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Predictability of EU Bank Stress Test Results

Kian Guan Lim*

Since the global financial crisis of 2008 and the European sovereign debt crisis of 2009, the banking system in EU and in the Eurozone in particular has been under-performing and weak. The EU bank stress tests were conducted for capital adequacies and to avoid systemic risks. The first test results indicated that of over 120 banks, seven banks failed the stress tests. Spain, with 27 tested banks, made up the biggest portion of the test banks. In this paper we examine using nonlinear LOGIT and PROBIT regression models, the predictability of stress test failures on the sample of Spanish banks, and identify the principal risk factors to watch out for. We find that size, returns performance, and to some extent deposit base are significantly more important than other measures that may be small such as non-interest incomes and other measures that could be fungible such as altering debt durations without materially improve asset qualities or reducing liability servicing capacities. Predictability would enable advance warning and more time for such banks to repair and shape up.

JEL Codes: G210 and G2

1. Introduction

Since the global financial crisis of 2008 and the European sovereign debt crisis of 2009, the banking system in the European Union (EU) and in the Eurozone in particular has been under-performing and weak. The EU bank stress tests were conducted for capital adequacies and to avoid systemic risks. In this paper we study using nonlinear LOGIT and PROBIT regression models, the issue of the predictability of the stress test failures, and identify the principal risk factors to watch out for.

The academic literature on bank stress tests predictability is sparse. Most published papers including research papers from financial institutions and public authorities dealt with issues related to the benefits and consequences of such stress tests. For examples, Wolff (2011) provides a discussion on the need for EU stress tests with respect to significantly declining bank equity prices, and attributes the latter to two major factors – the loss of confidence in Euro area banking system and the sovereign debt problem of Greece. Zuzana and Petr (2012) express how stress tests can be useful to detect systemic risk in banking sector even in emerging markets such as Russia. Beltratti (2011) and Petrella and Resti (2013) find some evidence of useful information arising out of stress tests in reducing bank opacity. Peristiani et. al. (2010) reported similar kinds of results in the U.S. based tests. Cardinali and Nordmark (2011) look at stock abnormal returns surrounding the EU stress tests and concluded that there were either no significant change or else banks to be tested showed negative returns with announcement of a more stringent test methodology. These studies, however, do not discuss if accounting information contained in the financial reports of banks offer any predictability of stress test results in the immediate future or in the following months when stress test is to be conducted.

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Another line of literature seeks to understand the effectiveness of stress tests when given different macroeconomic scenarios and their risk implications. Foglia (2009) reviews macro stress testing methods developed at selected central banks and supervision authorities for stress testing the credit risk of banks using bank-specific measures of credit risk as inputs. Lu and Yang (2012) uses a vector autoregression method to find key predictive variables of non-performing loans in Chinese commercial banks. They concluded that lower growth rate of GDP, slump in CPI, slowdown in supply of nominal currency, and residential property prices were key predictors.

Covas et.al. (2013) employ a dynamic panel quantile econometric framework to estimate major components of net charge-offs and pre-provision net revenue in 15 U.S. bank holding companies using data from 2007-2011. Macro-stress factors were used as inputs and projects of future losses in terms of probability densities were possible, but it was not related directly to event-based dependent variables such as actual failure of a stress test that could spell immediate negative market reaction. Kupiec (2000) analyses the difference between stress tests and value-at-risk capital allocations. In these studies, there was no direct usage of bank accounting numbers nor any empirical estimation of stress results.

The key contributions of this paper include the investigation of the predictability model for how EU banks would pass the stress tests. Predictability would enable advance warning and more time for such banks to repair and shape up. This is one robust policy of re-building a considerably weakened European banking system through more thorough investigation of bank problems by the market using pre-stress test financial statements as information.

The EU as of 2014 is an economic and monetary union of 28 member states located in Europe. Its early beginning was the European Economic Community (EEC) based on the EEC Treaty of Rome in 1957 that brought together for purposes of trade and economic expansion France, Germany, Italy and the Benelux countries. The Maastricht Treaty, signed in 1992 and enforced in 1993, opened the way to political integration by reinforcing the powers of the European Parliament, launching the process for economic and monetary union (EMU), and transforming the EEC to become the European Union. The European Exchange Rate Mechanism (ERM) was subsequently introduced on 13 March 1979 to reduce exchange rate volatility and attain monetary stability in Europe. This eventually led to the introduction of a single currency, the Euro, on 1 January 1999.

However, so far only 18 of the 28 EU member states or member countries have adopted the Euro as their common currency. This group of 18 countries as a major part of EU consists of Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, The Netherlands, Portugal, Slovakia, Slovenia, and Spain, and are collectively called the Eurozone or Euro area. The key monetary policy unit of the EU is the European Central Bank (ECB) which has the exclusive right to authorize and supervise the issue of Euro banknotes by the national central banks of individual countries of the Eurozone.

The American subprime crisis that started the global financial crisis of 2008 had serious repercussions on banking systems worldwide, including banks in the EU. Some EU countries such as Ireland and Spain had similar real estate bubbles that burst. Other EU countries such as Greece, Italy, and Portugal had poor public finances. These problems were exacerbated by the global financial crisis, and led to a generally weak banking system.

UK also had its share of bank problems. The banking problems, worsening public debts, and recessionary economies led in large part to the sovereign debt crisis of Europe in 2009.

Suddenly the global market was not willing to buy some EU sovereign bonds unless at a very high yield. A heated debate on the European Union (EU) solution of the sovereign debt crisis in 2011 included the idea of the issue of Eurobonds with redemption as a joint responsibility amongst all EU countries. See Lane (2012) for a detailed discussion. Other details can be obtained from various EU Commission reports. Eventually this led to the formation of the Single Supervisory Mechanism (SSM) in early 2014. Under SSM re-organization, the European Central Bank (ECB) expanded its mandate beyond just Euro stabilization to include overseeing in a supervisory role all credit institutions as well as capital requirements compliance amongst Eurozone nations. Non-Eurozone EU countries may opt to join in this arrangement although none so far had opted so. See various sources of reports and analyses such as in Quaglia (2010), Sibert (2012), and also various reports in the Official Journal of the European Union (reports 2010, 2013), and so on.

The Committee of European Banking Supervisors (CEBS), set up in April 2004, had been serving the role as regulatory advisor and co-ordinator for consistent EU measures across the large number of member states. This role was deemed necessary at that time because banks from different countries within the EU had diverse characteristics and institutional practices. The re-organization and rationalization under SSM converted CEBS to the European Banking Authority (EBA). The key role of EBA is to ensure the orderly functioning and integrity of the financial markets and the stability of the financial system in the Eurozone with optional participation by other EU countries. See Véron (2012) for further discussion on this.

One of the key initiatives in 2009 and 2010, in the aftermath of the GFC and the European sovereign debt crisis, was for the ECB and CEBS (EBA today), in conjunction with the European Commission and the Economic and Financial Affairs section of the EU Council, to conduct stress tests of all EU banks in order to assess systemic problems of such banks, and also to improve the Eurozone financial system.[1] The success of the tests would be important not just for providing impetus for sound banks to improve lending and spur economic growth but also to create a more transparent and market-based financial system whereby banks are judged by their own credit-worthiness rather than that of their governments.

The ECB would ultimately take over the regulatory responsibility of Eurozone banks, and implicitly, banks that would fail the tests must either match up or be re-organized, be merged into stronger banks, or liquidated. The EBA would assist in ensuring consistent prudential regulation and supervision across the European banking sector, and work toward the development of a single rule book in the Eurozone banks.

In the next section we provide a more detailed discussion of the context of the banking stress test in the EU, and also describe the financial data to be used in our LOGIT and PROBIT regression models. Section 3 then discusses the approach using qualitative response models. This discussion will help identify the key explanatory variables to use in the nonlinear LOGIT and PROBIT regression models that are implemented. The empirical results are shown and interpreted. Finally, we conclude in Section 4 and provide some insights on the usefulness of the EU stress tests.

2. Bank Stress Tests and Data

Following on the heels of the 2008 global financial crisis sparked off by the sub-prime mortgage market meltdown in the U.S., the Eurozone also faced a major economic crisis in 2009 which has been lingering with most economies languishing in low or zero growth with the exception of stronger economies such as Germany and some Scandinavian countries in EU. Of late in the beginning of 2015, the Eurozone began quantitative easing, but the economic results would take some time to unravel. In recent years, noticeably past 2008, many countries in the Eurozone faced slowing recessionary economies and the build-up of huge budget deficits. Recession was exacerbated by previously huge credit expansions in private sector debts and the subsequent collapse of property prices and businesses in a few EU countries.

Many firms in countries such as Portugal, Spain and Italy, owed far too much debt and are not able to adequately service their loans. Ireland and Greece have also been badly affected, though with some different reasons. Greece has collected far less tax revenues than it has been able to overspend. Many banks in these countries and connected banks in other parts of the EU faced enormous credit exposures and losses as many loans they made to private sector firms defaulted. Through their central bank bailouts, much of the banking and economy woes were transferred to national levels. When some of the sovereign states issued too much sovereign bonds to help finance their countries' deficits or bank bailouts, the financial market became jittery.

Fears that some of these sovereign states would default on their sovereign debt issues became very real, and by 2010, their bond yield spreads reached unprecedented heights. For example, by May 2010, the yield spread between a 10-year Greek sovereign bond and a German sovereign bond exceeded 10 percentage points. By January 2012 this spread reached over 40 percentage points. See Lane (2012). In the aftermath, the ECB and to some extent the IMF had to step in to provide emergency funding to some of the sovereign states to avert such sovereign defaults. The issue of the exit or not of Greece from the EU is still outstanding due to its continued inability to adequately service its sovereign debts.

As a result of the sovereign debt crisis, the EU decided to tighten control of monetary policies across its Eurozone members so that the same mistakes such as allowing single countries to over-issue Euro denominated but country-specific sovereign bonds could be better controlled. This led to agreement to place supervision of all Eurozone banks under a single supervisory mechanism under the ECB by end 2014. One of the initiatives of ECB has been to assess the constituent banking groups of the Eurozone before assuming responsibility for full supervision. To this end, stress tests would be applied to over 120 banking groups covering assets estimated to be around €30 trillion.

Within EU, precursors to such bank stress tests were done by the Committee of European Banking Supervisors (CEBS) since 2009. This Committee was succeeded by the European Banking Authority (EBA) in January 2011. EBA is a regulatory agency of EU whereby its responsibilities include conducting stress tests on European banks. In early 2010, CEBS conducted a second stress test of 91 European banks across 20 countries in EU, including banks outside of the Eurozone such as in Denmark, Hungary, Poland, Sweden, and U.K. The test was to assess the resilience of the EU banking system and to test the ability of the individual banks or banking groups to withstand major shocks in credit and market risks, including sovereign risks, and to remain solvent.

There were three levels of the stress tests. Each level dealt with a set of scenarios, beginning with mild shocks to major shocks. At extreme stresses, scenarios incorporated the impact of a four-step credit rating downgrade on securitized debt products, a 20 percent slump in European equities in both 2010 and 2011 and an economic contraction in the EU, amongst others. The stresses would stretch over a two-year horizon from 2010 to end 2011. A bank under the test regime would pass the test if its Tier one ratio comprising the fraction of equity in risk-weighted assets exceeded 6 % in the three levels starting from Normal to Adverse, and then sovereign Shock scenarios. The EU-wide stress test results were disclosed on 23 July 2010. Seven banks failed the stress tests; five were from Spain, one in Germany, and one in Greece.

Spain, with 27 tested banks, made up the biggest portion of the test banks. The five Spanish banks that did not pass the 2010 CEBS stress tests were CajaSur, Diada, Unnim, Espiga Caja Duero, and Banca Civica. Spain's largest bank, Banco Santander SA, maintained its Tier 1 capital ratio at 10 percent under the most stringent scenario. In all, Spanish banks alone had capital shortfalls of several tens of billions of Euros. The test results helped the EU and its member states to assess and make policy decisions about what stringent measures to put in place to improve banking stability and what other capital requirement measures would be needed.

The results also affected market confidence in some of the banks that failed the test. Their share prices dropped. They might find it more difficult in the short-run to borrow from other banks or from the market except at higher interest costs. Therefore it was important for the banks and for the market to be able to predict the test outcomes. To the extent that the stress-test outcomes could be predicted in advance with reasonable accuracy, the ECB and related national agencies where predictably weak or likely failure banks reside would be able not to lose time but help the banks to re-organize and shape up.

We consider these 2009 Spanish banks that are marginal or failed cases of the EU 2010 stress test as being those with tier one ratio scores less than 7.0 in both categories of the Adverse and Shock scenarios. In the EU 2010 stress test of 27 Spanish banks, 12 were identified in this category, viz. Caja Madrid, Diada (Caixa Catalunya), Espiga Caja Duero (Caja Espana), Banca Civica, Banco Pastor, Caja Sol, Unnim, Caja Circulo, Cajasur, Banco Guipuzcoano, Caja de Ahorros Y Monte de Piedad de Ontinyent, and Colonya Caixa de Pollenca. Those not in this category were 15 Spanish banks that passed the capital adequacy stress test by a margin of over 1% in the tier one ratios. They were Grupo Santander, Grupo BBVA, La Caixa, Caja de Ahorros Mediterraneo, Banco Popular Espanol, Banco de Sabadell, Breogan Caja de Ahorros de Galicia, Mare Nostrum Caja de Ahorros de Murcia, Bankinter, Ibercaja, Unicaja, Bilbao Bizkaia Kutxa, Kutxa, Banca March, and Caja Vital Kutxa. As the cultural and institutional differences across banks in different countries and jurisdictions are very different as has been well recognized in the literature, and since the SSM would take time to work through to achieve more uniformity, we choose only Spanish banks to avoid other cultural and country factors to affect the empirical results.

Financial statements data of these Spanish banks in 2009 were downloaded from Bloomberg. However, 2009 data for Espiga Caja Duero, Banca Civica, and Unnim were not available. We thus consider a total of 24 Spanish banks in our study. As indicated above, they were in two groups, those with weak capital ratios that were marginal or failed cases in the 2010 stress tests, and those with stronger capital ratios that clearly passed the stress tests. There are 9 banks in the first group of our sample; each of these is given a

corresponding dummy variable equal to 1. There are 15 banks in the second group of our sample; each of these is given a corresponding dummy variable equal to 0.

3. Qualitative Response Models and Empirical Results

We now investigate how the passing or failing of a bank stress test can be constructed as a binary event, and how this can be predicted using relevant economic and financial information. The prediction takes the form of an estimated probability. A cut-off can be fixed so as to separate cases with higher probability and other cases with lower probability into different categories. Such binary or dichotomous variable can be represented by a non-zero number for one response, and zero for the alternative response. Without loss of generality, 1 and 0 are often taken to be the values of the binary variable. Classic cases of using such a qualitative response model include the studies of the credit worthiness of individuals and also the loan default likelihood of lending to firms. See Altman (1968) and McFadden (1976) for such examples.

In this study of bank stress prediction, the binary or dichotomous qualitative response of either being relatively unsafe or being relatively safe, with respect to stress test result of capital adequacy, is given a dummy value of 1 or 0 respectively. We want to predict ex-ante if any bank belongs to the relatively unsafe or the relatively safe category. The explanatory variables were collected ex-ante from the 2009 bank annual financial reports.

In the empirical example of the Spanish banks, for different bank i = 1, 2, 3, ….. , 24, we define Y_i = 1 for Caja Madrid, Diada (Caixa Catalunya), Banco Pastor, Caja Sol, Caja Circulo, Cajasur, Banco Guipuzcoano, Caja de Ahorros Y Monte de Piedad de Ontinyent, and Colonya Caixa de Pollenca. We define Y_i = 0 for Grupo Santander, Grupo BBVA, La Caixa, Caja de Ahorros Mediterraneo, Banco Popular Espanol, Banco de Sabadell, Breogan Caja de Ahorros de Galicia, Mare Nostrum Caja de Ahorros de Murcia, Bankinter, Ibercaja, Unicaja, Bilbao Bizkaia Kutxa, Kutxa, Banca March, and Caja Vital Kutxa. We run several regressions employing different sets of regressors X_i for each regression. The regressors used are ROE, Pre-tax Profit Margin, Total Debt/Total Asset, Log Book Value[2] of Equity, Non-Interest Income Share of Sales, and Log Total Deposits. Both LOGIT and PROBIT regressions are performed using the sample data to estimate the respective $\hat{b}_j$'s in each of the regressions.

Suppose we let

$$E(Y_i|X_i) = \text{Prob}(Y_i = 1|X_i) = F(\beta' X_i) = \frac{e^{\beta' X_i}}{1 + e^{\beta' X_i}}$$

Where the last term $\frac{e^{\beta' X_i}}{1+e^{\beta' X_i}}$ is a CDF with a logistic distribution. Using the specification $F(\beta' X_i) = \frac{e^{\beta' X_i}}{1+e^{\beta' X_i}}$ leads to the LOGIT model in the binary response regression.

The likelihood function of joint but independent N observations of {Y_1, Y_2, $Y_{3,....}$, Y_N} is thus $L = \prod_{i=1}^{N} [F(\beta' X_i)]^{Y_i} [1 - F(\beta' X_i)]^{1-Y_i}$. Maximizing the log-likelihood function log L, we obtain asymptotically efficient estimates $\hat{\beta}$. The LOGIT regression results of the Spanish banks are shown below in Table 1.

The empirical results in Table 1 indicate that the best-fitted regression (lowest AIC) involves explanatory variables ROE, Total Debt/Total Assets, and Log of Book Equity Value. Both the ROE and Log of Book Equity Value coefficients are highly negatively significant at 10% and 5% significance levels respectively. If we replace them by Pre-tax Profit Margin and Log Total Deposits, the results are rather similar but weaker in the latter. Thus more profitable banks (higher ROE) and larger sized banks (higher log Equity Value or log Deposits) reduce the likelihood or the probability of failing the stress test. Other variable coefficients such as that of Total Debt to Total Assets are not significantly different from zero.

Table 1: LOGIT Regression of Spanish Bank Stress Capacity

The table shows four separate regressions each with a sample size of 24. Dependent variable is a binary response of 1 or 0 where 1 denotes a weak capacity and 0 denotes a strong capacity to withstand a stress test on capital adequacy. ROE, PM, TD/TA, Log EQ, NII, Log TD, and AIC denote return on equity, pre-tax profit margin, total debt/total assets, log of book value of equity, non-interest income share of sales, log of total deposits, and the Akaike Information Criterion respectively. The estimated coefficients of regression on the explanatory variables are reported. Numbers in the brackets denote t-values. *, ** denote significance at 10% and 5% levels respectively.

No.	Constant	ROE	PM	TD/TA	Log EQ	NII	Log TD	AIC
1	14.8164**	-0.7346*		0.1198	-1.9341**			20.27
	(2.18)	(-2.04)		(1.72)	(-2.13)			
2	11.9530**		-37.2311*	0.0983	-1.6719*			20.37
	(2.09)		(-1.80)	(1.38)	(-1.98)			
3	13.2178*	-0.6844*		0.1155	-1.9758**	7.1694		21.98
	(1.90)	(-1.84)		(1.57)	(-2.15)	(0.52)		
4	18.8581*	-0.7488*		0.1103		-0.3539	-1.8787*	23.93
	(1.99)	(-2.06)		(1.63)		(-0.03)	(-2.03)	

Suppose now we let

$$E(Y_i|X_i) = \text{Prob}(Y_i = 1|X_i) = \Phi(\beta' X_i) = \int_{-\infty}^{\beta' X_i} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}Z^2} dZ \ .$$

Letting CDF function $F(\cdot)$ be the normal CDF leads to the PROBIT regression model. The log-likelihood function of joint but independent N observations of $\{Y_1, Y_2, Y_{3,\ldots}, Y_N\}$ is

$$\log L = \sum_{i=1}^{N} \left(1_{Y_i} \log \Phi(\beta' X_i) + \left(1 - 1_{Y_i}\right) \log[1 - \Phi(\beta' X_i)]\right)$$

Where 1_{Y_i} denotes the indicator variable taking value 1 only when $Y_i = 1$, and otherwise zero. Maximizing the log likelihood function, we obtain PROBIT model estimates as follows in Table 2.

The coefficient estimates under PROBIT are qualitatively the same as those in LOGIT, except the magnitudes are smaller. The data also appears to fit the PROBIT model slightly better given that the AIC's are smaller and the coefficient estimate for ROE, for example, is more significantly negative. In general, the CDF curve for PROBIT approaches the axis faster than that of LOGIT. This is the same as saying that the LOGIT probability density function is fatter in the tails than that of PROBIT.

Unlike linear regression models or linear probability model where estimated coefficient of an explanatory variable implies that an additional unit of the latter would increase the dependent variable or the probability of test failure by an amount equal to the estimated slope, the marginal effect of a unit change in X_{ij} is more complicated in the LOGIT and PROBIT models. Suppose we denote predicted probability as $E(Y_i|X_i) = F(\hat{\beta}'X_i)$, given predetermined or exogenous information X_i. Then the marginal increase in predicted probability of $Y_i = 1$ per unit increase of X_{ij} is $\frac{\partial F(\hat{\beta}'X_i)}{\partial(\hat{\beta}'X_i)}\ \hat{b}_j$.

Table 2: PROBIT Regression of Spanish Bank Stress Capacity

The table shows four separate regressions each with a sample size of 24. Dependent variable is a binary response of 1 or 0 where 1 denotes a weak capacity and 0 denotes a strong capacity to withstand a stress test on capital adequacy. ROE, PM, TD/TA, Log EQ, NII, Log TD, and AIC denote return on equity, pre-tax profit margin, total debt/total assets, log of book value of equity, non-interest income share of sales, log of total deposits, and the Akaike Information Criterion respectively. The estimated coefficients of regression on the explanatory variables are reported. Numbers in the brackets denote t-values. *, ** denote significance at 10% and 5% levels respectively.

No.	Constant	ROE	PM	TD/TA	Log EQ	NII	Log TD	AIC
1	8.7966**	-0.4294**		0.0689*	-1.1408**			20.03
	(2.41)	(-2.25)		(1.82)	(-2.33)			
2	7.1046**		-22.2494*	0.0586	-0.9895**			20.13
	(2.34)		(-2.01)	(1.50)	(-2.18)			
3	7.8193*	-0.4033*		0.0672	-1.1735**	4.5960		21.66
	(2.09)	(-2.00)		(1.67)	(-2.40)	(0.60)		
4	10.8098**	-0.4351**		0.0621		0.1760	-1.0772**	23.79
	(2.16)	(-2.26)		(1.68)		(0.03)	(-2.20)	

4. Conclusions

The results of the EU bank stress tests were generally better than expected in the years since 2009. Our empirical results indicate that those banks with large return on equity and large log book size of equity have lower probabilities of failing the stress test. In other words, the market has factored in the banks' performance, and where the bank's equity is more valuable and its book size larger, the market's evaluation is that the bank is performing well and would have adequate capital to meet some degree of unexpected loss or unexpected market downturn. These strengths also appear to correspond with pre-tax profit margin and a larger depositor base.

However, it is surprising that many other key variables such as total debt to asset ratio, non-interest income share of sales, asset turnovers and so on (some of these were tested but not reported to save space) are not significant predictors of the banks' capital adequacy. It could be that many of these non-significant variables are either too small, e.g. non-interest income share, or else fungible such as reducing long term debt by switching to short-term rollover liabilities that do not appear on the numerator of the debt to asset ratio.

The importance of the stress tests extend beyond the supervisory capacity of ECB and EBA; it has in eventuality to do with the total financial health of the Eurozone banking system, and to restore confidence in this system in order for business as usual and for banks to be able to raise cheaper capital to fund business expansions and economic growth. The stress test are generally carried out with the assistance and cooperation of the relevant national authorities. However, there is also some distrust in supposing that some discretion on the part of the national agencies may not fully disclose the quality of some of the assets used to

support the stronger asset ratios. Some of these operational difficulties were reduced in subsequent tests.

There has been a simultaneous effort to perform what is known as asset quality review or AQR in this regard. Certainly in the future, the bank stress tests would have to combine assessments from AQR before testing some of the relevant measurements and ratios. As more quality data become available, some of the statistical tests such as those we perform in this paper would provide for even more accurate and important forecasts that would be extremely useful for macro-prudential management of the Eurozone as well as EU banks in totality.

Endnotes

1. We appreciate the pointing out by a referee that stress tests started in the U.S. While the idea of stress tests on financial institutions was not new, the Federal Reserve had started earlier in April 2009 a systematic program called The Supervisory Capital Assessment Program to assess the capital adequacy to withstand financial market turmoil of the largest U.S. financial organizations.
2. Market value should typically be used. However, many of the Spanish banks in the sample are not listed and so the market prices of shares are not available. Book values are used as proxies for firm size.

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