began with the structured financing of mortgage pools in the late 1970s. Formally, securitization can be viewed as a process of taking an illiquid asset or group of assets, and through financial engineering, transforming them into a security. A typical example of securitization is the *Mortgage-Backed Security* (MBS) which is a particular type of *Asset-Backed Security* (ABS) and is secured by a collection of mortgages. In general, the securitization process functions as follows. First, a regulated and authorized financial institution issues numerous mortgage loans being secured against the various real properties the mortgagors purchase. Then, all of the individual mortgages are assembled together into a mortgage pool which is held in trust as the collateral for a MBS. In the US, most MBSs are originated from the Government National Mortgage Association (Ginnie Mae), the Federal National Mortgage Association (Fannie Mae), and the Federal Home Loan Mortgage Corporation (Freddie Mac). Once a new security representing the claims on the cash flows from pool of mortgage loans, and in this case, the principal and interest payments made by the mortgagors, is created, it can be sold to the participants in the secondary mortgage market. Before the advent of the subprime crisis, this market was extremely large, and improved considerably the liquidity of mortgage assets, which otherwise would have been quite illiquid on their initial forms. It is equally important to note that the MBSs are subdivided into the CMBS (*Commercial Mortgage-Backed Securities*) and the RMBS (*Residential Mortgage-Backed Securities*).

Securitization has several advantages for banks. Initially, it represents a new funding source by allowing the transformation of illiquid portfolio into a liquid one as well as a means of expanding banks' credit lending capacity.¹ As a result, the risk of loss on the portfolio value will be transferred to the economic agents. In case where the portfolio ultimately contains bad credits and future cash flows generated are insufficient, investors must support the financial loss. With securitized mortgage loans, however, it is generally rare that the whole risk is transmitted to the investors. For the case of the US banking industry, the grantor preserves the "first risk" of non-payments on the portfolio, which is supported by the grantor's repurchases of the riskiest bonds (or subordinated bonds). Securitization also makes it possible, for banking institutions, to appropriately manage their balance sheet according to banking regulations in place. Indeed, the grantor can, by means of rebalancing the portfolio of credits, control for the swelling of its balance sheet, and thus generate new credits while maintaining its balance sheet on a controlled level of risk. Last but not least, securitization can also be considered as an instrument for exploiting the arbitrage opportunities available in international bond markets. That is, a bank can, at the same time, sell out some MBSs via a Special Purpose Vehicle (SPV) or a Special Purpose Company (SPC) and purchase a well-diversified portfolio of bonds. If the actual market conditions work for the mortgage portfolios, the bank is able to make capital gains due to the price appreciation of the portfolio's bonds.

B. Previous Literature on Banking and Subprime Crisis

González-Hermosillo (1999) pushes forward that the moral hazard may occur when banks take excessive risks by granting loans to very lucrative opportunities in the short run, but for which prospects for long-run refunding are reduced. This economic behavior is also motivated by the fact that bank supervisors expect that possible losses will be absorbed by a third part, such as governments through rescue operations or international financial organizations. Subsequently, Plihon and Miotti (2001) argue that the vulnerability of banks would not originate from only moral hazard, but also from a speculative behavior adopted by domestic banks which are encouraged by an intensive process of financial liberalization and transformation of the banking systems. According to these authors, the growing integration of global capital markets in the aftermath of financial liberalization process contributes to increase competition between foreign and domestic banks, and thus to reduce their profits from intermediation activities. At the same time, in the post-liberalisation period, the fact that companies have the possibility to directly raise the capital needed for their operations on international financial markets leads banks to speculate more in order to compensate the lack of profits. The Keynesian inspiration of Plihon and Miotti (2001) about banks' behavior is exactly in line with the analysis developed by Kindleberger (1989) according to which most of financial crises we went through in the financial history had three distinct phases: displacement, euphoria and distress. Displacement is an event which modifies the behavior and expectations of the market operators. The euphoria phase following displacement is characterised by periods of market blooming in terms of activity and investment turnover. The distress phase occurs with the swelling of market panics and corporate bankruptcies due to excessive risk-taking positions taken by economic agents during the euphoria phase.

The above analysis can also be applied to the recent subprime crisis in the US and the global financial crisis. We consider that securitization (period of displacement) as a new structured-financing tool on the market employed by American banks to commercialize securities whose claims depend on high-risk and/or low-risk mortgage loans. American banks then saw their profit increase considerably, and the final investors were happy to hold these mortgage-backed securities which pay high returns in low-interest rate environment without any concern about the quality of the mortgage borrowers and how the latter was evaluated. Economic agents thus entered in the euphoria's period over which they take excessive risks. When the interest rates began to rise in 2006-2007, as opposed to the common expectations, subprime borrowers default on their mortgage loan contracts, leading to the collapse of the US real-estate and banking markets as all of them are linked together. This episode finished by the prevailing of the distress period in financial markets. A major lesson from the recent past is that with the development of financial markets and the emergence of financial innovations (futures, options, credit derivatives, asset-backed securities, etc.), banks have opportunities to satisfy their liquidity preferences and make profitable placements which do not have a direct relation with the financing of the productive economy, unlike credits intended to finance investments. These speculative operations have then contributed to the creation of further fictive financial capital, being opposed to the industrial capital invested in the productive chain.

The majority of previous works related to the analysis of banking crisis have concentrated on the repercussions of the macroeconomic conditions on banks' risk behavior (e.g., Demirgüç-Kunt and Detragiache, 1998; Glick and Hutchison, 2000). For instance, Arteta and Eichengreen (2002) showed that the risk taken by financial institutions in emerging market countries increases following domestic financial liberalization, and the principal robust causes of their banking crisis include rapid domestic credit growth, large bank liabilities relative to reserves, and deposit-rate decontrol.² Noy (2004) attempted to empirically evaluate the probability of the occurrence of banking crisis using financial liberalization as well as macroeconomic, institutional and political variables. The results obtained from a panel-probit model indicate that the loss of monopoly power following financial liberalization, as competitions intensifies and profit margins narrow, drive banks to take more risky investments as long as they do not violate the banking regulatory constraints. Other studies have focused on the concept of financial securitization and investigated the basic similarities and differences between banks that securitize their loans and banks that do not. The results of Uzun and Webb (2007) indicated, for example, that the size factor is a significant determinant of whether a bank securitizes, and that the credit securitization is negatively related to banks' risk-based capital ratios. Using a dataset on securitized subprime mortgage loan contracts in the United States (FICO score, loan characteristics, maturity, borrower characteristics, and other information collected on the borrower) to examine whether securitization reduces financial intermediaries' incentives to screen borrowers, Keys et al. (2010) provided evidence of adverse effects of the securitization process on the behavior of banks.

By focusing directly on the microeconomics of bank risk management, Wolfe (2000) suggested that securitization increases the default risk of the bank because the securitized credits offered to the investors are generally riskier than those that remain in the bank's balance sheet. Dionne and Harchaoui (2003) sought to examine the

empirical relationship between bank's capital, securitization and risk. Their results, drawn from commercial banks in Canada over the period 1988-1998, indicated that securitization exerts negative effects on both Tier 1 and Total risk-based capital ratios, and that there exists a positive relation between securitization and banks' risk. Franke and Krahen (2005) shift attention to the effect of loan securitization on default risk, systematic risk and stock prices of financial institutions by considering a sample of European CDOs (Credit Default Obligations). They mainly found that securitization, while making possible for banks to transfer a part of their risks, incites them to take some more. In particular, banks' systematic risk tends to increase around securitization announcements. This means that financial markets see these banks riskier after such events. More recently, Bannier and Hansel (2008) investigated securitization activities of European banks and found that banks with higher risk (as measured by the ratio of banks' credit risk provisions to net interest income) and low liquidity are those which have generally recourse to loan securitization. Commercial banks are also involved in securitization transactions when they wish to indirectly access the investment-bank activities and the associated profits. The findings of the above-mentioned works are however not in line with those reported in Minton et al. (2004), and Jiangli and Pritsker (2008). Indeed, the first study documented that banks which securitize the most are riskless in terms of capital adequacy ratios, while the second assessed that banks utilizing loan securitization have a greater profitability, a considerable debt ratio, but a lower insolvency risk. Finally, in a related study, Gorton (2009) suggests that movements in real estate prices contributed to the rapid expansion of securitization process and its high complexity, which may generate asymmetric information and lead to higher risk for banks.

C. The Subprime Crisis: Some Stylized Facts

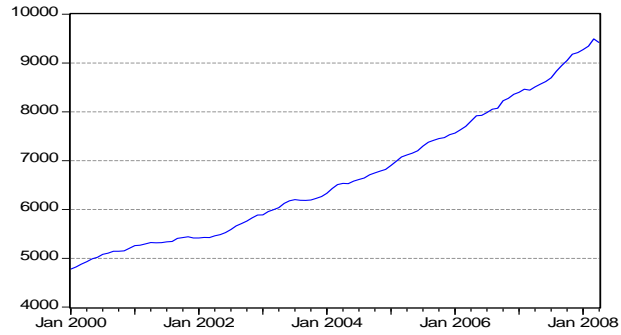
Over the last years, the US 2007 subprime crisis has progressively evolved to a global financial and economic crisis by inducing liquidity traps and credit crunch. Stock market volatility and major sources of corporate financing (debt and shareholder equity) are severely affected. Its phase of displacement according to Kindleberger (1989)'s analysis began with the rapid development of direct finance on financial markets, which intensifies competitions among banks and incites them to expand mortgage loans to high-risk population. This process is further accelerated by US government policies to increase home ownership rate since 1997 as well as banks' abundant liquidity from loan securitization.

As shown in Figure 1, total bank credits have considerably increased from \$4778.60 billion in January 2000 to \$9415.3 billion in April 2008, or an increase of about 97%. This spectacular change is essentially due to a huge increase in mortgage lending, as shown in Figure 2. We observe that mortgage credit expansion exceeded 141% over the same period, which is justified partly by the housing market boom following low interest rates, large inflows of foreign funds, and easy credit conditions.

Figure 3 shows that the United States has experienced a boom of real asset prices since 1997. The average price increased from \$150,500 in 1997 to reach a peak of \$266,000 in 2005. Shiller (2007) estimated that the real asset price index on the US markets has risen about 85% between 1997 and 2006. Banks have thus incentives to

Figure 1

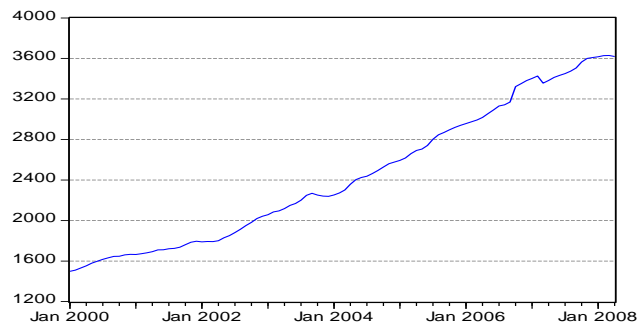
Evolution of the total volume of bank credit (in billion US dollars)



Source: Federal Reserve Statistical Releases

Figure 2

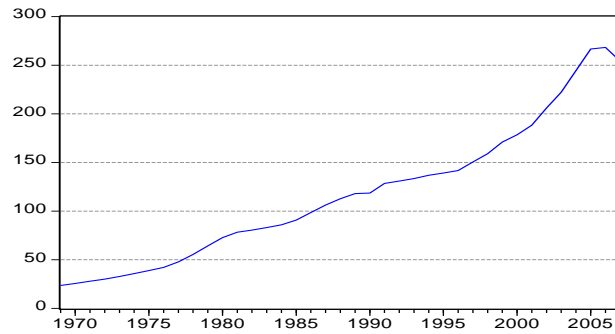
Volume of mortgage credit: Jan. 2000-Jan. 2008 (in billion US dollars)



Source: Federal Reserve Statistical Releases

Figure 3

Dynamics of the existing home prices (in thousand US dollars)

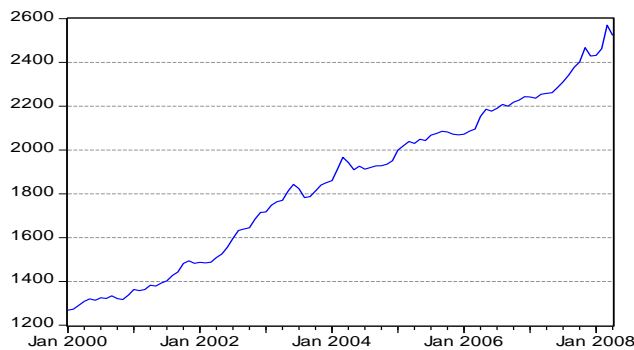


Source: National Association of Realtors

grant high-risk mortgage loans, and believe that they can, even in the worst situation where borrowers are insolvent, liquidate the assets under contract even. Following Demyanyk and Van Hemert (2009), the problems of insolvency of borrowers could have been detected before the occurrence of the subprime crisis, but they are hidden by the rise of the housing price index over the 2003-2005 period. Indeed, the subprime lending made it possible for a household to buy a real estate initially with a fixed interest rate during the first two years and a variable rate containing an allowance for risk afterwards. The particular feature is that the subprime loan contract is secured by a mortgage on the real estate purchased, and the loan is granted after examination of the value of the real estate, contrary to the standard lending practices based on the borrowers' solvency position. Thus, the monthly payments on the loan contract increase significantly after the second year, making impossible for the majority of purchasers to repay their loans. Consequently, they sold their real estates with a capital gain relying on the rise of American housing markets by 10% per year in order to pay back the loan and interests and, why not, to take again a new subprime credit if the market is still in the phase of euphoria. Securitization mechanism effectively contributed to increase high-risk loans by improving banks' liquidity.

Figure 4 shows a considerable increase in credits securitized by US banks. The overall amount of securitized loans has grown by about 100% from \$1268.6 billions in January 2000 to \$2523.4 billion. This phase of euphoria of the US economy, supported by high liquidity resulting from securitization operations, did not however persist for a long time. In 2006, we observe a general fall in the US housing prices because the Fed raised significantly its fund rates between July 2004 and July 2006, making the adjustable rate mortgage (i.e., mortgage loan's interest rate which is adjusted on a variety of indices) more expensive for the borrowers. More beneficiaries of subprime credits then made default on the payment of the principal and interests related to the subprime credits. The properties under mortgage contract were recovered back by the banks and offered for sale, but banks realize, on average, a loss that usually exceeded 20%. The continuing price decline sparked off the phase of distress, characterized by a chain of failures in the US housing and banking markets.

Figure 4
Evolution of the securitized bank credits (in billion US dollars)



Source: Federal Reserve Statistical Releases

III. RESEARCH METHODOLOGY AND DATA

We develop in this section an empirical framework to test whether securitization has played a significant role in the release of the US subprime crisis. To do so, we evaluate the probability of failure of US banks conditional on main financial indicators of sample banks including the volume of credit securitization, the doubtful debts, the level of credit risk, the demand and supply for bank credit and the profitability. The house price index is also introduced to control for the exogenous effects of the market on default risk of US banks.

A. Econometric Modelling

Four different methods of financial crisis prediction have been generally used in previous empirical studies. The simplest one consists of observing the evolution of the macroeconomic parameters in crisis countries and detecting their possible properties. Researchers have often recourse to this method when economic theory offers no insights about the occurrence and development of a crisis, but it can be neither quantified, nor subjected to significance tests. As for the three remaining methods, they are considered as more elaborated and rigorous: “events” detection, multivariate models including linear probability model, probit model and multivariate discriminant analysis, and advanced indicators borrowed from the detection of business cycles (Wenhua Yu and al 2009). Recently, the neural network methodology in artificial intelligence are more and more used to forecast bankruptcies and firms vulnerabilities (Celik and Karatepe, 2007), but it has several disadvantages including particularly long training time.

Since we are concerned by the probability of banks’ failures, the panel data logit model appears to be the most suitable of the aforementioned approaches. When investigating warning models for bank supervision, Jagtiani et al. (2003) also show that simple linear models such as the logit model give more adequate results than the more complex models in the early identification of the banking failures. Besides its simplicity, the logit model is equally advantageous in that it allows us to assess the contribution of a particular variable in the probability of the release of a crisis at a given point in time. It finally makes easier the handling of numerous qualitative variables that may be at the origins of the crisis.

Formally, logit model or also called logistic regression can be viewed as a generalization of the linear probability model (LPM) which is by far the simplest way of dealing with binary dependent variable. Let’s y_{it} and X_{it} denote respectively a binary dependent variable that takes the value of one when a bank fails and zeros otherwise, and a vector of explanatory variables that affect the probability of bank failure, the probability that a bank i fails at time t , $p(y_{it} = 1)$, is modeled as

$$P_{it} = p(y_{it} = 1) = \beta' X_{it} + \varepsilon_{it} \quad (1)$$

Since the actual probabilities are unobservable, we would have to estimate, by OLS procedure, a model where y_{it} (i.e., the series of ones and zeros) is the dependent variable. The fitted values from this regression are the estimated probabilities of bank failure for each observation. The slope estimate for a particular explanatory variable

can be interpreted as the change in the probability that the dependent variable will be equal to one for a one-unit change in the given variable, while holding the effects of remaining variables unchanged. The LPM suffer, however, from an important limitation that estimated probabilities can be either negative or above one. This problem can be avoided by transforming the regression model in Equation (1) so that the fitted values are bounded within the (0,1) interval. To date, one of the most interesting approaches consists of using the logistic function to transform the LPM into the logit model as follows:

$$P_{it} = p(y_{it} = 1) = \frac{e^{\beta'X_{it}}}{1 + e^{\beta'X_{it}}} \quad (2)$$

where e is the exponential operator. Under this form, the probability of bank failure rises monotonically between the bounds of zero and one. Therefore, the logit model is not linear and its estimation relies on the application of the maximum likelihood method. Note that in this study we estimate the model displayed in Equation (2) with panel data in order to investigate the common risk behavior of US banks.

B. Data and properties

Our empirical investigation is conducted on a sample of 6775 US banks from the Federal Deposit Insurance Corporation Database over the period from 2003 to 2007.³ Our econometric specification is based on the following logit model where the default variable depends on seven explanatory variables such as

$$\text{DEFAULT_BANK} = \alpha + \delta \text{MBS}_{it} + \beta'X_{it} + \varepsilon_{it} \quad (3)$$

The first and most important variable in this specification is the volume of securitized assets (MBS) for each bank, measured by the total value of mortgage backed securities in logarithm. We consider six control variables which may affect the probability of occurrence of banking failure: the ratio of total risk-weighted assets to total assets (RISK), the ratio of total deposits to total assets (DEP), the ratio of net loans and leases to total assets (LOANS), the return on assets (ROA), the ratio of net charge offs to loans (COL), and the house price index (HPI). The expected signs of these variables are presented and discussed in Table 1. Some of these variables have been employed in past studies to examine the house price evolution, the risk exposure related to securitization and the probability of bank failures (Arena, 2008; Keys et al., 2010; Barrell et al., 2010).

We also compute the correlation matrix for all variables used in the model, and report the results in Table 2. The low correlations between the variables suggest that each of the latter should be informative and useful in explaining the changes in dependent variable.

Table 1
Description of the variables

Variables	Definition	Expected Signs
<i>DEFAULT_BANK</i>	This variable refers to a binary variable which takes the value of 1 if the bank defaults and 0 otherwise.	-
<i>Mortgage Backed Securities (MBS)</i>	This variable corresponds to the volume of the securitized credits in logarithm.	The expected sign is positive, the higher the ratio, the more the bank takes on excessive risk by financing mortgage operations.
<i>Total risk-weighted assets / Total assets (RISK)</i>	This variable measures the bank's risk level.	The expected sign is positive. The higher the RISK ratio, the higher the probability of a bank's default risk is.
<i>Total deposits / Total assets (DEP)</i>	This variable reflects the capital sources to insure the credit supply activity.	The expected sign is negative because a failed bank is the one which concentrates less and less on its traditional activities, i.e. credit lending on the basis of the volume of the deposits. So, the higher the DEP ratio, the lower the probability of default.
<i>Net loans and leases / Total assets (LOANS)</i>	This variable measures the credit supply activity in percentage of total assets	The expected sign is positive since the probability of default would increase with high-risk loans.
<i>Return on assets (ROA)</i>	ROA is an indicator of a bank's profitability, measured by the ratio of net profit to total assets.	The expected sign is negative since a failed bank would have in general experienced a decreasing trend of profitability level.
<i>Net charge-offs to loans (COL)</i>	This variable reflects the importance of the doubtful debts over total credits.	We expect a positive sign because the larger the ratio, the poorer the quality of the credits granted to the borrowers.
<i>House Price Index (HPI)</i>	Expressed in logarithm term, this variable captures the dynamic evolution of the house price index in the United States.	The fall of the real estate prices coupled with the rise of interest rates may cause the incapacity of the households to honor their engagements and the incapacity of banks to have surplus when selling the mortgage house. Then, the expected sign is negative, i.e., the worst the value of real estate assets, the higher the probability of banking failure.

Table 2
Stamp correlations of the variables

Variables	DEFAULT _BANK	RISK	DEP	MBS	ROA	LOANS	HPI	COL
DEFAULT_BANK	1.0000							
RISK	0.0578	1.0000						
DEP	0.0005	-0.0150	1.0000					
MBS	0.0495	0.0106	0.0450	1.0000				
ROA	-0.0063	0.1023	-0.0834	-0.0027	1.0000			
LOANS	0.0014	0.0242	0.1211	0.0002	-0.0002	1.0000		
HPI	0.0000	-0.1021	-0.0240	0.0035	0.0209	0.0039	1.0000	
COL	0.0087	0.1004	0.0050	-0.0179	-0.1659	0.0033	0.0111	1.0000

It is equally important to note that the *Banker's almanac* database was used to distinguish default banks from non-default (healthy) banks. We indeed follow the definition of Arena (2008) according to which a bank is considered to be in default if it is subject to at least one of the following procedures: (1) the bank is under administration with support of a regulatory institution and especially recapitalization agencies; (2) the banking license is suspended or revoked; (3) the bank is in liquidation process; and (4) the bank goes bankrupt.

The selection procedure leads to a total of 78 default banks between 2003 and 2007 according to the criteria listed above.

IV. EMPIRICAL RESULTS

Before carrying out the estimation of our empirical model in Equation (3) for the sample of 6775 banks over the period 2003-2007, we have to be sure for the appropriateness of the panel technique. For this purpose, we first estimate the same equation for each year between 2003 and 2007, and observe that the coefficients and the significance level of the explanatory variables were sometimes quite different from one estimate to another. This leads us to conclude that the model should be estimated in panel data, owing to the presence of cross-sectional effects. We then check for the assumption of fixed effects for each cross-sectional unit. If the fixed effects are indeed present, it would be not necessary to allow the dependent variable to vary according to the specificity of each bank, independently of the explanatory variables. Our result indicates that the assumption of random effects is more suitable for modeling the probability of banking default. Finally, given that the large disproportion between the two categories of banks, i.e., 79 failed banks against 6696 healthy ones, may bias our empirical results, we decide to use the estimation method proposed by King and Zeng (2001). This method consists of weighting the observations in order to gauge their contribution to the whole population. More precisely, the weight of each group of observations is as follows:

$$\frac{1}{N_0} \binom{N_0 + N_1}{2} \text{ for group 0 (healthy banks) and}$$

$$\frac{1}{N_1} \binom{N_0 + N_1}{2} \text{ for group 1 (failed banks)}$$

where N_0 and N_1 denote respectively the number of observations of the healthy and failed banks in the sample data.

Table 3
Logit estimation results

Variables	Coefficient	Std. Errors	z-statistics	P-value
MBS	1.616 ^{***}	0.032	49.48	0.000
RISK	17.129 ^{***}	0.362	47.30	0.000
DEP	-1.866 ^{***}	0.694	2.69	0.007
ROA	-0.418 ^{***}	0.056	-7.42	0.000
LOANS	0.029 [*]	0.017	1.69	0.091
HPI	-4.150 ^{***}	1.056	-3.93	0.000
COL	0.393 ^{***}	0.096	4.09	0.000

Wald test statistics = 2309.42

P-value of the Wald test = 0.0000

P-value of the likelihood ratio test = 0.0000

Notes: This table reports the estimation results from a panel random-effect logistic regression for the model in Equation (3) over the period from 2003 to 2007. The sample data include 6775 American banks and a total of 33875 observations. The dependant variable, DEFAULT_BANK, takes the value of one for a default bank, and 0 for a healthy bank. MBS and HPI variables are expressed in logarithm. The Wald and Likelihood tests examine the null hypothesis of joint significance of all estimated coefficients of the logistic regression. ^{***}, ^{**} and ^{*} indicate significance at the 1%, 5% and 10% levels, respectively.

We now estimate the model in Equation (3) using the Logit estimation technique. Table 3 summarizes the results obtained for 6775 American banks over the period 2003-2007. Globally, the estimation result is significant in that at least one of the explanatory variables contributes to significantly explain the time-dynamics of the probability of banking default, as confirmed by the likelihood ratio and Wald test which clearly reject the null assumption of the nullity of the estimated coefficients. A close inspection of the results indicates that the estimates related to the seven explanatory variables introduced in the model are highly significant at the 1% level, except for the LOANS variable with a significance level of 10%. Moreover, all the variables under consideration have expected signs as discussed in Table 2. One should note that the economic interpretation of the binary models such as Logit and Probit is made only on the basis of the sign of the estimated coefficient of each variable and not on its value. In this scheme of things, a positive coefficient means that any increase in an explanatory variable $X_{i,t}$ contributes to increase the probability that a bank defaults, $\text{Prob}(Y_{i,t}=1)$. A negative coefficient implies inversely that any increase in $X_{i,t}$ causes $Y_{i,t}$ to move towards its weakest modalities, $\text{Prob}(Y_{i,t}=0)$.

As pointed out in Section II, the excessive risk-taking behavior can be explained by the possibility given to the US banks to increase their liquidity through securitizing credits. This statement is examined by inspecting the directional impact of *MBS* variable on the bank default probability. Results reported in Table 3 witness the important role of loan securitization in increasing the probability of bank failure since the associated coefficient is positive and statistically significant at the 1% level. These findings corroborate with those of several works in the existing literature which conclude that securitization of subprime mortgage loans eased the access of the low-income households to credits and incited banks to take more risks, which may affect their long-run financial performance (Gabriel and Rosenthal, 2006; Hansel and Krahen, 2007). On the other hand, loan securitization, as a new funding source for

banks, helped them to increase the supply of credits (Hirtle, 2007; Goderis et al., 2007). By analyzing collateralized loan obligation (CLO) transactions by European banks over the period 1997-2004, Bannier and Hansel (2008) show that securitizing banks have higher risk of failure than those which do not.

The significant and positive coefficients of the *COL* variable (ratio of doubtful debts to total credits) as well as of the *RISK* variable (ratio of total risk-weighted assets to total assets) show that the default probability of American banks increases with the amount of credits granted to high-risk households. In other words, American banks that involved with high volume of securitized credits were exposed to a high risk of default, likely caused by the borrowers' insolvency. This finding is thus in line with previous empirical studies examining the impact of the rise of doubtful debts on the explanation of banking crisis. For instance, Gavin and Hausmann (1998) argue that the doubtful debts may make the banking system more vulnerable to shocks and lead to crisis. The reason is that the rise of bad and doubtful debts provokes the slowdown of the capital reserved for loss recovery. Noy (2004) concludes that the implementation of financial liberalization may incite domestic banks to take on excessive risk in absence of prudential supervision. Accordingly, some regulation practices such as the establishment of limits on the interest rate and the volume of credits, in particular for certain sectors including real estates would be necessary.

It is commonly assumed that loan securitization allows for banks to make high profitability. Nevertheless, banks that securitize assets have generally experienced decreasing trend of profitability during the years preceding the crisis. This hypothesis is confirmed by the significant and negative coefficient associated with ROA, showing that. Finally, the macroeconomic influence of house price index variable (*HPI*) on the bank default probability is negative as expected, meaning that the decline in housing prices has contributed to the failure of banks. Indeed, over the US subprime crisis, when the housing prices experienced spectacular fall owing to the increasing adjustable-rate mortgages, borrowers who found themselves unable to pay higher monthly mortgage payments are the first to default. The non-payment of more and more borrowers, in turn, reduced the value of mortgage-backed securities, made banks' financial situations worst, and led many of them to default. The findings of Demyanyk and Van Hemert (2009) are consistent with the fact that the appreciation of housing prices masked the risk of a subprime crisis in the United States, but once the housing prices started to decline in the beginning of 2006, the occurrence of a subprime crisis became more apparent. When analyzing the US house prices before 2006, Goetzmann et al. (2009) assess that their subsequent fall was unforeseen and that both borrowers and lenders (banks) expected an increasing trend of these prices in the future.

V. CONCLUDING REMARKS

This study seeks to examine the role of loan securitization in explaining the risk-taking behavior of American banks as well as the occurrence of the 2007 subprime crisis in the United States. Using data from 6775 American deposit banks over a five-year period 2003-2007 which is characterized by important volume of the securitized loans, we find that the general assumption of excessive risk-taking behavior of US banks cannot be rejected. In particular, the probability of bank default is positively associated with the volume of securitized credits, suggesting that the more banks securitize their loans, the

higher their exposure to default risk is. Moreover, and the proportion of risk-weighted assets in total assets as well as of bad and doubtful loans in total loans are found to significantly increase the probability of US bank failure. Finally, the evolution of housing price level appears to have contributed largely to the explanation of the subprime crisis in the United States since July 2007.

Based on these results, it should be of interest for policymakers to build appropriate banking supervision policies and prudential standards for regulating banking system. They may include, among the others, a better transparency in securitization (the portion of risk retained by each operator involving in an asset transformation, the quality of transactions) the control of the methodology adopted by credit rating agencies in their assessment of bond creditworthiness, and revisions of banking supervision norms taking into consideration the volume of securitized loans.

ENDNOTES

1. See Cebenoyan and Strahan (2004), Hirtle (2007), and Goderis et al. (2007) for empirical evidence from 65 banks which emitted "Collateralized Loan Obligations" (CLOs) between 1995 and 2004.
2. It is now commonly accepted that if domestic financial liberalization, which aims at removing interest rate controls and giving financial intermediaries (banks and banking organizations) more autonomy in managing loan and credit policies, is accompanied by insufficient prudential supervision of the banking sector, it will lead to an excessive risk taken by financial operators and may result in a subsequent crisis.
3. The Federal Deposit Insurance Corporation (FDIC) is an independent agency of the federal government. It preserves and promotes public confidence in the U.S. financial system by insuring deposits in banks and thrift institutions for at least \$250,000; by identifying, monitoring and addressing risks to the deposit insurance funds; and by limiting the effect on the economy and the financial system when a bank or thrift institution fails.

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