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Abstract

This working paper studies the impact of the subprime crisis on the ratings issued by the rating agencies in evaluating the solvency of banks. After ascertaining a significant worsening of ratings after the crisis, the paper hypothesizes the possibility that this worsening is not due exclusively to deterioration in the banks' credit quality, but also to a change in the behavior of the rating agencies. The study designs a methodology to separate the observed change in ratings into two multiplicative components: one associated with the deterioration of the banks' solvency itself and another associated with the change in the agencies' valuation criteria. The methodology is applied to the Spanish Banking System during the period 2000-2009. The results obtained show that the observed ratings cuts (13%) are explained (65%) by the deterioration in the solvency of the banks, but also (35%) by the hardening of the valuation criteria adopted by the agencies. This shows the procyclical character of ratings.

Key words

Bank ratings, subprime crisis effect, financial and environmental risk factors, ordered probit models.

Resumen

Este documento de trabajo se centra en el estudio del impacto de la crisis *subprime* sobre los *ratings* emitidos por las agencias de calificación en la valoración de la solvencia de las entidades bancarias. Tras constatar un significativo empeoramiento de los *ratings* tras la crisis, este documento se plantea como hipótesis la posibilidad de que este empeoramiento no es debido exclusivamente a un deterioro de la solvencia de los bancos, sino también a un cambio en el comportamiento de las agencias de calificación. El trabajo diseña una metodología que separa el cambio observado de los *ratings* en dos componentes multiplicativos: uno asociado al propio deterioro de la solvencia de las entidades bancarias y otro asociado al cambio en los criterios de valoración de las agencias. La metodología se aplica al análisis del sistema bancario español durante el periodo 2000-2009. Los resultados obtenidos muestran que la rebaja observada en los *ratings* (13%) no se justifica totalmente (65%) por el deterioro en la solvencia de las entidades bancarias, sino que además (35%) se debe al endurecimiento de los criterios de valoración adoptados por las agencias. Este resultado evidencia el carácter procíclico de los *ratings*.

Palabras clave

Ratings bancarios, efecto crisis *subprime,* factores de riesgo financiero y de entorno, modelos de respuesta múltiple con datos ordenados.

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1. Introduction

THE outbreak of the subprime crisis in the summer of 2007 and the continued falls in the ratings of structured products and sovereign bonds have reopened the debate on the quality of ratings and the role of Credit Rating Agencies (CRAs) in the financial markets. A debate which, as pointed out by Duff and Einig (2009), began as a result of the rating agencies' inability to value correctly the risks in the Asian financial crisis of 1997 and in the bankruptcy of Enron and Parmalat at the beginning of this century[1]. As the IMF's Global Financial Stability Report (2010) indicates, the rating agencies undertook a process of review of the ratings issued, as well as an updating of the rating criteria and models in response to the criticisms received. Specifically, as pointed out in Deprés (2011), after having relaxed their criteria in the year before the crisis, the rating agencies hardened them once more, thus causing a general fall of ratings. This fall aggravated the economic situation even more, since for many governments and firms facing economic difficulties it meant a significant hardening in conditions of access to the capital markets.

At the same time, since 2007, financial institutions, especially in Europe and in the United States, have suffered the effects of a financial crisis without precedent since the crash of'29. According to the Financial Stability Report of the European Central Bank (2008a, b), profitability has reduced, and problems of solvency and liquidity have risen. The fall in profits has made internal generation of capital more difficult, thus increasing dependence on external financing. There has also been an increase in the cost of financing and a loss of credit quality. In these circumstances, together with an increase of general uncertainty in banking activity, the solvency levels of banks have deteriorated, particularly in those with greater need for short-term liquidity, with excessive dependence on wholesale markets, with a below-average level of reserves, and/or heavy exposure to structured products.

The consequence of these processes has been a significant worsening of ratings. The adjustment has been so severe that doubts arise as to whether this is totally justified by the worsening of banks' solvency, or on the contrary there has also been a change in the rating policies of the agencies, which following the criticisms received are much more scrupulous and prudent

[1] For example, Enron in the days before its bankruptcy presented an investment-grade rating, which according to Moody's, Standard and Poor's and Fitch, reflected a good credit quality.

when issuing their ratings. It is consequently hypothesized that the adjustment in ratings is not justified in its entirety by the worsening of the solvency of the banks, but also in large part is due to the hardening of agencies' valuation criteria. In this context, the aim of this paper is to design a methodology that will permit this hypothesis to be tested, separating the adjustment observed in the ratings into two additive components: one asso-ciated with the deterioration of the banks' solvency and future perspectives, and another associated with the change in the agencies' valuation criteria.

To analyze this question we use as our laboratory the Spanish Banking System (SBS), during the period 2000-2009[2]. This period permits us to analyze the impact that the subprime crisis has had, both on the solvency of banks and on the behavior of the rating agencies. The SBS is an especially suitable market for analyzing this question because from the mid-1990s to the year 2007 it experienced very strong economic growth[3]. This growth was grounded on the concentration of activities in credit and especially on activities related to construction and property development. In 2007, credit for construction (construction, real estate and purchase of dwellings) represented 61.3% of total credit, nearly 20% more than in 1997. This strong growth in credit was accompanied by high levels of profitability (ROA above the European average), low levels of doubtful assets and unlimited access to international markets. Responding to this reality, the rating obtained by the banks was high. However, as shown by several Financial Stability Reports of the Bank of Spain (2009, 2010), with the outbreak of the subprime crisis, the assets of credit institutions deteriorated rapidly. Profitability, liquidity and coverage by provisions were drastically reduced. At the same time doubtful assets grew exponentially and greater capital resources were needed. As a consequence of this change in the banking climate, the ratings of commercial and savings banks deteriorated rapidly.

Among the different types of rating, in this study we use the banks' issuer ratings issued by the agencies Fitch, Standard and Poor's (S&P), and Moody's. This choice is fundamentally for three reasons. First, the ratings play an important role in the banking industry, because as affirmed by Morgan (2002), traditionally this sector has been described as un-transparent and with problems of asymmetrical information, due to the uncertainty associa-ted with the prin-

[2] The last year is 2009, because we have no more recent data from the database used.

[3] According to chapter 4 of the Bank of Spain's Statistical Bulletin (2011), between 1997 and 2007 the Spanish Banking Sector grew by 11.94% annually in terms of assets.

cipal assets constituting the balance sheets of the banks (loans and other financial assets)[4]. In this sense, ratings resolve part of the problem, allowing the banks to access the capital markets and the interbank markets on better terms, paying credit differentials more fitting to their credit risk profile. Second, the literature on identification of the determinants and prediction of banks' ratings is limited, most of it focusing on sovereign risk and on other industries. In this sense, the studies by Morgan (2002), Godlewski and Christophe (2007), Iannotta, Nocera and Sironi (2008), Peresetsky and Karminsky (2004), Bellotti, Matousek, and Stewart (2011), Caporale, Matousek and Stewart (2011) must be highlighted. Except Morgan (2002) and Iannotta, Nocera and Sironi (2008), the rest of the studies use exclusively the individual ratings from Fitch or Moody's. In this way, only the intrinsic financial situation of the banks is being measured, without taking into account the external support that these entities have from their proprietors and/or the economic authorities. This is important, because, as observed in the subprime crisis, the economic authorities came to the rescue of the banks with difficulties with the aim of preventing their failure (Packer and Tarashev 2011)[5]. Therefore, as indicated by the methodological reports of the rating agencies, Fitch (2003, 2009, 2010 and 2011), Moody's[6] (2007a, b), and Standard and Poor's (2010 and 2011), individual ratings measure neither the probability of failure nor the total credit quality of the banks, but are the first step in evaluating the credit quality of financial institutions. Consequently, this study uses issuer ratings since we aim to analyze the impact of the subprime crisis in the behavior of the bank rating, taking into account the support that they have from the authorities and from their proprietors. Furthermore these ratings are

[4] Morgan (2002) describes loans as opaque, illiquid and a source of uncertainty, because loans granted to retail customers are difficult to monitor. He also considers that negotiable assets present high uncertainty given the ease with which positions can change and the difficulty of monitoring them. According to this author, the dominance of these assets in the balance sheet, together with the banks' high degree of leverage, create uncertainty for investors and analysts. This explains the discrepancy existing among the rating agencies when issuing a rating of these firms.

[5] An example of these interventions was that performed in Spain on Caja Castilla la Mancha and Caja de Ahorros del Mediterráneo. In other countries the intervention of Royal Bank of Scotland, UBS, Goldman Sachs, Morgan Stanley and Bank of Ireland stand out. It should also be noted that some large institutions were compelled to merge with strong banks and to accept support from the authorities to prevent their failure. Among these entities are Caja Sur, Fortis, Merrill Lynch, Wachovia, Dresdner Bank and Bear Stearns.

[6] This report is considered because according to Moody's (2007a) in the introduction on how to construct a bank rating, the first thing taken into account is the rating that evaluates only the bank's intrinsic financial solidity (BFRS) and then, after its conversion to the "Baseline Credit Assessment" scale (BCA), the external support (JDA) that the banks receive from their owners and/or from the economic authorities is incorporated.

used because the objective is to carry out a homogeneous analysis of ratings among the three rating agencies considered (Fitch, Standard and Poor's, and Moody's)[7].

To test the starting hypothesis we design a two-stage methodology. In the first stage we estimate the determinants of the probability that a bank will be allotted a particular rating. On the basis of these determinants we test whether the importance assigned to each of these determinants explaining the agencies' rating policy has changed with the start of the financial crisis. From the results of this first stage, in a second stage the variation undergone by the banks' ratings is decomposed into two components: the part due to the change in the creditworthiness of the banks and the part deriving from the hardening of rating policies. To perform these analyses we use Fitch's issuer rating, and the out-of-sample robustness of the results is tested using the ratings of Moody's and Standard and Poor's. Furthermore, we use as robustness analysis the ratings of Fitch with lags, and the individual ratings of this agency and Moody's.

The results obtained show that with the subprime crisis there is an average fall in ratings of 12%. Of the total change in ratings, 65% is due to the worsening solvency of the banks, and 35% to the hardening of the rating policy of the CRAs (Credit Rating Agencies). This hardening of the rating criteria confirms the procyclical character of the rating agencies, amply demonstrated by other studies in the literature[8]. The results also show that size is an important factor for explaining the evolution of the rating. Specifically, the results indicate that medium sized banks have suffered a greater fall in their ratings. Furthermore the results reflect the fact that the legal form of the banks also influences the behavior of ratings. Thus the medium sized savings banks have been penalized to a greater extent by the rating agencies. This last result is explained by the business model followed by a number of the savings banks, based on traditional credit activity, and concentrated in activities relating to "bricks and mortar", which were heavily punished with the outbreak of the subprime crisis and the property bubble. Another factor is that the rating agencies consider that the savings banks are politicized and thus their corporate governance is more rigid and conservative.

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[7] Most of the banks evaluated by the rating agencies considered in this study (Fitch, Moody's and/or Standard and Poor's) use the issuer ratings in their annual reports to show their credit quality at corporate level.

[8] This procyclical behavior has been expounded by other authors such as Deprés (2011), Bangia, Diebold and Schuermann (2000), Catarineu-Rabell, Jackson and Tsomocos (2002), Amato and Furfine (2003) and Zicchino (2005).

The rest of the paper is structured as follows. The second section contains a brief review of the literature on ratings prediction models. The third section specifies the sample used and analyzes the principal descriptive statistics that allow the behavior of ratings to be analyzed. The fourth section presents the empirical models with which we model the probability of obtaining a given rating as a function of the determinants that define banks' credit quality. The fifth section sets out the empirical results. In the sixth section the observed evolution of ratings is decomposed into one component derived from the banks' financial and economic situation and another derived from the hardening of the rating agencies' criteria. The seventh section analyses the robustness of the results, and finally the eighth section sets out the conclusions.

2. A Review of the Literature on Ratings Prediction Models

THE literature on modeling and prediction of banking ratings is sparse. As remarked above, very few studies focus exclusively on the modeling and prediction of banking ratings. Morgan (2002) analyses the factors explaining the discrepancies among rating agencies when issuing the ratings of financial institutions given the opacity and the problems of asymmetric information presented by this type of entities. For this, this author uses a logit model with fixed effects and a probit model with ordered data, and concludes that the discrepancies are due to the uncertainty presented by the assets that principally form the banks' balance sheets (loans and other financial assets). Iannotta, Nocera and Sironi (2008) evaluate the influence of the ownership structure of banks in the EU on Standard and Poor's issuer ratings and on Fitch's individual and issuer ratings. Using an ordered logit model the authors find evidence that publicly owned banks receive a higher rating and therefore present a lower risk of insolvency than private banks. Peresetsky and Karminsky (2004) use an ordered logit model to identify the determinants of Moody's Foreign-currency long term deposit rating (DR) and Bank Financial Strength Ratings (BFSR). They find that Moody's does not consider only the banks' internal factors, but also takes into account external factors such as political risk[9]. Bellotti, Matousek and Stewart (2011) focus on the prediction and identification of the determinants of bank ratings through the

[9] It should be noted that in Peresetsky and Karminsky (2008) the accuracy of the predictions of BFRS is greater than in DR because not all the non-financial factors determining DR are considered.

use of an ordered logit model and of the technique known as Support Vector Machine (SVM). Caporale, Matousek and Stewart (2011) try to determine whether there are systematic differences in Fitch's individual ratings, between the banks of different countries of the European Union. Using ordered probit and logit models they identify the determinants of bank ratings and find that significant differences exist among the banks of different countries. This result together with that obtained by Peresetsky and Karminsky (2004) shows the influence of external factors (the legal framework, the support of authorities and/or owners, etc.) over the banks' ratings. This shows the need to work with issuer ratings when measuring the credit quality of an entity and how individual ratings must be used as a complement to these. Finally, Packer and Tarashev (2011) analyze the behavior of the three main rating agencies (Standard and Poor's, Moody's and Fitch) in the evaluation of banks. They find evidence that with the outbreak of the subprime crisis, the ratings falls and the differences between agencies decreased. These authors also highlight the importance of considering the external support that the banks received from the economic authorities.

Most of the existing studies in the literature on identification of the determinants and prediction of ratings have focused on the rating of sovereign risk. Consequently it is in this field where the precision of the different econometric techniques used has been developed and debated in greatest detail. As a starting point we take the study by Cantor and Packer (1996) which attempts to identify the determinants of sovereign ratings using a linear regression model (OLS) within a cross-sectional context. This same line has been followed by other authors. Specifically, Alexe et al. (2003) apply a non-recursive multiple regression model, Butler and Fauver (2006) use a two-stage ordinary least square model (2SLS) and Ratha et al. (2010) use a simple linear regression model. The main limitation presented by earlier studies is that they do not take individual effects into account, so the results may be biased. For this reason, other studies use panel data models which take into account these individual effects. Among these studies we would highlight Monfort and Mulder (2000), Eliasson (2002), Borio and Packer (2004) and finally Canuto et al (2004).

The disadvantage of the above techniques is that they are based on a linear representation of ratings, thus ignoring the fact that ratings are ordinal measures, are not continuous in their distribution, and the distances between the different categories are not identical. It must be emphasized that though this distance may be identical, biased results may occur when there are ratings at the extremes of the rating scale. To overcome this problem Maltzan (1999) uses

a logistic transformation, while Afonso (2003) also applies an exponential transformation of ratings. This problem can also be overcome by using a probit model with ordered data, as done by Trevino and Thomas (2001), Hu et al (2002), Bissoondoyal-Bheenick et al (2005), Afonso et al (2009), Hill et al (2010) and Al-Sakka and Gwilym (2009, 2010).

Another field on which the literature on identification of the determinants and prediction of ratings has focused has been the rating of the bond issues of different industries. In this field, as in the valuation of sovereign risk, special emphasis has been placed on comparing the accuracy of the different econometric techniques when predicting ratings. In this sense it should be mentioned that the techniques traditionally used, as indicated by Altman and Saunders (1998) have been multivariate discriminant analysis, the logit model and the probit model. Kamstra et al (2001), on the other hand, suggest the combination of different methods for predicting bond ratings. These methods are the combination of OLS models, Multinomial Discriminant Analysis (MDA) models with equal proportional probabilities, and ordered models (logit and probit). Specifically, this author uses his own model: Kamstra and Kennedy (1998), which is a combination of an MDA model and an ordered Probit mo-del. The results obtained in their study show that this model and a modification of it improve the accuracy of predictions over the standard models. Kim (2005) uses a non-parametric artificial intelligence technique to model the dynamic relationship among the variables that define the determinants of the ratings for bonds. With this technique this author identifies the determinants of the ratings for bonds, and also performs prediction exercises with high precision. Other authors, Zan et al. (2004) and Lee (2007) have recently used the Support Vector Machine (SVM) technique, reaching the conclusion that this non-parametric technique does not enable better predictions than the ordered models (logit and probit).

In this field studying the bond ratings of different industries, the studies by Altman and Rijken (2004 and 2006) stands out. These authors try to value the importance of the "through-the-cycle" policy, based on the prediction of the probability of failure in the long term and the prudent ratings migration policy as against the "point in time" rating policy focused on predicting the probability of failure in the short term. For this, by means of a logit model, they estimate the probability of default in the short and long term. Furthermore, using a logit model with ordered data that permits prediction of the rating, these authors demonstrate that the rating agencies focus on the prudent "through-the-cycle" rating policy, modifying only the rating when a permanent change occurs in the credit quality of the issuer.

Finally, one group of studies focuses on analyzing the behavior of ratings, and predicting them, using the so-called transition matrices. Outstanding in this sense are the study by Jafry and Schuermann (2004), which sets out the different methodologies for the implementation of this technique, and the study by Nickell, Perraudin and Varotto (2000) which demonstrates the importance of considering the economic cycle when analyzing the probabilities of transition of the ratings and defines a system for defining the different states of the economic cycle. Other studies that analyze the influence of the economic cycle on the beha-vior of the ratings are Bangia, Diebold and Schuermann (2000), Catarineu-Rabell, Jackson and Tsomocos (2002), Amato and Furfine (2003); Zicchino (2005) and Deprés (2011). The result that they obtain is that the agencies present a procyclic character, characterized by a relaxation of the rating criteria during times of economic expansion and by a hardening of the criteria at times of economic recession. Deprés (2011) stands out among these studies for its relationship with our study, as it incorporates in its sample (1981-2009) the negative effect of the subprime crisis on the behavior of the ratings.

3. Sample

THE sample contains 2379 observations of quarterly ratings[10] from the first quarter of 2000 to the fourth quarter of 2009 and includes 1681 quarterly accounting observations of 44 credit institutions[11], which represent 90.33% of the total assets of the SBS in 2009. This period of time allows us to analyze the behavior of the ratings before and after the subprime crisis[12]

[10] The type of rating used is that called "issuer rating". This reflects the credit quality of the issuers evaluated by Fitch, Standard and Poor's or Moody's, taking into account the external support that they may receive in event of difficulties (situation of failure) with the aim of preventing default on their obligations.

[11] Outliers detected have been excluded from the sample. The initial number of quarterly accounting observations was 1912.

[12] The period before the subprime crisis is established as the first quarter of 2000 to the fourth quarter of 2007. The period after the subprime crisis includes from the first quarter of 2008 to the fourth quarter of 2009. The return on assets of the Spanish banks presents an increasing profile precisely until December 2007 and from then onwards the trend is inverted.

in the three principal CRAs in the world[13] (Fitch, Standard and Poor's and Moody's). The ratings were obtained from the databases CreditViews of Reuters and Bankscope of Bureau van Dijk. The accounting information relating to the statistical yearbook was obtained from the Spanish Banking Association (AEB) and the Spanish Confederation of Savings Banks (CECA).

The categorical scale of ratings has been transformed into a numerical scale, formed by 6 categories, as specified in annex 1. The numerical scale associates higher values as credit quality improves[14].

Table 1 shows the principal descriptive statistics and shows that Fitch is the most important CRA in the SBS, issuing 63.01 % of the ratings. This high market share is due to the fact that Fitch was the first agency to set up in Spain, thus accumulating greater experience in the valuation of banks, which is valued positively by those that ask to be evaluated. Standard and Poor's and Moody's, on the other hand, present very low market shares. For these two agencies we have a relatively small number of observations, especially when analyzing the post-crisis period. For this reason, the results presented will be for Fitch, using the results for Standard and Poor's and Moody's as measures of out-of-sample robustness.

From table 1 we also deduce that throughout the period analyzed, 2000-2009, the a-verage rating of the banks is A/A2 (on the numerical scale defined, 4.09 in Fitch, 4.88 in Moody's and 4.93 in Standard and Poor's). This result reflects the opinion of the three CRAs on the financial strength of the commercial banks and savings banks of the SBS.

If we focus on analyzing the effect of the subprime crisis on the distribution of the ratings, in figure 1 we observe an adjustment in the ratings issued by the three agencies, as the number of observations of the lower rating categories increases. This same effect is observed also in table 1 from the reduction of the mean rating that occurs in each of the three CRAs analyzed.

[13] According to Dittrich (2007) in 2005, Moody's and standard and Poor's represents the 77% of the market share, and Fitch the market share of 15%.

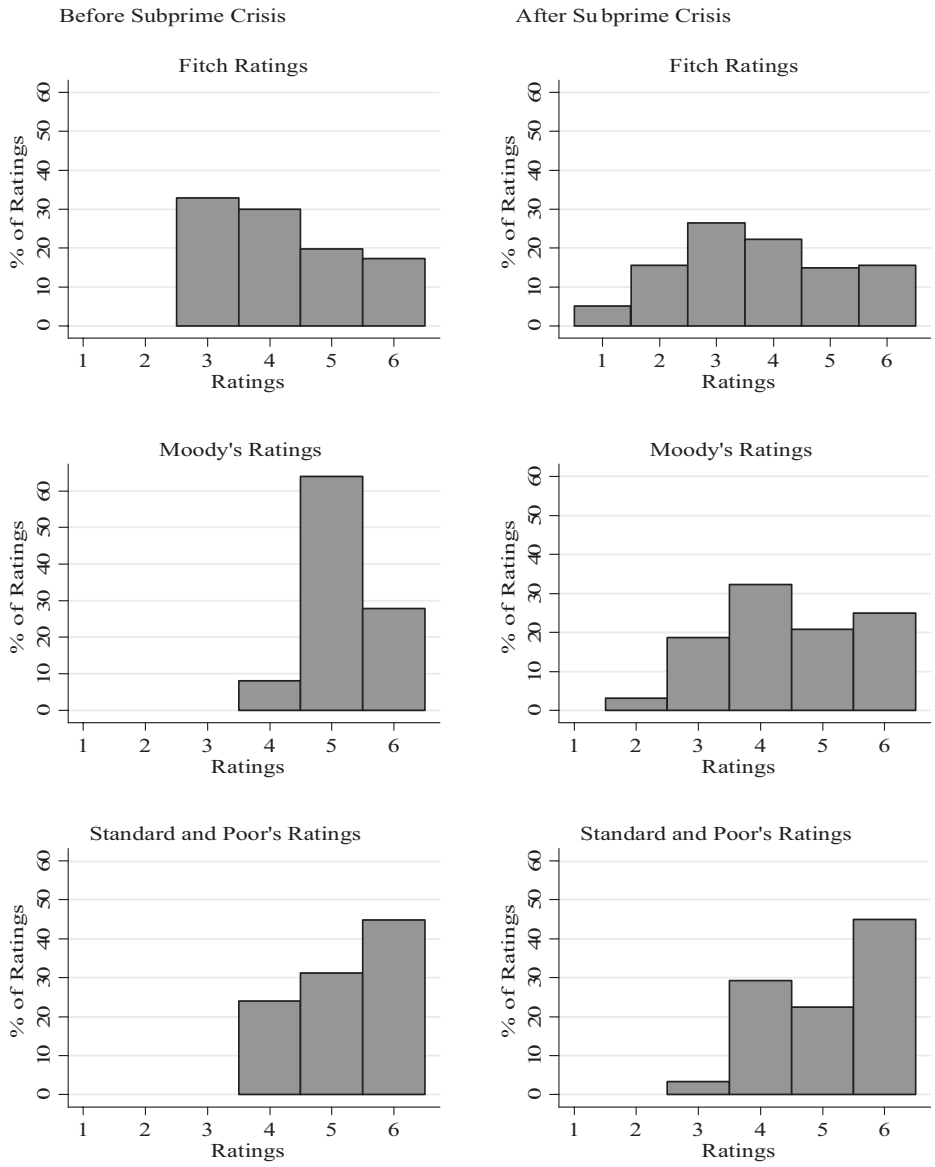
[14] The categories with an insufficient number of observations are grouped. Ratings below BB+/Ba1 are excluded from the representation since there is no entity with a lower rating.

TABLE 1: **Descriptive statistics of the sample**

Numerical scale	Rating	2000-2009				2006-2007				2008-2009			
		Fitch	S&P	Moody's	Total	Fitch	S&P	Moody's	Total	Fitch	S&P	Moody's	Total
6	AAA- AA+/Aaa- Aa1	-	-	6.47%	1.13%	-	-	10.47%	1.78%	-	-	18.75%	3.61%
6	AA/Aa2	5.47%	14.47%	12.23%	8.41%	6.81%	16.67%	11.63%	9.50%	6.69%	30.34%	6.25%	10.82%
6	AA-/Aa3	10.54%	16.41%	5.76%	10.84%	10.53%	28.13%	5.81%	13.07%	8.92%	14.61%	-	8.22%
5	A+/A1	18.55%	35.21%	44.60%	26.36%	19.81%	31.25%	63.95%	29.50%	14.97%	22.47%	20.83%	17.43%
4	A/A2	29.95%	30.02%	25.90%	29.26%	30.03%	23.96%	8.14%	25.15%	22.29%	29.21%	32.29%	25.45%
3	A-/A3	30.62%	3.89%	4.32%	20.81%	32.82%	-	-	20.99%	26.43%	3.37%	18.75%	20.84%
2	BBB+/Baa1	3.80%	-	0.72%	2.52%	-	-	-	-	15.61%	-	3.13%	10.42%
1	BBB/Baa2	0.60%	-	-	0.38%	-	-	-	-	2.87%	-	-	1.80%
1	BBB-/Baa3	-	-	-	-	-	-	-	-	-	-	-	0.00%
1	BB+/Ba1 and lower	0.47%	-	-	0.29%	-	-	-	-	2.23%	-	-	1.40%
	Obs. (Ratings issued)	1,499	463	417	2,379	323	96	86	505	314	89	96	499
	Mean rating	4.09	4.93	4.88	4.39	4.22	5.21	5.20	4.57	3.73	5.09	4.46	4.11
	Sd	55.75	10.66	10.63	22.60	35.26	4.27	5.64	10.10	27.68	3.97	3.85	8.72
	Rated firms	42	13	12	47	42	12	12	46	39	13	12	44
	Market share	63.01%	19.46%	17.53%	100%	63.96%	19.01%	17.03%	100%	62.93%	17.84%	19.24%	100%

Note: This table shows for the period 2000-2009, and for the pre-crisis period (in this case defined as the period 2006-2007) and post-subprime crisis: the percentage distribution of the ratings, the mean rating, the number of ratings, the market share, and the number of firms rated, for each of the CRAs and for all of them together. The mean rating was calculated from the numerical scale defined from 1 to 6, so that the higher the score the better the credit quality on average.

FIGURE 1: **Distribution of ratings between the pre- and post-subprime crisis periods**



Note: Distribution of the ratings issued by each of the rating agencies for the commercial banks and savings banks of the SBS. This distribution differentiates between the period before the subprime crisis (in this case defined as the period 2006-2007) and the period after it.

To observe with greater precision the adjustment in the ratings, table 2 shows the matrices of transition for the total period (a), pre-crisis period (b) and post-crisis period (c). The comparison between matrices (b) and (c) shows that after the subprime crisis the ratings become less stable, as the probabilities that appear on the main diagonal are lower. We also observe a downward adjustment, with an increased probability of being located in the lower rating categories, i.e. below the main diagonal. This downward adjustment is also observed in the matrices that refer to the pre- vs. post-subprime crisis period (d).

TABLE 2: Transition matrices

Fitch

2000-2009 (a)

t-1 \ t	1	2	3	4	5	6	EX
1	1	-	-	-	-	-	-
2	0.109	0.848	0.022	-	-	-	0
3	-	0.031	0.954	0.015	-	-	-
4	-	0.007	0.023	0.964	0.005	-	0.002
5	-	-	-	0.011	0.982	0.007	-
6	-	-	-	-	0.009	0.987	0.004
EN	-	-	-	-	0.005	-	-

2000-2007 (b)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	0.875	0.125	-	-	-	-
3	-	-	0.981	0.019	-	-	-
4	-	-	0.008	0.986	0.005	-	-
5	-	-	-	-	0.991	0.009	-
6	-	-	-	-	0.005	0.995	-
EN	-	-	-	-	0.006	-	-

2008-2009 (c)

t-1 \ t	1	2	3	4	5	6	EX
1	1	-	-	-	-	-	-
2	0.132	0.842	-	-	-	-	0.026
3	-	0.156	0.844	-	-	-	-
4	-	0.038	0.090	0.859	-	-	0.013
5	-	-	-	0.061	0.939	-	-
6	-	-	-	-	0.020	0.961	0.020
EN	-	-	-	-	-	-	-

Before subprime vs after subprime (d)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	0.067	0.200	0.600	0.067	-	-	0.067
4	-	0.154	0.231	0.462	0.077	-	0.077
5	-	-	0.286	0.143	0.571	-	-
6	-	-	-	-	-	1	-
EN	-	-	-	-	-	-	-

Moody's

2000-2009 (a)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	1	-	-	-	-	-
3	-	0.083	0.917	-	-	-	-
4	-	-	0.065	0.916	0.019	-	-
5	-	-	-	0.032	0.957	0.005	0.005
6	-	-	-	-	0.010	0.990	-
EN	-	-	-	0.001	0.004	0.002	-

2000-2007 (b)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	0.973	0.027	-	-
5	-	-	-	0.006	0.981	0.006	0.006
6	-	-	-	-	0.013	0.987	-
EN	-	-	-	0.002	0.005	0.003	-

2008-2009 (c)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	1	-	-	-	-	-
3	-	0.083	0.917	-	-	-	-
4	-	-	0.212	0.788	-	-	-
5	-	-	-	0.200	0.800	-	-
6	-	-	-	-	-	1	-
EN	-	-	-	-	-	-	-

Before subprime vs after subprime (d)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	0.250	0.750	-	-	-
5	-	-	-	0.600	0.400	-	-
6	-	-	-	-	-	1	-
EN	-	-	-	-	-	-	-

Standard and Poor's

2000-2009 (a)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	0.778	0.056	-	-	0.167
4	-	-	0.022	0.948	0.030	-	-
5	-	-	-	0.056	0.920	0.025	-
6	-	-	-	-	0.022	0.978	-
EN	-	-	-	-	0.002	-	-

2000-2007 (b)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	0.933	0.067	-	-	-
4	-	-	-	0.964	0.036	-	-
5	-	-	-	0.022	0.949	0.029	-
6	-	-	-	-	0.010	0.990	-
EN	-	-	-	-	0.002	-	-

2008-2009 (c)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	1
4	-	-	0.130	0.870	-	-	-
5	-	-	-	0.250	0.750	-	-
6	-	-	-	-	0.048	0.952	-
EN	-	-	-	-	-	-	-

Before subprime vs after subprime (d)

t-1 \ t	1	2	3	4	5	6	EX
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	0.750	0.250	-	-
5	-	-	-	0.167	0.333	0.500	-
6	-	-	-	-	0.667	0.333	-
EN	-	-	-	-	-	-	-

Note: Transition matrices are shown for each of the rating agencies considered (Fitch, Moody's and Standard and Poor's). (a) Transition matrix for the period between January 2000 and December 2009. (b) The transition matrix for the period defined as a pre-subprime crisis. (c) The transition matrix for the period defined as post- subprime crisis. (d) Transition matrix between the mean rating of the pre- and post-subprime crisis periods. These matrices have been calculated as the total number of transitions between quarters t-1 and t of the sample defined in each matrix. The ratings are ordered from lower to higher credit quality. EN and EX refer respectively to a rating's entry into, and exit from, the sample.

To sum up, the results show that with the outbreak of the subprime crisis there is a downward adjustment in the ratings, the magnitude and intensity of which depends on the CRA analyzed. In the following sections the explanatory factors of the ratings are defined, an econometric model is estimated and different prediction exercises are performed with the aim of determining the contributions of the change in behavior and the worsening of solvency to the adjustment in the ratings.

4. Methodology

ACCORDING to the methodological reports of Fitch (2003, 2009, 2010, 2011), Moody's (2007a, b) and Standard and Poor's (2010 and 2011), the rating agencies carry out the valuation of the banks' credit quality taking into account quantitative/objective and qualitative/subjective factors. Leaving aside the qualitative determinants, arising from meetings between the analysts of the rating agencies and the managers of the banks, we focus on the quantitative determinants.

The quantitative determinants refer to both internal and external objective factors that affect the solvency of the banks assessed. Among the internal factors we consider aspects as varied as profitability, equity, liquidity, sources of financing, the credit risk assumed both on- and off- balance sheet, market power, the diversification of the banking business, the quality of the corporate governance and the level of efficiency. Among the external factors, on the other hand, we consider basically the economic and regulatory environments and the market in which the bank operates.

As commented above, the aim of this study is to analyze the behavior of the CRAs and to develop a methodology to allow our starting hypothesis to be tested, i.e. whether as a result of the subprime crisis and the criticisms received for the rating policy for structured products, the CRAs have changed their criteria for evaluating banks. For this it is necessary first to model the process of assignation of ratings, and second to design a test that will allow us to infer whether there has been a change in the behavior of the rating agencies.

To model the behavior of ratings we use an ordered probit with random effects[15]. This specification seems to be the most suitable according to Trevino and Thomas (2001), Bennell

[15] All the models are estimated in STATA by means of the REOPROB procedure created by Frechette G. (2001 a,b).

et al. (2006), Afonso et al. (2009) and Al-Sakka and Gwilym (2010). When specifying the data panel model we consider the existence of idiosyncrasies characteristic of each commercial bank and savings bank. The ordered probit models estimate the probability of obtaining a given rating as a function of the variables with which the decision to grant a ra-ting is modeled. Two models are defined. The first specifies the rating defined according to the characteristics of the banks and of the environment in which they operate. The second uses a model that permits us to test whether there is a structural change in the agencies' ra-ting policy in response to the financial crisis.

The first model, which estimates the decision by the rating agencies to grant a rating to a bank, depends on a latent variable Y_{it}^{*} which is a linear function of a set of explanatory variables according to the following equation:

$$Y_{it}^{*} = \beta' x_i + u_{it} + \varepsilon_i \tag{1}$$

where X, are the k explanatory variables for bank i at the moment t. uit is the random error which is distributed according to a normal distribution, εi refers to the individual effect of each bank.

On the basis of the latent variable Y_{it}^{*}, the agencies grant a certain rating if a certain threshold is exceeded:

$$\begin{aligned}
&Y_{it} = 1 \ \text{ if } \ Y_{it}^{*} < \lambda_1 \\
&Y_{it} = 2 \ \text{ if } \ \lambda_1 \le Y_{it}^{*} < \lambda_2 \\
&Y_{it} = 3 \ \text{ if } \ \lambda_2 \le Y_{it}^{*} < \lambda_3 \\
&Y_{it} = 4 \ \text{ if } \ \lambda_3 \le Y_{it}^{*} < \lambda_4 \\
&Y_{it} = 5 \ \text{ if } \ \lambda_4 \le Y_{it}^{*} < \lambda_5 \\
&Y_{it} = 6 \ \text{ si } \ Y_{it}^{*} \ge \lambda_5
\end{aligned} \tag{2}$$

where the parameters $\lambda_1,.....,\lambda_5$, are also estimated jointly with the model and are subject to the restriction that $\lambda_1<\lambda_2<\lambda_3<\lambda_4<\lambda_5$.

From these equations we estimate the following ordered probit model, where the probability of selecting each of the alternatives is modeled:

$$\begin{aligned}
&P(Y_{it} = 1) = \Phi(\lambda_1 - x_i'\beta) \\
&P(Y_{it} = 2) = \Phi(\lambda_2 - x_i'\beta) - \Phi(\lambda_1 - x_i'\beta) \\
&..... \\
&P(Y_{it} = 6) = 1 - \Phi(\lambda_5 - x_i'\beta)
\end{aligned} \tag{3}$$

In all the estimations temporal effects are also introduced with the objective of capturing factors specific to all the banks and specific to each of the years and quarters analyzed.

Once this model has been estimated we test for the existence of structural change in all the parameters estimated. That is, we test whether the importance of each of the explanatory variables is different before and after the outbreak of the subprime crisis. For this, we introduce a dummy variable (SB) which takes the value of one for the quarters after the start of the crisis (December 2007). This variable interacts with all the explanatory variables. The effect of interaction indicates whether subsequent to the crisis each explanatory variable has a different importance:

$$Y_{it}^{*} = \beta' x_i + SB \cdot \beta' x_i + u_{it} + \varepsilon_i \qquad (4)$$

Following the methodological reports of Fitch (2003, 2009, 2010 and 2011), Moody's (2007a, b), and Standard and Poor's (2010 and 2011), the vector of explanatory variables is made up of variables that measure profitability, liquidity, efficiency, capital, size, credit risk management, diversification of banking business, market power, the economic environment and the quality of the corporate governance. Consequently we do not consider only the quantitative factors relating to the individual financial strength of each bank, but also other factors of a structural and environmental character that affect the credit quality of credit institutions as a whole, and capture the external support that they receive from economic authorities and/or proprietors. In this sense it has to be said that most of the studies carried out hitherto on modeling and prediction of bank ratings have concentrated only on the financial ratios relating to individual financial solidity, without controlling for other environmental factors that might significantly affect the banks' solvency and future outlook, which may constitute a bias in the results obtained.

Of the quantitative/objective factors that, according to the methodological reports, the agencies usually consider, the profitability stands out as it is a key factor in evaluating a bank's credit quality as it generates resources that protect from the risks inherent to the acti-vity that it performs. To capture the current profitability as done by Altman and Rijken (2004, 2006) we use the average return per asset (ROA) based on the quotient between pre-tax profits and total assets. As said before, all the accounting information comes from AEB and CECA.

The level of a capital is the fundamental characteristic for analyzing its solvency le-vel, as it acts as a measure of absorption of losses in the event of running into difficulties. This factor is measured as the quotient between equity and total assets (Capital).

Liquidity is a fundamental aspect in the valuation of credit quality, because it reflects the bank's capacity to face its commitments in the short term. The higher the liquidity the less exposure to the risks derived from intermediation in investment in long term assets and short term deposits. The variable *liquidity* is defined as the sum of cash, deposits in central banks and deposits with other credit institutions, all divided by total assets. This is not enough to measure a bank's liquidity level; it is also necessary to evaluate the different sources of financing available to it. A bank whose principal source of finance is the wholesale market is more susceptible to problems of liquidity than one specialized in retail banking, which obtains a higher percentage of finance through deposits. We therefore also use the ratio between deposits and total assets as an indicator of the specialization of retail banking (Deposits).

Another aspect fundamental to evaluating a bank's future solvency problems is its exposure to credit risk, which is measured by the percentage that loans represent in the ba-lance sheet (Loans). This factor also allows us to determine the specialization adopted by the bank being assessed. Retail banking has traditionally focused on granting credits, this type of assets being the most important in the balance sheet. As well as the importance of credits in the balance sheet another variable is introduced to measure the quality of them. Given the fact that we do not have information of doubtful assets, we use the percentage of provisions over total assets (Provisions). This ratio is a proxy of the ratio of doubtful assets to total loans[16].

In addition to the quantity and quality of loans, another important characteristic for measuring the credit risk is the degree of geographical diversification of the bank's activity. Excessive concentration of a bank's activity in a particular region increases its risk profile, as it will be subject to a greater extent to the shocks of the region where it operates. That is to say that the geographical concentration of a bank implies that the different economic cycles to which the region in which it concentrates its activity is subjected will affect the bank more. This factor is measured by means of the Herfindahl-Hirschman index (HHI) of the provincial distribution of the branch network of each bank. This information also comes from the AEB and CECA.

[16] Pastor (2000), uses the provisions as proxy for doubtful assets, on the assumption that the greater the volume of doubtful credits the greater will be the provisions.

The high competition normally faced by credit institutions, the standardization of banking products and the reduction of banking margins, make it increasingly important to control and reduce costs, and hence increase efficiency. To measure the cost efficiency of each bank in each period (Efficiency) we use the non-parametric technique DEA[17]. The application of this technique permits us to measure efficiency by comparing the distance between the frontier of cost efficiency generated by the banks that produce the same banking output with the lowest possible costs, and the cost of the rest of the banks. This technique, as pointed out by Pastor (2000), allows us to isolate the effects of size, specialization and risk. This implies that it is a less biased measure of efficiency than other indicators such as the ratio cost to income ratio.

Market power is also included. This factor reflects the bank capacity to set prices over marginal costs. The greater the market power, the greater the bank's capacity to gene-rate income and thus maintain or improve its protection against the different risks that it fa-ces. Market power is measured by the Lerner Index (Fernández de Guevara and Maudos 2009, 2010) [18], which measures a bank's capacity to set a price above its marginal cost (Market Power). This index is calculated on the basis of average output prices obtained from the profit and loss accounts and marginal costs estimated from a translog total cost function for all banks operating in Spain in the period 2000-2009. We follow the same specification as in Fernández de Guevara and Maudos (2009). Data used comes from AEB and CECA.

We also include the variable *size* to test the "too-big-to-fail" hypothesis which establishes a negative relationship between the size of the banks and the probability of failure (Altman and Rijken, 2004 and 2006). This relationship is explained by the large size of the banks and the possible systemic effects that their failure might have. The authorities will always come to the rescue of the banks of largest size, due to the contagion effect that their failure might have on the rest of the financial system and the rest of the economy.

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[17] To calculate the index of efficiency we used as outputs: total credits, total deposits, other earning assets, and commissions received. As inputs we used: cost of lendable funds, cost of labour and the price of capital.

[18] In the calculation of the marginal cost on the basis of the translog function we used as inputs: the price of labour (wages/number of workers), the price of capital (other operating costs/fixed assets) and the price of deposits (financial costs/deposits). We also include a trend to capture the technical progress, which is reflected with movements of the cost function over time. As output we used total assets and as costs, total costs, operating costs and financial costs.

Another factor to be considered is the economic environment in which a bank ope-rates. A recessive economic cycle will inevitably have negative consequences for the credit quality of a bank, because it will mean a deterioration of the quality of its assets and of its profits. To capture the economic cycle we use the unemployment rate by provinces (Unemployment), weighting for each bank according to the provincial distribution of branches. The unemployment rate is taken from the Spanish Statistical National Institute (INE).

Finally, we introduce a dummy variable bank that captures multiple characteristics related to the legal form. There is some evidence about the idea that saving banks have less quality in their management due to excessive dependence on regional government. Another characteristic is that the savings banks are riskier due to their specialization grant credits in activities related to construction, real estate and mortgages. Furthermore, these latter institutions may have more difficulties in raising capital due to their legal status. This variable takes the value of one if the entity is a commercial bank and zero if it is a saving bank.

Table 3 shows the average of each factor that determines the creditworthiness of the entities evaluated by at least a rating agency. We can observe that with the subprime crisis there is a worsening of the creditworthiness of banks. This result is due to the worsening on average of the liquidity, profitability, market power and deposits. On the contrary, there is an increase of the level of provisions, the negative effect of the economic cycle (Unemployment). Despite these negative effects, banks have experienced an improvement in the size, level of efficiency, exposure to credit risk capture by total loans between total assets and the geographical concentration of the business activity (HHI).

TABLE 3: **Average values of the variables that define banks' creditworthiness**

Variable	2000-2009	2006-2007	2008-2009
Equity	0.063	0.057	0.057
Liquidity	0.110	0.097	0.071
ROA	0.006	0.006	0.004
Size	16.593	16.869	17.073
Provisions	0.003	0.002	0.005
Loans	0.684	0.734	0.720
Efficiency	0.759	0.774	0.819
Unemployment	10.926	8.276	14.043
Market Power	0.424	0.433	0.408
Deposits	0.893	0.902	0.888
HHI	0.365	0.337	0.316

Note: This table shows the mean of the factors that define the creditworthiness of the entities evaluated by at least a rating agency, for the period 2000-2009, pre-crisis period (in this case defined as the period 2006-2007) and post-subprime crisis.

5. Empirical Results

IN this section we present the results of the two empirical models (1) and (2), which estimate the probability of obtaining a certain rating, as a function of the internal and external factors affecting the solvency of the banks. The results are presented for Fitch, using the results for Moody's and Standard and Poor's as measures of out-of-sample robustness in the following section.

Model (1) of table 4 captures the estimations of the model that does not take into account the possible structural change originating from the outbreak of the subprime crisis for Fitch. In this table we observe that both the internal and external factors affecting the solvency of credit institutions are significant, and in general the coefficients estimated have the expected sign. Specifically, we observe a positive effect of capital, liquidity, size, loans, market power, deposits and/or efficiency on the probability of being located in the highest rating category. This result is because an increase in these factors implies an improvement in the creditworthiness and/or lower risk. On the other hand, from the same model (1) of table 4 we deduce the negative influence of the provisions, HHI index and/or unemployment, on the probability of obtaining the maximum credit score. The negative influence of these variables is explained by the fact that an increase in these factors implies a bad management of credit risk and/or worsening of the economic environment. ROA presents a negative coefficient although it is not significant.

Among the above results the positive sign of the weight of loans in the balance-sheet must be emphasized. This can be interpreted not only as an increase of risk, but also as a measure of specialization in traditional banking. Taking into account that until 2007 the growth of the SBS relied on loans, it is no surprise that this factor has a positive effect on the probability of obtaining a higher rating. Another result to be highlighted in model (1) of table 4, is the positive and significant coefficient of the size effect. This allows us to accept, as do Altman and Rijken (2004 and 2006), the "too-big-to-fail" hypothesis establishing a negative relationship between the size and the probability of failure of a bank.

Table 4 also presents a model that considers the possible structural change origina-ting after the outbreak of the subprime crisis. The objective pursued with model (2) is to determine whether a change occurs in the behavior of the rating agencies. To determine if there is a change in the influence of each factor after the subprime crisis, model (2) adds the interaction of each factor with the dummy variable SB. Hence, the influence of each variable on the rating during the period before the burst of the crisis is measured by its coefficient (without the interaction).

But to calculate the effect of the variable on the rating after the crisis both the coefficient with and without the interaction with the SB dummy have to be considered.

TABLE 4: **Ordered probit model with random effects. Eq(1) − (2). Fitch, 2000-2009**

	Model (1)		Model (2)	
Capital	42.219	***	34.203	***
Liquidity	3.126	***	5.388	***
ROA	-25.45		-29.841	
Size	1.884	***	2.473	***
Provisions	-164.672	***	-146.309	***
Loans	1.509	***	2.734	***
Efficiency	2.735	***	3.338	***
Unemployment	-0.127	***	-0.071	***
Market power	3.655	***	1.957	
Deposits	11.453	***	-1.183	
HHI	-1.44	***	-2.59	***
Bank	1.273	***	1.716	***
SB			-22.293	***
SB*Capital			71.629	***
SB*Liquidity			-4.022	
SB*ROA			57.873	*
SB*Size			0.972	***
SB*Provisions			57.343	
SB*Loans			-6.464	***
SB*Efficiency			-7.352	***
SB*Unemployment			-0.103	***
SB*Market power			-6.32	***
SB*Deposits			15.5	***
SB*HHI			3.026	***
SB*Bank			2.87	***
Term2	0.192		0.136	
Term3	0.35	**	0.187	
Term4	0.755	***	0.516	**
Time	-0.07	***	-0.082	***
cut1	39.237	***	36.904	***
cut2	41.021	***	39.06	***
cut3	44.021	***	42.561	***
cut4	46.875	***	45.993	***
cut5	51.22	***	50.788	***
Rho	0.666	***	0.679	***
No. of observations	1,499		1,499	
LR chi2	592.792		758.546	
Log Lik	-777.678		-661.482	
RV-Test			232.392	
P-value			0.00	

*** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Note: Results of the estimation of the ordered probit model with random effects (Eq.1 − Eq.2) for the rating agency Fitch, from the first quarter of 2000 to the fourth quarter of 2009. Model (1) does not consider the possible structural change arising from the subprime crisis. Model (2) considers the possible structural change arising since the outbreak of the subprime crisis. Rho shows the importance of the unobservable effect in the random effects model. RV likelihood ratio test between the model (1) (the restricted model) and model (2) (the general model), i.e., H_0: $\beta_{sb}\beta_k = 0$.

To confirm the effect of the subprime crisis and consequently the change in the influence of the determinants of the ratings, we perform a likelihood ratio test between model (1) (the restricted model) and model (2) (the general model). The likelihood test in table 4 allows us to reject of the null hypothesis of joint non-significance of the variable SB and the cross effects between this dummy variable and the rest of the explanatory variables. It is therefore confirmed that after the subprime crisis rating agencies changed their criteria[19].

From model (2) we observe that with the financial crisis there is an increase in the positive effect of profitability, capital, size, deposits and of the quality of the management on the probability of entering the higher rating category. On the other hand, there is an increase of the negative effect of unemployment and/or loans on the probability of obtaining a higher rating. The significance of the unemployment rate points to the idea that the rating agencies behave procyclically rather than through the cycle, as they claim, because ratings seem to respond to the cyclical evolution of economic activity, as other authors have already stressed (Bangia, Diebold and Schuermann 2000; and Deprés 2011).

This is explained by the strong correlation between the rate of doubtful assets and the economic cycle. The result obtained also show that the agencies penalize those banks that do not diversify their banking activity, concentrating the greater part of their balance sheet on credit activity.

In order to analyze the effect of each variable on each of the rating categories before (SB = 0) and after (SB = 1) the subprime crisis we calculate the elasticities of the change in the probability of obtaining a rating when each determinant change. To calculate these elasticities both the coefficients of column (2) and the average value of each determinant for each rating group are used. According to these elasticities (table 5), we can clearly differentiate a change in the behavior of the Fitch rating agency, due to the change in the elasticities. In general they are higher (in absolute value) when the effects of the crisis are considered.

[19] Salvador, Pastor and Fernández de Guevara (2011) also find evidence of a structural change with the outbreak of subprime crisis, in SBS, by means of logit ordered model with fixed effects.

6. Prediction

THE estimation of the empirical model with structural change (2) makes it possible to carry out prediction exercises to confirm that the changes in ratings respond both to the worsening of the solvency level of the banks and to the hardening of the CRAs' rating policies.

TABLE 5: **Elasticities Eq(2). Fitch**

a) Before the crisis

	Significative	1	2	3	4	5	6
Capital	***	-16.4741	-11.9073	-4.7980	-0.0782	4.4042	14.1965
Liquidity	***	-4.8663	-3.5173	-1.4173	-0.0231	1.3009	4.1935
ROA		1.4454	1.0447	0.4210	0.0069	-0.3864	-1.2456
Size	***	-18.8126	-13.5975	-5.4790	-0.0893	5.0293	16.2116
Provisions	***	2.2735	1.6433	0.6621	0.0108	-0.6078	-1.9592
Loans	***	-14.0491	-10.1545	-4.0917	-0.0667	3.7559	12.1066
Efficiency	***	-18.8307	-13.6106	-5.4843	-0.0894	5.0342	16.2272
Unemployment	***	5.5331	3.9993	1.6115	0.0263	-1.4792	-4.7681
Market Power		-6.3746	-4.6075	-1.8566	-0.0303	1.7042	5.4933
Deposits		8.0566	5.8232	2.3464	0.0382	-2.1538	-6.9427
HHI	***	7.7288	5.5863	2.2509	0.0367	-2.0662	-6.6602
Bank	***	-3.0184	-2.1816	-0.8791	-0.0143	0.8069	2.6011

b) Since the outbreak of the crisis

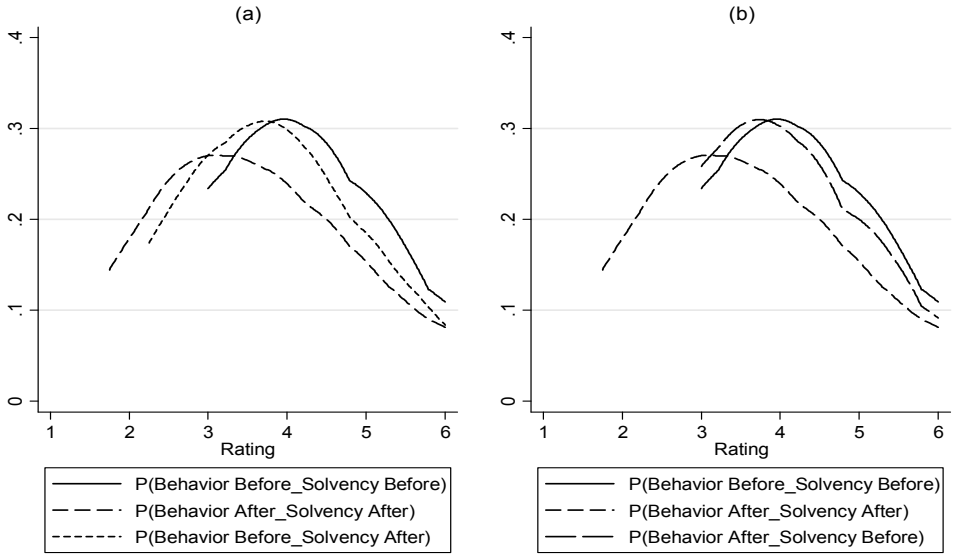
	Significative	1	2	3	4	5	6
Capital	***	-37.0768	-24.7415	-6.5422	3.1289	19.3254	46.4945
Liquidity		-0.6262	-0.4178	-0.1105	0.0528	0.3264	0.7852
ROA	*	-0.7069	-0.4717	-0.1247	0.0597	0.3685	0.8865
Size	***	-21.5805	-14.4007	-3.8078	1.8211	11.2483	27.0620
Provisions		2.7023	1.8033	0.4768	-0.2280	-1.4085	-3.3887
Loans	***	16.7828	11.1992	2.9613	-1.4163	-8.7476	-21.0457
Efficiency	***	20.6419	13.7744	3.6422	-1.7419	-10.7591	-25.8851
Unemployment	***	15.5458	10.3738	2.7430	-1.3119	-8.1029	-19.4945
Market power	***	11.0399	7.3670	1.9480	-0.9316	-5.7543	-13.8441
Deposits	***	-79.6036	-53.1198	-14.0460	6.7176	41.4915	99.8235
HHI	***	-0.8999	-0.6005	-0.1588	0.0759	0.4690	1.1284
Bank	***	-6.9533	-4.6399	-1.2269	0.5868	3.6242	8.7195

*** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Note: Elasticities for each of the explanatory factors of the rating issued by Fitch, in model (2) which takes into account the possible structural change originating with the subprime crisis.

Using the predictions of the ratings from model (2), figures 2 (a) and (b) present the Kernel density functions that show the probability of obtaining a certain rating. This graph permits us to analyze the possible change in the distribution of ratings that occurs with the subprime crisis. For this, figure 2 (a) and (b), establishes a comparison between the probabi-lities of obtaining a certain rating in the pre-crisis period $P(R^{t-1}(x_{t-1}))$ and in the post-crisis period $P(R^{t}(x_{t}))$, where R^{t-1} and R^{t} refer respectively to the grading policy before and after the subprime crisis. Likewise, x_{t-1} and x_{t} refer respectively to the levels of solvency of banks before and after the subprime crisis. These two lines show the overall effect of the crisis, that is, a leftward shift of the density function. With the financial crisis, the probability of reaching the higher rating categories is reduced whereas the probability in the lower rating classes increases.

FIGURE 2: **Change in the rating estimated by Fitch between the pre- and post-crisis periods**



Note: Kernel density functions according the predictions from the model (2) that considers the possible structural change, applied to Fitch rating categories.

The model (2) estimated in table 4 allows us to disentangle the overall reduction in ratings into the effect of the deteriorating of bank solvency and of the hardening of rating policies. To test this, in figure 2 (a) the value of each determinant after the subprime crisis (x_t) is used as a benchmark to compare the prediction in the rating with the rating policy before and after the burst of the crisis. Given the level of the determinants evaluated at the average values after the crisis (x_t), the probability of obtaining a certain rating with the pre-crisis the policy (that is only the coefficients which do not interact with the dummy variable SB) is calculated, $P(R^{t-1}(x_t))$. If this probability is higher than that derived from the post-crisis methodology and the post-crisis values of x_t, that is if

$P(R^{t-1}(x_t)) > P(R^t(x_t))$, we can conclude that Fitch had modified its behavior, hardening its evaluations towards more conservative or stricter positions. As can be observed in figure 2 (a), the density function $P(R^{t-1}(x_t))$ is placed between the functions $P(R^{t-1}(x_{t-1}))$ and $P(R^t(x_t))$, indicating that given a certain level of solvency Fitch assigns worse ratings than before the outbreak of the financial crisis. The distance between the two functions, $P(R^{t-1}(x_{t-1}))$ and $P(R^{t-1}(x_t))$ is an indicator of the lower bank creditworthiness before and after the subprime crisis, whereas the difference between $P(R^{t-1}(x_t))$ and $P(R^t(x_t))$ measures the hardening of the rating policy. From this comparison, we can conclude that part of the overall worsening of the ratings is due to a larger extent to deterioration in the levels of solvency, although the effect of the change in the rating policy is also important. Figure 2 (b) indicates that these results are maintained if instead of setting the solvency level in the post-crisis period it is set in the pre-crisis period (x_{t-1}) and the rating policy is set in the post-crisis period R^t.

To determine analytically the adjustment in the ratings, and the contributions of the change in the agencies' behavior and the change in the levels of solvency, we posit the Change Rating Index (CRI) as a quotient of the banks' ratings in period *t* and those obtained in period *t-1*, which can be decomposed as follows:

$$\begin{aligned} CRI = \frac{R^t(x_t)}{R^{t-1}(x_{t-1})} &= \left(\frac{R^t(x_t)}{R^{t-1}(x_t)} \times \frac{R^{t-1}(x_t)}{R^{t-1}(x_{t-1})}\right)^{0.5} \cdot \left(\frac{R^t(x_{t-1})}{R^{t-1}(x_{t-1})} \times \frac{R^t(x_t)}{R^t(x_{t-1})}\right)^{0.5} \\ &= \underbrace{\left(\frac{R^t(x_t)}{R^{t-1}(x_t)} \times \frac{R^t(x_{t-1})}{R^{t-1}(x_{t-1})}\right)^{0.5}}_{\text{Change in rating policy}} \cdot \underbrace{\left(\frac{R^{t-1}(x_t)}{R^{t-1}(x_{t-1})} \times \frac{R^t(x_t)}{R^t(x_{t-1})}\right)^{0.5}}_{\text{Change in bank solvency}} \end{aligned} \quad (5)$$

This index offers values lower than unity if the rating has worsened with the subprime crisis, a value equal to unity if no change has occurred, and a value higher than unity if there has been an improvement.

The CRI can be decomposed multiplicatively into two factors. The first one $\left(\frac{R^t(x_t)}{R^{t-1}(x_t)} \times \frac{R^t(x_{t-1})}{R^{t-1}(x_{t-1})}\right)^{0.5}$ is the geometric mean of the change in behavior occurring in the rating agency between the pre-crisis period and the post-crisis period evaluating the changes in the pre- and post-crisis values of the determinant variables x_{t-1} and x_t, respectively[20]. The numerator of each

[20] The choice of period in setting the solvency and the behavior components is not trivial. For this reason the index is calculated as a geometric mean considering both the initial and final period.

ratio indicates the rating obtained with the rating policy of the post-crisis period and the value of the determinants of the post-crisis or pre-crisis period, $R^{t}(x_t \text{ or } x_{t-1})$. The denominator indicates the rating obtained by a bank with the level of solvency after or before the crisis and the rating policy before the crisis, $R^{t-1}(x_t \text{ or } x_{t-1})$. A quotient below one, indicates that a hardening of the rating policy has occurred, because by setting the solvency level in the post-crisis or pre-crisis period, the banks obtain a higher rating with the rating policy of the pre-crisis period. A quotient equal to one indicates that the rating agencies have maintained the same policy, because the rating remains constant between the two periods. On the other hand, a quotient higher than unity one, indicates that following the subprime crisis a more flexible rating policy has been implemented, since the rating increases.

The second factor of the index, $\left(\frac{R^{t-1}(x_t)}{R^{t-1}(x_{t-1})}\times\frac{R^{t}(x_t)}{R^{t}(x_{t-1})}\right)^{0.5}$, refers to the variation of the rating due to the changes in the banks' solvency levels between the pre- and post-crisis periods holding constant the rating policy. As before, a geometric mean is used to obtain an indicator invariant of the period. The numerators indicate the rating obtained by a bank with the pre-crisis or post-crisis rating policy and the post-crisis solvency level $R^{t-1 \text{ or } t}(x_t)$. The denominator indicates the rating obtained with the different rating policies and the solvency level of the pre-crisis period $R^{t-1 \text{ or } t}(x_{t-1})$. A ratio lower than one, indicates that a worsening of solvency has occurred. A quotient equal to unity one indicates that the banks have maintained their solvency constant. On the other hand, a quotient above unity one indicates that there has been an improvement in the banks' solvency.

Table 6 shows that on average the banks of the SBS present a CRI of 87%. This result implies a worsening of the rating between the pre- and post-subprime crisis periods of 13%. The results of the decomposition indicate that 35% of this worsening is due to the hardening of Fitch's rating policy[21] and 65% to the worsening of the banks' solvency level.

After verifying the worsening of the banks' ratings and after quantifying that more than one third of it (34,75%) is due to a hardening of the rating policies, several further questions can be asked. In particular: has the worsening of the ratings behaved in the same way in all banks or are there differences by size or legal form? And: has CRAs' hardening of their rating evaluation policy been homogeneous or more severe in the case of smaller banks or of any legal form in particular?

[21] As is mentioned in the report of the US Securities and Exchange Commission (2008) and in Deprés (2011), the rating agencies relaxed their criteria in the rating policies before the outbreak of the subprime crisis, underestimating the risks.

TABLE 6: **Size, CRI and its components. Fitch**

	Fitch total					Fitch commercial banks					Fitch savings banks				
	No. of observations	**CRI**	**Adjustment**	**Behavior**	**Solvency**	**No. of observations**	**CRI**	**Adjustment**	**Behavior**	**Solvency**	**No. of observations**	**CRI**	**Adjustment**	**Behavior**	**Solvency**
Small	11	0.94	6.0%	0.0%	100.0%	2	1.01	-0.6%	2540.2%	-2440.2%	9	0.91	8.8%	44.3%	55.7%
Medium	21	0.86	14.5%	60.4%	39.6%	3	0.95	5.0%	19.8%	80.2%	18	0.84	16.3%	65.3%	34.7%
Big	8	1.06	-6.0%	-34.7%	163.6%	4	0.98	2.2%	-136.0%	236.0%	4	1.14	-14.1%	-63.3%	163.3%
Total	40	0.87	13%	34.7%	65.3%	9	0.98	2%	-234.4%	334.4%	31	0.90	10%	84.5%	15.5%

	Statistical *t*	**Critical value of *t* (one tail)**	**Critical value of *t* (two tails)**
Small vs. medium	1.01	1.70	2.05
Small vs. big	1.92	1.74**	2.11*
Medium vs. big	3.23	1.70***	2.05***

*** significant at 1% , ** significant at 5% and * significant at 10%.

Note: Disaggregation of the CRI, and of its explanatory factors (change in rating policy and change in solvency level), according to size and legal form of the banks evaluated by Fitch. Negative values of Behavior or Solvency indicate that its contribution on CRI is negative. Adjustment is equal to 1-CRI, thus it measures the worsening or improvement of the ratings in terms of percentage. The size is defined on the basis of the mean size of each bank during the period 2006-2009.The small banks include those with a size below quartile 25. The medium banks include those of a size between quartiles 25 and 75. The large banks include those of a size above quartile 75. We show the test of differences in means, under the null hypothesis $\mu 1 = \mu 2$.

Table 6 permits us also to analyze these questions, showing the CRI and its components by size of bank and legal form. The results indicate that medium sized banks experience a greater fall in their ratings. This greater fall is due to the greater worsening of their solvency and to the greater hardening of the rating criteria. On the other hand, the large banks improve their ratings. Disaggregating the CRI according to legal form, we observe that the greater fall depends on the size of the bank being analyzed. Small and medium sized savings banks present a higher CRI than the commercial banks, savings banks of large size present a lower one. The greater downward adjustment that occurs in medium and small savings banks is explained by their specialization in the granting of credits to activities rela-ted with "bricks and mortar", which have been heavily punished by the outbreak of the subprime crisis and the property bubble. They also have more difficulties in rising capital in the markets due to their legal status.

7. Robustness Analysis

IN this section we present the results of the application of the methodology to the rating agencies Moody's and Standard and Poor's. The aim is to analyze the robustness of the results and conclusions obtained for Fitch.

Table 7 presents the estimation of model (1), which does not take into account the possible structural change originating with the subprime crisis. In this table we appreciate that the results are similar to those obtained for Fitch. Specifically, we observe that in Moody's and Standard and Poor's, an increase in profitability, in the level of capital, liquidity, size, market power, and/or of deposits, imply an increased probability of being in the higher rating category. However, with an increase in provisions, the HHI index, and/or the regional unemployment rate, the probability of being highly rated is reduced. Furthermore, according to the likelihood ratio test the effect of the subprime crisis is significant for these two CRAs, since the joint hypothesis of non-significance of the dummy variable (SB) and its cross effects with the rest of the determinants of the rating, is rejected. As can be appreciated from the estimation of model (2) in table 7, with the outbreak of the subprime crisis, as already occurred in the case of Fitch, there is also a change in the behavior of Moody's and Standard and Poor's. Furthermore as is pointed in Salvador, Pastor and Fernandez (2011) for SBS, the three rating agencies analyzed adopt different rating policies as they assign different weights to the factors that define the issuer banks' ratings.

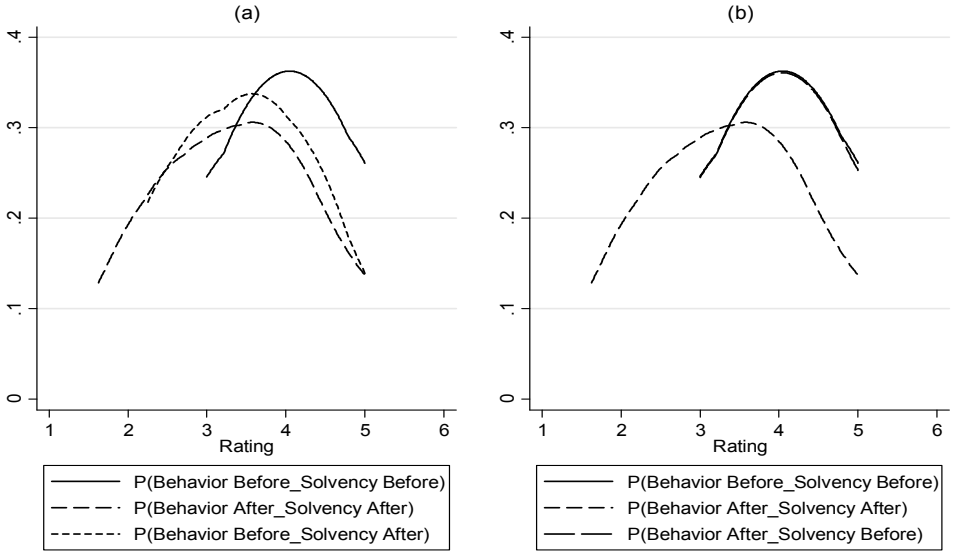
TABLE 7: Ordered probit model with random effects. Eq(1) − (2). Period 2000-2009

	Moody's		Standard and Poor's	
	Model (1)	**Model (2)**	**Model (1)**	**Model (2)**
Capital	95.19***	131.568***	34.332***	22.422**
Liquidity	-9.366*	-31.49**	19.061***	30.239***
ROA	355.861***	603.097***	206.085***	216.137***
Size	5.001***	12.13***	3.443***	3.752***
Provisions	-308.922***	3.351	-80.237	116.328
Loans	-9.971***	-12.727	13.52***	17.071***
Efficiency	4.837	6.854	0.94	3.5*
Unemployment	-0.633***	-1.294***	-0.048	-0.206**
Market Power	14.687***	20.006**	-2.248	-1.217
Deposits	17.116**	48.905**	19.91***	23.762***
HHI	-6.889***	-18.385***	-4.956***	-1.2
Bank	-1.403***	-4.844***	-1.83***	-2.873***
SB		68.706		-18.074
SB*Capital		232.714***		50.841**
SB*Liquidity		71.034**		39.326***
SB*ROA		643.202*		-458.574***
SB*Size		1.512		6.368***
SB*Provisions		-228.098		-405.375***
SB*Loans		26.535*		44.642***
SB*Efficiency		-19.111		-39.937***
SB*Unemployment		-0.042		-0.288*
SB*Market Power		-24.794*		-6.742
SB*Deposits		-115.471***		-97.851***
SB*HHI		-26.898**		-11.15*
SB*Bank		-0.855		4.225***
Term2	-0.736*	-1.931**		-0.473
Term3	-1.397***	-3.943***		-1.185***
Term4	-0.596	-3.654*		-1.582***
Time	-0.167***	-0.512***		-0.124***
cut1	82.9***	205.282***	83.535***	94.285***
cut2	86.764***	215.497***	88.606***	99.421***
cut3	92.686***	230.147***	91.325***	103.277***
cut4	103.57***	249.37***		
Rho	0.916***	0.983***	0.766***	0.87***
No. of observations	417	417	463	463
LR chi2	337.411	410.894	224.322	333.023
Log Lik	-87.395	-50.653	-219.231	-164.881
RV-Test		73.484		108.7
P-value		0.00		0.00

*** significant at 1% , ** significant at 5% and * significant at 10%.

Note: Results of the estimation of the ordered probit model with random effects (Eq.1 − Eq.2) for the rating agencies Moody's and Standard and Poor's, from the first quarter of 2000 to the fourth quarter of 2009. (1) Model that does not consider the possible structural change arising from the subprime crisis. (2) Model that does consider the possible structural change arising since the outbreak of the subprime crisis. Rho shows the importance of the unobservable effect in the random effects model. RV likelihood ratio test between the model (1) (the restricted model) and model (2) (the general model), i.e , H_0:β_{sb} $\beta_k = 0$.

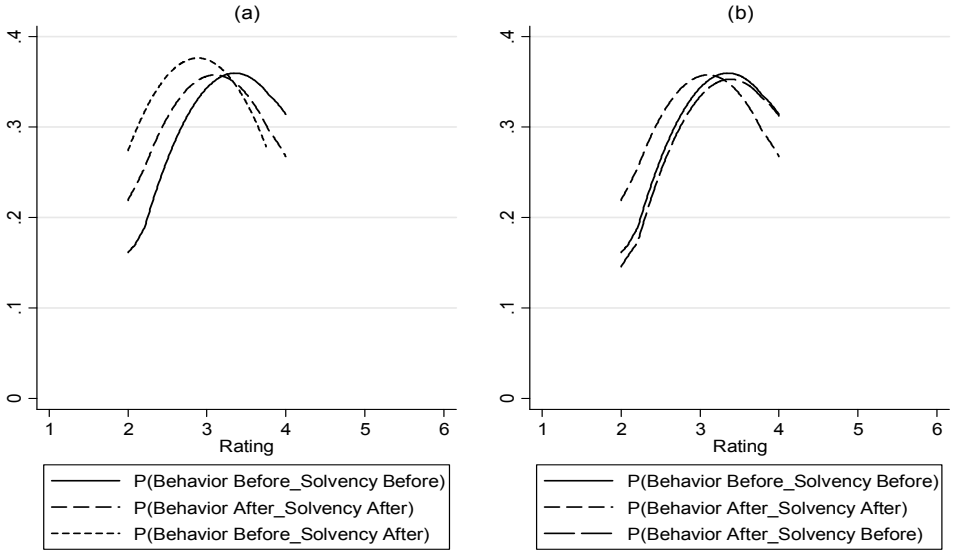
FIGURE 3: **Change in the rating estimated by Moody's between the pre- and post-crisis periods**



Note: Kernel density functions according the predictions from the model (2) that considers the possible structural change, applied to Moody's rating categories.

Once the robustness of econometric models (1) and (2) are confirmed when other rating agencies are used, we likewise verify the robustness of the predictions made, through analysis of the density functions and the calculation of the CRI. In a similar manner to the case of Fitch, the figures 3 and 4 show that Moody's and Standard and Poor's also carry out a lowering of ratings. In the case of Moody's the reduction in the ratings is due both to the worsening of the banks' solvency and to the hardening of their rating policy. In Standard and Poor's, however, we the fall in the ratings is due solely to the worsening of their creditworthiness. These results are confirmed by calculating the CRI. According to this index Moody's ratings fell by 16% and Standard and Poor's by 6%. If this adjustment is decomposed, in the case of Moody's 86.5% is explained by the worsening of solvency levels and 13.5% by the hardening of the rating criteria. On the other hand Standard and Poor's is the only CRA that has not toughened its rating policy following the crisis. In this case, the lowering of the rating levels is due exclusively to the worsening of the banks' solvency. If we disaggregate the CRI and its determinants according to entities size, we observe from table 8 that as in the case of Fitch, the greatest lowering of ratings occurs in the small and medium sized entities. It should be mentioned that in the case of these two agencies we cannot perform a disaggregation according to the legal form, due to the small number of observations.

FIGURE 4: **Change in the rating estimated by Standard and Poor's between the pre- and post-crisis periods**



Note: Kernel density functions according the predictions from the model (2) that considers the possible structural change, applied to Standard and Poor's rating categories.

Altogether, the results obtained for Moody's and to a lower extend for Standard and Poor's confirm the same behavior pattern as the adjustment of ratings experienced in Fitch[22]. This adjustment is characterized by a fall in ratings, which occurs with greater intensity in entities of medium size and with less intensity in banks of larger entities.

Another robustness exercise is to estimate models (1) and (2) but taking the determinants of bank ratings in lags (one to four lags) with respect to the rating, as accounting information is not usually available at the same time as when rating agencies issues their ratings. The results of the estimations (table 9) are similar to that obtained in the table 4 and the CRI (table 10) is also comparable to that of table 6. These results confirm the robustness of the estimations of model (1) and (2).

[22] As Deprés (2011) show there is a strong correlation between the ratings of three main agencies (Fitch, Moody's and Standard and Poor's) due to the competition among them. Hence, it is not surprising the similarity of the results across rating agencies.

TABLE 8: **Size, CRI and its components. Moody's and Standard and Poor's**

	Moody's total					Standard and Poor's total				
	No. of observations	CRI	Adjustment	Behavior	Solvency	No. of observations	CRI	Adjustment	Behavior	Solvency
Small	4	0.82	18.4%	-4.4%	100.0%	2	0.96	4.2%	-372.5%	100.0%
Medium	5	0.79	20.9%	26.8%	73.2%	6	0.93	6.5%	-7.8%	107.8%
Big	2	0.97	2.5%	50.0%	50.0%	3	1.01	-1.2%	667.3%	-567.3%
Total	11	0.84	16%	13.5%	86.5%	11	0.94	6%	-60.9%	160.9%

	Statistical *t*	Critical value of *t* (one tail)	Critical value of *t* (Two tails)	Statistical *t*	Critical value of *t* (one tail)	Critical value of *t* (Two tails)
Small vs. medium	0.31	1.890	2.36	0.22	1.94	2.45
Small vs. big	0.92	2.130	2.78	1.54	2.35	3.18
Medium vs. big	2.56	2.015**	2.57**	0.76	1.89	2.36

*** significant at 1% , ** significant at 5% and * significant at 10%.

Note: Disaggregation of the CRI and of its explanatory factors (change in rating policy and change in solvency level), according to size and legal form of the banks evaluated by Moody's and Standard and Poor's. Values negatives of behavior or Solvency indicate that its contribution on CRI is negative. Adjustment is equal to 1-CRI, thus it measures the worsening or improvement of the ratings in terms of percentage. The size is defined on the basis of the mean size of each bank during the period 2006-2009.The small banks include those with a size below quartile 25. The medium banks include those of a size between quartiles 25 and 75. The large banks include those of a size above quartile 75. We show the test of differences in means, under the null hypothesis $\mu 1 = \mu 2$.

In the line of the results obtained by Packer and Tarashev (2011), that highlight the importance of consider the external support that received the banks from the economic authorities in the subprime crisis, as a last robustness test we model and predict the individual ratings of Fitch and Moody's (not shown). In the case of Fitch individual ratings, the CRI in the table 11 show a worsening of rating of 13.65%, of which a 94.92% is due to the worsening of solvency and in 5.08% due to the hardening of rating criteria. For Moody's Bank Financial Strength (BFRS) the worsening of rating is 27%, corresponding in a 67.56% to the deterioration of the financial position and in a 32.44% to the hardening of rating criteria.

TABLE 9: **Ordered probit model with random effects with determinants of ratings in lags. Eq(1) − (2). Period 2000-2009**

	1 lag		2 lags		3 lags		4 lags	
	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)	Model (1)	Model (2)
Capital	34.740***	46.633***	51.495***	22.833***	58.175***	13.134**	52.323***	31.091***
Liquidity	1.590*	5.951***	0.076	1.905	2.776***	2.284*	4.397***	8.517***
ROA	10.465	-73.432***	-34.424	-78.012***	-33.390	-54.243*	-43.783*	-0.779
Size	2.632***	2.785***	2.637***	2.475***	2.020***	2.881***	2.189***	2.550***
Provisions	-257.748***	-188.119***	-249.945***	-233.844***	-207.662***	-198.234***	-196.784***	-136.316**
Loans	1.030*	5.581***	0.486	0.442	0.186	5.077***	-0.990	5.168***
Efficiency	1.428***	4.445***	1.635***	2.244***	2.959***	2.502***	1.414***	2.074***
Unemployment	-0.093***	-0.005	-0.109***	-0.061***	-0.097***	-0.012	-0.061***	0.045***
Market Power	5.904***	4.093***	7.645***	5.051***	10.649***	3.847***	10.793***	2.043
Deposits	18.992***	-3.448	19.476***	-2.241	16.756***	-1.615	16.300***	-2.589
HHI	-0.638**	-0.961**	-0.624*	-3.481***	-0.396	0.594	-2.690***	-0.956**
Bank	2.345***	1.053***	3.538***	3.140***	0.795***	3.588***	1.319***	2.960***
SB		-30.543***		-52.933***		-43.279***		-38.448***
SB*Capital		65.759***		67.098***		56.514***		53.116***
SB*Liquidity		-8.199**		-2.968		0.502		3.589
SB*ROA		293.849***		233.558***		167.022***		113.393***
SB*Size		0.696**		1.004***		0.952***		0.899***
SB*Provisions		-125.792**		-77.566		-47.176		-75.308
SB*Loans		-9.773***		-5.348**		-3.345		-2.653
SB*Efficiency		-6.591***		-7.884***		-8.818***		-9.977***
SB*Unemployment		-0.094***		-0.094***		-0.076**		-0.102***
SB*Market Power		-3.673		3.141		5.671**		9.237***
SB*Deposits		30.244***		42.828***		30.714***		25.859***
SB*HHI		2.822***		4.193***		4.976***		3.759***
SB*Bank		2.573***		2.887***		2.684***		2.476***

TABLE 9 *(cont.):* **Ordered probit model with random effects with determinants of ratings in lags. Eq(1) – (2). Period 2000-2009**

	1 lag		2 lags		3 lags		4 lags	
	Model (1)	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**
Term2	-0.785***	-0.964***	0.440***	0.509***	0.286**	0.164	0.306**	0.085
Term3	-0.592***	-0.727***	-0.622***	-0.662***	0.642***	0.532***	0.625***	0.101
Term4	-0.365***	-0.553***	-0.299**	-0.389***	-0.271**	-0.359**	0.930***	0.277
Time	-0.099***	-0.091***	-0.109***	-0.086***	-0.085***	-0.100***	-0.099***	-0.059***
cut1	55.668***	42.937***	58.364***	30.182***	49.509***	43.036***	49.763***	38.520***
cut2	57.355***	45.318***	60.049***	32.604***	50.975***	45.243***	51.046***	40.558***
cut3	60.344***	49.107***	63.015***	36.772***	53.645***	48.771***	53.750***	43.911***
cut4	63.354***	52.792***	66.065***	40.719***	56.482***	52.606***	56.579***	47.505***
cut5	68.957***	58.407***	71.405***	47.101***	60.866***	59.211***	61.539***	54.137***
Rho	0.717***	0.691***	0.703***	0.783***	0.733***	0.797***	0.659***	0.691***
No. of observations	1,458	1,458	1,417	1,417	1,376	1,376	1335	1335
chi2	625.761	888.387	591.639	907.632	483.569	852.881	451.778	757.181
ll	-728.857	-597.544	-722.724	-564.728	-755.300	-570.644	-745.395	-592.694
RV-Test		262.626		315.992		369.312		305.402
P-value		0.000		0.000		0.000		0.000

*** significant at 1% , ** significant at 5% and * significant at 10%.

Note: Results of the estimation of the ordered probit model with random effects (Eq.1 − Eq.2) for the rating agency Fitch with explanatory variables in lags (from quarter t-1 to quarter t-4). The period considered is from the first quarter of 2000 to the fourth quarter of 2009. (1) Model that does not consider the possible structural change arising from the subprime crisis. (2) Model that does consider the possible structural change arising since the outbreak of the subprime crisis. Rho shows the importance of the unobservable effect in the random effects model. RV likelihood ratio test between the model (1) (the restricted model) and model (2) (the general model), i.e, H_0:β_{sb} $\beta_k = 0$.

TABLE 10: **Accuracy of model (2). CRI and its components. Fitch**

Lags	% accuracy	CRI	Adjustment	Behavior	Solvency
0	68.91%	0.87	13%	34.7%	65.3%
1	63%	0.88	11.6%	51.7%	48.3%
2	63%	0.90	9.6%	32.5%	67.5%
3	71%	0.89	11.0%	44.8%	55.2%
4	70%	0.90	10.4%	58.1%	41.9%

Note: Correct predictions, the results for the CRI, and its components, to the model (2) in contemporary values and with lags (from quarter t-1 to quarter t-4) in explanatory variables. Adjustment is equal to 1-CRI, thus it measures the worsening or improvement of the ratings in terms of percentage.

TABLE 11: **CRI and its components for individual and deposits ratings**

Type of rating	CRI	Adjustment	Behavior	Solvency
Individual rating of Fitch	0.86	13.65%	94.92%	5.08%
Indivudual rating of Moody's (BFRS)	0.73	27%	67.56%	32.44%
Bank deposits rating of Moody's	0.87	13%	60.83%	39.17%

Note: The results for the CRI and its components, to the model (2) for individual ratings of Fitch and Moody's, and for the Deposits ratings of Moody's. Adjustment is equal to 1-CRI, thus it measures the worsening or improvement of the ratings in terms of percentage.

Likewise, if we do the same exercise for deposit ratings by Moody's, we obtained a worsening of ratings of 13% that in 60.83% is due to the deterioration of the creditworthiness and in 39.17% due to the hardening of rating criteria. These results confirm that the downward adjustment in ratings is mainly due to the worsening of financial position although the hardening of rating criteria has also a significant role.

8. Conclusions

THIS study analyses the impact of the subprime crisis on the behavior of the ratings issued for commercial banks and savings banks of the Spanish Banking System, during the period 2000-2009. With this analysis we determine the contribution of the banks' worsened solvency and the change in the behavior of the rating agencies to the adjustment in the ratings.

For this, we designed a methodology based on the specification of an ordered probit model with random effects, permitting us to monitor the possible structural change occurring as a result of the subprime crisis. The evidence presented confirms that with the outbreak of the crisis there is a lowering of the ratings issued, due both to a hardening of the agencies' rating

policy and to a worsening of the banks' creditworthiness. Specifically, we find that on average the ratings of the banks of the SBS have worsened by 13%. Of this adjustment, 65% is due to the deterioration of the banks' solvency levels and 35% to the hardening of the rating policy. This important change in rating policy questions the role of the rating agencies in reflecting at any time the true credit quality of the banks and savings banks. This provides evidence for the affirmations of the stability report of the International Monetary Fund (2010) and of the study by Deprés (2011), about the updating of the rating models and the procyclical behavior of the ratings. These results are robust to different specifications, since different rating agencies and types of rating are considered.

The disaggregation of the results according to the banks' size and legal form shows that medium sized banks, and more specifically the savings banks, present a greater fall in their ratings. This is because of the savings banks' specialization in the granting of credits to activities related with "bricks and mortar".

9. Annex 1. Equivalencies Between the Rating Agencies and the Numerical Scale Defined

***a)* Investment**

Moody's						Fitch				Standard and Poor's	
Issuer		**BFRS**		**Deposits**		**Isuuer**		**Individual**		**Issuer**	
Aaa	6			Aaa	5	AAA	6			AAA	6
Aa1	6			Aa1	5	AA+	6			AA+	6
Aa2	6			Aa2	5	AA	6			AA	6
Aa3	6			Aa3	4	AA-	6			AA-	6
A1	5			A1	3	A+	5			A+	5
A2	4	A	4	A2	2	A	4	A	4	A	4
A3	3	A-	4	A3	2	A-	3	A/B	4	A-	3
Baa1	2	B+	4	Baa1	1	BBB+	2	B	4	BBB+	2
Baa2	1	B	3	Baa2	1	BBB	1	B/C	3	BBB	1
Baa3	1	B-	2	Baa3	1	BBB-	1	C	2	BBB-	1
***b)* Speculative**											
Ba1	1	C+	1	Ba1	1	BB+	1	C/D	2	BB+	1
Ba2	1	C	1	Ba2	1	BB	1	D	1	BB	1
Ba3	1	C-	1	Ba3	1	BB-	1	D/E	1	BB-	1
B1	1	D+	1	B1	1	B+	1	E	1	B+	1
B2	1	D	1	B2	1	B	1	F	1	B	1
		D-	1								
B3	1	E+	1	B3	1	B-	1			B-	1
Caa1	1	E	1	Caa1	1	CCC+	1			CCC+	1
Caa2	1			Caa2	1	CCC	1			CCC	1
Caa3	1			Caa3	1	CCC-	1			CCC-	1
Ca	1			Ca	1	CC	1			CC	1
C	1			C	1	C	1			C	1
D	-		-	D	-	D	-			D	0
WR	-	WR	-	WR	-	WR	-			WR	-

Note: Equivalencies between the rating assigned by Moody's, Fitch and Standard and Poor's and the numerical scale defined in this study. As the score decreases, so does the credit quality, and consequently the probability of default increases. The top and bottom categories are grouped, due to the small number of observations they present. Issuer ratings are the ratings that consider the external support that the banks received from the economic authorities. Individual ratings and BFRS (individual rating in Moody's) are the ratings that only consider the intrinsic financial position of bank without consider the external support that the entities receive from economic authorities. Deposits ratings of Moody's concerns the ability of each bank to repay punctually its deposit obligations..

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