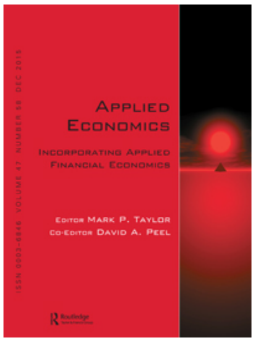

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Loan price modelling for local governments using risk premium analysis

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Previous studies have highlighted the question of government loan interest as one of great current importance. Government borrowing levels are high, and reducing interest payments would generate savings to meet other spending needs and/or to lower taxation, thus supporting the sustainability of public finances. However, no previous study has presented a method for a local government to calculate its own credit risk and thus be in a position to negotiate lower interest rates on its borrowing. This article defines a financial model that enables local governments to estimate the interest rate payable on a bank loan, based on their credit risk premium, in accordance with the Basel II rules and the findings of our empirical study of large local governments.

Keywords: loan pricing; probability of default; credit risk premium; local governments; Basel II

JEL Classification: C33; H72; H74

I. Introduction

In the present international context of economic crisis and widespread debt, the conditions attached to government borrowing are crucial to the financial sustainability of the public sector, according to researchers (Guillamón *et al.*, 2011, 2013; Bailey *et al.*, 2014; Bastida *et al.*, 2014; Checherita-Westphal *et al.*, 2014; Navarro *et al.*, 2014; Šťastná and Gregor, 2015) and international organizations (European Union, 2012, 2015; IFAC, 2012; International Monetary Fund, 2014; Worldwide Bank Group, 2014).

Thus, in line with the Maastricht Treaty rules and the EU Stability and Growth Pact, concerns about high levels of bank lending to eurozone governments have led researchers to identify the study of interest rates (IRs) as an issue of great current interest, especially in countries like Portugal, Ireland, Greece, Italy and Spain, where for decades public spending rose much faster than government revenues, generating significant budgetary shortfalls (Lassen, 2010; Martell and Kravchuk, 2010; Bailey and Asenova, 2011).

However, to date studies have focused more on identifying factors that influence the volume of

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government debt (León *et al*., 2010; Guillamón *et al*., 2011; Pérez *et al*., 2013; Capalbo and Grossi, 2014) or explanatory factors of IRs (Christieaens *et al*., 2010; Lassen, 2010; Martell and Kravchuk, 2010; Bastida *et al*., 2014), and none have specifically undertaken to design a methodology for local governments (LGs) to calculate the minimum IRs corresponding to their respective credit risk premiums, and thus reduce debt repayments.

The increased volume of government borrowing need not necessarily increase the IRs applicable. Furthermore, any savings that can be achieved in this respect will greatly benefit LGs by allowing other spending needs to be met or the tax burden lightened (Hoelscher, 1986; Vijayakumar, 1995; Bastida *et al*., 2014).

Nevertheless, LG managers do not currently have access to a solid methodological procedure that would enable them to calculate the appropriate IR for their specific circumstances, prior to negotiations with financial institutions. The only information available is the offer made by the bank in question, often with little or no explanation of its justification. If a calculation methodology were available so that LG managers could themselves estimate the financial risk (credit risk premium) pertaining to their loans, this would provide them with solid arguments to determine the maximum IR acceptable, thus enabling loans to be subscribed under optimal conditions.

In view of the above considerations, the aim of this article is to define a financial model to enable an LG to estimate the IR corresponding to its bank borrowing, in accordance with its credit risk premium. Taking into account recent legislation on bank credit risk (Basel Committee on Banking Supervision (BCBS), 2006), we propose a loan pricing model, based on two factors that can be estimated by the LG itself, namely the probability of default (PD) and the market risk premium for the banking sector. To design and construct this model, we conducted an empirical study of 148 large LGs in Spain.

Large municipalities were chosen for study because they represent a level of administration where very high volumes of bank debt are managed (Bailey *et al*., 2014; Bastida *et al*., 2014) and also because rating agencies (Moody's Investors Service, 2013) and the EU Fiscal Sustainability Report (2012) consider the financial situation of LGs to be among the areas of greatest concern within the eurozone. We chose to study the situation in Spain in particular because this is one of the countries with the greatest structural gap in its government finances (EU, 2012) as a result of a severe disparity between revenues and expenses (caused by the housing bubble), which is significantly hindering LGs' access to bank credit.

II. LGs, Basel II Capital Requirements and Loan Pricing Methods

Generally, in loan negotiations with LGs, banks assign IRs according to the corresponding risk of default. In this regard, the International Convergence of Capital Measurement and Capital Standards (BCBS, 2006, henceforth Basel II) is a rules framework for banks to calculate the credit risk capital requirements to be met in order to comply with their own credit exposure limits. In Spain, where our empirical study was conducted, adaptation to the Basel II rules is required under Circular 3/2008 of 22 May, issued by the Bank of Spain (2008), which stipulates capital requirements for credit institutions. The greater the LG credit risk, the more stringent the capital requirements and the higher the IR applicable to loans.

The Basel II rules have substantially changed the way in which banks measure credit risks and calculate IRs. In turn, this has affected the loan conditions imposed on all their clients, including LGs. An LG that has a good credit rating should negotiate IRs in accordance with its PD and with the profitability required by the bank of its own resources dedicated to the credit operation.

Basel II provides two methods for banks to calculate the capital requirement arising from their exposure to credit risk. The first, the standardized approach, relies on the judgement of external rating agencies (such as S&P, Moody's, Fitch and DBRS) to establish the credit risk weighting factors and capital requirements. Under this standardized approach, LGs are included within the category *Exposures to regional governments and local authorities*.

The second method is the internal ratings-based (IRB) approach, under which the credit institution itself calculates the PD, the loss given default (LGD), the risk weighting factors, the maximum loss that a loan might produce and the value at risk (VaR) for a 99.9% confidence level. To cover credit risk, Basel II defines the expected loss (EL), covered by the bank's provisions, and the unexpected loss (UL), covered by capital provided by shareholders. The PD is calculated on the basis of the bank's experience of LG defaults. The capital requirement (K) calculation in the IRB approach is set out in Formula A2 of Appendix 1. Under the IRB approach, LGs are included in the *Institutions* category of risk exposure.

The main goal of the loan pricing model for LGs is to calculate credit risk premiums and the risk-adjusted IRs to be applied by the banks granting the credit. Thus, the IR payable on a loan must remunerate the resources allocated to the bank loan transaction, including (1) EL, (2) UL, (3) cost of funds, (4) operational costs and (5) commissions. The sum of components (3), (4) and (5) is termed the *commercial loan price*. This forms part of the IR specific to each bank and is not directly linked to the credit risk of the LG receiving the loan.

Thus, the *credit risk premium* (the technical risk-adjusted spread) is the sum of the *risk premium for expected loss* (return required to funds allocated to the provision) and the *risk premium for unexpected loss* (compensation required for funds allocated to the capital requirement). The first of these elements is determined by parameters set out in the Basel II rules, including PD and severity (LGD = 1 – R), where R is the rate of loan recovery in the event of default. The risk premium for UL is calculated by multiplying the return required from the bank's own funds by the own-funds capital requirement (K), under the Basel II IRB approach (see Appendix 1: IRB approach). Finally, the *technical risk-adjusted interest rate* is the sum of the risk-free IR and the credit risk premium.

For LG managers responsible for negotiating loans with banks, this breakdown of the different elements involved reveals that it would be very interesting, on the one hand, to know how banks calculate the IRs for the loans granted to LGs and, on the other hand, to have a model with which the LG itself could independently calculate the maximum IR that it is willing to pay, according to its credit risk premium. If these managers could apply a loan pricing method themselves, they would have robust arguments with which to negotiate IRs more in accordance with their PD and thus reduce the impact of financial costs on the municipal budget.

To effectively negotiate bank loans, municipal managers must use loan calculation instruments for two purposes: to verify that the IRs charged do not incorporate risk premiums above those corresponding to the LG's PD and to minimize the repercussions of factors not directly related to the LG (such as bank profitability, market risks, operating costs and commissions). These considerations highlight the great current interest for managers of the present study. The application of a calculation instrument such as we describe could transform the credit risk premium from being a problem into an ally in LGs' loan negotiations with banks.

Remuneration to cover expected loss

Following Basel II, we suppose, in line with previous studies (Hasan and Zazzara, 2006; Domenico and Gianfrancesco, 2009), that a bank conducts its credit business in a risk-neutral context and grants, at the present time, a zero coupon loan of 1 euro at an IR of r_1 for 1 year to a LG that is ranked at the ith level of the bank's internal rating, at a known PD and with a recovery rate of R. The 1-year risk-free recovery rate in the current market is r_f (given $r_1 = r_f + PEL$, where PEL is the risk premium for the EL on a 1-year loan).

At 1 year after the loan, the LG will be in one of two mutually exclusive situations: (1) default, with probability PD, where the bank obtains a cash flow equal to $(1 + r_1)\cdot R\cdot PD$ or (0); or nondefault, with probability $(1 – PD)$, in which case the bank obtains a cash flow of $(1 + r_1)\cdot(1 – PD)$. Alternatively, if we consider the 1-euro investment to be a risk-free asset, the cash flow generated in a year is equal to $(1 + r_f)$, regardless of whether the LG is in default or not. As shown in Fig. 1, in a risk-neutral market, the present value of the credit and that of the investment in the risk-free asset are equal. As all assets must yield the risk-free rate, it also follows that the expected cash

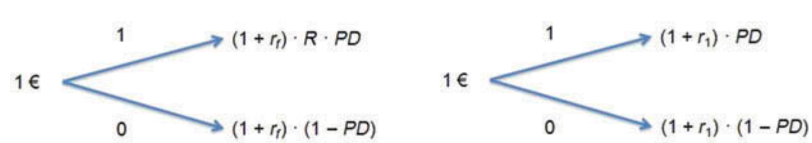

Fig. 1. Cash flows in a risk-neutral context

flows from both investments, in a year, will be the same, under Formula 1.

$$(1 + r_1) \cdot [R \cdot PD + (1 - PD)] = (1 + r_f) \tag{1}$$

By clearing the variable r_1 from Equation 1, we obtain the credit-risk-adjusted cost of EL (R_{EL}) and the credit-risk-adjusted premium for EL (P_{EL}):

$$r_1 = R_{\mathrm{EL}} = \frac{r_{\mathrm{f}} + PD \cdot (1 - R)}{1 - PD \cdot (1 - R)} = \frac{r_{\mathrm{f}} + PD \cdot LGD}{1 - PD \cdot LGD} \tag{2}$$

$$P_{\mathrm{EL}} = r_1 - \mathrm{r_f} = R_{\mathrm{EL}} - r_{\mathrm{f}} = \frac{r_{\mathrm{f}} + PD \cdot LGD}{1 - PD \cdot LGD} - r_{\mathrm{f}} \tag{3}$$

where

$$\frac{\partial R_{\mathrm{EL}}}{\partial PD} > 0 \quad \text{and} \quad \frac{\partial P_{\mathrm{EL}}}{\partial PD} > 0 \tag{4}$$

Remuneration to cover unexpected loss

Under Basel II, the cost of funds assigned to UL in the loan transaction is calculated by multiplying the capital requirement arising from the credit risk (K) by the return required by the market on own funds in the banking sector (the capital asset pricing model).

The *credit-risk-adjusted cost* of UL (R_{UL}) and the *credit-risk-adjusted premium* for UL (P_{UL}) are, respectively:

$$R_{\mathrm{UL}} = r_{\mathrm{E}} \cdot K = (r_{\mathrm{f}} + \beta_{\mathrm{E}} \cdot (r_{\mathrm{m}} - r_{\mathrm{f}})) \cdot K \tag{5}$$

$$P_{\mathrm{UL}} = (r_{\mathrm{E}} - r_{\mathrm{f}}) \cdot K = \beta_{\mathrm{E}} \cdot (r_{\mathrm{m}} - r_{\mathrm{f}}) \cdot K \tag{6}$$

where R_{UL} is the credit-risk-adjusted cost of UL; P_{UL} is the credit-risk-adjusted premium for UL; r_{E} is the return required by the market on own funds in the banking sector. This return is adjusted to the market risk (capital asset pricing model, CAPM); β_{E} is the beta of shares in the banking sector; r_{m} is the return on the stock market; r_{f} is the return on a risk-free asset; ($r_{\mathrm{m}} - r_{\mathrm{f}}$) is the risk premium for the capital market; and K is the capital requirement for credit risk under Basel II (Appendix 1).

Remuneration to cover expected and unexpected loss

From the previous sections, we obtain the following final formulas for the technical risk-adjusted interest premium and for the technical risk-adjusted IR:

$$\textit{Technical Risk} - \textit{Adjusted Interest Premium}, \quad P_{\mathrm{RC}} = P_{\mathrm{EL}} + P_{\mathrm{UL}}$$

$$P_{\mathrm{RC}} = \left(\frac{r_{\mathrm{f}} + PD \cdot LGD}{1 - PD \cdot LGD} - r_{\mathrm{f}}\right) + \beta_{\mathrm{E}} \cdot (r_{\mathrm{m}} - r_{\mathrm{f}}) \cdot K \tag{7}$$

$$\textit{Technical Risk} - \textit{Adjusted Interest Rate}, \quad i_{\mathrm{RC}} = R_{\mathrm{EL}} + R_{\mathrm{UL}}$$

$$i_{\mathrm{RC}} = \left(\frac{r_{\mathrm{f}} + PD \cdot LGD}{1 - PD \cdot LGD}\right) + (r_{\mathrm{f}} + \beta_{\mathrm{E}} \cdot (r_{\mathrm{m}} - r_{\mathrm{f}})) \cdot K \tag{8}$$

As can be seen, in accordance with Basel II, the loan pricing model cannot be applied to LGs without previously estimating two parameters, the PD of the borrower and the indicator of systematic risk, or beta value (β), of the banking sector. Both parameters are needed in order to calculate the return required by the banking sector and are considered in our empirical study, as discussed below.

III. Research Methodology

This empirical study is focused on Spain for two reasons. First, previous research has highlighted the fact that this country is of particular interest with respect to the IRs charged on government loans because for decades public spending here increased at a faster rate than government revenue, thus generating significant budgetary shortfalls (Lassen, 2010; Martell and Kravchuk, 2010; Bailey and Asenova, 2011). This situation, as in other countries in a similar financial situation, has provoked the issuance of balanced-budget rules, specifying and limiting access to borrowing in the Spanish local sector (Bastida *et al*., 2013).

Second, Spain has an extremely high level of borrowing and a large structural gap in its government finances (European Union (EU), 2012). This difficult financial situation is a consequence of the breach between revenues and expenses, caused by the housing bubble, which led to cutbacks in public services and to the adoption of regulatory reforms such as the Local Government Rationalisation and Sustainability Act, No. 27/2003 (Cabaleiro *et al*., 2013; Bastida *et al*., 2014).

Estimation of PD

Sample and data. Our empirical study took into account all Spanish LGs with a population of over 50 000 inhabitants. We selected these large municipalities for several reasons. First, they have very high volumes of bank debt (Bailey *et al*., 2014; Bastida *et al*., 2013). According to the Bank of Spain (2014), during the period 1992–2005, municipal debt in Spain increased by 32.60% in real terms. In 2008, the total debt of Spanish LGs exceeded 26 billion euros (2.4% GDP), and by 2009 this figure had risen to over 29 billion euros (2.8% GDP). Most of this borrowing corresponded to the large LGs, which account for 38.7% of total local spending (Fundación La Caixa., 2013).

According to credit rating agencies (Moody's Investors Service, 2013) and the EU Fiscal Sustainability Report (2012), the financial situation of these LGs is among those causing most concern in the eurozone. Thus, the Local Government Rationalisation and Sustainability Act, No. 27/2003, included among its background motivations the existence of solvency problems arising from financial mismanagement by large Spanish municipalities.

Second, Spain has 8112 LGs, most of which have fewer than 5000 inhabitants and widely varying service-provision powers, which forces us to adopt a selection criterion. In accordance with numerous prior empirical studies of LG finance (Pina *et al*., 2009; Zafra-Gómez *et al*., 2009; Benito *et al*., 2010; Guillamón *et al*., 2011; Alcaraz-Quiles *et al*., 2014; Navarro *et al*., 2014; Rodríguez *et al*., 2014), we chose to examine exclusively municipalities with relatively large populations.

Among other reasons, this decision was taken because (a) municipalities with over 50 000 inhabitants represent nearly 56% of the Spanish population (Fundación La Caixa., 2013); (b) the accounting model used by LGs with large populations (regulated by Ministry of Finance and Public Administration, 2013) is considerably more complete and detailed than the simplified version used by small municipalities, and thus we were able to obtain high-quality information with which to design our financial model; (c) as observed by Navarro *et al*. (2010) and Rodriguez Bolivar and Navarro Galera (2007), the professional training of managers in large municipalities is usually more complete than that available to municipalities with smaller populations, which could favour innovation regarding IR negotiations; (d) under current legislation, large municipalities are obliged to provide an identical catalogue of services (including public transport, policing, sewage, waste disposal, green areas and sports services), which facilitates the homogeneity of our analysis.

In accordance with these considerations, we selected the 148 Spanish municipalities with more than 50 000 inhabitants and analysed information for the period 2008–2011, obtaining a sample of 592 observations.

The dependent variable. According to Basel II and Circular 3/2008 of the Bank of Spain, a loan is in default when there are reasonable doubts as to whether the borrower can meet his financial obligations. Such doubts may be raised, among other circumstances, if the debtor's solvency worsens, as revealed by an inadequate economic or financial structure, negative equity, continuing losses, generalized late payments, insufficient cash flow to pay debts, inability to obtain additional financing or a situation of official receivership. Following these criteria, and those set out in Spanish legislation and recommended in prior studies of the financial analysis of LGs (Zafra-Gómez *et al*., 2009; Cohen *et al*., 2012; Moody's Investors Service, 2013; Cabaleiro *et al*., 2013; Rodríguez *et al*., 2014), we consider an LG to be in default when at least one of the conditions, or financial indicators, stipulated below is met:

- *Default 1*: Cash surplus for overheads < 0 (Index of cash surplus). Addressed in Article 193 of the Revised Text of the Local Government Finance Act. For information on this item, we consulted various sources, in the following order of preference: (a) the Court of Auditors, through its accountability website; (b) the external audit body for the autonomous community to which the municipality belongs; and (c) the local authority's own website.

- *Default 2*: Legal borrowing limit (capital or current debt) exceeding 110% of current revenues, in accordance with Article 53.2 of the Revised Text of the Local Government Finance Act. For information on this variable, we consulted the virtual office of local authorities, administered by the Ministry of Finance and Public Administration.
- *Default 3*: Solvency (current assets/current liabilities) < 1. This indicator of solvency is commonly used in financial analysis. For information on this variable, we consulted the same sources of information as for the Default 1 condition.
- *Default 4*: Gross budget savings (current revenue – current expenditure) < 0, as established in Article 53.1 of the Revised Text of the Local Government Finance Act. For information on this variable, we consulted the virtual office for financial coordination with local authorities, administered by the Ministry of Finance and Public Administration.

Independent variables. Table 1 shows the input variables used in our study to calculate PD, classified into three groups: population, socio-economic and financial. This classification and the expected signs for each variable are based on the findings of previous research into LG finance.

Previous studies (Solé-Ollé, 2006; Schaltegge and Torgler, 2006; Gonçalves-Veiga and Veiga, 2007; Zafra-Gómez *et al.*, 2009; Benito *et al.*, 2010; Guillamón *et al.*, 2011; Wang and Hou, 2012) have found that four population variables – population size, population density, dependent population and

Table 1. Description of demographic, socio-economic and government financial variables

Variable	Description	Expected estimator sign (β)
Population variables		
Pop_Size	Population size (million) Numeric variable. Source: Spanish Institute of Statistics (INE).	+
Pop_Dens	Population density: number of inhabitants/surface area of municipality (km^2). Numeric variable. Source: INE and La Caixa Yearbook.	+
Depend_Pop	Proportion of dependent population: number of inhabitants aged < 16 and > 65/ total population. Numeric variable. Source: INE.	+
Immigr	Proportion of immigrant population: number of immigrants/total population. Numeric variable. Source: INE.	+
Socio-economic variables		
Abs_Maj	Absolute majority. Dummy variable: (0) absolute majority, (1) no absolute majority. Source: Ministry of the Interior.	–
Political_Sign	Political sign. Dummy variable: (0) conservative, (1) progressive. Source: Ministry of Finance and Public Administration.	–
IPC	Municipal income per capita: real budget income (thousands €)/total population. Numeric variable. Source: Ministry of Finance and Public Administration and INE.	–
Unemployment	Proportion of unemployment: number of persons unemployed/total population. Numeric variable. Source: Ministry of Employment and Social Security and INE.	+
Government financial variables		
Fin_Aut	Financial autonomy: total income less transfers and grants/total income. Numeric variable. Source: Ministry of Finance and Public Administration.	–
Fin_Struct	General financing structure: debt finance/equity finance. Numeric variable. Source: Court of Auditors.	+
Comp_Debt	Debt composition and maturity: short-term debt/long-term debt. Numeric variable. Source: Court of Auditors.	+
Source_Debt	Origin and nature of the debt: financial debt/commercial debt. Numeric variable. Source: Court of Auditors.	+

immigrant population – are positively associated with the volume of LG debt; the greater their magnitude, the higher the demand for public spending and services. These variables are expected to present a positive sign because, as in the business sector (West, 2000; Abdou, 2009), increased debt would increase PD.

Second, the socio-economic variables affecting municipalities could also affect their PD. Previous research (Solé-Ollé, 2006; Wang *et al.*, 2007; Zafra-Gómez *et al.*, 2009; Benito *et al.*, 2010; Guillamón *et al.*, 2011; Pérez *et al.*, 2013) has shown that LGs without an absolute majority and led by progressive parties are more likely to resort to borrowing, and so we expect a negative sign for the first two socio-economic variables. In parallel to this, Wang *et al.* (2007) and Zafra-Gómez *et al.* (2009) concluded that a higher value of the IPC suggests there is less need for borrowing, and so the volume of debt would be lower (expected negative sign). Furthermore, in studies of fiscal pressure on LGs, a positive relationship has been observed between unemployment and the volume of debt (Zafra-Gómez *et al.*, 2009; Benito *et al.*, 2010), and so we expect this sign to be positive. In short, these socio-economic variables may influence the volume of government debt; accordingly, we believe they are also related to PD.

Third, we considered the financial variables that may influence PD. According to Cabaleiro *et al.* (2013), greater financial autonomy enhances the financial health of LGs, in inverse relation to PD. Therefore, the expected sign for this variable is negative. Furthermore, studies on default by private companies (Mossman *et al.*, 1998) show that an increase in the leverage ratio raises PD. To the best of our knowledge, no previous studies have included the variable 'composition of the debt', but logically this is a variable of interest for our purposes. A greater proportion of short-term than of long-term debt reduces LGs' decision-making capabilities, and so an increase in this ratio would be expected to increase PD. Another variable we include that has not been considered in previous studies in this field is a proxy for the origin and nature of the debt (Source of Debt). We expect a greater weight of bank debt to be associated with higher PD.

Finally, research papers focused specifically on explanatory factors of IRs have highlighted the value of analysing the three types of variables we consider. Thus, Christieaens *et al.* (2010) and Benson and Marks (2004) recommend further study of the relationship between financial information and IRs, while Martell and Kravchuk (2010) and Daniels and Vijayakumar (2007) believe that socio-economic features of the community may account for variations in IRs.

Statistical model. In this study, a mixed logistic regression model was used to measure PD. According to the literature, discrete choice models are appropriate when the study goal is to analyse the determinants of the probability of an individual economic agent choosing a particular course of action within a set of options, and such models have been used in many cases to explain the factors underlying PD (Hwang *et al.*, 2013; Jacobson *et al.*, 2013; Kukuk and Rönnberg, 2013; Huyghebaert *et al.*, 2014). Logit panel data can be used to establish the correlation between unobserved factors over time, and to eliminate the bias arising from the existence of unobservable and time-invariant heterogeneity among individuals (Train, 2003).

The random intercept logit model was chosen for several reasons: first, to control and model the unobserved heterogeneity in our data. The model also provides intra-class correlation, i.e. a percentage of the variance of the dependent variable that is due to individual unobserved characteristics. Second, it allows for subject-specific interpretations and inferences. However, this model is sensitive to possible subject-level confounding, which can produce inconsistent estimates. Third, panel data methodology is applied to the financial sustainability of the public sector, particularly in public administration and public management (De Mello Jr, 2002; Schaltegge and Torgler, 2006; Solé-Ollé and Sorribas-Navarro, 2012).

Under the theoretical framework based on the discrete choice model proposed by McFadden (2001) and McFadden and Train (2000), for each observation i there may be j alternatives at time t given a deterministic indirect utility function of alternative j that can be captured by the explanatory variables. To deal with the particular structure of these municipal data – i.e. longitudinal data structure and random time effects – a logit panel model is used to estimate the probability that a LG i will default at time t (PD). This can be computed as follows:

$$PD = Prob(Y_{it} = 1) = \frac{\exp(\alpha_i + X_{it}\beta_i + \varepsilon_{it})}{1 + \exp(\alpha_i + X_{it}\beta_i + \varepsilon_{it})} \quad (9)$$

where α_i represents the constant term, X_{it} represents a vector of explanatory variables that affect the PD each year and ε_{it} is a random term. Y_{it} is a dummy variable that equals 1 if at time t the LG i is in default, and 0 if at time t it is not:

$$Y_{it} = \begin{cases} 1, & \text{if local government } i \text{ defaults}, \\ 0, & \text{if local government } i \text{ does not default} \end{cases} \quad (10)$$

Finally, the model implemented in this study meets all the requirements of Basel II and of Circular 3/2008, issued by the Bank of Spain, for statistical models used to calculate PD. In both texts, these requirements include the following: (a) the model must present good predictive power; (b) the variables introduced should provide a reasonable and effective basis for the predictions made, and the model must not be subject to any significant degree of bias; (c) there must exist a process to verify the data entered as parameters for the model, assessing the accuracy, completeness and appropriateness of the data; and (d) it must be shown that the data used to build the model are truly representative of the credit institution's debtors and of its risk exposure.

Empirical estimation of the β of the banking sector

To calculate the β of the banking sector, we used a linear regression model in which the return of this sector is the dependent variable and the return of the General Index of the Madrid Stock Exchange is the explanatory variable. We then calculated the market risk premium and the return required by bank shareholders on the capital invested, applying a CAPM model.

Formulas 7 and 8 above depend on the return required by bank shareholders on the capital supplied in loan operations. In turn, according to the CAPM model, this return depends on the risk-free IR, the systematic risk (β) of the banking sector and the risk premium of the capital market. The β for the Spanish banking sector was estimated by running the OLS regression for the above equation with 2008–2011 data for the Spanish Index, according to the banking sector data set, where R_{i} is the average monthly return in the Spanish banking sector (Madrid Stock Exchange bank shares index) and R_{m} is the average monthly return on the Madrid Stock Exchange general shares index in the regression. Ruthenberg and Landskroner (2008) and Kontogeorgis (2010) have also applied this methodology, to the Israeli and Danish banking sectors, respectively.

IV. Empirical Results

Calculating the probability of default

The logistic regression analysis performed on the data included in this study shows that a loan default occurred in 302 cases (51.01%), while in 290 (48.99%) there was no default. Table 2 presents the estimated coefficients of the conditional random-effects logistic regression of the final model, together

Table 2. Variables included in the final model

Variable	Coeff. (β)	SE	Exp (β)
POP_DENS	−0.270232***	0.0768787	0.7632023
DEPEND_POP	−21.59687***	7.266459	4.1744E-10
POLITICAL_SIGN (1)	−1.757557***	0.3756014	0.1724656
IPC	−5.756884***	0.7862592	0.0031609
FIN_STRUCT	0.444984***	0.1428	1.560465
COMP_DEBT	1.182225***	0.2314663	3.261624
Constant	13.267***	2.618851	

Notes: Log likelihood: 261.67.
Wald χ^2: 77.07; sig.: 0.000.
χ^2: 28.54; sig.: 0.000.
Hausman (1978) test: 7.79; sig.: 0.2542.
*Represent significance at the 10% level, **represent significance at the 5% level and ***represent significance at the 1% level.

with their statistical significance and other relevant statistics. Of the 12 variables analysed, 6 were found to be significant. The model overall was significant, and according to the coefficients, two variables exerted a positive influence on PD, and another four, a negative influence. There was a very low level of correlation among the statistically significant variables.

For an optimal cut-off of 0.50, we obtained an accuracy of 76.01% for the correct classification of the database items. This result, together with a sensitivity value of 76.42% and a specificity of 75.64%, suggests that the model has good predictive capabilities.

Our results show that an increase in the two population variables (population density and dependent population) can increase PD. We also found evidence of an inverse relationship between PD and the socio-economic variables per capita income and government by a conservative party. The results for the financial variables suggest that an increase in the proportion of short-term debt can increase PD.

The multicollinearity study confirms that there is no relationship among these variables that would account for the event studied. We conclude, therefore, that the results obtained are robust and reliable.

Beta of the banking sector

The results obtained from the linear regression model show that the β of the Spanish banking sector is 1.445 (i.e. when the return on the market index changes by 1%, the profitability of the banking sector changes by 1.445%). The model adequately explains the variations in the returns of the banking sector in relation to changes in the Spanish General Stock Market index (p-value of the β: 0.000; adjusted R^2 value: 88.3%; Durwin–Watson value: 2.062). The Spanish market risk premium used for the study period was 5.9% (Fernández *et al.*, 2011). The risk-free IR was 1.969% (LIBOR in euros at 12 months, listed at year-end 2011). Finally, the return required by the banking sector for credit risk was 10.47% (see Formula 11).

$$r_E = r_f + \beta_E \cdot (r_m - r_f) = 1.966\% + 1.445 \cdot 5.9\% = 10.47\% \tag{11}$$

Formulation of the study model

As explained in Section II, in order to apply the financial loan pricing model reflected in Formulas 7 and 8 we must empirically estimate two parameters, PD and the β of the banking sector. Once these estimates have been obtained, the resulting financial model has the following mathematical formulation:

$$P_{RC} = \left(\frac{1.969\% + PD \cdot 45\%}{1 - PD \cdot 45\%} - 1.969\% \right) + 1.445\% \cdot 5.9\% \cdot K \tag{12}$$

$$i_{RC} = \left(\frac{1.969\% + PD \cdot 45\%}{1 - PD \cdot 45\%} \right) + 10.47\% \cdot K \tag{13}$$

To calculate the credit risk premium and the credit-risk-adjusted bank IR for the LGs analysed, we assign a rating to each LG according to its PD, taking as a benchmark the internal credit quality ratings and the PDs applied by Banco Santander in its IRB approach for LGs. The rationale for using the rating scale of this bank is, first, that Banco Santander is certified by Standard & Poor's (see the Banco Santander 2012 Report 'Information of Prudential Relevance', p. 60. http://www.santander.com) and, moreover, it is the Spanish bank with one of the largest portfolios of loans granted to LGs in Spain.

After having assigned the credit ratings, we calculate the average credit risk premiums and credit-risk-adjusted IRs for each rating group, using both the standardized approach and the IRB. Finally, for each of the 148 LGs we calculate its credit risk premium and the corresponding IRs, taking into account the PD determined by both methods.

From the PD obtained for each LG, under Formula 10, and from Table A2.1, it can be seen that of the 148 LGs studied, 3 (2% of the total) have an AA– rating, 1 (1%), has a rating between BB and BB–, 9 (6%) have a rating of B+ to B–, 39 (26%) have a rating of CCC to C (26%) and 96 (65%) are rated D.

Analysis of the credit risk premium (Fig. 2) shows that the LGs rated AA– with the standardized approach obtain an average credit risk premium of 0.16%, while the corresponding figure under IRB is 0.12%. The LGs rated as BB to BB– have a risk

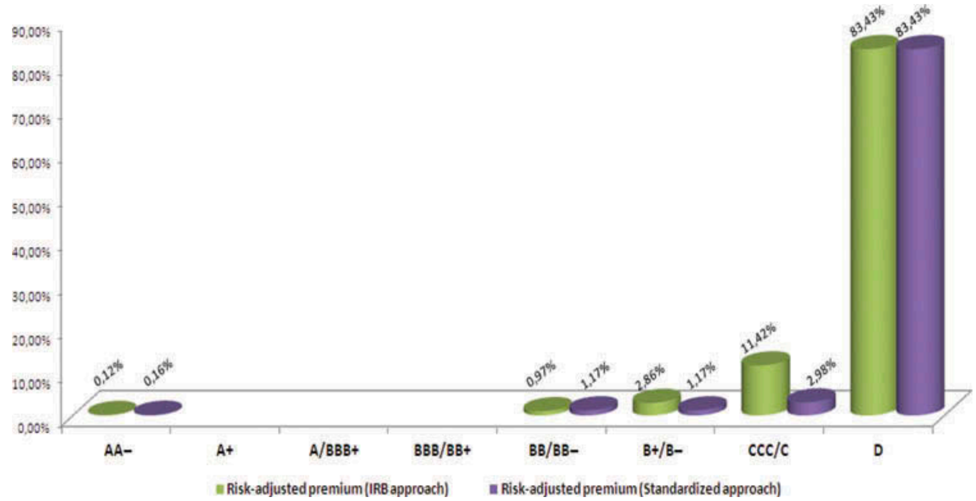

Fig. 2. Credit-risk-adjusted premiums for the LGs analysed

premium of 1.17% (standardized approach) and 0.97% (IRB). Those rated from B+ to B– have a risk premium of 1.17% (standardized approach) and 2.86% (IRB). Those rated from CCC to C have a risk premium of 2.98% (standard) and 11.42% (IRB). Finally, those rated D have a premium of 83.43% under both methods since PD in this case is 100%.

Figure 3 shows the average credit-risk-adjusted IRs for the different credit ratings. The LGs with an AA– rating in the standardized approach have an IR of 2.16% and one of 2.11% with IRB approach. For a rating of BB to BB–, the IR is 3.30% under the standardized approach and 3.08% under IRB. LGs with a rating from B+ to B– have an IR of 3.30% under the standardized approach and 5.07% under IRB approach. For those with a credit rating of CCC to C, the IR is 5.19% under the standard approach and 13.77% under IRB approach. Finally, those with a D credit rating have an IR of 85.40% because the PD is 100%.

Finally, Appendix 2 shows the individual credit risk situation for each of the Spanish LGs analysed, with respect to the PD determined according to the standardized approach and IRB approach, together with the result of applying this credit risk to the corresponding credit risk premiums, according to the standardized approach and to IRB approach, and in terms of the risk-adjusted IRs according to each method.

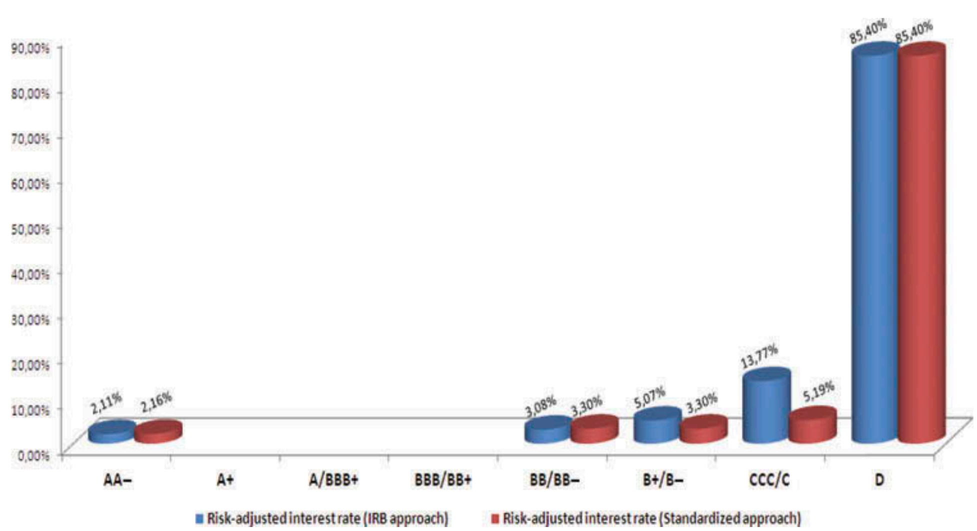

Fig. 3. Credit-risk-adjusted interest rates for the LGs analysed

V. Conclusions

Analysis of the IRs applied to government borrowing is a research question of great current interest. Previous studies and international agencies acknowledge that in the present context of high levels of LG borrowing a reduction in IRs would produce budgetary savings and enable other spending priorities to be met and/or the tax burden reduced, thus contributing to the sustainability of public services. However, to date, previous studies have not sought to provide LG managers with a means of calculating the IR derived from the risk premium applicable to their situation.

Following the Basel II rules, in this article we define a financial model to estimate loan pricing. The mathematical formulation of this model allows LG managers to negotiate bank loans with robust arguments to achieve the lowest possible IR. Based on an empirical study of the largest Spanish municipalities for the period 2008–2011, our model allows managers to calculate, from their own resources, the maximum IR acceptable by estimating the specific risk premium applicable and by analysing the technical and commercial components of the IRs charged.

The loan pricing model we have designed shows that the credit risk premium and the risk-adjusted IR depend on variables that are included in the Basel II rules (PD, severity and capital requirements), and also on financial market variables (risk-free IR, the β of the banking sector and the risk premium of the capital market). Therefore, for our financial model to accurately calculate the IR applicable, the LG concerned must empirically estimate two parameters: PD, which depends on the individual characteristics of each LG, and the systematic risk of the banking sector, which is determined by financial market variables.

Our empirical study shows that PD is influenced by population, socio-economic and financial factors. The behaviour of these variables may impact on the PD of the LG requesting the loan and therefore affect the IR charged, which its managers must negotiate after analysing the effect produced on the risk premium.

Under the financial model designed, our results indicate that in municipalities with low population density and a relatively small dependent population, LGs have a lower PD, and so their risk premiums should be lower. In consequence, they should be charged lower IRs than municipalities where the population density is high and the dependent population larger. The model, thus, provides consistent arguments to support LG managers in their loan negotiations with banks.

Furthermore, our evidence shows that a rising per capita income is associated with a lower PD and hence the risk premium should be lower. Accordingly, LGs where this variable presents higher values should pay lower IRs than less prosperous LGs. Our empirical results also show that the political orientation of the governing party can influence the risk premium and, consequently, may be an argument for reducing the IR payable.

Similarly, in designing this model, we obtained evidence that the short-/long-term nature and the volume of the debt both affect the risk premium. Specifically, LGs with greater volumes of short-term debt would be more poorly placed to negotiate lower IRs than those with less debt and longer-term maturities.

In contrast, we found no evidence of any relationship between other factors and PD, although previous studies have reported that population size, immigrant population, simple majority of the governing party and level of unemployment in the municipality all influence the volume of LG debt. Thus, the formulation of our model shows that not all factors that contribute to increasing the volume of debt actually influence the risk premium and hence the IR payable. This fact could alleviate the upward impact made on IRs by higher levels of LG borrowing.

In summary, we have designed a loan pricing model that is useful and reliable for managers seeking to negotiate lower IRs on LG bank loans. The proposed mathematical formulation allows LGs to justify alternative proposals by citing credit-risk-adjusted IRs that are specific to the situation of each municipality.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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References

Abdou, H. A. (2009) Genetic programming for credit scoring: the case of Egyptian public sector banks, *Expert Systems with Applications*, **36**, 11402–17. doi:10.1016/j.eswa.2009.01.076

Alcaraz-Quiles, F. J., Navarro-Galera, A. and Ortíz-Rodríguez, D. (2014) Factors determining online sustainability reporting by local governments, *International Review of Administrative Sciences 0020852314541564*, *first published on November* 20, 2014. doi:10.1177/0020852314541564.

Bailey, S. J. and Asenova, D. (2011) A case study of Glasgow's use of the prudential borrowing framework (PBF), for schools rationalisation, *Local Government Studies*, **37**, 429–49. doi:10.1080/03003930.2011.588703

Bailey, S. J., Valkama, P. and Salonen, S. (2014) The EU's public finance crisis: causes, consequences and cure, *Public Money & Management*, **34**, 83–90. doi:10.1080/09540962.2014.887514

Bank of Spain (2008) *Circular 3/2008 of 22 May 2008 to Credit Institutions on the Determination and Control of Minimum Own Funds (BOE of 10 June 2008)*, Bank of Spain, Madrid.

Bank of Spain. (2014) Boletín Estadístico del Banco de España. Available at http://www.bde.es/bde/es/secciones/informes/boletines/Boletin_Estadist/anoactual/. (accessed 15 July 2015).

Basel Committee on Banking Supervision (BCBS) (2006) *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework – Comprehensive Version*, Bank for International Settlements Press & Communications, Basel.

Bastida, F., Beyaert, A. and Benito, B. (2013) Electoral cycles and local government debt management, *Local Government Studies*, **39**, 107–32. doi:10.1080/03003930.2012.683861

Bastida, F., Guillamón, M.-D. and Benito, B. (2014) Explaining interest rates in local government borrowing, *International Public Management Journal*, **17**, 45–73. doi:10.1080/10967494.2014.874257

Benito, B., Bastida, F. and Muñoz, M. J. (2010) Factores explicativos de la presión fiscal municipal, *Revista de Contabilidad-Spanish Accounting Review*, **13**, 239–83. doi:10.1016/S1138-4891(10)70018-2

Benson, E. D. and Marks, B. R. (2004) Bond insurance and governmental accounting research, in *Research in Governmental and Nonprofit Accounting*, Copley, P. (ed), Elservier, Oxford, pp. 35–50.

Cabaleiro, R., Buch, E. and Vaamonde, A. (2013) Developing a method to assessing the municipal financial health, *The American Review of Public Administration*, **43**, 729–51. doi:10.1177/0275074012451523

Capalbo, E. and Grossi, G. (2014) Assessing the influence of socioeconomic drivers on Italian municipal financial destabilization, *Public Money & Management*, **34**, 107–14. doi:10.1080/09540962.2014.887518

Checherita-Westphal, C., Hallett, A. H. and Rother, P. (2014) Fiscal sustainability using growth-maximizing debt targets, *Applied Economics*, **46**, 638–47. doi:10.1080/00036846.2013.861590

Christieaens, J., Dennis, M., Van Steeland, J. *et al*. (2010) Implications of local governments reporting of financial institutions' credit policy, in *Paper Presented at the 33rd Annual European Accounting Association Congress*, European Accounting Association, Istanbul, 19–21 May.

Cohen, S., Doumpos, M., Neofytou, E. *et al*. (2012) Assessing financial distress where bankruptcy is not an option: an alternative approach for local municipalities, *European Journal of Operational Research*, **218**, 270–79. doi:10.1016/j.ejor.2011.10.021

Daniels, K. N. and Vijayakumar, J. (2007) Does underwriter reputation matter in the municipal bond market?, *Journal of Economics and Business*, **59**, 500–19. doi:10.1016/j.jeconbus.2006.09.002

De Mello Jr, L. R. (2002) Public finance, government spending and economic growth: the case of local governments in Brazil, *Applied Economics*, **34**, 1871–83. doi:10.1080/00036840210128726

Domenico, C. and Gianfrancesco, I. (2009) Bank loans pricing and Basel II: a multi-period risk-adjusted methodology under the new regulatory constraints, *Banks and Bank Systems*, **4**, 66–75.

European Union (EU). 2012. Fiscal Sustainability Report. Available at http://ec.europa.eu/economy_finance/publications/european_economy/2012/pdf/ee-2012-8_em.pdf (accessed 9 July 2015).

European Union (EU). 2015. Stability and Growth Pact. Available at http://ec.europa.eu/economy_finance/economic_governance/sgp/index_en.htm. (accessed 9 July 2015).

Fernández, P., Aguirreallamoa, J. and Cortés, L. 2011. Market risk premium used in 56 countries in 2011: a survey with 6,014 answers. Working Paper 920, IESE Business School, University of Navarra.

Fundación La Caixa. (2013) *Anuario Económico De España*, La Caixa, Barcelona.

Gonçalves-Veiga, L. and Veiga, F. J. (2007) Political business cycles at the municipal level, *Public Choice*, **131**, 45–64. doi:10.1007/s11127-006-9104-2

Guillamón, M. D., Benito, B. and Bastida, F. (2011) Evaluación de la deuda pública local en España*/Evaluation of local government debt in Spain, *Spanish Journal of Finance and Accounting/Revista Española de Financiación y Contabilidad*, **40**, 251–85. doi:10.1080/02102412.2011.10779703

Hasan, I. and Zazzara, C. (2006) Pricing risky bank loans in the new Basel 2 environment, *Journal of Banking Regulation*, **7**, 243–67. doi:10.1057/palgrave.jbr.2350026

Hausman, J. A. (1978) Specification test in econometrics, *Econometrica*, **46**, 1251–71.

Hoelscher, G. (1986) New evidence on deficits and interest rates, *Journal of Money, Credit and Banking*, **18**, 1–17.

Huyghebaert, N., Quan, Q. and Sun, L. (2014) Financing decisions after partial privatization in China: can a stock market quotation really provide discipline?, *Journal of Financial Intermediation*, **23**, 27–46. doi:10.1016/j.jfi.2013.08.005
Hwang, R.-C., Chung, H. and Ku, J.-Y. (2013) Predicting recurrent financial distresses with autocorrelation structure: an empirical analysis from an emerging market, *Journal of Financial Services Research*, **43**, 321–41. doi:10.1007/s10693-012-0136-0
International Federation of Accountants (IFAC). 2012. Recommended practice guideline. Reporting on the long-term sustainability of an entity's finances. Available at https://www.ifac.org/publications-resources/recommended-practice-guideline-1 (accessed 9 July 2015).
International Monetary Fund. 2014. Vertical fiscal imbalances and the accumulation of government debt. *Working Paper*. Available at http://www.imf.org/external/pubs/ft/wp/2014/wp14209.pdf (accessed 9 July 2015).
Jacobson, T., Lindé, J. and Roszbach, K. (2013) Firm default and aggregate fluctuations, *Journal of the European Economic Association*, **11**, 945–72. doi:10.1111/jeea.12020
Kontogeorgis, O. 2010. Basel II and lending policies of Danish banks under on-going economic crisis." Copenhagen Business School, November.
Kukuk, M. and Rönnberg, M. (2013) Corporate credit default models: a mixed logit approach, *Review of Quantitative Finance and Accounting*, **40**, 467–83. doi:10.1007/s11156-012-0281-4
Lassen, D. D. (2010) "Fiscal consolidation in advanced industrialized democracies: economics, politics and governance." *Swedish fiscal policy council background report*, University of Copenhagen.
León, J., Dorta, J. and Pérez, J. (2010) Contraste de los modelos de asignación presupuestaria en el presupuesto social municipal, *Gestión Y Políticas Públicas*, **19**, 351–94.
Martell, C. R. and Kravchuk, R. S. (2010) Bond insurance and liquidity provision: impacts in the municipal variable rate debt market 2008-09, *Public Finance Review*, **38**, 378–401. doi:10.1177/1091142110368048
McFadden, D. (2001) Economic choices, *American Economic Review*, **91**, 351–78. doi:10.1257/aer.91.3.351
McFadden, D. and Train, K. (2000) Mixed MNL models for discrete responses, *Journal of Applied Econo-metrics*, **15**, 447–70. doi:10.1002/(ISSN)1099-1255
Ministry of Finance and Public Administration (2013) Order HAP/1781/2013, of 20 September 2013, by which approves the instruction normal local accounting model (BOE nº 237 of 3 October 2013), Madrid. Available at http://www.boe.es/boe/dias/2013/10/03/pdfs/BOE-A-2013-10268.pdf (accessed 9 July 2015).
Moody's Investors Service. 2013. *A Methodology of Rating to Local and Regional Governments*. Available at https://www.moodys.com (accessed 9 July 2015).
Mossman, C. E., Bell, G. G., Swartz, L. M. *et al*. (1998) An empirical comparison of bankruptcy models, *The Financial Review*, **33**, 35–54. doi:10.1111/fire.1998.33.issue-2
Navarro, A., Alcaraz, F. J. and Ortiz, D. (2010) La divulgación de información sobre responsabilidad social corporativa en administraciones públicas: un estudio empírico en gobiernos locales, *Spanish Accounting Review*, **13**, 285–314.
Navarro, A., De Los Ríos Berjillos, A., Ruiz, M. *et al*. (2014) Transparency of sustainability information in local governments: English-speaking and Nordic cross-country analysis, *Journal of Cleaner Production*, **64**, 495–504. doi:10.1016/j.jclepro.2013.07.038
Pérez, G., Plata, A., Zafra, J. L. *et al*. (2013) Deuda viva municipal en un contexto de crisis económica: análisis de los factores determinantes y de las formas de gestión, *Spanish Accounting Review*, **17**, 83–93.
Pina, V., Torres, L. and Yetano, A. (2009) Accrual accounting in EU local governments: one method, several approaches, *European Accounting Review*, **18**, 765–807. doi:10.1080/09638180903118694
Rodriguez Bolivar, M. P. and Navarro Galera, A. (2007) Could fair value accounting be useful, under NPM models, for users of financial information?, *International Review of Administrative Sciences*, **73**, 473–502. doi:10.1177/0020852307081153
Rodríguez, M. P., Navarro, A., Alcaide, L. *et al*. (2014) Factors influencing local government financial sustainability: an empirical study, *Lex Localis*, **12**, 31–54.
Ruthenberg, D. and Landskroner, Y. (2008) Loan pricing under Basel II in an imperfectly competitive banking market, *Journal of Banking & Finance*, **32**, 2725–33. doi:10.1016/j.jbankfin.2008.07.009
Schaltegge, C. A. and Torgler, B. (2006) Growth effects of public expenditure on the state and local level: evidence from a sample of rich governments, *Applied Economics*, **38**, 1181–92. doi:10.1080/00036840500392334
Solé-Ollé, A. (2006) The effects of party competition on budget outcomes: empirical evidence from local governments in Spain, *Public Choice*, **126**, 145–76. doi:10.1007/s11127-006-2456-9
Solé-Ollé, A. and Sorribas-Navarro, P. (2012) The dynamic adjustment of local government budgets: does Spain behave differently?, *Applied Economics*, **44**, 3203–13. doi:10.1080/00036846.2011.570723
Šťastná, L. and Gregor, M. (2015) Public sector efficiency in transition and beyond: evidence from Czech local governments, *Applied Economics*, **47**, 680–99. doi:10.1080/00036846.2014.978077

Train, K. E. (2003) *Discrete Choice Methods with Simulation*, Cambridge University Press, UK.
Vijayakumar, J. (1995) An empirical analysis of the factors influencing call decisions of local government bonds, *Journal of Accounting and Public Policy*, **14**, 203–31. doi:10.1016/0278-4254(95)00031-9
Wang, W. and Hou, Y. (2012) Do local governments save and spend across budget cycles? Evidence from North Carolina, *The American Review of Public Administration*, **42**, 152–69. doi:10.1177/0275074011398387
Wang, X., Dennis, L. and Tu, Y. S. (2007) Measuring financial condition: a study of U.S. States, *Public Budgeting & Finance*, **27**, 1–21. doi:10.1111/pbaf.2007.27.issue-2
West, D. (2000) Neural network credit scoring models, *Computers & Operations Research*, **27**, 1131–52. doi:10.1016/S0305-0548(99)00149-5
Worldwide Bank Group. 2014. World Governance Indicators. Available at http://data.worldbank.org (accessed 9 July 2015).
Zafra-Gómez, J. L., López-Hernández, A. M. and Hernández-Bastida, A. (2009) Developing an alert system for local governments in financial crisis, *Public Money & Management*, **29**, 175–81. doi:10.1080/09540960902891731

Appendix 1. Capital Requirement Formulas for LGs under Basel II Rules and according to Bank of Spain Circular No. 3/2008

Standardized approach

$$K = [EAD \cdot WF] \cdot 8\% = RWA \cdot 8\% \quad \text{(A1)}$$

where K is the capital requirement according to credit risk; EAD is the exposure at default, net of bank provisions; WF is the credit risk weight factor, according to ratings agencies; RWA is the risk-weighted asset. Calculated as EAD * WF. *Coefficient of capital according to credit risk* = 8%.

IRB approach

$$K = \left[LGD \cdot N\left(\frac{G(PD) + \sqrt{\rho(PD)} \cdot G(0.999)}{\sqrt{1-\rho(PD)}}\right) - PD \cdot LGD\right] \cdot \frac{[1 + (M - 2.5) \cdot b(PD)] \cdot 1,06}{1 - 1.5 \cdot b(PD)} \quad \text{(A2)}$$

$$b(PD) = (0.11852 - 0.05478 \cdot \ln(PD))^2 \quad \text{(A3)}$$

$$RWA = 12.5 \cdot K \cdot EAD \quad \text{(A4)}$$

$$\rho(PD) = 0.12 \cdot \frac{1 - e^{-50 \cdot PD}}{1 - e^{-50}} + 0.24 \cdot \left(1 - \frac{1 - e^{-50 \cdot PD}}{1 - e^{-50}}\right) \quad \text{(A5)}$$

$$EL = PD \cdot LGD \cdot EAD \quad \text{(A6)}$$

$$\frac{\partial K}{\partial PD} > 0; \ \frac{\partial K}{\partial LGD} > 0; \ \frac{\partial K}{\partial \rho}\left\langle 0 \text{ and } \frac{\partial K}{\partial M}\right\rangle 0 \quad \text{(A7)}$$

where K is the capital requirement according to credit risk, or UL; $N(x)$ is the accumulated distribution function of a standard normal random variable; $G(x)$ is the inverse accumulated distribution function of a standard normal random variable; PD is the PD of the LG loan; LGD is the loss given default. It is normally assumed that LGD = 45%, given R is the default recovery rate ($LGD = 1 - R$); $b(PD)$ is the adjustment for loan maturity. This adjustment reflects the increase in K as PD rises; RWA is the risk-weighted asset; *Capital coefficient* = 8%. In Formula d, this coefficient is calculated as 1/8% = 12.5; ρ is the coefficient of correlation of the borrower with the evolution of the economy; α(99.9%) is the confidence level at which default losses are calculated for the bank, to be met from provisions and capital; EAD is the exposure at default; EL is the expected losses. This variable is assumed to approximate the value of bank provisions. It is calculated as $PD \cdot PGD \cdot EAD$; M is the maturity (time horizon of the exposure to credit risk). It is normally assumed that M = 2.5 years.

Appendix 2. Loan Pricing for LGs in Spain with a Population Exceeding 50 000 Inhabitants

Table A2.1. PD, risk premium and credit-risk-adjusted IRs for LGs in Spain with a population exceeding 50 000 inhabitants

	Municipality	PD logit (1) (%)	Standard & Poor's rating (2)	PD-IRB (3) (%)	PD-standard (4) (%)	RWA-IRB (5) (%)	RWA-standard (6) (%)	K-IRB (7) (%)	K-standard (8) (%)	Risk premium IRB (9) (%)	Risk premium standard (10) (%)	Risk-adjusted IR-IRB (11) (%)	Risk-adjusted IR-Standard (12) (%)
1	Melilla	0.03	AA–	0.03	0.05	15.31	20.00	1.22	1.60	0.12	0.16	2.11	2.16
2	Ceuta	0.03	AA–	0.03	0.05	15.31	20.00	1.22	1.60	0.12	0.16	2.11	2.16
3	Barcelona	0.03	AA–	0.03	0.05	15.31	20.00	1.22	1.60	0.12	0.16	2.11	2.16
4	Hospitalet de Llobregat	0.79	BB/BB–	0.79	1.07	89.57	100.00	7.17	8.00	0.97	1.17	3.08	3.30
5	Donostia-San Sebastián	1.10	B+/B–	1.10	1.07	101.19	100.00	8.10	8.00	1.20	1.17	3.32	3.30
6	Santa Coloma de Gramenet	1.22	B+/B–	1.22	1.07	104.80	100.00	8.38	8.00	1.28	1.17	3.41	3.30
7	Granollers	2.61	B+/B–	2.61	1.07	131.02	100.00	10.48	8.00	2.11	1.17	4.28	3.30
8	Vitoria-Gasteiz	3.11	B+/B–	3.11	1.07	242.56	100.00	19.41	8.00	3.10	1.17	5.45	3.30
9	Calvià	3.53	B+/B–	3.53	1.07	142.57	100.00	11.41	8.00	2.62	1.17	4.81	3.30
10	Girona	5.13	B+/B–	5.13	1.07	160.22	100.00	12.82	8.00	3.50	1.17	5.73	3.30
11	Prat de Llobregat	5.17	B+/B–	5.17	1.07	160.64	100.00	12.85	8.00	3.52	1.17	5.75	3.30
12	Cádiz	6.38	B+/B–	6.38	1.07	172.98	100.00	13.84	8.00	4.19	1.17	6.43	3.30
13	Getxo	6.46	B+/B–	6.46	1.07	173.77	100.00	13.90	8.00	4.24	1.17	6.48	3.30
14	Manresa	7.45	CCC/C	7.45	4.19	183.22	150.00	14.66	12.00	4.79	2.98	7.05	5.19
15	Tarragona	7.81	CCC/C	7.81	4.19	186.51	150.00	14.92	12.00	4.99	2.98	7.25	5.19
16	Sant Cugat del Vallès	8.23	CCC/C	8.23	4.19	190.24	150.00	15.22	12.00	5.22	2.98	7.49	5.19
17	Madrid	8.77	CCC/C	8.77	4.19	194.86	150.00	15.59	12.00	5.52	2.98	7.80	5.19
18	Segovia	9.07	CCC/C	9.07	4.19	197.35	150.00	15.79	12.00	5.68	2.98	7.96	5.19
19	Cornellà de Llobregat	9.61	CCC/C	9.61	4.19	201.67	150.00	16.13	12.00	5.99	2.98	8.27	5.19
20	Lleida	9.95	CCC/C	9.95	4.19	204.29	150.00	16.34	12.00	6.17	2.98	8.46	5.19
21	Sabadell	10.69	CCC/C	10.69	4.19	209.74	150.00	16.78	12.00	6.58	2.98	8.88	5.19
22	Mataró	11.02	CCC/C	11.02	4.19	212.05	150.00	16.96	12.00	6.77	2.98	9.07	5.19
23	San Bartolomé de Tirajana	12.30	CCC/C	12.30	4.19	220.37	150.00	17.63	12.00	7.48	2.98	9.80	5.19
24	Coruña (A)	12.64	CCC/C	12.64	4.19	222.42	150.00	17.79	12.00	7.67	2.98	9.99	5.19

(*continued*)

Table A2.1. Continued

	Municipality	PD logit (1) (%)	Standard & Poor's rating (2)	PD-IRB (3) (%)	PD-standard (4) (%)	RWA-IRB (5) (%)	RWA-standard (6) (%)	K-IRB (7) (%)	K-standard (8) (%)	Risk premium IRB (9) (%)	Risk premium standard (10) (%)	Risk-adjusted IR-IRB (11) (%)	Risk-adjusted IR-Standard (12) (%)
25	Pamplona/ Iruña	12.81	CCC/C	12.81	4.19	223.41	150.00	17.87	12.00	7.76	2.98	10.08	5.19
26	Vilanova i la Geltrú	13.03	CCC/C	13.03	4.19	224.68	150.00	17.97	12.00	7.88	2.98	10.21	5.19
27	Reus	13.16	CCC/C	13.16	4.19	225.41	150.00	18.03	12.00	7.96	2.98	10.28	5.19
28	Sant Boi de Llobregat	14.52	CCC/C	14.52	4.19	232.54	150.00	18.60	12.00	8.71	2.98	11.05	5.19
29	Marbella	15.10	CCC/C	15.10	4.19	235.29	150.00	18.82	12.00	9.04	2.98	11.38	5.19
30	Rubí	15.76	CCC/C	15.76	4.19	238.21	150.00	19.06	12.00	9.41	2.98	11.75	5.19
31	Ourense	15.76	CCC/C	15.76	4.19	238.21	150.00	19.06	12.00	9.41	2.98	11.75	5.19
32	Castelldefels	16.94	CCC/C	16.94	4.19	242.94	150.00	19.44	12.00	10.07	2.98	12.42	5.19
33	Puertollano	18.34	CCC/C	18.34	4.19	247.78	150.00	19.82	12.00	10.86	2.98	13.22	5.19
34	Irun	19.32	CCC/C	19.32	4.19	250.70	150.00	20.06	12.00	11.42	2.98	13.78	5.19
35	Soria	19.60	CCC/C	19.60	4.19	251.47	150.00	20.12	12.00	11.58	2.98	13.94	5.19
36	Pozuelo de Alarcón	21.71	CCC/C	21.71	4.19	254.26	150.00	20.34	12.00	12.77	2.98	15.14	5.19
37	Zaragoza	22.04	CCC/C	22.04	4.19	257.06	150.00	20.56	12.00	12.98	2.98	15.36	5.19
38	Barakaldo	22.22	CCC/C	22.22	4.19	257.39	150.00	20.59	12.00	13.08	2.98	15.46	5.19
39	Gandia	22.52	CCC/C	22.52	4.19	257.93	150.00	20.63	12.00	13.26	2.98	15.64	5.19
40	Huesca	23.19	CCC/C	23.19	4.19	259.04	150.00	20.72	12.00	13.65	2.98	16.02	5.19
41	Valencia	23.87	CCC/C	23.87	4.19	260.03	150.00	20.80	12.00	14.04	2.98	16.42	5.19
42	Badalona	24.03	CCC/C	24.03	4.19	260.24	150.00	20.82	12.00	14.14	2.98	16.52	5.19
43	Terrassa	27.03	CCC/C	27.03	4.19	263.04	150.00	21.04	12.00	15.91	2.98	18.30	5.19
44	Benidorm	27.09	CCC/C	27.09	4.19	263.08	150.00	21.05	12.00	15.95	2.98	18.33	5.19
45	Salamanca	27.20	CCC/C	27.20	4.19	263.14	150.00	21.05	12.00	16.02	2.98	18.40	5.19
46	Viladecans	28.32	CCC/C	28.32	4.19	263.58	150.00	21.09	12.00	16.69	2.98	19.08	5.19
47	Avilés	29.48	CCC/C	29.48	4.19	263.76	150.00	21.10	12.00	17.39	2.98	19.78	5.19
48	Logroño	31.98	CCC/C	31.98	4.19	263.21	150.00	21.06	12.00	18.94	2.98	21.32	5.19
49	Bilbao	33.44	CCC/C	33.44	4.19	262.35	150.00	20.99	12.00	19.85	2.98	22.24	5.19
50	Santiago de Compostela	33.52	CCC/C	33.52	4.19	262.29	150.00	20.98	12.00	19.90	2.98	22.28	5.19
51	Alcobendas	33.54	CCC/C	33.54	4.19	262.28	150.00	20.98	12.00	19.91	2.98	22.29	5.19
52	Sevilla	33.86	CCC/C	33.86	4.19	262.03	150.00	20.96	12.00	20.12	2.98	22.50	5.19

53	Estepona	34.22	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
54	Mollet del Vallès	34.50	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
55	Benalmádena	34.76	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
56	Santander	35.15	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
57	Eivissa	35.36	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
58	Gijón/Xixón	36.19	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
59	Málaga	39.88	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
60	Torrelavega	40.35	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
61	Torremolinos	41.03	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
62	León	42.59	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
63	Lugo	42.75	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
64	Alcalá de Guadaíra	43.04	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
65	Burgos	44.45	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
66	Cerdanyola del Vallès	45.63	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
67	Palencia	46.74	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
68	Vélez-Málaga	47.99	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
69	Alcorcón	48.61	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
70	Palma	50.79	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
71	Toledo	51.48	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
72	San Fernando	53.19	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
73	Teruel	54.77	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
74	Mérida	55.36	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
75	Leganés	56.85	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
76	Cartagena	58.29	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
77	Algeciras	58.81	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
78	Rivas-Vaciamadrid	59.42	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
79	Albacete	59.51	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
80	Getafe	59.97	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
81	Córdoba	60.76	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
82	Linares	60.88	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
83	Dos Hermanas	61.40	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40

(*continued*)

Table A2.1. Continued

	Municipality	PD logit (1) (%)	Standard & Poor's rating (2)	PD-IRB (3) (%)	PD-standard (4) (%)	RWA-IRB (5) (%)	RWA-standard (6) (%)	K-IRB (7) (%)	K-standard (8) (%)	Risk premium IRB (9) (%)	Risk premium standard (10) (%)	Risk-adjusted IR-IRB (11) (%)	Risk-adjusted IR-Standard (12) (%)
84	Avila	63.61	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
85	Rozas de Madrid (Las)	64.29	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
86	Siero	64.69	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
87	Utrera	65.95	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
88	Chiclana de la Frontera	66.38	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
89	Vigo	66.97	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
90	Coslada	69.42	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
91	Santa Lucía de Tirajana	70.10	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
92	Elche/Elx	70.12	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
93	Talavera de la Reina	70.43	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
94	Palmas de Gran Canaria (Las)	71.11	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
95	Torrevieja	71.22	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
96	Cuenca	71.35	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
97	Granada	72.92	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
98	Pontevedra	72.99	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
99	Valladolid	73.67	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
100	Molina de Segura	74.34	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
101	Telde	74.62	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
102	Arona	75.25	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
103	Aranjuez	75.86	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
104	Fuenlabrada	76.16	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
105	Sagunto/Sagunt	78.37	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
106	Ferrol	78.89	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
107	Fuengirola	79.18	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
108	Mijas	79.90	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40

109	Cáceres	81.06	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
110	Orihuela	82.84	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
111	Alicante/ Alacant	83.07	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
112	Arrecife	83.43	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
113	Vila-real	84.00	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
114	Oviedo	84.17	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
115	Lorca	84.31	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
116	Alcoy/Alcoi	84.33	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
117	Almería	84.59	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
118	Jaén	85.35	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
119	Torrent	85.76	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
120	Collado Villalba	85.92	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
121	Ponferrada	86.01	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
122	Motril	86.55	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
123	Castellón de la Plana	87.10	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
124	Murcia	87.13	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
125	Paterna	87.40	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
126	Torrejón de Ardoz	88.14	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
127	Roquetas de Mar	88.65	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
128	Badajoz	89.15	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
129	Majadahonda	89.24	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
130	Ciudad Real	89.25	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
131	Guadalajara	89.40	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
132	Parla	89.97	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
133	Elda	90.13	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
134	Huelva	90.31	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
135	Arganda del Rey	90.54	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
136	Puerto de Santa María (El)	91.89	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40

(continued)

Table A2.1. Continued

	Municipality	PD logit (1) (%)	Standard & Poor's rating (2)	PD-IRB (3) (%)	PD-standard (4) (%)	RWA-IRB (5) (%)	RWA-standard (6) (%)	K-IRB (7) (%)	K-standard (8) (%)	Risk premium IRB (9) (%)	Risk premium standard (10) (%)	Risk-adjusted IR-IRB (11) (%)	Risk-adjusted IR-Standard (12) (%)
137	Jerez de la Frontera	93.83	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
138	San Vicente del Raspeig	94.06	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
139	San Cristóbal de La Laguna	94.63	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
140	Ejido (El)	95.17	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
141	Santa Cruz de Tenerife	95.23	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
142	Sanlúcar de Barrameda	95.64	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
143	Móstoles	95.65	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
144	Alcalá de Henares	97.10	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
145	Línea de la Concepción (La)	97.63	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
146	Zamora	98.37	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
147	Valdemoro	98.61	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40
148	San Sebastián de los Reyes	99.80	D	100.00	100.00	0.00	0.00	0.00	0.00	83.43	83.43	85.40	85.40

Notes: The calculations presented were performed using a BIS II capital ratio of 8.00%, a β for the banking sector versus Madrid General SE Index of 1.445, a risk-free interest rate of 1.969%, a market risk premium of 5.90%, a return to equity in the banking industry of 10.49% and LGD of 45.00%.
(1) PD obtained from the logit panel data model. Formula 10.
(2) PD assigned according to the Standard & Poor's rating scale.
(3) PD assigned according to the internal method for Institutions of Banco Santander.
(4) PD assigned according to the standardized approach, replacing the weighting factor by credit risk in the Basel II capital requirement graph for institutions.
(5) Risk-weighted assets according to IRB. See Appendix 1, (2) IRB approach, Formula d.
(6) Risk-weighted assets according to standardized approach. See Appendix 1, (1) standardized approach, Formula a.
(7) Capital requirement for credit risk according to IRB. Risk-weighted assets according to IRB. See Appendix 1, (2) IRB approach, Formula b.
(8) Capital requirement for credit risk in according to standardized approach. Risk-weighted assets according to IRB approach. See Appendix 1, (1) standardized approach, Formula a.
(9) Credit risk premium if the bank applies IRB and PD (3). Formula 7.
(10) Credit risk premium if the bank applies the standardized and PD approach (4). Formula 7.
(11) Credit-risk-adjusted interest rate if the bank applies IRB and PD approach (3). Formula 8.
(12) Credit-risk-adjusted interest rate if the bank applies the standardized and PD approach (4). Formula 8.