PREDICTING BANKRUPTCY USING NEURAL NETWORKS IN THE CURRENT FINANCIAL CRISIS: A STUDY FOR US COMMERCIAL BANKS

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Predicting bankruptcy using neural networks in the current financial crisis: a study for US commercial banks[⊥]

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Abstract

We develop a model of neural network to study the bankruptcy of banks in the US in 2009. We provide a new model to predict bank defaults some time before the bankruptcy happens, taking into account the specific features of the current financial crisis. Based on data from the Federal Deposit Insurance Corporation our results corroborate the higher credit risk taken by distressed banks, and their heavier concentration on real estate. Interestingly, distressed banks do not show lower cost efficiency than their wealthy counterparts, so that bank failures seem to be a consequence of careless bank strategies rather than low cost efficiency. After drawing the profile of distressed banks, we use our model to predict possible future bankruptcies and we test the performance of the model by comparing our predictions with the actual bankruptcies between January and June 2010. Our model shows a high discriminant power and is able to differentiate correctly wealthy and distressed banks. More specifically, our model would have been able to predict in December 2009around 60% of failures happened in 2010.

Keywords: bankruptcy, banks, financial crisis, neural networks.
JEL Classification codes: G21, C45, G33.

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1. Introduction

The current financial crisis, the generalization and propagation of systemic risk in a more and more global financial environment, and the high social costs of bank failures have drawn the attention to the mechanisms of control of banks solvency. The Finance Ministers and Central Bank Governors of G-20 countries, who met in June 3rd-5th in Busan (Korea) seem to agree on this concern. Their press release stated "*the commitment to reach agreement on stronger capital and liquidity standards as the core of our reform agenda and call on them to propose internationally agreed rules to improve both the quantity and quality of bank capital and to discourage excessive leverage and risk taking*" The so-called Basel III[1] Accord advices banking regulators to develop capital and liquidity rules of sufficient rigor to allow our financial firms to withstand future downturns in the global financial system.

This accord follows the capital agreement in 1988 known as Basel I Accord, enforced by law in the G-10. This roundtable had the goal of minimizing credit risk and set out the minimum capital requirements of financial institutions based on a percent of risk-weighted assets. Most other countries, numbering over 100, have also adopted the principles prescribed under Basel I. The innovation and financial changes in the world led to the need of a more comprehensive set of guidelines known as Basel II. The purpose of this new framework was to promote greater stability in the financial system and reduce the social costs of financial instability. To fulfill this aim, a broader view of financial risk was put in place (incorporating the difference among credit, operational and market risk), and both supervisors and markets were given a wider range of action.

The collapse of a number of financial institutions in the United States in 2008 due to the emergence of new financial products and risks, to the fall of real estate prices, and to biased pricing methods of real estate premises underlined the shortcomings of Basel II. New standards for supervision of financial intermediaries and new metrics of financial risk were required. Our paper tries to join to this stream by analyzing the failures of US banks in recent years. In so doing, we intend to follow the recommendations of the Finance Ministers of G-20 who "*welcome the progress on the quantitative and macroeconomic impact studies which will inform the calibration of these new rules*".

We develop a model of neural network to study the bankruptcy of banks in the US in 2009. With this contribution we hope to complement previous evidence and introduce new

[1] In December 2009 The Basel Committee on Banking Supervision published two consultative documents entitled "Strengthening the Resilience of the Banking Sector" and "International Framework for Liquidity Risk Measurement, Standards and Monitoring". Although these papers are not the Basel III framework, they have been widely dubbed Basel III.

features updated to the current financial environment. The aim of our paper is twofold: descriptive and predictive. First, we aim to describe the main characteristics of distressed banks. The implementation of our model and the analysis of the most powerful variables provide interesting insights about the most critical features of distressed banks relative to non-distressed banks. Second, we try to provide a reliable tool to predict the probability of bank failures some time before it happens. We provide predictions of the probability of bankruptcy in 2010 and 2011. Then we test the predictive power of our model by applying to the banks that actually went bankruptcy between January and June, 2010.

We provide an orderly method to be followed in the construction of a prediction model of bank failures, and a rational and easily replicable process to improve existing failure detection models. Our work means a step forward in two fields relative to previous models: First, we deviate from previous models in the selection of variables, and implement better selection criteria based on the experience and performance of previous research. Second, we explicitly take into account the specific features of the current crisis and the concern with the measurement of credit risk coherently with Basel accords.

Our results corroborate the higher credit risk taken by distressed banks, and their heavier concentration on real estate at the explosion of the mortgage bubble. Distressed banks have carried out a strategy of quick expansion both in deposit taking and in loans. The worse quality of the loan portfolio of distressed banks relative to their counterparts results in higher provisions. This process leads to the reversion of profits into loss and, finally, it is amplified by the downturn of the economic cycle. Interestingly, distressed banks do not show lower cost efficiency than their wealthy counterparts, so that bank failures seem to be a consequence of careless bank strategies rather than low cost efficiency.

The paper is divided into five sections. Section 2 reviews previous research on models of bankruptcy prediction. Section 3 describes the main characteristics of our neural network model. In Section 4, we provide the results of the application of our model to a sample of US banks. We provide both descriptive results and the results of the prediction of banks failures in 2010. Finally, in Section 5, we draw some conclusions from our results and offer some directions for future research.

2. A review of bankruptcy prediction models

2.1. Traditional approaches

The prediction of corporate bankruptcies is an important and widely studied topic in the finance literature. Models of prediction have become more sophisticated in order to take account of the effects of financial crises or other outstanding business episodes, as suggested by Laffarga and Mora (1998) and Castaño and Tascón (2009). Although it is not easy to draw a line sharp line, broadly speaking there are two approaches to bankruptcy prediction (Angelini, Tollo and Roli, 2007). The structural approach is based on modeling the dynamics of firm characteristics and derives the default probability based on these dynamics. In the empirical approach, instead of modeling the default with the characteristics of a firm, the default relationship is learned from the data (Atiya, 2001).

The foundations of the empirical approach can be traced to Altman (1968), Beaver (1966), and Ohlson (1980). Beaver (1966) pioneered the prediction of bankruptcy using financial statement data. His univariate analysis focused on the evolution of some financial ratios such as financial leverage, return on assets and liquidity and showed how these ratios worsened as long as firms faced bankruptcy. Altman and Ohlson's models are linear models that classified firms using financial ratios as inputs. Altman (1966) widened the scope of the model by introducing a multiple discriminant credit scoring analysis. The model identifies financial variables that have statistical explanatory power. Ohlson (1980) introduced the logistic regression approach and used a novel set of financial ratios as inputs. Another milestone is Fulmer, Moon, Gavin and Erwin (1994), who used step-wise multiple discriminant analysis to discriminate between corporate future failures and successes.

These models and their empirical derivatives have been standard benchmarks for the credit risk and default prediction problem, being the explanatory variables mainly limited to balance sheet data. Since financial information may be infrequently updated and determinated by book rather than market valuation, Bernhardsen (2001) implemented a logit model introducing the nature of the firm and the characteristics of corporate markets. In the same vein, Hol (2006) introduced macroeconomic variables to test the influence of the business cycle on bankruptcy likelihood. Her results show that macroeconomic condition, although relevant, are less influential than financial ratios.

2.2. The neural network approach

Research on bankruptcy through neural networks started in 1990's and is still active now (Piramuthu, 1999; Vellido, Lisboa and Vaughan, 1999; Wu and Wang, 2000; Zhang, Hu, Patuwo and Indro, 1999). Cinca Serrano and Martín del Río (1993) is a seminal contribution that shows that banks lacked of liquidity and performance before going bankruptcy.

Neural networks differ from the classical approach because these models assume a non-linear relation among variables. According to Atiya (2001), there are two reasons why a nonlinear approach could be superior to the above-mentioned linear models. First, there can be saturation effects in the relation between financial ratios and the prediction of default. Second, it can be argued that there are multiplicative factors as well.

The comparison between traditional models and neural networks remains an open question with literature providing disputing results (Altman, Marco and Varetto, 1994; Coats and Fant, 1993; Fernández and Olmeda, 1995; Salchenberger, Cinar and Lash, 1992). Furthermore, the choice of a method over another one is usually based on several and not homogeneous criteria, such as data availability. Nevertheless, in latest years, some authors have shown the relative superiority of neural networks relative to other techniques (Jo, Han and Lee, 1997; Tsai and Wu, 2008; Jardin, 2010). It is worthy to note Jardin's contribution, who uses more than 500 ratios taken from around 200 previous papers. This large scale comparison shows that a neural network based model using a set of variables selected with a criterion that it is adapted to the network leads to better results than a set chosen with criteria used in the financial literature.

Neural networks are learning systems which can model the relation between a set of inputs and a set of ouputs. They have a *black-box* nature since it is not possible to extract symbolic information from their internal configuration (Angelini, Tollo and Roli, 2007). Neural networks are machine learning systems that modify their internal parameters in order to perform a computational task.

In a neural network application there are two main issues to be defined: the network structure and the learning algorithm. Whereas the most used network structures are the layered and the completely connected ones, the three typologies of learning mechanisms are the supervised learning, the unsupervised learning and the reinforced learning. Supervised learning is applied when the network has to learn to generalize some given examples. Unsupervised learning is used for tasks where some regularities in a large amount of data have to be found. Reinforced learning algorithms are applied to train adaptive systems which perform a task composed of a sequence of actions.

As far as the different algorithms to train neural networks are concerned, the backpropagation algorithm and the genetic algorithm are among the most popular (Rojas, 1996). The learning algorithm works to reduce the error, i.e., the difference between the desired output and the output actually produced by the network. The backpropagation algorithm aims to propagate backwards the errors from the output units to the intermediate units. This means that, after calculating the error from the intermediate units, the connection between both types of units can be modified and the process goes on until the error falls below a defined threshold.

There are some links between network training and network topologies. Backpropagation networks are necessarily multilayer perceptrons (usually there is one input, one hidden, and one output layer). In order for the hidden layer to serve any useful function, multilayer networks must have non-linear activation functions for the multiple layers. The multilayer perceptrons models are a classificatory and pattern detection process. Learning occurs in the perceptron by changing connection weights after each piece of data is processed, based on the amount of error in the output compared to the expected result.

The methodology of neural network is an efficient approach to develop dynamic models for bankruptcy prediction since it allows considering the financial environment of firms. Nevertheless, previous models have proved not to be able to predict the recent wave of failures of a number of banks, mainly in US. This fact does not invalidate the neural network approach but calls for new improvements by considering some specific issues of the current global financial crisis. Keeping this aim in mind, in the next section we present our model with which we try to complement previous research.

3. The bankruptcy prediction model: Empirical design

We take our data from the information from the Federal Deposit Insurance Corporation (FDIC). All US banks must report quarterly their financial statements in the Uniform Bank Performance Report, so that the information becomes then publicly available. For each bank, this report provides information about the loans portfolio, the default rate, the capital composition, the liquidity, etc. We select a set of 41 variables potentially explanatory for the bankruptcy risk of each bank. To enhance the comparability of our results, most of these variables have been previously used by other authors (Altman, 1968; Bernhardsen, 2001; Pina, 1989). Consistently with Jardin (2010), we also add some variables suitable to control for specific features of the current global financial crisis. These variables are selected with a criterion adapted to the network in order to improve the results of the model. In Table 1 we report the name and definition of the variables.

Our sample covers the 2003-2009 period. We train our model with data from 2003 to 2008 and test the accurateness of our model with bankruptcies arisen in 2009. Later on, we use the model to predict bankruptcies in 2010 and 2011. Although during 2003-2008 192 US

Table 1: List of variables and meaning

Classification	Name	Calculation
Performance	INC	Interest income / Average assets
Performance	EXP	Interest expense / Average assets
Performance	NET_INC	Net interest income / Average assets
Performance	NON_INC	Noninterest income /Average assets
Performance	NON_EXP	Noninterest expense /Average assets
Performance	PROV	Provision for loans and leases receivables losses / Average assets
Performance	EASST	Average earning assets / Average assets
Performance	LNLCR	Gross loans and lease charge-off less gross recoveries / Average total loan and leases
Performance	EFFCY	Efficiency ratio (Average total costs / Total assets)
Performance	PERS	Average personnel expense per employee
Performance	ASST	Average assets per employee (millions)
Performance	YLD_LNLS	Yield of total loans and lease / Average total loans
Performance	YLD_DOM	Yield of interest and fees on domestic office loans secured primiraly by real state / Average domestic real state loans
Performance	MBS_YLD	Interest on mortgage backed securities (MBS)/ Average MBS
Performance	HIGH_INT	Cost of interest on deposits higher $ 100.000 / Average deposits higher $ 100.000
Asset structure	BAL	On average, all interest-bearing balances due from depository institutions / Total assets
Asset structure	NLLA	The sum of the averages for net loans and lease-financing receivables, held-to-maturity and available-for-sale securities, interest-bearing balances due from depository institutions, federal funds sold and resold, and trading-account securities / Average total assets.
Asset structure	FIX	Average of bank premises,furniture,equipment and others / Total assets
Asset structure	PREM	Average real estate owned other than bank premises / Average total assets
Asset structure	MMDA	Average Money Market Deposit Account / Average total assets
Asset structure	DEP	Average total deposits less time deposits>$100 thousand and in foreign offices / Total assets
Asset structure	TMDEP	The sum of the averages for time certificates of deposit of $100 thousand or more and other time deposits in amounts of $100 thousand or more / Average total assets
Loan portfolio	LNLL	Gross loan and lease losses / Average total loans and leases
Loan portfolio	LNLR	Gross loan and lease recoveries / average total loans and leases
Loan portfolio	LOSS	Net losses by real estate loans
Loan portfolio	LOSSC	Net losses by construction and land development loans
Loan portfolio	LOSSCS	Net losses by construction loans secured by 1-4 family porperties
Loan portfolio	OFCR	Credit to the bank's executive officers, main shareholders as of the report date / Total loans
Loan portfolio	OFCR_ASST	Credit to the bank's executive officers, main shareholders/total assets
Concentration	CONS	Construction, land development and other land loans plus Closed end loans secured by family residential properties First liens plus Revolving open end loans plus loans secured by farmland plus Secured by nonfarm nonresidential properties as a percent of Total Capital
Concentration	FARM	Loans to finance agricultural production in domestic offices as a percent of Total Capital
Concentration	CMID	Commercial and Industrial Loans to U.S. addressees in domestic offices plus Commercial and industrial loans to non-U.S. addressees in domestic offices as a percent of Total Capital
Concentration	CARDO	Credit card plans in domestic offices plus Other revolving credit plans in domestic offices plus Other consumer loans in domestic offices as a percent of Total Capital
Concentration	CARD	Credit card plans in domestic offices as a percent of Total Capital
Concentration	REAL	Real State Loans 90 + day past due
Capital	LNEQ	Number of times net loans and lease-financing receivables exceed equity capital
Capital	NET_INCEQ	Net income / Average total equity capital
Capital	INTG	Intangible assets / average total equity capital
Capital	TIER2	Tier 2 capital
Capital	TIER1	Net tier 1
Capital	RISK	Total risk-based capital / risk-weighted assets.

banks went bankruptcy, given the innovative set of variables we use, there was not enough available information from 108 defaulted banks, so our sample is made of 84 US defaulted banks. This sample size is consistent with previous research (Angelini, Tollo and Roli, 2007; Fernández and Olmeda, 1995; Hung, Chen and Wermter, 2007; Odom and Sharda, 1990).

In order to isolate the main drivers of bankruptcy, we select a random sample among the remaining US banks FDIC members. This random selection is common in the neural networks approach and accounts for 70% of the whole sample. Although in many papers the non-default sample accounts for 50% of the total sample, the high number of US banks not included in the sample suggests using a higher percentage of randomly selected banks in order to reduce the type I error risk[2]. The final sample includes 280 banks: 84 default and 196 non-default banks.

A critical issue in neural networks analyses is the partition of the whole sample into the training and the validation sub-samples. Our training sample accounts for 70 percent of the total sample (188 banks), whereas the validation sample accounts for 30 percent (92 banks). As a robustness test, we also check the validity of our model with the whole population of US banks, including the failures arisen in the first months of 2010.

We run a cluster analysis to reduce the number of variables in our model. The objective of the cluster analysis is identifying sets of similar variables in order not to reiterate the information and determining the relative weight of each group. This cluster analysis should provide groups of homogeneous variables for each year. As reported later, for each year we find 9 groups of variables, being the composition of each cluster quite stable throughout the time. For brevity we do not report the results of the cluster analysis.[3]

In a multi-year study such as ours we face the problem concerning the most relevant year to determine a possible bankruptcy. In other terms, if we analyze the defaults in 2009 based on the differences in variables between 2003 and 2008, a simple eyeball analysis would identify the default banks. But we aim to develop a process that allows us to predict the likelihood of bankruptcy some time ahead, which requires a yearly analysis of all the variables. The complexity of such process suggests the implementation of complex computational methods such as neural networks.

An additional problem is the identification of the variables with the most predicting power within each cluster. Following the Basel II Accord, banks have to classify their loan portfolio and identify the risks they may face through its lending and investment practices to

[2] The type I error is the possibility of classifying as wealthy a company in financial distress.

[3] Results are available from the authors upon request.

ensure that they hold enough capital reserves. Banks are given some freedom to choose the calculation method of credit and operational risk, but these methods have to be calibrated periodically to find out which variables are the most informational to predict defaults in loans portfolios. The most widely used tools for calibration are the ROC (receiver operating characteristic) curves and the power indexes such as the Gini index or the PowerStat (PS)[4]. These indexes are a metric of the model ability to classify correctly the dependent variable. Therefore, they provide a relative metric of how close an actual model or variable is to the ideal model of prediction. The ideal Gini's index is 100%, which means that the model predicts perfectly the distressed firms. The lower the index, the worse the predictive power of the model. The PowerStat index is also a measure of the discriminant power. Although not exactly the same, the value is supposed to be similar to the Gini's index.

To some extent, this process is a univariate predictive analysis which allows us accomplishing one of our objectives. By calculating the individual predictive power of each variable we can assess its relative impact and the evolution throughout the time. Depending on its degree of influence this variable has to be reinforced or drop out of the calibration process.

In Table 2 we report the predictive power for each year and each variable. Taking into account this information, we select the 15 variables with the highest predictive power. The decision about the number of selected variables is ad-hoc since it has to balance pro's and con's of choosing many variables and depends on the correlation among variables. On the one hand, too few variables will result in a poor predictive model. On the other hand, too many variables will mean the reiteration of the information contained in each variable and will lead to a too complex model.

The model has been implemented through the PASW18 software. The dependent variable is a dummy one: it equals 1 whether the bank has gone bankruptcy and equals 0 otherwise.

[4] For a more detailed explanation of both indexes, please see the Appendix.

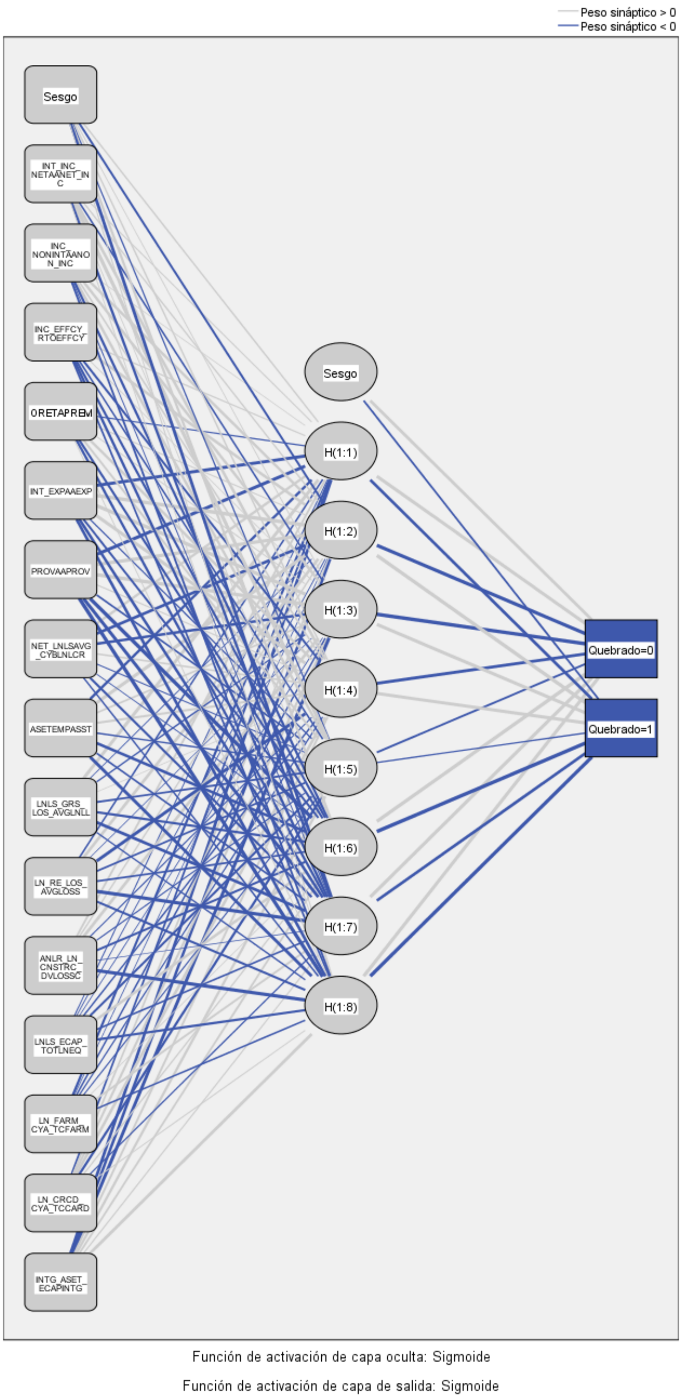
Table 2: Power predictive of each variable in all the models

In bold font the variables included in each model because of their higher predictive power

Variable	6 years		5 years		4 years		3 years		2 years		1 year	
	PowerStat	Gini	PowerStat	Gini	PowerStat	Gini	PowerStat	Gini	PowerStat	Gini	PowerStat	Gini
INC	**32.40%**	**32.48%**	**42.04%**	**41.67%**	**55.83%**	**55.78%**	**65.48%**	**65.82%**	**60.67%**	**60.54%**	3.34%	4.08%
EXP	13.96%	14.29%	**25.17%**	**24.83%**	**44.46%**	**44.05%**	**57.45%**	**57.31%**	**64.14%**	**64.12%**	**70.37%**	**69.90%**
NET_INC	**22.62%**	**22.92%**	**24.95%**	**25.17%**	29.77%	29.93%	30.79%	30.27%	11.98%	12.24%	**55.70%**	**55.78%**
NON_INC	6.30%	6.29%	9.14%	9.69%	10.19%	9.86%	24.57%	25.00%	**34.52%**	**34.52%**	**46.31%**	**46.43%**
NON_EXP	14.05%	13.61%	5.73%	4.93%	2.24%	2.38%	7.22%	7.31%	3.69%	3.06%	12.33%	12.07%
PROV	**37.41%**	**37.41%**	**46.70%**	**46.77%**	**34.56%**	**34.69%**	**39.31%**	**39.63%**	**56.52%**	**56.63%**	**85.75%**	**85.20%**
EASST	14.91%	14.41%	**21.68%**	**21.43%**	17.93%	16.84%	15.12%	15.31%	13.93%	14.63%	4.73%	5.44%
LNLCR	1.98%	2.72%	3.19%	2.72%	6.50%	6.63%	10.90%	11.56%	27.11%	27.55%	**75.87%**	**75.51%**
EFFCY	3.47%	3.57%	6.57%	5.95%	20.66%	20.75%	28.51%	28.74%	8.82%	9.18%	**50.53%**	**51.19%**
PERS	**35.60%**	**35.37%**	**31.56%**	**31.29%**	**32.37%**	**32.31%**	**41.46%**	**41.67%**	**43.48%**	**43.71%**	**47.62%**	**47.96%**
ASST	**17.27%**	**17.01%**	**26.51%**	**26.70%**	**30.59%**	**30.61%**	**35.64%**	**35.20%**	**43.11%**	**43.03%**	**47.70%**	**47.96%**
YLD_LNLS	12.18%	12.07%	12.56%	12.07%	**35.30%**	**34.86%**	**51.35%**	**51.19%**	**38.14%**	**37.93%**	33.05%	33.50%
YLD_DOM	13.49%	14.12%	14.54%	14.29%	**36.73%**	**36.39%**	**52.27%**	**52.55%**	**39.42%**	**39.80%**	31.05%	31.29%
MBS_YLD	6.71%	6.63%	0.09%	0.68%	4.46%	4.81%	2.99%	2.89%	6.89%	7.31%	18.74%	18.71%
HIGH_INT	3.13%	3.57%	15.15%	15.48%	**40.00%**	**39.97%**	**44.90%**	**45.75%**	**34.44%**	**34.69%**	37.77%	36.90%
BAL	12.48%	12.59%	9.74%	10.03%	7.68%	7.65%	7.67%	7.65%	3.57%	3.23%	6.05%	5.61%
NLLA	5.24%	5.10%	8.18%	7.99%	9.28%	8.84%	12.83%	12.76%	7.76%	7.14%	19.10%	19.05%
FIX	9.60%	10.03%	4.40%	4.08%	2.05%	1.70%	1.54%	1.70%	1.25%	0.85%	1.85%	1.87%
PREM	7.42%	7.82%	11.01%	10.88%	5.98%	5.95%	11.19%	11.39%	26.19%	26.36%	61.69%	61.56%
MMDA	**22.97%**	**23.47%**	20.40%	20.41%	17.86%	18.20%	16.96%	15.99%	18.20%	18.71%	5.96%	5.95%
DEP	**29.73%**	**29.25%**	**39.07%**	**39.29%**	**46.33%**	**45.92%**	**52.39%**	**52.21%**	**42.92%**	**42.69%**	26.75%	26.70%
TMDEP	**31.20%**	**30.61%**	**34.35%**	**34.01%**	**45.63%**	**45.41%**	**52.61%**	**52.38%**	**38.06%**	**38.27%**	26.81%	26.53%
LNLL	7.56%	7.31%	7.47%	6.97%	19.07%	19.05%	4.81%	4.76%	18.12%	18.71%	**73.63%**	**73.47%**
LNLR	**33.83%**	**33.67%**	**32.82%**	**32.65%**	35.35%	35.03%	**37.85%**	**37.59%**	31.23%	30.95%	0.36%	0.51%
LOSS	3.95%	4.25%	3.00%	3.57%	13.30%	12.93%	3.19%	3.23%	27.13%	27.04%	**73.51%**	**72.96%**
LOSSC	**56.57%**	**56.97%**	**64.08%**	**64.12%**	**74.05%**	**73.98%**	**43.56%**	**43.54%**	9.07%	8.84%	**68.12%**	**67.86%**
LOSSCS	**87.42%**	**83.33%**	**86.77%**	**86.47%**	**81.12%**	**81.22%**	**73.31%**	**73.80%**	**79.38%**	**79.43%**	**74.27%**	**74.44%**
OFCR	3.86%	2.32%	9.90%	10.03%	1.59%	0.79%	5.43%	5.97%	4.71%	4.42%	4.20%	4.74%
OFCR_AST	2.66%	3.06%	10.27%	10.01%	0.60%	0.12%	3.41%	3.27%	3.51%	3.08%	3.30%	2.86%
CONS	13.67%	17.64%	16.54%	15.90%	16.75%	17.40%	16.60%	16.17%	9.23%	9.53%	15.23%	14.85%
FARM	**27.62%**	**27.55%**	**28.43%**	**27.92%**	25.32%	25.23%	29.49%	29.48%	**31.69%**	**31.81%**	29.76%	29.69%
CMID	13.18%	20.27%	19.58%	19.17%	14.00%	13.79%	11.41%	11.20%	10.62%	11.12%	14.13%	14.78%
CARDO	11.06%	6.80%	10.60%	9.85%	5.25%	5.04%	8.08%	7.24%	17.29%	17.64%	19.73%	19.43%
CARD	**44.91%**	**44.73%**	**40.61%**	**40.22%**	**36.17%**	**35.71%**	**39.53%**	**39.31%**	**44.94%**	**44.73%**	**45.62%**	**45.84%**
REAL	**15.35%**	**14.85%**	11.38%	11.39%	24.81%	24.04%	13.99%	14.18%	6.49%	6.23%	5.54%	5.97%
LNEQ	12.03%	14.89%	18.78%	18.60%	20.01%	20.35%	20.02%	20.41%	12.28%	11.74%	15.87%	15.97%
NET_INCEQ	1.88%	1.71%	12.24%	12.44%	16.94%	16.97%	19.82%	19.77%	22.20%	21.74%	0.78%	1.12%
INTG	**51.64%**	**51.36%**	**51.82%**	**51.80%**	**51.24%**	**51.55%**	**49.00%**	**49.29%**	**45.59%**	**45.55%**	**50.44%**	**50.49%**
TIER2	2.32%	5.37%	8.62%	8.81%	11.58%	11.40%	14.91%	14.87%	12.99%	13.31%	12.49%	12.36%
TIER1	0.21%	0.68%	3.02%	1.87%	7.10%	6.79%	8.87%	8.33%	10.53%	10.88%	9.31%	9.59%
RISK	5.79%	6.12%	7.18%	6.73%	13.54%	13.73%	13.99%	14.45%	11.80%	11.49%	12.38%	12.35%

The output of our model is a set of relations among variables that explain bank defaults from 2003 in after and with up to 6 years in advance to the bankruptcy. Thus, we have the yearly likelihood in 2003-08 of going bankruptcy in 2009. This output is different for each year. Obviously, the shortest the difference between the year analyzed and the bankruptcy, the better the performance of the model. Therefore, we display the one year predictive model in Figure 1.

Figure 1: Graphic representation of the model for prediction to one year



The architecture of our model is tailored and the software is allowed to choose the number of hidden layers. The change of scale to activate the hidden layer and to obtain the output layer is a sigmoid function. The network training is batch one, with initial lambda of 0.0000005, initial sigma of 0.00005, the centre of the interval fixed around 0 and displacement of +/- 5. The optimization algorithm is the scaled conjugated gradient (Möller, 1993).

4. Results

4.1. Descriptive results

As previously stated, in Table 2 we report the predictive power of the 41 initial variables for each year according to the Gini index and the PowerStat index. There are remarkable differences among the predictive power of the variables for each year. These differences arise due to timing effects of the economic activity, business cycles and the characteristics of the sample for each year. Therefore, we do not include the same variables for all the years but we select for each year 15 variables depending on their predictive power. This choice also depends on the information available for each year and on the cluster to which the variable belongs.[5] The total number of variables included in at least one model is 30. In Table 3 we provide the Pearson correlation coefficients among the 15 variables included in the last year model[6]. As it can be seen, most of the coefficients are quite low, which confirms the selection of variables.

We have defined one model for each year, so we have six models. Each model tries to explain and predict bank failures in 2009 using the information available in each year and based on the validation sample. It makes sense that the performance of the model increases as long as we move closer to 2009. This assertion is supported by Figure 2 and Table 4 and. In Figure 2 we display the predictive power of each model. As shown, this power increases from 55% in 2003 (6 years ahead the bankruptcy) to 90% in 2008 (one year before the bankruptcy). Table 4 provides more detailed information to enable the comparison among models. As shown, the training and trial squared errors decrease as long as we approach 2008. In addition, the right side column shows how the area below the ROC curve increases from 0.757 to 0.96.

[5] Models for prediction to one or two years ahead include variables from 6 out of the 9 clusters.

[6] Data with the correlation of the 41 variables is available from the author upon request

Table 3: Table of Pearson correlation coefficients

	NON_INC	EFFCY	PREM	EXP	PROV	LNLCR	ASST	LNLL	LOSS	LOSSC	LNEQ	FARM	CARD	INTG
NET_INC	0.127	-0.459	-0.426	-0.648	-0.501	-0.493	-0.443	-0.488	-0.498	-0.416	-0.109	0.040	-0.049	0.104
NON_INC		-0.078	0.035	-0.232	0.039	0.059	-0.196	0.055	0.057	0.064	-0.045	-0.061	-0.017	0.027
EFFCY			0.468	0.336	0.357	0.361	0.213	0.363	0.353	0.293	0.067	-0.053	-0.033	-0.028
PREM				0.400	0.410	0.448	0.058	0.442	0.441	0.373	0.144	-0.034	-0.009	-0.046
EXP					0.466	0.446	0.453	0.439	0.442	0.383	0.161	-0.043	0.038	0.018
PROV						0.903	0.197	0.893	0.873	0.659	0.120	-0.081	0.041	-0.013
LNLCR							0.229	0.994	0.959	0.761	0.099	-0.111	0.039	0.031
ASST								0.227	0.245	0.306	0.093	0.008	0.000	-0.047
LNLL									0.951	0.762	0.100	-0.116	0.030	0.021
LOSS										0.808	0.080	-0.107	0.016	-0.002
LOSSC											0.103	-0.101	-0.008	-0.013
LNEQ												-0.005	0.018	-0.084
FARM													-0.009	-0.063
CARD														0.047

Figure 2: Predictive power of each model

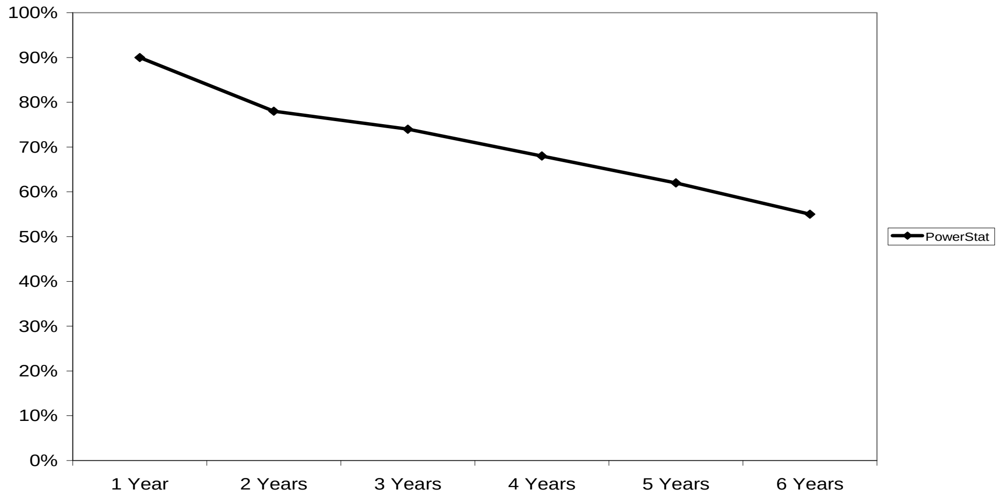


Table 4: Performance of each model

Model	Sample size	Training squared errors	Trial squared errors	Area below ROC
6 years	235	30.695	11.881	0.757
5 years	264	24.371	12.687	0.805
4 years	249	25.031	8.338	0.839
3 years	245	17.778	5.373	0.895
2 years	240	15.608	5.909	0.904
1 year	231	2.95	6.578	0.96

To avoid too much dispersion in the presentation of our results, we focus on the two closest to bankruptcy models (2007-2008). Table 5 reports the variables with the highest predictive power one year and two years before bankruptcy. We also report the p-value for the test of means comparison between defaulted and non-defaulted banks.

This table provides interesting insights about the evolution of distressed and non-distressed banks two years before bankruptcy. This is in line with the first objective of our paper concerning the identification of the main characteristics of defaulted banks some time ahead the bankruptcy. First, these banks had higher interest income than their counterparts (INC variable). The difference between both groups of banks is statistically significant only for the 2007 model. Indeed, INC has enough predictive power only for this model. Distressed banks also report more provisions (PROV) than their counterparts. Although PROV shows significant differences in both years, the difference increases from 2007 to 2008. This fact may be the consequence of higher default rates and is likely to result in lower profits.

Table 5: Power predictive of each variable in the two latest models

	Two years model (2007)				One year model (2008)			
Variables	Gini	Defaulted banks	Non-defaulted banks	*p*-value	Gini	Defaulted banks	Non-defaulted banks	*p*-value
INC	60.54%	74,017.00	65,030.00	0.00		58,155.08	58,755.11	0.48
PROV	56.63%	5.44	0.81	0.00	85.20%	29.61	2.56	0.00
YLD_LNLS	37.93%	84,568.40	78,439.39	0.00	-	65,956.80	70,684.03	0.00
YLD_DOM	39.80%	84,604.58	78,285.09	0.00	-	65,949.69	70,417.89	0.00
EXP	64.12%	35,532.04	28,618.16	0.00	69.90%	30,210.23	22,781.46	0.00
PERS	43.71%	684,178.67	555,863.17	0.00	-	725,237.27	577,314.06	0.00
ASST	43.03%	53,054.81	38,169.79	0.00	47.96%	60,173.76	40,559.44	0.00
NET_INC	-	38,485.02	364,113.86	0.05	55.78%	27,944.81	35,973.69	0.00
NON_INC	-	3.11	3.31	0.91	46.43%	2.27	3.05	0.26
EFFCY	-	655,375.65	665,368.16	0.66	51.19%	1,482,006.71	681,723.65	0.00
LNLCR	-	2.28	1.17	0.14	75.51%	25.45	2.71	0.00
HIGH_INT	34.69%	49,631.14	47,329.78	0.00	-	42,416.88	39,287.17	0.00
LNLR	30.95%	0.04	0.20	0.09	-	0.54	0.14	0.26
LOSSC	-	6.22	2.77	0.16	67.86%	53.13	6.81	0.00
LNLL	-	2.53	1.50	0.20	73.47%	26.69	3.11	0.00
LOSS	-	2.50	0.66	0.02	72.96%	26.24	2.07	0.00
INTG	45.55%	46.94	54.94	0.64	50.49%	32.96	46.10	0.33
LNEQ	-	68,697.32	63476.12	0.15	15.97%	70,753.65	65,087.88	0.11
TMDEP	38.27%	210,089.05	157,917.12	0.00	-	195,868.40	156,898.27	0.00
MMDA	-	146.48	115.64	0.02	-	132.21	119.27	0.32
DEP	42.69%	590,077.33	662,481.01	0.00	-	603,026.32	651,798.50	0.00
PREM	26.36%	2.00	0.66	0.04	61.56%	12.44	1.36	0.00
CARD	44.73%	9.82	9.05	0.84	45.84%	9.38	6.66	0.39
FARM	31.81%	307.86	509.25	0.06	29.69%	327.80	495.29	0.15

Interestingly, the yield of loans –both total loans and mortgage backed loans- (YLD_LNLS and YLD_DOM) shows a reversion. Whereas two years before bankruptcy distressed banks received higher yields, the situation switches one year before bankruptcy. This is consistent with defaulted banks collecting higher interest income enough time before bankruptcy. Nevertheless, the worse credit quality of these banks leads to worsening loans yields one year later. This fact has to do with a possible credit expansion of distressed banks through riskier credits as a consequence of the economic upturn in 2006 and 2007 in the US.

Interest expenses (EXP) are significantly higher for distressed banks in both years. This difference corroborates the more aggressive strategy of these banks. Paying higher interests allowed these banks taking deposits and investing in riskier loans for a fast growth in a quite competitive market. The economic downturn in 2008 and the lack of liquidity in financial markets could also force these banks to pay even higher interest rates to keep their market share.

Distressed banks show a higher average personnel expense too (PERS). This is in contrast with higher assets per employee (ASST) in these banks. Surprisingly, the efficiency index (EFFCY) has not enough predictive power two years before bankruptcy and is significantly higher in distressed banks the year before bankruptcy. This result should be emphasized since it suggests that bank failures are not due to low cost efficiency but to too much credit risk exposure and to an unbalanced loan portfolio structure.

Coherently with more provisions created in distressed banks, these banks reported more losses (LOSSC) the year before bankruptcy by loans to construction and land development. Nevertheless, there were not significant differences two years before bankruptcy. This fact lends support to models for bankruptcy prediction since operating losses do not allow discriminating between distressed and non-distressed bank enough time ahead. In contrast with the lack of signification of LOSSC, the loss from real state loans (LOSS) is significantly higher in both years for distressed banks. This pair of results could suggest a higher concentration of distressed banks in construction loans and a process of deterioration triggered by the real estate crisis.

Although having high enough predictive power, intangible assets (INTG) do not show significant differences between both groups of banks. Finally, distressed banks take fewer deposits in foreign offices (DEP) and own higher real estate (PREM). These facts are consistent with less diversification of these banks.

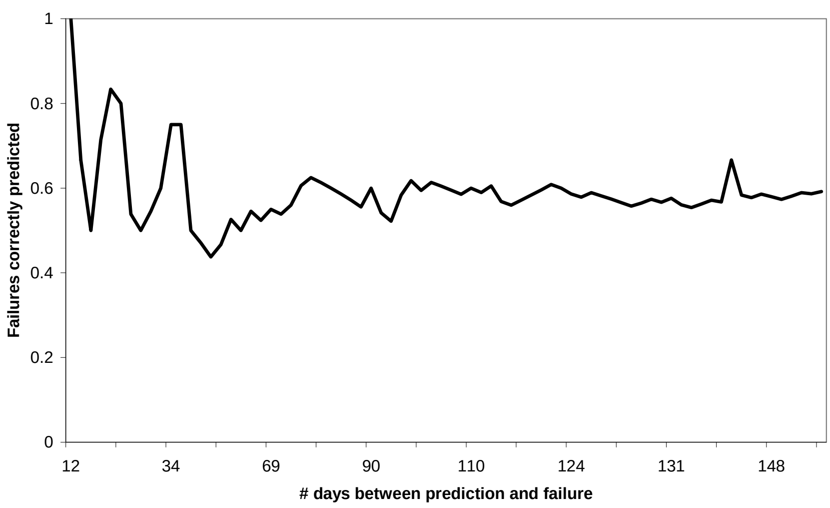
Taken together, all the previous results provide a clear portray of the crisis of US banks in 2009. From 2006 on, and as a consequence of the US business upturn fuelled by low interest rates, financial institutions expand and try to gain market share as quick as possible. The real estate boom along with low interest rates impelled banks to grant loans to construction and land development irrespective of the credit quality. Distressed banks succeeded in taking more deposits than their counterparts in order to reinvest in the real estate industry, achieve high loans yield and pay back higher interest rates to depositors. Due to the business downturn in 2008 and the fall of the prices of real estate collateral, these banks faced a growing default rate, had to create more provisions, and accumulate a troublesome portfolio of real estate. The provisions impacted negatively the earnings and the solvency of the bank worsened. The liquidity crisis constrained the possibility of improving the solvency of the banks through equity issuance and banks had to pay higher interest rates. These growing interests on deposits along with low interests on loans led to a negative margin. This vicious circle cannot be kept for long time and the financial authorities must intervene.

4.2. Results of the predicting model

Our second objective is providing a useful tool for bankruptcy prediction. This forecast should not be done for more than two or three years ahead given the changing conditions in the current macroeconomic environment. Thus, we compute the probability of the US banks to go bankruptcy between January 2010 and December 2011. More specifically, we compute two different probabilities: the likelihood of going bankruptcy during 2010 and during 2011. Since there may be some divergence between both of them, we take the highest value. Therefore, we could say that we provide information about the probability of US banks to go bankruptcy within two years based on the financial statements on December 2009.

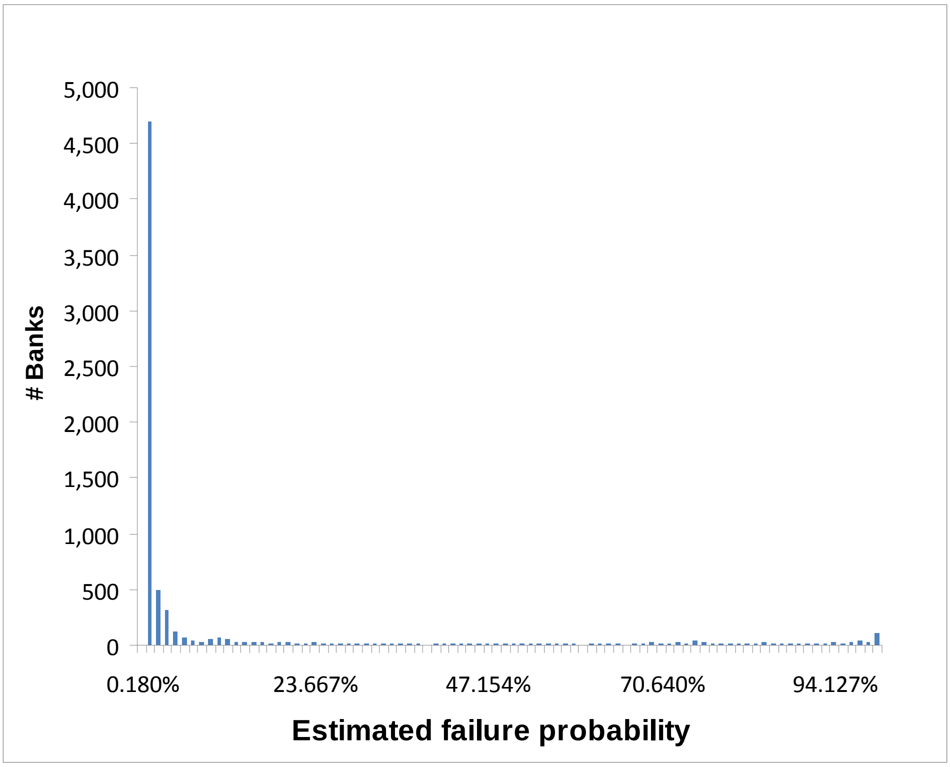
The implementation of a bankruptcy prediction model may lead to two different errors. The type I error is the possibility of classifying as wealthy a company in financial distress. On the contrary, the type II error is the possibility of considering in financial distress a wealthy bank. To rule out the possibility of error type I, we apply our model to the US banks which went bankruptcy between January 1st and June 18th, 2010. The Federal Financial Institutions Examination Council reports 76 bank failures within this time. When we apply our model to each bank on the base of the information available in December 31st of 2009, we find that the average probability of failure of these distressed banks is 57.01%. Since our model identifies as distressed the observations with probability higher than 0.5, this means that, on average, our model would have identified the defaulted banks some months before the bankruptcy happens. Furthermore, 59.21% of observations have default probability higher than 0.5.

Figure 3: Proportion of failures correctly predicted



These results suggest a couple of comments. First, the model shows a good performance since it allows predicting correctly around 60% of bank failures. It is not surprising that a number of banks to be in financial distress show low probability of failure because it is impossible to forecast all the failures. Moreover, it must be a cause of concern that the credit risk may affect banks with *a priori* low probability of distress. Second, the performance of our model keeps at a high level throughout 2010, as shown in Figure 3. In this figure we report the proportion of banks failures correctly predicted by our model depending on the time distance between the failure and December 31st, 2009. Obviously, the model exhibits the highest proportion of correct predictions in the first month, but then a flat evolution around 60% of correct predictions may be noticed.

Figure 4: Number of banks depending on the failure probability



As far as type II error is concerned, we run our model on the whole population of US banks. It amounted to 7.279 banks at the last day of 2009. The possibility of error type II can be ruled out by analyzing the distribution of probability across all the population of US banks. As shown in Figure 4, most of the banks are concentrated in the left side of the figure: the probability of failure is lower than 0.01 in 59.05% of banks, lower than 0.025 for 71.15% of banks, lower than 0.05 for 77.41% of banks and lower than 0.1 for 80.4% of banks. On the contrary, there are 835 banks (11.47% of the US banking system) with failure probability higher than 0.5; 756 banks with failure probability higher than 0.6; 636 banks with failure probability higher than 0.7; 442 banks with failure probability higher than 0.8; 295 banks with failure probability higher than 0.9; 220 banks with failure probability higher than 0.95; and 14 banks with failure probability higher than 0.99. As we can see, 4.05% of US banks had a default probability within two years higher than 90% and 0.2% of US banks had 99% of default probability within 2010-2011. The average probability for the sample is 0.12% and the median value is 0.007. These figures are clearly different from the ones of the distressed banks and corroborate the accuracy of our prediction.

For an easier interpretation of our results, Table 6 provides a summary of the results and the corresponding errors. As one can see, our model predicts 45 out of 76 bank defaults, so that the type I error is 40.78 percent. Although this error could seem too high, we should keep in mind that we do not assert that the 31 unpredicted banks will keep on operating. The output of our model is that 45 out of the 76 bank failures could have been predicted in advance. In addition, the type II error rate in our model is 11.59 percent since our model predicts as likely failures 835 banks that kept on operating in June 18th, 2010. Again, although a seemingly too high error rate, this result must be taken with some caveats since a higher number of bankruptcies could arise after that day. All these results have been calculated assuming as default a bank with a failure rate over 0.5. A higher rate would have increased the type I error at the same time that would have decreased the type II error.

Table 6: Summary of predictive results and errors

		Prediction		
		Defaulted	Not defaulted	
Defaulted	76	45	31	Error I: 40.78%
Not defaulted	7203	835	6368	Error II: 11.59%

5. Summary and conclusions

The current financial crisis, the dynamism of financial markets and the globalization process have accelerated the obsolescence of bankruptcy prediction models and emphasized the need to reformulate these models. Neural networks arise as a powerful tool to enhance the models flexibility and dynamism and to identify the most outstanding patterns to forecast financial distress.

We provide a new model to predict bank defaults some time before the bankruptcy happens. Our model grounds on financial variables previously used in the literature but we introduce some innovates in the definition of the variables and update the method consistent with the new business and economic conditions.

Our model allows us explaining the defaults in the US banks in 2009. The variables with the highest predictive power show that distressed banks have carried out an aggressive strategy of deposits taking which has resulted both in higher interest income and expenses. Their worse loan portfolio has forced the creation of more provisions for defaults and resulted in the sudden arise of losses short time before the bankruptcy. We also find that distressed banks follow a less diversified strategy, with more concentration on the domestic market and on the real estate industry. Surprisingly, defaulted banks do not shown differences in terms of efficiency with their wealthier counterparts, so that bank failures are not a consequence of bad cost efficiency but of a careless loans and deposits strategy.

After drawing the profile of distressed banks, we use our model to predict possible future bankruptcies and we test the performance of the model by comparing our predictions with the actual bankruptcies between January and June 2010. Our model shows a high discriminant power and is able to differentiate wealthy and distressed banks. More specifically, our model would have been able to predict around 60% of failures in December 2009.

One direction for future research is the extension of our model to the European international framework. It would be interesting to check to which extent different national regulations are answers to credit risk and even to identify the best performing regulations. Another application could be assessing whether the wave of mergers and acquisitions among banks (for instance, among the Spanish saving banks) reduces the bankruptcy risk and reinforces the solvency of financial institutions.

References

Altman, E. (1968): "Financial ratios, discriminant analysis and prediction of corporate bankruptcy" *Journal of Finance*, pp. 589 – 609.

Altman, E.; Marco, G. and Varetto, F. (1994): "Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks". *Journal of Banking and Finance* vol.18, pp. 505-529.

Angelini, E.; di Tollo, G. and Roli, A. (2007): "A neural network approach for credit risk evaluation". *Quarterly Review of Economics and Finance* vol.48, pp. 733-755.

Atiya, A. F. (2001): "Bankruptcy prediction for credit risk using neural networks: A survey and new results". *IEEE Transactions on Neural Networks* 12(4), 929-935.

Beaver, W. H. (1966): "Financial ratios as predictors of feilure", empirical Research in Accounting: *Journal of Accountant Research* vol.4, pp. 71 – 111.

Bernhardsen, E. (2001): "A model of Bankruptcy prediction". Working paper financial analysis and structure department, Research department, Norges Bank, Oslo.

Cinca Serrano, C. and Martín del Río, B. (1993): "Predicción de la quiebra bancaria mediante el empleo de redes neuronales artificiales", Revista Española de Financiación y Contabilidad. Vol. XXIII, No. 74. pp. 3153 –3176.

Castaño, F.J. and Tascón, M.T. (2009): " Predicción del fracaso empresarial: Una revisión". Comunicación presentada al XV Congreso AECA, Valladolid,

Coats, P. and Fant, L. (1993): "Recognizing financial distress patterns using a neural network tool". *Financial Management* vol.22, pp.142-155.

Fulmer J.G.Jr, Moon J.E., Gavin T.A. and Erwin M.J. (1984): "A bankruptcy classification model for small firms". *Journal of Commercial Bank Lending*, vol.66 (11), pp. 25-37

Fernández, E. and Olmeda, I. (1995): "Bankruptcy prediction with artificial neural networks". *Lectures Notes in Computer Science* 930, pp. 1142-1146.

Hol, S. (2006): "The influence of the business cycle on bankruptcy probability", Discussion papers No. 466, Statistics Norway, Research Department.

Jo, H.; Han, I. and Lee, H (1997): "Bankruptcy prediction using case-based reasoning, neural networks, and discriminant analysis". *Expert Systems with Applications* 13(2), pp. 97-108.

Jardin, P. (2010): "Predicting bankruptcy using neural networks and other classification methods: The influence of variable selection techniques on model accuracy*". Neurocomputing* 73, pp. 2047–2060.

Hung, C., Chen, J.H. and Wermter, S. (2007): "Hybrid probability-based ensembles for bankruptcy prediction". *Proceedings of International Conference on Business and Information*.

Laffarga, J. B. and Mora, A. E. (1998): Los Modelos de Predicción de la Insolvencia Empresarial: Un análisis Critico. In A. S. Calvo-Flores & D. P. L. García (Eds.), *El Riesgo Financiero de la Empresa*. AECA, Madrid. pp.11-58.

Möller, M.F. (1993): "A scaled conjugate gradient algorithm for fast supervised learning". *Neural Networks* vol. 6(4), pp. 525-533.

Odom, M. and Sharda, R. (1990): "A neural network model for bankruptcy prediction". *Proceedings of International Joint Conference on Neural Networks*, pp. 163-168.

Ohlson, James. (1980): "Financial Ratios and Probabilistic Prediction of Bankruptcy". *Journal of Accounting Research* vol.18(1), 109-131.

Peat, M. J. (2003): “Factor affecting the probability of bankruptcy”. Working paper No. 130. School of business and economics, University of Technology Sidney.

Piramuthu, S. (1999): “Financial credit-risk evaluation with neural and neurofuzzy systems”. *European Journal of Operational Research* vol.112, pp. 310-321.

Pina Martinez, V. (1989): “La información contable en la predicción de la crisis bancaria 1977-1985”. *Revista Española de Financiación y Contabilidad* vol. 19(58), pp. 309–338.

Rojas, R. (1996): *Neural network*. Ed. Springer-Verlag Berlin.

Salchenberger, L; Cinar, E. and Lash, N. (1992): Neural networks: A new tool for predicting thrift failures”. *Decision Sciences* vol.23, pp. 899-916.

Tsai F.Ch. and Wu J.W. (2008): “Using neural network ensembles for bankruptcy prediction and credit scoring”. *Expert Systems With Applications* vol.34, pp. 2639 – 2649.

Vellido, A.; Lisboa, P., and Vaughan, J. (1999): “Neural networks in business: A survey of applications (1992-1998)”. *Expert Systems with Applications* vol.17, pp. 51-70.

Wilcox, J.W. (1971): A simple theory of financial ratios as predictors of failure. *Journal of Accounting Research* vol.3, pp. 389-395.

Wu, C. and Wang, X.M. (2000): “A neural network approach for analyzing small business lending decisions“. *Review of Quantitative Finance and Accounting* vol.15(3), pp. 259-276

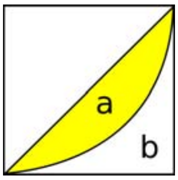
Zhang, H. Y. Michael. Patuwo Eddy B. Indro C. Daniel, 1999. “Artificial neural networks in bankruptcy predition: General framework and cross – validation analysis”, *European Journal of Operational Research* vol.116, pp. 16 – 32.

Appendix: The Gini and PowerStat indexes

Both indexes are measures of a model ability to discriminate and to detect changes in predictions over time. For bankruptcy research, these models allow to quantify the degree of concentration of the failed banks in the groups most at bankruptcy risk.

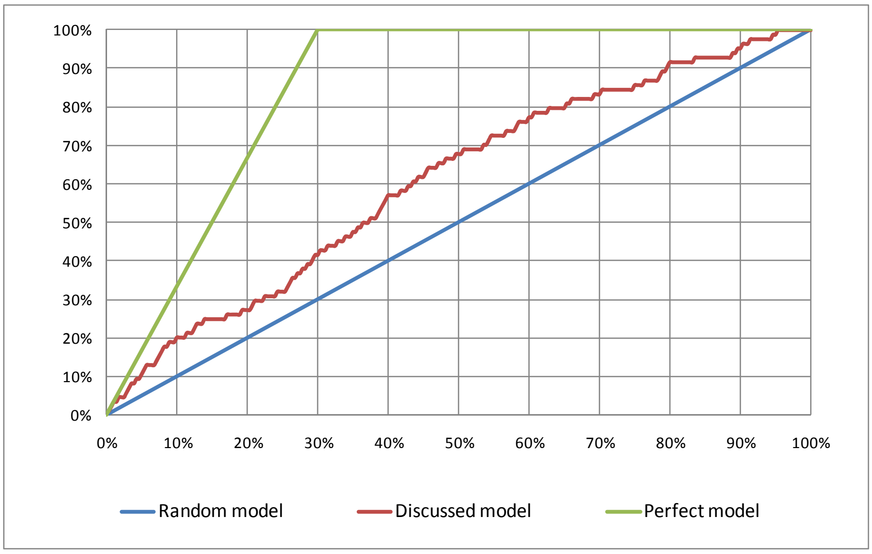
The Gini coefficient is often calculated with the Brown formula:

$$G = \left| 1 - \sum_{k=1}^{k=n-1} (X_{k+1} - X_k)(Y_{k+1} + Y_k) \right|$$



In the X-axis we place the sample under study, consisting of failed and not failed banks ordered on the basis of the default probability. Then, we divide the X-axis into 20 partitions. The vertical axis represents the cumulative percentage on the sample. The area "a" (power area) is calculated indirectly by calculating previously area “b”. The area over each one of the 20 partitions of the X-axis can be divided into a triangle and a rectangle, both of them with the same basis. The addition of the surface of these 20 partitions is the area “b”. The power area “a” is the difference between the area under the diagonal line and area “b”. The Gini index is equal to the area marked “a” divided by the sum of the areas marked “a” and “b”; that is, Gini = a/(a+b). If the model performs a perfect classification, the Gini index is 1. If the classification is completely random, the Gini index equals 0.

To compute the PowerStat index we order the sample of non-default and default banks from highest to the lowest probability of bankruptcy in the X-axis. In the Y-axis we place the cumulative percentage of bank failures. The sample should be partitioned in a number of partitions each one as thin as possible.



The allegedly perfect model should be the one that computes the most likely to fail banks in the first quantile. Then we calculate the area of the triangle from the Y-axis to the left of the perfect model.

$$\frac{\text{triangle base x height}}{2} = \frac{\text{total failed banks x} \frac{1}{\text{total observations}}}{2}$$

The PowerStat index is the relation between the area of the model of prediction and the perfect model. The area of the prediction model is computed as follows:

$$\sum_{i=1}^{n}(X_{i+1} - X_i)(Y_{i+1} - Y_i) = \sum_{i=1}^{n} \frac{1}{\text{total observations}}(Y_{i+1} - X_{i+1}) = \frac{1}{\text{total observations}} \sum_{i=1}^{n} Y_{i+1} - X_{i+1}$$

We then subtract the area of the triangle of the perfect model to the total area of the bisector (1/2):

$$\frac{1}{2} - \frac{\text{total failed banks x} \frac{1}{\text{total observations}}}{2}$$

The PowerStat index is the ratio:

$$\frac{A}{A+B} = \frac{\frac{\sum_{i=1}^{n} Y_{i+1} - X_{i+1}}{\text{total observations}}}{\frac{1 - \frac{\text{total failed banks}}{\text{total observations}}}{2}}$$

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