

Understanding the Determinants of Sovereign Debt Ratings: Evidence for the Two Leading Agencies

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Abstract

An analysis of the possible determinants of sovereign credit ratings assigned by the two leading credit rating agencies, Moody's and Standard and Poor's, is conducted in this paper by using linear, logistic, and exponential transformations of the rating scales. Of the large number of variables that can be used, the set of explanatory variables selected in this study is significant in explaining the credit ratings. Namely, six variables appear to be the most relevant to determining a country's credit rating: GDP per capita, external debt, level of economic development, default history, real growth rate, and inflation rate. (*JEL* C21, G15)

Introduction

The relevance of rating the creditworthiness of sovereign borrowers arises from the fact that national governments are by far the largest issuers on capital markets and also because those country ratings are seen as an indication of public and private sector issues. The financial literature devoted to modelling sovereign credit rating is rather sparse. Nevertheless, some examples of this line of research are Cosset and Roy (1991), Moon and Stotsky (1993), Lee (1993), Cantor and Packer (1997), and Larrain, Helmut, and Maltzan (1997).

This paper studies the factors that seem to play an important role in determining sovereign debt rating. For that purpose, information concerning several quantitative and qualitative variables was collected for a universe of 81 developed and developing countries, and also the ratings assigned to those countries by Standard & Poor's and Moody's in June 2001. With this sectional sample an attempt is made to replicate the effective ratings given by those two agencies. This is done using a linear, a logistic, and a logistic transformation of the rating levels.

The organisation of the paper is as follows. The next section describes briefly the more commonly used rating notation systems for sovereign public debt; the rating model estimated in this paper is discussed in the third section; the results are reported in the fourth; and the fifth contains a summary and conclusions.

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Rating Systems

The rating classification of sovereign public debt is, somehow, besides being a measure of the solvency and capacity of interest payment and return of loans, an assessment of the economic, financial, and political situation of an economy, giving also a measure of the country's development. In fact, higher default risk premiums are associated with lower ratings and higher government yields, increasing therefore the financing cost of the government. While there are a large number of credit rating agencies, the more well known are Moody's Investment Service, Standard & Poor's (S&P), Duff Phelps Credit Rating Co., and Fitch IBCA, Inc.¹ There seems also to be a kind of duopoly between the first two agencies, responsible for around 80 percent of the credit rating market.² Table 1 presents, as an example, the rating levels and a summary description, given by Moody's, of the government bonds that receive those classifications. Under the conventions used, the notations AAA and Aaa are the highest rating classifications assigned respectively by S&P and by Moody's.

TABLE 1. S&P AND MOODY'S RATING SYSTEMS

| Characterization of debt and issuer (source: Moody's) | Rating | |
|---|--------|---------|
| | S&P | Moody's |
| Bonds that are judged to be of the best quality. They carry the smallest degree of investment risk and are generally referred to as "gilt edged." Interest payments are protected by a large or by an exceptionally stable margin, and principal is secure. | AAA | Aaa |
| Bonds that are judged to be of high quality by all standards. Together with the Aaa group, they constitute what are generally known as high-grade bonds. They are rated lower than the Aaa bonds because margins of protection may not be as large. | AA+ | Aa1 |
| | AA | Aa2 |
| | AA- | Aa3 |
| Bonds that possess many favorable investment attributes and are to be considered as upper-medium-grade obligations. Factors giving security to principal and interest are considered adequate, but elements may be present that suggest a susceptibility to impairment some time in the future. | A+ | A1 |
| | A | A2 |
| | A- | A3 |
| Bonds that are considered medium-grade obligations. Interest payments and principal security appear adequate for the present, but certain protective elements may be lacking or may be characteristically unreliable over any great length of time. | BBB+ | Baa1 |
| | BBB | Baa2 |
| | BBB- | Baa3 |
| Bonds that are judged to have speculative elements; their future cannot be considered well assured. The protection of interest and principal payments may be very moderate and thereby not well safeguarded during either good or bad times. | BB+ | Ba1 |
| | BB | Ba2 |
| | BB- | Ba3 |
| Bonds that generally lack characteristics of the desirable investment. Assurance of interest and principal payments or of maintenance of other terms of the contract over any long period of time may be small. | B+ | B1 |
| | B | B2 |
| | B- | B3 |
| Bonds that are of poor standing. Such issues may be in default, or there may be present elements of danger with respect to principal or interest. | CCC+ | Caa1 |
| | CCC | Caa2 |
| | CCC- | Caa3 |

¹ S&P's history can be traced back to 1860 (Kunczik 2001).

² A more complete reference about rating agencies may be found in the Asian Development Bank site, <http://aric.adb.org/links/crerat.asp>, and also in BIS (2000).

This study uses the rating classifications of S&P and Moody's, in June 2001, for a sample consisting of 81 countries. In this country sample, there are 29 developed countries and 52 developing countries, as reported by the IMF (2001) classification. The rating classifications for external government debt, for each country, are presented in Table 2.

TABLE 2. EXTERNAL DEBT RATING CLASSIFICATIONS (JUNE 2001)

| Country | Rating | | Country | Rating | |
|------------------|--------|---------|---------------------|--------|---------|
| | S&P | Moody's | | S&P | Moody's |
| Argentina | B | B2 | Lithuania | BBB- | Ba1 |
| Australia | AA+ | Aa2 | Luxemburg | AAA | Aaa |
| Austria | AAA | Aaa | Malaysia | BBB | Baa2 |
| Barbados | A- | Baa2 | Malta | A | A3 |
| Belgium | AA+ | Aa1 | Mexico | BB+ | Baa3 |
| Belize | BB | Ba2 | Mongolia | B | |
| Bolivia | B+ | B1 | Morocco | BB | Ba1 |
| Botswana | A | A2 | Netherlands | AAA | Aaa |
| Brazil | BB- | B1 | New Zealand | AA+ | Aa2 |
| Bulgaria | B+ | B2 | Norway | AAA | Aaa |
| Canada | AA+ | Aa1 | Oman | BBB | Baa2 |
| Chile | A- | Baa1 | Pakistan | B- | Caa1 |
| China | BBB | A3 | Panama | BB+ | Ba1 |
| Colombia | BB | Ba2 | Papua New Guinea | B+ | B1 |
| Costa Rica | BB | Ba1 | Paraguay | B | B2 |
| Cyprus | A | A2 | Peru | BB- | Ba3 |
| Czech Republic | A- | Baa1 | Philippines | BB+ | Ba1 |
| Denmark | AAA | Aaa | Poland | BBB+ | Baa1 |
| Dominican Repub. | B+ | B1 | Portugal | AA | Aa2 |
| Egypt | BBB- | Ba1 | Qatar | BBB+ | Baa2 |
| El Salvador | BB+ | Baa3 | Romania | B- | B3 |
| Estonia | BBB+ | Baa1 | Russia | B- | B3 |
| Finland | AA+ | Aaa | Senegal | B+ | |
| France | AAA | Aaa | Singapore | AAA | Aa1 |
| Germany | AAA | Aaa | Slovakia | BB+ | Ba1 |
| Greece | A | A2 | Slovenia | A | A2 |
| Hong Kong | A+ | A3 | South Africa | BBB- | Baa3 |
| Hungary | A- | A3 | Spain | AA+ | Aa2 |
| Iceland | A+ | Aa3 | Suriname | B- | |
| India | BB | Ba2 | Sweden | AA+ | Aa1 |
| Ireland | AA+ | Aaa | Switzerland | AAA | Aaa |
| Israel | A- | A2 | Taiwan | AA+ | Aa3 |
| Italy | AA | Aa3 | Thailand | BBB- | Baa3 |
| Jamaica | B+ | Ba3 | Trinidad and Tobago | BBB- | Baa3 |
| Japan | AA+ | Aa1 | Tunisia | BBB | |
| Jordan | BB- | Ba3 | Turkey | B- | B1 |
| Kazakhstan | BB | Ba2 | UK | AAA | Aaa |
| Korea | BBB | Baa2 | USA | AAA | Aaa |
| Kuwait | A | Baa1 | Uruguay | BBB- | Baa3 |
| Latvia | BBB | Baa2 | Venezuela | B | B2 |
| Lebanon | B+ | B1 | | | |

Source: S&P, available at <http://www.standardandpoors.com>; Moody's, available at <http://www.moody's.com>

Only countries with rating notation between AAA (Aaa) and B- (B3) were selected, in order to avoid lower quality bonds, eventually with more speculative characteristics. One should notice that this sample has around 29 percent of countries with rating classification equal or above AA (using, for instance, the S&P notation), and that 56 percent of the selected countries had an assigned rating below the A- notch. Also, there are around 35-37 percent of countries whose rating falls below the investment grade cutoff (starting at BB+ or Ba1).

Some sort of conversion between qualitative information and cardinal variables is always needed before doing some empirical estimation. In order to get appropriate data to implement empirical estimations, it is necessary to perform a numerical transformation of the rating notches into numbers. Therefore, one may construct a variable *RATING* that takes numeric values between 1 and 16, defined according to the notation levels of the two rating agencies, using a linear transformation. For instance, to the rating level B- (B3) corresponds the value 1 for the variable *RATING*, and to the rating level AAA (Aaa) corresponds the maximum value of 16 for the variable *RATING*.

The correspondence between the rating levels and the values given to the *RATING* variable, presented in Table 3 (along with logistic and exponential transformations, to be used ahead), is not very different from the ones already used in the literature. For instance, Cantor and Packer (1996) use also 16 levels, while Larrain et al. (1997) use 20 levels, taking therefore into account some of the C notches of the rating scales.

TABLE 3. LINEAR AND NON-LINEAR TRANSFORMATION OF THE RATINGS LEVELS

| | Rating Levels | | | | | | | | |
|-------------|---------------|--------|--------|--------|--------|--------|--------|--------|-------|
| S&P | B- | B | B+ | BB- | BB | BB+ | BBB- | BBB | BBB+ |
| Moody's | B3 | B2 | B1 | Ba3 | Ba2 | Ba1 | Baa3 | Baa2 | Baa1 |
| Linear | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Logistic | -3.434 | -2.269 | -1.686 | -1.273 | -0.938 | -0.647 | -0.379 | -0.125 | 0.125 |
| Exponential | 2.120 | 2.476 | 2.893 | 3.379 | 3.947 | 4.611 | 5.386 | 6.291 | 7.349 |
| S&P | A- | A | A+ | AA- | AA | AA+ | AAA | | |
| Moody's | A3 | A2 | A1 | Aa3 | Aa2 | Aa1 | Aaa | | |
| Linear | 10 | 11 | 12 | 13 | 14 | 15 | 16 | | |
| Logistic | 0.379 | 0.647 | 0.938 | 1.273 | 1.686 | 2.269 | 3.434 | | |
| Exponential | 8.585 | 10.028 | 11.714 | 13.683 | 15.984 | 18.671 | 21.810 | | |

Notes: See section four for details on the logistic and exponential transformations used; these are the values assigned to the *Rating* variable.

According to the qualitative notations and the cardinal transformation reported, one may notice a few points. All the EU-15 countries had at the time (June 2001) a rating level of at least A (A2), which was the notation attributed to Greece, with most of the countries with ratings between AAA (Aaa) or AA (Aa). Also, and considering the classification of developed countries used by the IMF, all these countries have a rating level equal to or above A. In other words, the rating level appears clearly correlated with the development of the country.

Another point to mention is that the rating levels given by the two agencies are quite similar. Indeed, the correlation between the two rating scales within the common sample is around 0,9878. Notice also that the difference between the two classifications is never higher than two points, according to the cardinal classification used in this paper, except for the following countries: Barbados, China, Kuwait, Taiwan, and Turkey. For the entire country sample, one may also see that Moody's gives a better rating than S&P to only 11 countries and that S&P assigns better ratings to only 17 countries. In terms of the cardinal classification used in this paper, this means, for this country sample, an accumulated difference of 13 and 21 points, respectively, for Moody's and for S&P. These differences suggest eventually both the use of slightly different explanatory factors and different weights by each agency in its rating methodologies. There could be also some attempt by the agencies to gain market share by giving some countries a notch more than the competitors.³

Additionally, for the EU-15 countries, the notations of the two agencies are basically the same, except for a difference of one point in four countries. Moody's assigns to Ireland and Finland a better rating than the one proposed by S&P, while S&P gives Italy and Spain better ratings than Moody's does. Even if "split rating" at a letter grade commonly occurs, this may give conflicting information to potential investors.

Rating Determinants

To assess the credit risk of governments is not an easy task. One must take into account both solvency facts and aspects such as the stability of the political system, social cohesion, and the degree of interdependence with international economic and financial systems. It is also worthwhile noticing that sovereigns, unlike corporate issuers, are less likely to face claims from creditors if the circumstance of a default arises.⁴ This is true even if governments have an incentive to make payments, resulting from the possibility of capital market autarky. Potential relevant variables should therefore relate to the country's fundamentals, the country's external solvency position, and the history of defaults.

Among the factors that might influence the attribution of a higher or lower rating level to each sovereign issuance, one may mention for instance the political stability of the country, the level of external debt, the evidence on previous issuances and defaults, information about the public accounts, indicators of economic performance, and the degree of the country's development. Edwards (1984), Haque et al. (1996), and Cantor and Packer (1996) discuss the rationale for several of these factors, while Haque, Mark, and Mathieson (1998) assess the importance of political factors. One may also see, for instance, the criteria definition used by Moody's (2001).

After a first analysis, where the correlation of several variables with the cardinal variable *RATING* was assessed, along with the plausibility of the economic relations, the following variables were selected: per capita GDP; inflation rate; GDP real growth rate; development indicator; default indicator; external debt-exports ratio (this variable is only relevant for developing countries); and the government deficit as a percentage of GDP. Variables such as the current account deficit as a percentage of GDP, central government spending as a percentage of GDP, or the debt-to-GDP ratio turned out to be poorly correlated with the rating classifications.

³ For instance, with data for 252 US municipal government debt, Moon and Stotsky (1992) mention that there was some tendency for S&P to give a better rating than Moody's.

⁴ See, for instance, Bulow and Rogoff (1989) and also Bulow (1992) for the differences between corporate and sovereign default.

Nevertheless, both the current account deficit and the debt-to-GDP ratio were used in the estimations but with no significant result.

Alesina et al. (1992) and Bayoumi et al. (1995) provide previous research on the relevance of economic growth in this context, while Catão and Sutton (2002) test for the relevance of macroeconomic volatility. Concerning default history, the existent literature is quite vast, and one can see namely Eaton, Gersovitz, and Stiglitz (1986), Fernandez (1995), Rogoff (1996), and Rose (2002), while Huhne (1998) offers some insight on the relevance of the structure of external debt.

The general model to estimate is as follows:

$$RATING_i = \alpha_0 + \alpha_1 GDPPC_i + \alpha_2 INFL_i + \alpha_3 GDPGR_i + \alpha_4 DEVELOP_i + \alpha_5 DEBTX_i + \alpha_6 DEF_i + \alpha_7 BUDGET_i \quad (1)$$

where we have:

| | | |
|----------------|---|--|
| <i>RATING</i> | = | quantitative variable, obtained by linear/non-linear transformation; |
| <i>GDPPC</i> | = | per capita GDP, values for 2000, thousands of dollars; |
| <i>INFL</i> | = | inflation rate, average of the last three years (1998-2000); |
| <i>GDP</i> | = | <i>GR</i> – real GDP growth rate, average of the last three years (1998-2000); |
| <i>DEVELOP</i> | = | $\begin{cases} 1, & \text{developed country} \\ 0, & \text{developing country} \end{cases}$, indicator of developed country; |
| <i>DEBTX</i> | = | $(1 - DEVELOP)(edebt/exp)$, the external debt-to-exports ratio, with <i>edebt</i> – external debt, values for 2000, <i>exp</i> – exports, values for 2000; |
| <i>DEF</i> | = | $\begin{cases} 1, & \text{with default} \\ 0, & \text{without default} \end{cases}$, indicator of default that assesses if the country defaulted either on interest or principal payments since 1975 (nine episodes of default occurred); |
| <i>BUDGET</i> | = | budget balance as a percentage of GDP, average of the last three years (1998-2000). |

According to sensible economic relationships, it seems reasonable to anticipate the following signs for the coefficients of each variable in equation (1): $\alpha_1 > 0$ (per capita GDP); $\alpha_2 < 0$ (inflation); $\alpha_3 > 0$ (GDP real growth); $\alpha_4 > 0$ (developed country indicator); $\alpha_5 < 0$ (external debt-to-exports ratio); $\alpha_6 < 0$ (default indicator); and $\alpha_7 > 0$ (budget balance).

Estimation and Results

Equation (1) was estimated using OLS. An attempt was also made to estimate a multinomial Logit; however, the absence of a significant number of values for the dependent variable and a reduced number of sectional data prevent the maximum likelihood convergence of the coefficients.

Using a Linear Transformation

Of the several versions tried for equation (1), only the more statistically significant are presented, taking into account namely the pattern of the residuals and the absolute percentage average errors. The estimations were carried out using the two series for the *RATING* variable, according to the ratings of S&P or Moody's, with the linear transformation constructed in the second section. The results for both ratings are reported in Table 4 and allow us to conclude that

all the coefficients have the expected signs. Also, most of the coefficients are indeed statistically different from zero.

Regarding both the S&P and the Moody's notations, the specifications of Table 4 enhance the role of the variables that try to capture the information from the default history and from the ratio of external debt to exports. In other words, these two factors appear as highly important in determining and explaining the rating level and are both, as expected, negatively related to sovereign credit quality. Additionally, the budget balance variable, as a percentage of GDP, even if it has the correct sign, is not unequivocally statistically significant, since its estimated coefficient is only different from zero at the 15 percent level (results not presented).

TABLE 4. ESTIMATION OF EQUATION (1), S&P AND MOODY'S DATA, USING A LINEAR TRANSFORMATION

| | With the <i>DEFAULT</i> variable | | | With the <i>DEBTX</i> variable | | |
|-------------------------|----------------------------------|-----------------------|-----------------------|--------------------------------|-----------------------|-----------------------|
| | S&P | Moody's | Pooled data | S&P | Moody's | Pooled data |
| Constant (α_0) | 5.8864 ** (10.72) | 5.3499 ** (10.15) | 5.6173 ** (14.98) | 7.0717 ** (10.18) | 6.8069 ** (9.99) | 6.9400 ** (14.48) |
| GDPPC (α_1) | 0.00014 ** (3.42) | 0.00016 ** (4.10) | 0.00015 ** (5.38) | 0.00013 ** (3.30) | 0.00015 ** (4.06) | 0.00014 ** (5.28) |
| INFL (α_2) | -0.0913 ** (-4.05) | -0.0610 ** (-2.82) | -0.0761 ** (-4.94) | -0.0953 ** (-4.41) | -0.0674 ** (-3.18) | -0.0814 ** (-5.47) |
| GDPGR (α_3) | 0.2764 * (2.32) | 0.3270 ** (2.82) | 0.3026 ** (3.69) | 0.2228 * (1.94) | 0.2533 * (2.22) | 0.2386 ** (2.99) |
| DEVELOP (α_4) | 4.3214 ** (4.25) | 3.8960 ** (3.98) | 4.1120 ** (5.91) | 3.6102 ** (3.45) | 2.8584 ** (2.78) | 3.2325 ** (4.47) |
| DEBTX (α_5) | | | | -0.0097 ** (-3.34) | -0.0123 ** (-4.31) | -0.0110 ** (-5.49) |
| DEFAULT (α_6) | -2.3381 ** (-2.93) | -3.1596 ** (-3.86) | -2.7153 ** (-4.82) | | | |
| Adjust. R ² | 0.8496 | 0.8607 | 0.8584 | 0.8636 | 0.8707 | 0.8702 |
| N° of observations | 72 | 70 | 142 | 70 | 69 | 139 |
| F test | | | 0.3159 ^s | | | 0.3265 ^s |

Notes: The t statistics are in parentheses. * - Significant at the 5 or 10 percent level. ** - Significant at the 1 percent level. ^s - At the 1 percent level, one cannot reject the hypothesis that the separate regressions are not statistically different from the pooled regression. The 1 percent thresholds are F(6,127)= 2.9587; F(6,130)= 2.9582.

It is interesting to point also to the significance of the explanatory variable *DEVELOP*, corroborating, as expected, the initial idea that the so-called developing countries have lower credit ratings. Inflation has also rather meaningful information to explain the rating levels, with low inflation countries getting a better notation from both agencies in all versions of the model.

Table 4 also assesses the question of whether S&P and Moody's are using the same explanatory variables when assigning their country ratings. This is tested by pooling the data for both ratings and by running a common regression. The reported F test does not reject the idea, at the 1 percent level, that the two agencies are basically looking into the same economic variables in a rather similar way.

The model with the default variable for the S&P data and the model with the external debt variable for the Moody's data were selected to replicate the ratings given by the two agencies. The estimated ratings are quite similar, with both models presenting an absolute percentage average error of around 30 percent, the lowest figure for each rating scale.

TABLE 5. PREDICTION ERRORS: MODEL FOR S&P, WITH THE DEFAULT VARIABLE, LINEAR TRANSFORMATION (SEE TABLE 4)

| Country | Rating (R) S&P | Prediction (P) | Error = P - R | Country | Rating (R) S&P | Prediction (P) | Error = P - R |
|-------------|-------------------|-------------------|------------------|----------------|-------------------|-------------------|------------------|
| Argentina | B | 2 | 3 | Lithuania | BBB- | 7 | 7 |
| Australia | AA+ | 15 | 14 | Luxembourg | AAA | 16 | 16 |
| Austria | AAA | 16 | 14 | Malaysia | BBB | 8 | 7 |
| Barbados | A- | 10 | 8 | Malta | A | 11 | 9 |
| Belgium | AA+ | 15 | 15 | Mexico | BB+ | 6 | 7 |
| Bolivia | B+ | 3 | 4 | Morocco | BB | 5 | 6 |
| Brazil | BB- | 4 | 4 | Netherlands | AAA | 16 | 15 |
| Bulgaria | B+ | 3 | 6 | New Zealand | AA+ | 15 | 13 |
| Canada | AA+ | 15 | 14 | Norway | AAA | 16 | 16 |
| Chile | A- | 10 | 6 | Pakistan | B- | 1 | 5 |
| China | BBB | 8 | 8 | Panama | BB+ | 6 | 7 |
| Colombia | BB | 5 | 4 | P. New Guinea | B+ | 3 | 5 |
| Cyprus | A | 11 | 14 | Paraguay | B | 2 | 6 |
| Czech Rep. | A- | 10 | 7 | Peru | BB- | 4 | 4 |
| Denmark | AAA | 16 | 15 | Philippines | BB+ | 6 | 6 |
| Egypt | BBB- | 7 | 7 | Poland | BBB+ | 9 | 6 |
| El Salvador | BB+ | 6 | 7 | Portugal | AA | 14 | 13 |
| Estonia | BBB+ | 9 | 7 | Romania | B- | 1 | 1 |
| Finland | AA+ | 15 | 15 | Russia | B- | 1 | 2 |
| France | AAA | 16 | 15 | Singapore | AAA | 16 | 16 |
| Germany | AAA | 16 | 14 | Slovakia | BB+ | 6 | 6 |
| Greece | A | 11 | 13 | Slovenia | A | 11 | 8 |
| Hong Kong | A+ | 12 | 15 | South Africa | BBB- | 7 | 7 |
| Hungary | A- | 10 | 7 | Spain | AA+ | 15 | 13 |
| Iceland | A+ | 12 | 15 | Sweden | AA+ | 15 | 15 |
| India | BB | 5 | 7 | Switzerland | AAA | 16 | 16 |
| Ireland | AA+ | 15 | 16 | Taiwan | AA+ | 15 | 13 |
| Israel | A- | 10 | 13 | Thailand | BBB- | 7 | 6 |
| Italy | AA | 14 | 14 | Trin. and Tob. | BBB- | 7 | 8 |
| Jamaica | B+ | 3 | 6 | Tunisia | BBB | 8 | 7 |
| Japan | AA+ | 15 | 15 | Turkey | B- | 1 | 1 |
| Jordan | BB- | 4 | 7 | UK | AAA | 16 | 14 |
| Kazakhstan | BB | 5 | 6 | USA | AAA | 16 | 16 |
| Korea | BBB | 8 | 8 | Uruguay | BBB- | 7 | 4 |
| Latvia | BBB | 8 | 7 | Venezuela | B | 2 | 4 |
| Lebanon | B+ | 3 | 6 | | | | |

Table 5 reports the predicted errors, using the S&P data, of the linear model with the default variable from Table 4. With this specification, the maximum prevision error is four notches, and this occurs only for three countries: Chile, Pakistan, and Paraguay. For Chile the model under-predicts the rating, and for the other two countries it delivers an over-prediction of the rating level. For the developed countries, one can also notice that the absolute prediction error is always equal to or below two notches. Also, the absolute prediction errors obtained from this model do not go beyond one notch for 42 of the 71 countries.

For the EU-12 countries one may additionally mention some results. The maximum absolute error is two notches, with zero error for four countries: Belgium, Finland, Italy, and Luxemburg. The model assigns a better rating to only two countries: Ireland (one notch more) and Greece (two notches more). Also, the model suggests a lower rating for the six remaining countries of the EU-12: France, Netherlands, and Portugal, minus one notch; Austria, Germany, and Spain, minus two notches. The prediction errors from the same model with Moody's data are quite identical and therefore are not presented here.

FIGURE 1. RATING PREDICTION WITH THE LINEAR MODEL FOR S & P,
WITH THE DEFAULT VARIABLE (DATA FROM TABLE 5)

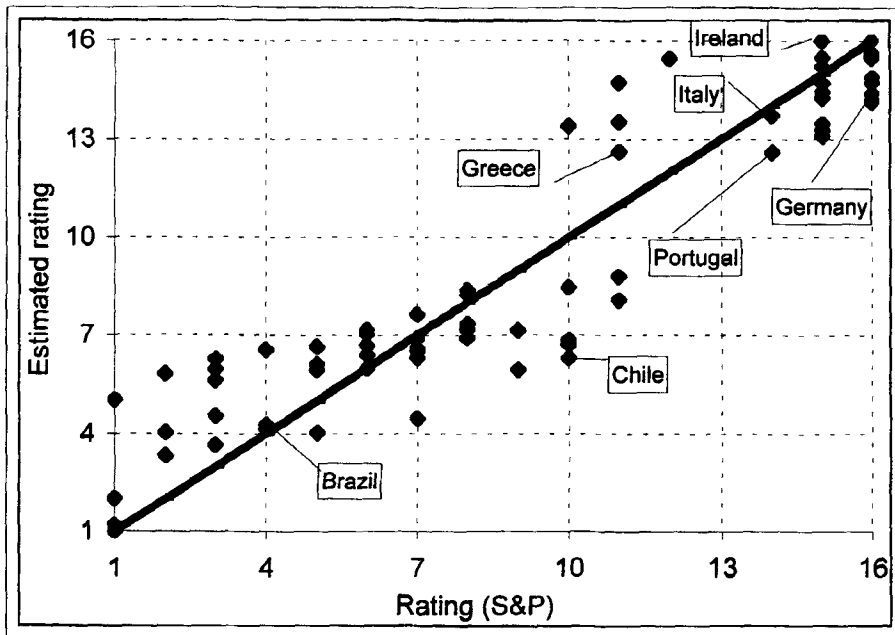


Figure 1 illustrates the prediction power of the linear model used in Table 5 (S&P data), helping to point out some additional conclusions. For instance, two countries with the same effective rating level, such as Portugal and Italy, are set apart by one notch by the model, with Italy getting a better estimated rating. One of the reasons for this simulation result is the fact that GDP per capita is in Portugal roughly half of its Italian counterpart, respectively 11,266 and 21,816 U.S. dollars for Portugal and for Italy (with 2000 figures).

Also, and considering now two EU-12 countries with a similar a GDP per capita, Portugal and Greece (11,780 U.S. dollars), it is possible to see that the model assigns them the same rating,

while the effective ratings are set apart by three notches, with Greece having the lower rating. In this case, the circumstance that Greece did not make it to the euro group from the start may have negatively affected the rating of its sovereign debt.

TABLE 6. PREDICTION ERRORS: MODEL FOR MOODY'S, WITH THE EXTERNAL DEBT VARIABLE, LINEAR TRANSFORMATION (SEE TABLE 4)

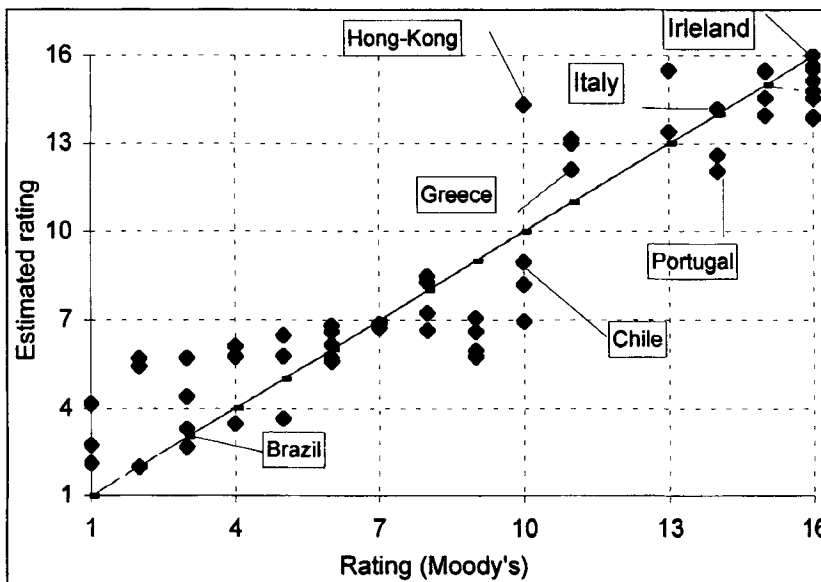
| Country | Rating (R) Moody's | Prediction (P) | Error = P - R | Country | Rating (R) Moody's | Prediction (P) | Error = P - R |
|-------------|-----------------------|-------------------|------------------|----------------|-----------------------|-------------------|------------------|
| Argentina | B2 | 2 | 3 | Lithuania | Ba1 | 6 | 6 |
| Australia | Aa2 | 14 | 14 | Luxembourg | Aaa | 16 | 16 |
| Austria | Aaa | 16 | 14 | Malaysia | Baa2 | 8 | 7 |
| Barbados | Baa2 | 8 | 8 | Malta | A3 | 10 | 7 |
| Belgium | Aa1 | 15 | 14 | Mexico | Baa3 | 7 | 7 |
| Bolivia | B1 | 3 | 3 | Morocco | Ba1 | 6 | 6 |
| Brazil | B1 | 3 | 6 | Netherlands | Aaa | 16 | 15 |
| Bulgaria | B2 | 2 | 7 | New Zealand | Aa2 | 14 | 13 |
| Canada | Aa1 | 15 | 14 | Norway | Aaa | 16 | 16 |
| Chile | Baa1 | 9 | 7 | Pakistan | Caa1 | 1 | 3 |
| China | A3 | 10 | 8 | Panama | Ba1 | 6 | 4 |
| Colombia | Ba2 | 5 | 5 | P. New Guinea | B1 | 3 | 5 |
| Cyprus | A2 | 11 | 13 | Paraguay | B2 | 2 | 6 |
| Czech Rep. | Baa1 | 9 | 6 | Peru | Ba3 | 4 | 3 |
| Denmark | Aaa | 16 | 16 | Philippines | Ba1 | 6 | 6 |
| Egypt | Ba1 | 6 | 7 | Poland | Baa1 | 9 | 7 |
| El Salvador | Baa3 | 7 | 7 | Portugal | Aa2 | 14 | 12 |
| Estonia | Baa1 | 9 | 7 | Romania | B3 | 1 | 2 |
| Finland | Aaa | 16 | 16 | Russia | B3 | 1 | 1 |
| France | Aaa | 16 | 14 | Singapore | Aa1 | 15 | 16 |
| Germany | Aaa | 16 | 14 | Slovakia | Ba1 | 6 | 6 |
| Greece | A2 | 11 | 12 | Slovenia | A2 | 11 | 8 |
| Hong Kong | A3 | 10 | 14 | South Africa | Baa3 | 7 | 6 |
| Hungary | A3 | 10 | 7 | Spain | Aa2 | 14 | 13 |
| Iceland | Aa3 | 13 | 16 | Sweden | Aa1 | 15 | 15 |
| India | Ba2 | 5 | 6 | Switzerland | Aaa | 16 | 16 |
| Ireland | Aaa | 16 | 17 | Taiwan | Aa3 | 13 | 13 |
| Israel | A2 | 11 | 13 | Thailand | Baa3 | 7 | 5 |
| Italy | Aa3 | 13 | 13 | Trin. and Tob. | Baa3 | 7 | 8 |
| Jamaica | Ba3 | 4 | 5 | Turkey | B1 | 3 | 2 |
| Japan | Aa1 | 15 | 14 | UK | Aaa | 16 | 14 |
| Jordan | Ba3 | 4 | 7 | USA | Aaa | 16 | 16 |
| Kazakhstan | Ba2 | 5 | 6 | Uruguay | Baa3 | 7 | 6 |
| Korea | Baa2 | 8 | 8 | Venezuela | B2 | 2 | 4 |
| Latvia | Baa2 | 8 | 7 | | | | |
| Lebanon | B1 | 3 | 5 | | | | |

GDP per capita is rather influential in the estimated models. Nevertheless, notice for instance that the aforementioned linear model, with the S&P data, predicts two notches below the effective rating level for Austria and Germany, two countries with similar GDP per capita, respectively 23,142 and 24,091 dollars. Also, there is a prediction of only one notch below the effective rating for France and Netherlands, countries where the GDP per capita is respectively 26,919 and 27,851 dollars. GDP real growth rate may be playing here an invaluable role since the average real growth rate between 1998 and 2000 was 3.2 percent in France and only 2.2 percent in Germany.

For the estimated linear model for Moody's, with the external debt variable, the prediction errors are reported in Table 6. Concerning now the estimated ratings for the EU-12 countries, there are only minor changes from the results of the previous model. The prediction error is null for four countries: Denmark, Finland, Italy, and Luxembourg. This model assigns a higher rating than the effective rating to the same two countries: Ireland and Greece (plus one notch). Also a lower rating is estimated for six countries: Belgium, Netherlands, and Spain, minus one notch, and Austria, France, Germany, and Portugal, minus two notches.

Figure 2 illustrates the prediction ability of the estimated linear model using Moody's data and allows assessing more clearly the several comments offered above.

FIGURE 2. RATING PREDICTION WITH THE LINEAR MODEL FOR MOODY'S, WITH THE EXTERNAL DEBT VARIABLE (DATA FROM TABLE 6)



Additionally the *RATING* variable was constructed as the arithmetic average of the ratings assigned by the two agencies, still using the linear transformation. Since the estimation results using the rating data in such a way are not substantially different from the ones already reported, these results are not presented in the text.

Using Non-linear Transformations

The models estimated so far, based on a linear transformation of the rating levels, show some lack of accuracy for the countries located on the top end of the rating scale. Another approach was therefore attempted, by using a logistic transformation of the ratings instead of the usual linear transformation.

The idea underlying the use of the logistic transformation is that at the bottom of the scale, since the rating level is low, ratings can rise rather quickly as the sovereigns deliver some improvements. At the top end of the rating scale, however, the increase of an additional notch is slower, since the requisites of sovereign quality are now more demanding.

If one assumes that the functional form that describes the relationship between the creditworthiness rating, R_i , normalized to grade each of the countries on a scale of zero to one, with zero representing the least creditworthy countries and one representing the most creditworthy countries, and the same set of explanatory variables, X , used in (1), is the standard conventional logistic form,

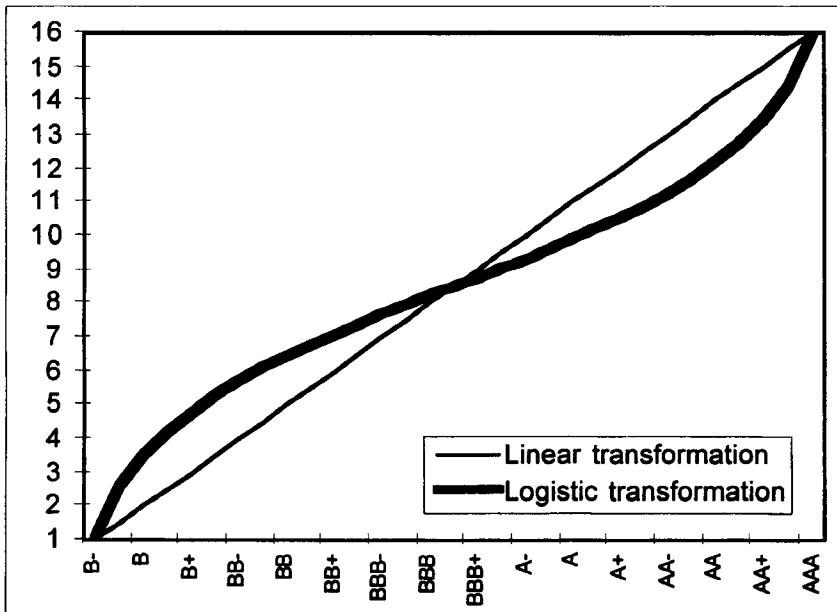
$$R = \frac{e^{\beta'X}}{1 + e^{\beta'X}}, \tag{2}$$

where the vector β' includes the parameters of the exogenous variables. The logistic transformation then becomes

$$L_i = \ln[R_i / (1 - R_i)] = \beta' X, \tag{3}$$

where L_i is the logit of R_i . This equation is not only linear in X , but also linear in the parameters, and can be estimated using ordinary least squares. Figure 3 compares the linear and the logistic transformations.

FIGURE 3. COMPARISON OF RATINGS TRANSFORMATIONS (S&P NOTATION)



The estimation results of equation (3), using the logistic transformation once again for the S&P and the Moody's ratings, are reported in Table 7.

TABLE 7. ESTIMATION OF EQUATION (3), S&P AND MOODY'S, USING A LOGISTIC TRANSFORMATION

| | With the <i>DEFAULT</i> variable | | | With the <i>DEBTX</i> variable | | |
|-------------------------|----------------------------------|-----------------------|-----------------------|--------------------------------|------------------------|------------------------|
| | S&P | Moody's | Pooled data | S&P | Moody's | Pooled data |
| Constant (α_0) | -0.7600 ** (-3.67) | -1.0805 ** (-4.99) | -0.9208 ** (-6.18) | -0.3903 (-1.43) | -0.6197 * (-2.09) | -0.5047 * (-2.52) |
| GDPPC (α_1) | 0.000070 ** (4.61) | 0.000086 ** (5.42) | 0.000078 ** (7.14) | 0.0000679 ** (4.48) | 0.0000859 ** (5.22) | 0.000077 ** (6.94) |
| INFL (α_2) | -0.0474 ** (-5.57) | -0.0269 ** (-3.03) | -0.0375 ** (-6.07) | -0.0490 ** (-5.77) | -0.0293 ** (-3.18) | -0.0392 ** (-6.30) |
| GDPGR (α_3) | 0.0827 * (1.84) | 0.1149 * (2.41) | 0.0993 ** (3.05) | 0.0665 (1.47) | 0.0913 * (1.84) | 0.0792 * (2.38) |
| DEVELOP (α_4) | 1.1313 ** (2.95) | 0.8119 * (2.02) | 0.9733 ** (3.52) | 0.8764 *** (2.13) | 0.4475 (1.00) | 0.6611 * (2.19) |
| DEBTX (α_5) | | | | -0.00309 ** (-2.71) | -0.00415 ** (-3.34) | -0.00361 ** (-4.32) |
| DEFAULT (α_6) | -0.8404 ** (-2.79) | -1.2990 ** (-3.86) | -1.0519 ** (-4.71) | | | |
| Adjust. R ² | 0.8557 | 0.8439 | 0.8504 | 0.8582 | 0.8371 | 0.8490 |
| N° of observ. | 72 | 70 | 142 | 70 | 69 | 139 |
| F test | | | 0.7611 § | | | 0.6481 § |

Notes: The t statistics are in parentheses. * - Significant at the 5 or 10 percent level. ** - Significant at the 1 percent level. § - At the 1 percent level, one cannot reject the hypothesis that the separate regressions are not statistically different from the pooled regression. The 1 percent thresholds are F (6,130)= 2.9582; F (6,127)= 2.9587.

All the estimated coefficients have again the expected sign. The results in terms of the prediction errors with the default variable, where the estimated coefficients are broadly more statistically significant, are reported in Table 8 (only for S&P, for space purposes). Nevertheless those results are not very different from the errors produced by the linear specification.

Using the S&P data, the maximum prediction error, four notches with the logistic transformation, now occurs for the Czech Republic, Hong Kong, Hungary, Israel, and Lebanon. Nevertheless, the logistic transformation does improve the adjustment for the top end of the rating scale and for the entire sample, since the absolute percentage average error is now around 23 percent (recall the 30 percent figure for the model using the linear transformation).

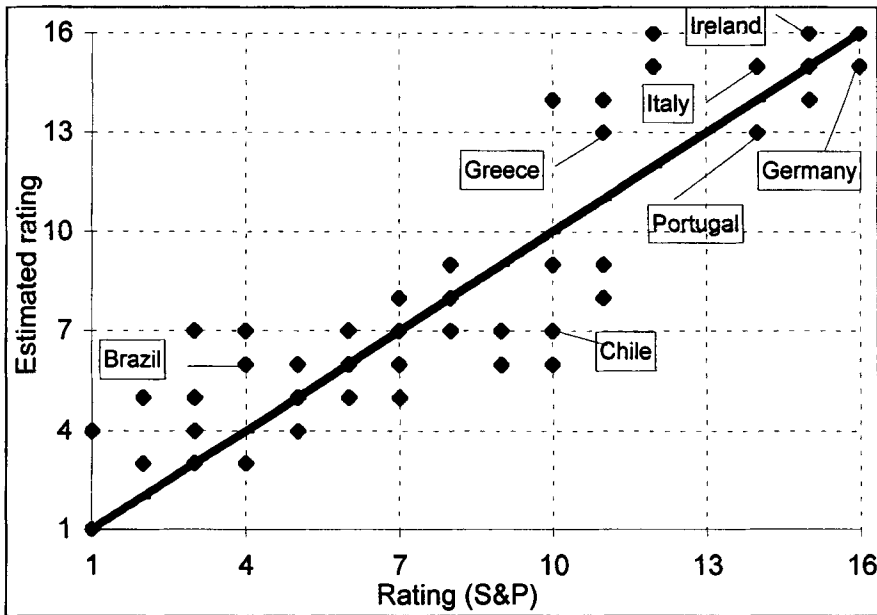
For instance, for a sub-set of the developed countries that are usually the best-rated sovereigns (EU-15 plus Japan, United States, Australia, New Zealand, Singapore, Norway, and Switzerland), the linear model with the S&P ratings gives an accumulated prediction error of 20 points, while the logistic model reduces this margin to 13 points. Also, for the EU-15 countries, prediction errors from the linear model add up to 15 points, and the logistic model now delivers a sum of only 10 points (see Tables 5 and 8). Figure 4 supplements the previous analysis by depicting the aforementioned prediction differences for the S&P logistic model.

TABLE 8. PREDICTION ERRORS: MODEL FOR S&P, WITH THE DEFAULT VARIABLE, LOGISTIC TRANSFORMATION (SEE TABLE 7)

| Country | Rating (R) S&P | Prediction (P) | Error = P - R | Country | Rating (R) S&P | Prediction (P) | Error = P - R |
|-------------|-------------------|-------------------|------------------|----------------|-------------------|-------------------|------------------|
| Argentina | B | 2 | 5 | Lithuania | BBB- | 7 | 6 |
| Australia | AA+ | 15 | 15 | Luxembourg | AAA | 16 | 16 |
| Austria | AAA | 16 | 15 | Malaysia | BBB | 8 | 7 |
| Barbados | A- | 10 | 9 | Malta | A | 11 | 9 |
| Belgium | AA+ | 15 | 15 | Mexico | BB+ | 6 | 6 |
| Bolivia | B+ | 3 | 3 | Morocco | BB | 5 | 6 |
| Brazil | BB- | 4 | 6 | Netherlands | AAA | 16 | 15 |
| Bulgaria | B+ | 3 | 5 | New Zealand | AA+ | 15 | 14 |
| Canada | AA+ | 15 | 15 | Norway | AAA | 16 | 16 |
| Chile | A- | 10 | 7 | Pakistan | B- | 1 | 4 |
| China | BBB | 8 | 8 | Panama | BB+ | 6 | 5 |
| Colombia | BB | 5 | 4 | P. New Guinea | B+ | 3 | 4 |
| Cyprus | A | 11 | 14 | Paraguay | B | 2 | 5 |
| Czech Rep. | A- | 10 | 6 | Peru | BB- | 4 | 3 |
| Denmark | AAA | 16 | 16 | Philippines | BB+ | 6 | 5 |
| Egypt | BBB- | 7 | 7 | Poland | BBB+ | 9 | 6 |
| El Salvador | BB+ | 6 | 7 | Portugal | AA | 14 | 13 |
| Estonia | BBB+ | 9 | 7 | Romania | B- | 1 | 1 |
| Finland | AA+ | 15 | 15 | Russia | B- | 1 | 1 |
| France | AAA | 16 | 15 | Singapore | AAA | 16 | 16 |
| Germany | AAA | 16 | 15 | Slovakia | BB+ | 6 | 6 |
| Greece | A | 11 | 13 | Slovenia | A | 11 | 8 |
| Hong Kong | A+ | 12 | 15 | South Africa | BBB- | 7 | 6 |
| Hungary | A- | 10 | 6 | Spain | AA+ | 15 | 14 |
| Iceland | A+ | 12 | 16 | Sweden | AA+ | 15 | 15 |
| India | BB | 5 | 6 | Switzerland | AAA | 16 | 16 |
| Ireland | AA+ | 15 | 16 | Taiwan | AA+ | 15 | 14 |
| Israel | A- | 10 | 14 | Thailand | BBB- | 7 | 5 |
| Italy | AA | 14 | 15 | Trin. and Tob. | BBB- | 7 | 8 |
| Jamaica | B+ | 3 | 5 | Tunisia | BBB | 8 | 7 |
| Japan | AA+ | 15 | 16 | Turkey | B- | 1 | 1 |
| Jordan | BB- | 4 | 7 | UK | AAA | 16 | 15 |
| Kazakhstan | BB | 5 | 5 | USA | AAA | 16 | 16 |
| Korea | BBB | 8 | 9 | Uruguay | BBB- | 7 | 6 |
| Latvia | BBB | 8 | 7 | Venezuela | B | 2 | 3 |
| Lebanon | B+ | 3 | 7 | | | | |

The logistic transformation applied to the Moody's data gives a maximum prediction error of five notches for one country, Hong Kong, and of four notches for another single country, Lebanon. All other countries get estimated ratings equal or below three points. Once again, the use of the logistic transformation improves the overall adjustment of the model. This is true since the absolute percentage average error for the logistic model is around 25 percent, better than the absolute percentage average error of 30 percent that was associated with the linear model.

FIGURE 4. RATING PREDICTION WITH THE LOGISTIC MODEL FOR S&P, WITH THE DEFAULT VARIABLE (DATA FROM TABLE 8)



Doing also the comparison between the prediction errors of the linear and logistic models for Moody's for the EU-15 countries, it is possible to say that the logistic transformation appears to perform better than the linear transformation. Indeed, the cumulative prediction errors of 15 points from the linear model are now reduced to 11 points with the logistic model. Therefore, using either of the rating notations, S&P or Moody's, one gets better adjustments with a logistic transformation of the qualitative data. This implies the absence of a linear transition from one notch to the next along the rating scale.

Since there were few changes in the results between the linear and logistic transformations, an exponential transformation was also tested. Such an approach allows for the increase of the slope according to the frontier between the risk scale and the investment one, probably gathering the market perception in a more appropriate way.

The exponential transformation used was determined computing the least squares fit through points $R_i = 1, \dots, 16$, by using the following equation:

$$E_i = ae^{bR_i}, \quad (4)$$

where the best fit values for the constants a and b were respectively 1.8148 and 0.1554 and where E_i is the transformed rating level.

The results from the regressions using the exponential transformation are always worse than the ones already present with logistic transformation. As a matter of fact, the exponential transformation is clearly less performing than the logistic and the linear transformation for the S&P data, with absolute percentage average errors around 45-50 per cent (the results for the exponential transformation are not presented for space purposes, but are available from the author).

Only for the Moody's rating, the exponential approach could be somehow interesting since one gets an absolute percentage average error of 32.6 percent, with a maximum absolute error of four notches. Also, these specifications somehow do not invalidate altogether the explanatory power of the budget balance, a variable that has the right coefficient even if only statistically significant at the 10 percent level.

Developing and Developed Countries

In order to assess if there are interesting differences in the coefficients of the economic variables for the two sets of countries, I estimated separate regressions for each group. The results are reported in Table 9 for the S&P rating scale, both with the linear and with the logistic models.

TABLE 9. ESTIMATION OF EQUATIONS (1) AND (3), S&P, SEPARATE REGRESSIONS FOR DEVELOPED AND DEVELOPING COUNTRIES

| | Linear model | | | Logistic model | | |
|-------------------------|----------------------|-----------------------|-----------------------|----------------------|-----------------------|-----------------------|
| | Developed | Developing | Pooled data | Developed | Developing | Pooled data |
| Constant (α_0) | 12.1592 ** (9.74) | 4.3329 ** (5.91) | 5.7450 ** (9.36) | 0.80 (1.20) | -1.0823 ** (-4.73) | -0.7971 ** (-2.52) |
| GDPPC (α_1) | 0.00001 * (2.66) | 0.00427 ** (3.78) | 0.00284 ** (7.14) | 0.00066 ** (3.27) | 0.00113 ** (3.21) | 0.00108 ** (13.25) |
| INFL (α_2) | -0.0091 (-0.00) | -0.0754 ** (-3.25) | -0.0989 ** (-3.93) | 0.0263 (0.21) | -0.0438 ** (-6.04) | -0.0494 ** (-5.52) |
| GDPGR (α_3) | 0.0827 (-0.12) | 0.4108 ** (2.84) | 0.3146 * (2.36) | -0.0387 (-0.38) | 0.1330 ** (2.94) | 0.0927 * (1.96) |
| DEFAULT (α_4) | na | -1.9567 * (-2.43) | -2.5670 ** (-2.88) | na | -0.7807 ** (-3.10) | -0.9003 ** (-2.84) |
| Adjust. R ² | 0.1079 | 0.5596 | 0.8114 | 0.2017 | 0.6854 | 0.8391 |
| N° of observ. | 28 | 44 | 72 | 28 | 44 | 72 |

Notes: The t statistics are in parentheses. * - Significant at the 5 or 10 percent level. ** - Significant at the 1 percent level. na - not applicable since there are no defaults in the developed country sample. One must be aware that the results reported for the pooled data are different from the ones in Tables 4 and 7 since the *DEVELOP* variable is now excluded.

It seems worthwhile mentioning that for the developing countries the separate regression allows us to identify the same economic variables already found with the pooled data: GDP per capita, inflation, economic growth rate, and the default indicator. Also, the effect of these variables on the credit rating is still pretty much the same. However, and as one might have suspected, the main variable when assessing the credit ratings for the developed countries turns out to be only GDP per capita. This is in line with the discussion in previous sections about how GDP per capita plays a role when differentiating developed countries sovereign ratings.

Conclusion

This study aimed at understanding the economic determinants of sovereign credit rating, using data for the two major agencies: S&P and Moody's. The variables that seem to have statistically significant explanatory power for the rating levels are GDP per capita, external debt as a percentage of exports, the level of economic development, default history, real growth rate, and the inflation rate.

The GDP per capita is a rather important variable when estimating the appropriate rating level both for developed and developing countries. Actually, it is virtually the sole relevant economic variable when rating developed countries credit. The external debt variable is basically important for developing countries. The maximum prediction errors are four and five notches for a rather small number of countries (linear and logistic transformations): Chile, Pakistan, Paraguay, Bulgaria, Lebanon, and Hong Kong. These results are consistent with previous empirical work offered by the literature, namely Haque et al. (1996) and Cantor and Packer (1996).

For the empirical estimation of the models, a linear transformation was used as well as both a logistic and an exponential transformation of the qualitative rating data. The results of the estimations using the logistic transformation turned out to be better for the overall sample, particularly for the countries placed on the top end of the rating scale. This seems in line with general knowledge that rating agencies prove right evaluating developed sovereign risks, while their abilities to rate developing countries is not as good. Also, one cannot statistically reject the hypothesis that both agencies are looking at the same economic variables when assigning their country ratings.

Furthermore, with data from S&P, the absolute percentage average error of the selected model is around 23 percent if one uses the logistic transformation and around 30 and 45 percent when using respectively the linear and the exponential transformation. The ability of the model to duplicate the actual Moody's country ratings is also more satisfactory with the logistic transformation, and the same is true for the exponential transformation.

Of the several fiscal variables tested, only the budget balance was moderately relevant in explaining the rating level. Future analysis could take into consideration several components of public expenditures and revenues. In fact, when facing fiscal episodes, the assessment of its success in balancing public accounts may hinge on the composition of the episode.⁵ Also, taking into account implicit public pension liabilities as part of the country's global fiscal unbalance that might be perceived by capital markets as future borrowing requirements, not fully embedded in the public fiscal figures, may lead to added country risk.⁶

Other variables such as management quality, the use of derivatives, or the existence of management benchmarking strategies are also considered by rating agencies; however, collecting that sort of qualitative data proved to be a rather difficult task for the given country sample. Still another additional improvement for the models would be to consider the political risk of each sovereign, even if Haque et al. (1998) mention that the introduction of political variables, as explanatory factors of the rating levels, does not give much additional information over models where those variables are not included.

Finally, if one collects data on the changes of the rating levels for each country throughout a series of years, one can pursue another approach by assessing the factors that help explain the

⁵ On these topics, see for instance Kneller et al. (1999).

⁶ Holzmann et al. (2001) report and review some data on this issue.

upgrade or downgrade of the rating notations. This is a line of work that may be followed in future research but was outside the scope of this study.³

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³ Altman (1997) and Larrain et al. (1997) have some work along this line.

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Appendix – Data Sources

- GDP per capita – dollars, figures for 2000, source: S&P.
- Inflation rate – 1998-2000, source: IMF and EC.
- GDP real growth rate – 1998-2000, source: IMF, OECD and EC.
- Developed country classification – source: IMF (2001), Table B of the Statistical Appendix.
- Default history – source: S&P.
- External debt-to-exports ratio – figures for 2000, source: Moody's. For some developed countries, that issue public debt mainly denominated in their own currencies, external debt means rather local currency debt, hold either locally or by foreigners.
- Budget balance as a percentage of GDP – 1998-2000, source: EC, OECD and IMF.