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A NON-RECURSIVE REGRESSION MODEL FOR COUNTRY RISK RATING

S. Alexe[a] P L. Hammer[b] A.Kogan[c] M.A. Lejeune[d]

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RUTCOR
Rutgers Center for
Operations Research
Rutgers University
640 Bartholomew Road
Piscataway, New Jersey
08854-8003
Telephone: 732-445-3804
Telefax: 732-445-5472
Email: rrr@rutcor.rutgers.edu
http://rutcor.rutgers.edu/~rrr

[a] RUTCOR - Rutgers University Center for Operations Research, Piscataway, NJ, USA, Email: salexe@rutcor.rutgres.edu
[b] RUTCOR - Rutgers University Center for Operations Research, Piscataway, NJ, USA, Email: hammer@rutcor.rutgers.edu
[c] RUTCOR- Rutgers University Center for Operations Research, Piscataway, NJ, USA & Rutgers Business School, Rutgers University, 180 University Avenue, Newark, NJ, USA, Email: kogan@rutcor.rutgers.edu
[d] Rutgers Business School, Rutgers University, 180 University Avenue, Newark, NJ, USA, Email: mlejeune@andromeda.rutgers.edu

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A NON-RECURSIVE REGRESSION MODEL FOR COUNTRY RISK RATING

S. Alexe P.L. Hammer A. Kogan M.A. Lejeune

Abstract. The central objective of this paper is to develop a transparent, consistent, self-contained, and stable country risk rating system, closely approximating one of the major existing ones (Standard & Poor's). The proposed model uses economic-financial and political variables, is non-recursive (i.e., it does not rely on the previous year's ratings) and is constructed using multiple regression. The accuracy of the linear regression's predictions measured by their correlation coefficient with Standard and Poor's ratings, evaluated by *k*-folding cross-validation, is 95.6%. The stability of the constructed non-recursive regression model is shown in three ways: by the correlation of the prediction with those of other agencies (Moody's and The Institutional Investor), by predicting 1999 ratings using the non-recursive multiple regression model derived from the 1998 dataset applied to the 1999 data, and by successfully predicting the ratings of several previously non-rated countries.

1 Country Risk, Country Risk Ratings and Objectives of the Paper

1.1 Country risk, country risk ratings and their importance

The globalization of the world economies, and in particular the internationalization of financial markets in the last decades, have dramatically expanded and diversified investment possibilities, leading to numerous new opportunities, accompanied by new risks. Consequently, there has been growing interest in obtaining reliable estimates of the risk of investing in different countries. These concerns have led to the development of the concept of country risk, and even to the regular publication of country risk ratings by various agencies. The importance of ratings has been magnified by the recommendations addressed in the Basel Capital Accord (2001), that pinpoints the role of agencies' ratings for the assessment of credit risk.

Different definitions have been proposed for country risk, i.e. for the risk that a country defaults on its obligations. The existing literature on the topic recognizes both financial/economic and political components of country risk. According to the degree to which some of these components are emphasized, country risk is viewed either from the financial/economic perspective only, or from the combined financial/economic and political perspectives.

There are two basic approaches to the interpretation of the reasons for defaulting. The *debt-service capacity approach* focuses on the deterioration of solvency of a country, which prevents it from fulfilling its commitments. For instance, Bourke and Shanmugam (1990) define country risk as "the risk that a country will be unable to service its external debt due to an inability to generate sufficient foreign exchange". Within this framework, country risk is viewed as a function of various financial and economic country parameters. The *cost-benefit approach* views a default on commitments or a rescheduling of debt as a deliberate choice of the country, which may prefer this alternative over repayment, in spite of its possible long-term negative effects (e.g. the country's exclusion from certain capital markets, reputation damage). Since the deliberate decision to default results from a political process, political country parameters are included in this type of country risk modeling, along with the financial and economic ones. This approach is strongly recommended by Brewer and Rivoli (1990, 1997) as well as Citron and Neckelburg (1987), who emphasize the impact of the political stability indicator on country risk ratings.

In response to the increased demand for the evaluation of creditworthiness, several agencies such as Moody's, Standard & Poor, Fitch, the Institutional Investor, Euromoney, Dun & Bradstreet, etc. have developed expertise in estimating country risk. These estimates are presented in the form of ratings, or *scores*, and are generally viewed as indicative of possible future default. Haque et al. (1996) define country credit risk ratings compiled by commercial sources as an attempt "to estimate country-specific risks, particularly the probability that a country will default on its debt-servicing obligations". Sovereign ratings can be viewed as the probability that a borrowing country will fail to pay back.

Country (or sovereign) risk ratings impact countries in a number of ways. The primary significance of ratings is due to their influence on the interest rates at which countries can obtain

credit on the international financial markets: the higher the ratings (i.e., the lower the risk of default) the lower the interest rate**.** Following its sovereign rating downgrade[1], Japan's borrowing became more expensive as interest rates have increased, reflecting the higher chance of default[2], which deteriorates even more the situation of the heavily indebted Japanese government and economy.

Second, sovereign ratings also influence credit ratings of national banks and companies, and affect their attractiveness to foreign investors. Ferri et al. (2001) call sovereign ratings the "pivot of all other country's ratings". Similarly, Erb et al. (1995a) underline that raters have historically shown a reluctance to give a company a higher credit rating than that of the sovereign where the company operates. For example, after Moody's downgraded Japan in November 1998 (from Aaa to Aa1), all other Aaa Japan issuers have been downgraded (Jüttner & McCarthy, 2000). This led sovereign ratings to be named "sovereign credit risk ceilings".

Third, institutional investors are sometimes contractually restricted on the degree of risk they can assume, implying in particular that they cannot invest in debt rated below a prescribed level. Ferri et al. (2001) refine this analysis, pointing out the contrast between the ratings of banks operating in high- and low-income countries, and show that ratings of banks operating in low-income countries are significantly affected by variations in sovereign ratings, while the ratings of banks operating in high-income countries do not seem to depend significantly on country ratings. Similarly, Kaminsky and Schmukler (2000) as well as Larrain et al. (1997) note that sovereign ratings are crucial for developing economies, which have a very high sensitivity to rating announcements.

1.2 Critiques of present rating systems

The purpose of ratings is that of compressing a variety of information about a country into a single parameter which can be easily understood, and therefore conveniently used in a decision making process involving comparisons between different countries. Consequently, ratings provide aggregations of diverse indicators into a single metric and can be viewed as a kind of "commensuration" (Kunczik, 2000). The interpretation of ratings is complicated by the heterogeneity of indicators (political stability, inflation, etc.) which may have been used in deriving them.

Comprehensibility: The country risk ratings published by different agencies appear as outputs of "black boxes", the real content and meaning of which are unexplained and hard to understand, since rating agencies specify neither the factors which are taken into consideration in determining their ratings, nor the "rules of compression" of multiple factors into a single rating. This raised the discontent of Japan's Prime Minister, Junichiro Koizumi, who was "railed at being rated in the same neighborhood as African countries[3] to which Japan is providing assistance"[4]. Officials of Japan's Ministry of Finance[5] added that big rating agencies are "making

[1] The foreign currency sovereign risk rating of Japan has been downgraded in February 2001 (AA+) and November 2001 (AA) by Standard & Poor.
[2] The Economist, April 20, 2002, page 74
[3] Botswana
[4] The Economist, May 18, 2002, 70
[5] Wall Street Journal, May 1, 2002, 14

unfair qualitative judgments"[6], while Moody's denied and claimed that the motives for the downgrade lie in the "increased debt load"[7] of Japan. In view of such controversy, uncovering both the factors which are taken into account by these black boxes, and the mechanisms of deriving ratings, are essential for ascertaining the consistency of a country rating system.

Unknown factors: It is generally assumed that ratings are obtained by aggregating economic/financial and/or political variables. Clearly, the main objective of any country risk rating system is to represent the creditworthiness of countries, i.e., their capacity to pay off loans. It is not clear however which ones of the many possible factors do actually influence the payback capacity of a country. This question is subject to different analyses. Haque et al. (1998) claim that it is sufficient to restrict the scope of analysis to economic/financial factors only, while others (Brewer and Rivoli,1990) claim that both economic/financial and political factors impact country risk ratings.

Rating failures: Some recent failures have challenged the trustworthiness of country risk ratings. Criticisms directed towards ratings institutions have been especially intense after the Tequila and the Asian crises. Indeed, the tequila crisis in Mexico (1994-95) had not been preceded by a rating downgrade, implying that either the crisis was not predicted, or that its significance was overlooked. Similar observations apply to the Asian crisis (1997-99). On the other hand, rating agencies have been more insightful in anticipating other crises, e.g. in Russia (1998), Brazil (1998) and Argentina (2001).

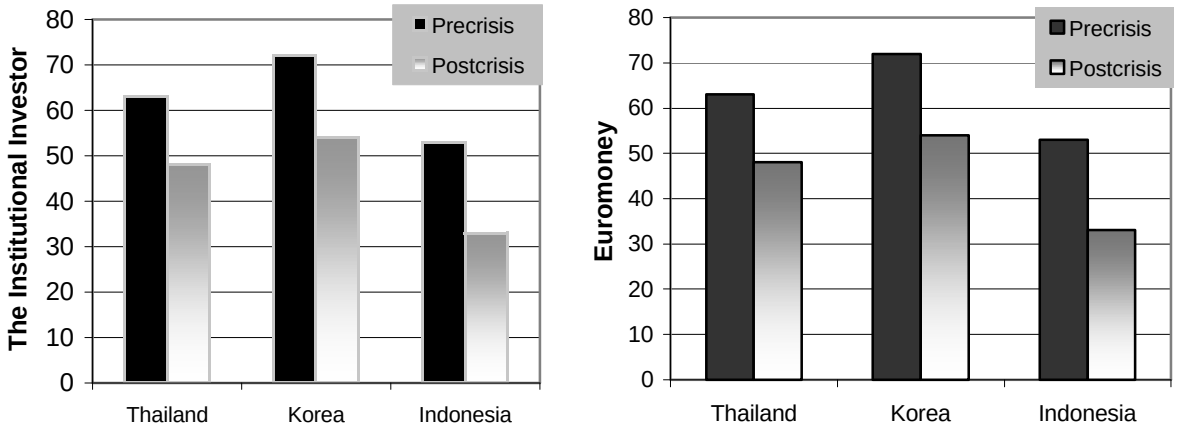
Regional bias: Diverse explanations have been provided for the failure of rating agencies to signal crisis emergencies in various countries. There are claims that certain rating agencies favor certain regions. For instance, Haque et al. (1997) note that Euromoney usually gives higher ratings to Asian and European countries than to Latin or Caribbean countries, while the Institutional Investor is more generous to Asian and European countries than to African ones.

Latency: Another criticism lies in the time taken by the rating agencies to react to new facts (e.g., according to *The Economist*[8], "rating agencies may have been too slow to downgrade Japan. Markets have already moved ahead of them").

Overreactions: The IMF criticizes rating agencies claiming that they reacted in panic during the Asian crisis. After they had missed to predict the Asian crisis, they reacted by harshly downgrading countries such as Thailand or South Korea, thus accelerating the flight of capital. In this and other situations, rating agencies gave the impression of overreacting (*Figure 1*) instead of being a stabilizing force.

[6] The Economist, May 18, 2002, 70
[7] New York Times, June 1, 2002, C1
[8] *The Economist*, August 1, 1998, page 62

Figure 1: Precrisis and postcrisis ratings for specific countries



It appears that the objectivity and reliability of country risk ratings is questionable, mainly because of human intervention and conflicting goals and/or interests.

Negative impact of rating changes: It is reported that the hesitation or reluctance of raters to downgrade a country stems from the fact that a downgrade announcement can precipitate a country into crisis. During the Asian crisis, the rating agencies arouse the discontent of the Malaysian Prime Minister, Dr Mahathir bin Mohamad, who condemned them and charged them with rendering the crisis even more acute. "The rating agencies, when we have a need to borrow money, they immediately downgraded us so that it will cost us 15% to borrow money. They stop us completely from borrowing money" (1999)[9]. Along the same line, Reisen and Von Maltzan (1999) claim that such a sharp downgrade impeded "commercial banks to issue letters of credit, forced investors to offload Asian assets to maintain portfolios in investment-grade securities". They argue that rating agencies lagging behind rather than anticipating the state of financial markets reinforce positive expectations and capital inflows when they upgrade countries and intensify outflows of capital and crisis when they downgrade.

Conflicts of interest: An even more pointed criticism is that raters, having started charging fees to rated countries, can be suspected of reluctance to downgrade them, because of the possibility of jeopardizing their income sources. This is claimed, for example, by Tom McGuire, an executive vice-president of Moody's, who states that "the pressure from fee-paying issuers for higher ratings must always be in a delicate balance with the agencies' need to retain credibility among investors"[10]. The necessity to please the payers of the ratings, investors as well as issuers, lead to what Robert Grossman, the chief credit officer at the rating agency Fitch, calls "a tendency we do with investors – rating committees, outlooks, meetings, then the press release, all to soften the blow of the rating change"[11]. Studying the rating transitions, Altman and Saunders (1998) notice that a downgrade in the rating of a country is regularly followed by further

[9] This article appeared in the February 19, 1999 issue *Executive Intelligence Review.*
Interview: Datuk Seri Dr. Mahathir bin Mohamad Malaysian Prime Minister: `We had to decide things for ourselves'. On Jan. 22 (1999), Gail G. Billington of EIR's Asia Desk and Dino de Paoli of the Schiller Institute were given the opportunity to interview Datuk Seri Dr. Mahathir bin Mohamad, Prime Minister of Malaysia.
[10] The Economist, July 15, 1995, 62
[11] Euromoney, January 2002, 38, "*Investors turn cool on the rating game*"

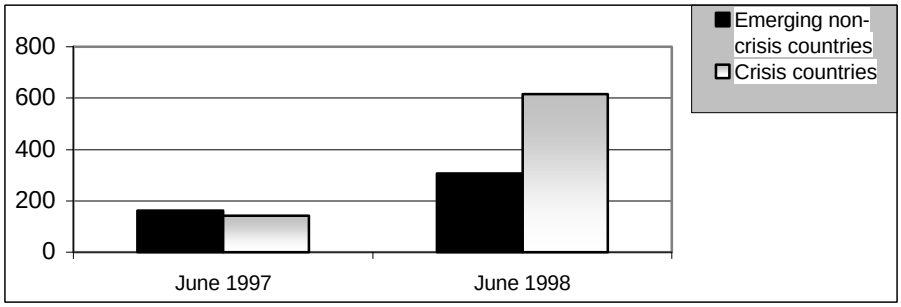
downward adjustments. The explanation given by Altman and Saunders is that agencies gradually downgrade the rating of a country, since they do not want to hurt the country, which is also their client. Kunczik (2001) note that the IMF (1999) fears the danger that "issuers and intermediaries could be encouraged to engage in *rating shopping* – a process in which the issuer searches for the least expensive and/or least demanding rating".

The problems described above will become more acute as the role of ratings increases. Indeed, the Basel Accord will intensify the pressure on countries to obtain high ratings, potentially leading to a switch from rating shopping to rating fraud. For instance, Pakistan has been forced to pay back $55 million credits to the IMF because of budget falsification, the blame being put on the former Prime Minister Nawaz Sharif, accused of having falsified the budget deficit. Similarly, Ukraine has been proven to have reported misleading data on its reserves in foreign exchanges, attempting to obtain IMF credits. Kunczik (2001) claims that "it is only a question of time when firms will specialize in rating advising for sovereigns".

1.3 Can yield spreads replace country risk ratings?

To mitigate the problems described above, it is sometimes advocated to use yield spreads instead of sovereign ratings as a proxy for default risk, since large yield spreads correspond to high risk. Yield spreads refer to the difference between sovereign yields and US treasury bill yields of the same maturity. Market yields are less stable, fluctuating daily and sometimes substantially.

Figure 2: Precrisis and postcrisis yield spreads on an aggregate basis



It appears that the use of market spreads rather than country ratings is not more efficient. Indeed, for Asian countries, spreads have substantially widened after the crisis. As exhibited by *Figure 2*, spreads were roughly of the same order of magnitude before the crisis. While spreads of non-crisis countries have widened by less than 100% after the crisis, spreads of crisis countries have more than tripled. Consequently, we conclude that spreads provide about the same information as sovereign ratings do, and are much more volatile. This conclusion can be extended to the Brazilian and the Russian crises. This discussion implies that yield spreads are characterized by a lack of predictive power and cannot be used to obtain a reliable early warning of country insolvency.

1.4 Objectives and paper structure

Our discussion in the preceding subsections indicates a need for making country risk ratings more *(i) transparent* and *(ii) consistent*. A third criterion we would like to impose on an ideal country risk rating system is that of *(iii) self-containment*, i.e. its non-reliance on any other past or present country risk ratings. Clearly, this requirement precludes the use of lagged ratings as independent variables. It is important to note that this approach is in marked contrast with that of the current literature (Haque et al., 1996 & 1998, Monfort and Mulder, 2000). Finally, a fourth requirement imposed on the model is its *(iv) stability*, i.e. extensibility to subsequent years and previously unrated countries.

The wide acceptance of several of the major rating systems indicates that, while they may not be perfect, they provide the currently best known evaluation of country risk. It is therefore reasonable to base the design of any new rating system on one of the existing ones.

The **central objective** of this paper is to develop a *transparent, consistent, self-contained,* and *stable* system, closely approximating one of the major existing country risk rating systems. We have selected the Standard & Poor country risk rating system as a benchmark for the desired system. It is to be expected that, on the one hand, the ratings of the new system will closely resemble in most cases those of Standard and Poor, and on the other hand, in the few cases where the two ratings differ, the objective reasons which imply the ratings of the proposed model will be supported by subsequent developments.

In line with the existing literature, we use in this paper the technique of multiple regression to achieve the stated objective. In view of the stated criteria, we shall call the proposed system the *non-recursive multiple regression* model of the Standard and Poor country rating system. In two subsequent papers (Alexe et al., 2003a and b), we revisit the same problem using two different combinatorial-logical techniques, and arrive to surprisingly similar ratings with those proposed in this paper.

The paper is structured as follows. Section Section 2 describes the data considered and selected for use in this paper. We provide a thorough literature review (see references in *Table 7* and *Table 8*) and describe the selection of explanatory variables.

In Section 3, we use the 1998 Standard & Poor country risk ratings to develop a non-recursive multiple regression model for the ratings considered as the dependent variable, regressed on a set of economic and political variables (considered as the predictor variables). To evaluate the accuracy of linear regression predictions, we use the *k*-folding cross-validation technique.

In Section 4, we evaluate the stability of the constructed non-recursive regression model in three ways. First, we show that it correlates well not only with the ratings of Standard & Poor, but also with those of other agencies (Moody's and The Institutional Investor). Second, we show the temporal stability of the non-recursive multiple regression model derived from the 1998 dataset by applying it to the 1999 data. Third, we show that the proposed model can successfully predict the ratings of several previously non-rated countries.

2 Data

2.1 Sources

In this paper, we focus on the Standard & Poor country risk ratings. The risk of default is generally defined by Standard & Poor as the probability that a sovereign obligor fails to meet a principal or interest payment on the due date and in full. Standard & Poor's ratings are based on the information provided by the debtors themselves and by other sources considered reliable.

Standard & Poor provides sovereign ratings for local and foreign currency debt. In this paper, we used the foreign currency sovereign ratings. Countries are more vulnerable to foreign currency obligations. An obligor's capacity to repay foreign currency obligations may be lower than its capacity to repay obligations in its local currency, owing to the sovereign government's relatively lower capacity to repay external versus domestic debt. As noted by Cantor and Packer (1996), foreign currency ratings remain the decisive factor in the international bond market. Indeed, foreign currency obligations are more likely to be acquired by international investors than domestic obligations. Foreign currency ratings reflect economic factors, as well as the country intervention risk, i.e. the risk of a country imposing, for example, exchange controls or a debt moratorium, while local currency ratings exclude country intervention risk.

Table 9 in the Appendix lists the different country risk levels or labels used by Standard & Poor, and also provides descriptions associated with these labels. Countries which are assigned a label inferior to BB+ are considered as non-investment grade (speculative) countries. Countries rated CCC+ or lower are regarded as presenting serious default risks. BB indicates the least degree of speculation and CC the highest. Ratings labeled from AA to CCC can be modified by the addition of a plus or minus sign to show relative standing within the major rating categories. We consider such subcategories as separate ratings in our analysis.

In *Table 10* of the Appendix, we display Standard & Poor's foreign currency sovereign ratings of 69 countries published at the end of December 1998. Standard & Poor rates a limited number of countries, with a special focus (at least in the past) on the industrial ones. However, in the last decade, the number of Asian, Latin American and Eastern European economies rated by Standard & Poor has significantly increased. We refer the reader to Hu et al. (2002) for the evolution of the number of countries rated by Standard & Poor.

As mentioned above, country risk ratings encompass economic, financial and political aspects. The statistical data of the economic and financial variables considered in this paper come from the International Monetary Fund (World Economic Outlook database), from the World Bank (World Development Indicators database) while those about the ratio of debt to gross domestic product come from Moody's publications. Values of political variables are provided by Kaufmann et al. in two papers (1999a,b) that are joint products of the Macroeconomics and Growth, Development Research Group and Governance, Regulation and Finance Institutes which are affiliated with the World Bank. Before describing the relevance of the selected variables, we discuss in Section 2.2 the selection method used.

2.2 Variable selection criteria

As underlined by Bilson et al. (2001), the selection of variables lends itself to criticism due to the subjectivity and arbitrariness involved in this process. In this paper, the selection of relevant variables is based on three criteria.

The first criterion is the significance of variables for estimating a country's creditworthiness. We have performed an extensive literature review which played an important role in defining the set of candidate variables for inclusion in our model. *Table 7* and *Table 8* list variables that have been considered in the existing literature on country risk.

The second criterion is the availability of complete and reliable statistics. We want to avoid difficulties related to missing data that could reduce the statistical significance and the scope of our analysis. For instance, according to recent information received from The World Bank[12], their research concentrates on developing economies and they have data on the debt of 137 countries to whom they loan funds and who report their external debt to The World Bank. Since high income countries do not receive World Bank funds, they do not report their debt numbers to The World Bank. Such situations have significantly complicated the process of compiling complete debt statistics. Hu et al. (2002) also report the problem of data availability.

The third criterion is the uniformity of data across countries. We have considered, for example, incorporating the unemployment rate statistics disclosed by the World Bank. However, the World Bank underlines that unemployment is analyzed and compiled according to definitions which differ from country to country.

It is worth noting that in addition to the variables listed in *Table 7* and *Table 8* (in Appendix), Haque et al. (1996), Cantor and Packer (1996), Larrain et al. (1997), Monfort and Mulder (2000) and Hu et al. (2002) use a dummy variable that represents the historical solvency of a country. Haque et al. (1996) use the lagged rating at time (t-1) as an independent variable in their regression model. Monfort and Mulder (2000) claim that membership in the OECD is likely to be a significant indicator for country risk ratings. The same authors emphasize also the importance of the location of countries, by adding to their set of independent variables two dummy variables to characterize the country's location in Asia or in Latin America. Hu et al. (2002) also use regional dummy variables.

2.3 Selected variables

Based on the criteria of relevance, availability and uniformity described above, we have decided to incorporate the following variables[13] in our model:

Gross domestic product per capita[14] *(GDPc):* the *GDP* is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. The *GDP* is an indication

[12] Anat Lewin, Private Communication, Development Data Group, The World Bank, June 06, 2001

[13] Acronyms in parentheses following the name of variables are used in tables and appendices for referring to variables.

[14] Calculated on the basis of purchasing power parity in international dollars.

of the capacity of the government to solve a balance-of-payments crisis without having to default on external debt. The larger the *GDP*, the wider the potential tax base and thus the higher the ability of the government to fulfill its external obligations. The *GDPc* is a measure of the relative wealth of a country and its level of development. The gross domestic product (*GDP*) is converted to international dollars using purchasing power parity rates. The international dollar has the same purchasing power over *GDP* as the U.S. dollar has in the United States.

Inflation rate (IR): the inflation rate is the change in the national price level between two periods. The inflation rate used in our study is based on the consumer price index and is the annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services. High inflation rates indicate structural problems in the country's finances and may lead to sovereign economic crises, as governments hike interest rates sharply in order to strengthen their countries' currencies. Should a country be unable or unwilling to pay the current budgetary expenses, it must resort to inflationary money financing. High inflation rate results in a substantial consumers' purchasing power reduction and increases political discontent.

Trade balance (TB): trade balance is the balance of trade in goods expressed as a percentage of *GDP* (purchasing power parity-PPP). This is the difference in value between a country's total imports and exports (including information of oil and non oil exports, consumer goods, capital goods) measured in current U.S. dollars divided by the value of *GDP* converted into international dollars using purchasing power parity rates.

Exports' growth rate (EGR): annual growth rate of exports of goods and services based on constant local currency. Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude labor and property income as well as transfer payments. Countries having a high export growth rate are expected to be more creditworthy. Indeed, exports are the primary source of foreign currency inflows and therefore have a significant influence on the capacity of the country to finance imports and service debt obligations.

International reserves (RES): this variable refers to gross international reserves, expressed in terms of the number of months for which the existing reserves can cover the cost of imports of goods and services. It gives an indication of the short-term capacity of an economy to meet its imports obligations. The higher the value of *RES*, the lower the risk of default and the higher the creditworthiness.

Fiscal balance (FB): fiscal balance is approximated by the ratio of central government financial balance (surplus or deficit) to *GDP*. The central government's balance represents the yearly fiscal balance. Fiscal balances and debt stocks of governments are crucial indicators when analyzing sovereign risk. The ability of governments to extract revenues from taxpayers and users of services is a key factor that helps to determine whether governments will be able to make full and timely payments of interest and principal on outstanding debt.

Debt to GDP (DGDP): here debt refers to the general government debt. The general government debt as defined by the IMF (2001) includes "the consolidated budgets of the central, state/regional, and local governments, along with the social security system and other extra-budgetary funds engaged in noncommercial activities. Excluded are lending and refinancing and the assets/liabilities of commercial state-owned or guaranteed enterprises, except for any net

financial transfers made as subsidies to these enterprises". This balance, i.e., the difference between total revenues and total expenditures, determines the net borrowing requirement of general government, which can be met only by running down financial assets or borrowing net new resources from the public and, thereby, adding to debt.

We have considered incorporating the unemployment rate and the ratio of the current account balance to GDP. While the latter turned out to be redundant with trade as a percentage of GDP, the former has been excluded from consideration due to the lack of consistency in its definition. As noted by the World Bank, the treatment reserved to temporarily laid off workers, to those looking for their first job, and the criteria referred to for being considered as unemployed, differ significantly between countries.

For political variables, it is very difficult to find reliable and complete data. In our model, we have considered the six variables provided by Kaufmann et al. (1999a). These six variables are: political stability and violence, voice and accountability, government effectiveness, regulatory burden, corruption , rule of law. These variables are viewed as capturing the fundamentals of the governance concept defined as "the traditions and institutions by which authority in a country is exercised" (Kaufmann et al.,1999a).

As emphasized by Kaufmann et al. (1999, a and b), political stability and voice and accountability both refer to the process by which governments are elected, monitored and replaced. Government effectiveness and regulatory burden reflect the capacity of the government to adopt sound policies. Corruption and rule of law are proxies for the "respect of citizens and institutions for the rules which govern their interactions". In order to avoid or at least limit redundancies in our model, we select only one variable for each dimension of governance. We have selected:

Political stability (PS),
Government effectiveness (GE), and
Corruption (COR).

The higher the values of these variables, the less likely the country is to default[15]. The variables are defined on a (-3.5, 3.5) interval and are based on estimations provided by polls of experts and cross-country surveys.

The variables we have described so far have been considered previously in the literature and are available in the form used in our study (as ratios or as growth rates). We have also decided to construct a new variable (*ER*) and to add a variable (financial depth and efficiency) which, to the best of our knowledge, has not been used before in country rating studies. Here are the descriptions of these two variables:

Exchange rate (ER): is defined as the ratio of the current value of the exchange rate to the moving average of the real effective exchange rate[16] over five years (1994 to 1998). While the exchange rate has been used in previous country rating studies, we consider the ratio introduced here to be more significant, since it indicates the dynamics of changes in the exchange rate, by specifying whether the trend is up ($ER>1$) or down ($ER<1$).

[15] The higher the value of the corruption variable, the less corrupted the considered country is perceived to be. This variable can therefore be called "corruption quality".

[16] Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.

Financial depth and efficiency (FDE): is represented by the ratio of the domestic credit provided by the banking sector to the *GDP*. Households accumulate claims on financial institutions that, acting as intermediaries, pass funds to final users. Correlated to the development of the economy, the indirect lending by savers to investors becomes more efficient and gradually increases assets relative to the *GDP*. Viewed from this perspective, the ratio of domestic credit to the *GDP* reflects the financial depth and efficiency of the country's financial system. More specifically, this variable is used to measure the growth of the banking system since it reflects the extent to which savings are financial. To our knowledge, the financial depth and efficiency variable has not been considered previously in the evaluation of country risk ratings.

2.4 Dataset content

In summary, on the basis of the considerations described above, we have constructed a dataset involving nine economic/financial variables:

- gross domestic product per capita, inflation rate, trade balance, international reserves, fiscal balance, exports growth rate, debt to *GDP*, financial depth and efficiency, and exchange rate (we have used the values taken by these variables at the end of 1998);

and three political variables:

- political stability, government effectiveness and corruption level.

We have compiled the values of these twelve variables for the sixty-nine countries considered: 24 industrialized countries, 11 Eastern European countries, 8 Asian countries, 10 Middle Eastern countries, 15 Latin American countries and South Africa. We use the Standard & Poor country risk ratings for these countries at the end of December of 1998.

3 Non-recursive multiple regression model

3.1 Model and results

In order to derive a non-recursive model of Standard & Poor's ratings, we shall fit the regression equation:

$$Y = a + \sum_{i=1}^{M} b_i * X_i + e \,, \tag{1.1}$$

where the dependent variable Y is the country risk rating given by Standard & Poor at the end of December 1998 (or more precisely a numerical representation of Standard & Poor's ratings), the independent variables X_i are the economic and political variables described in Section 2.1, and e is the error term. In view of the desired non-recursiveness of the model, the independent variables do not include directly or indirectly ratings of previous years. Results given in this section have been obtained using the SPSS statistical package.

The proposed model exhibits an excellent fit, with the coefficient of multiple determination *R-square* being 91.2%, and the adjusted *R-square* 89.3%. The multiple correlation level between

the observed values (i.e. the Standard & Poor ratings) and the predicted ones (i.e. the ratings given by the non-recursive regression model) is equal to 95.5%.

Table 1 below details how the regression equation accounts for the variability in the response variable, the last column giving the statistical level (*1-p*) at which the model is significant.

Table 1: Analysis of variance (ANOVA)

	Sum of Squares	Degrees of freedom	Mean Square	F-statistic	*p*-value
Regression	1609.546	12	134.129	48.458	0.000
Residual	155.005	56	2.768		
Total	1764.551	68			

Predictors: (Constant), COR, DGDP, ER, EGR, RES, TB, IR, FB, FDE, PS, GDPC, GE
Dependent Variable: S&P RATING

Table 2 presents the regular and the standardized regression coefficients (i.e., those corresponding to the model fitted to standardized data). The last column in *Table 2* indicates whether the corresponding independent variable is statistically significant (at the confidence level of *1-p*).

At the 5% significance level, it appears that five independent variables are statistically significant. These are: financial and depth efficiency (*FDE*), gross domestic product per capita (*GDPc*), ratio debt to gross domestic product (*DGDP*), political stability (*PS*) and government efficiency (*GE*).

Table 2: Regression results

Variables	Unstandardized coefficients	Standard error	Standardized coefficients (Beta)	t-statistic	p-value
(Constant)	8.769	.860		10.195	0.000
FDE	1.693E-02	0.007	0.148	2.513	0.015
RES	0.116	0.101	0.055	1.148	0.256
IR	-2.831E-02	0.018	-0.080	-1.557	0.125
TB	-1.192E-02	0.006	-0.094	-1.960	0.055
EGR	-1,218E-02	0.031	-0.017	-0.396	0.694
GDPC	3.081E-04	0.000	0.499	5.294	0.000
ER	-1.968E-02	0.011	-0.079	-1.768	0.083
FB	0.120	0.086	0.078	1.393	0.169
DGDP	-1.610	0.795	-0.091	-2.026	0.047
PS	1.378	0.533	0,197	2.584	0.012
GEF	1.977	0.920	0.316	2.149	0.036
COR	-0.605	0.842	-0.111	-0.718	0.476

The regression results described above indicate that the non-recursive regression model has an excellent fit with the data. However, the excellence of the fit does not automatically guarantee

the predictive power of the model, if the model violates some of the critical assumptions of multiple regression theory, as is the case with proposed model. Indeed,

- There is a strong correlation between some of the variables considered, e.g. between the political variables, especially government efficiency and corruption, possibly leading to difficulties related to multicollinearity, and the ill-conditioned nature of the resulting matrix.
- The predictors are not normally distributed.
- If too many predictor variables are used relatively to the number of observations, fitting multiple regression can lead to overfitting, and the estimates of the regression line can be unstable and the results may not be reproducible. The number of variables used is generally recommended to be no more than 5 to 10% of the number of observations, which is clearly not the case of this study that involves 69 observations and 12 variables.

In view of these issues, it is surprising that the cross-validation results presented in the next section provide a strong confirmation of the predictive power of the non-recursive regression model presented above.

3.2 Cross-validation

To validate the predictive power of the non-recursive regression model, we use a resampling technique known as cross-validation, and more specifically, a popular variant of it called *k*-folding (e.g., Shao, 1993, Shao and Tu, 1995, Efron, 1982, Hurvich and Tsai, 1989, Hjorth 1994, Breiman and Spector, 1992). In *k*-folding, observations are divided into *k* subsets of approximately equal size. The regression model is trained *k* times, each time leaving out from training one of the *k* subsets, and using only the omitted subset to test the regression-predicted country risk rating. In this paper, based on the relatively small size of the sample, we have selected *k* to be 10, and partitioned the sample into 10 groups of 6 or 7 countries each. The groups were selected using stratified random sampling, i.e. assuring that each group contains about the same number of investment-, speculative- and default-grade countries (see Standard & Poor's classification, *Table 9*).

In *Table 11* (Appendix) we present the Standard and Poor ratings, the in-the-sample predictions of the non-recursive multiple regression model obtained in Section 3.1, and the out-of-the-sample predictions obtained using the 10-fold cross-validation. The major results are the following:

- the correlation between the in-the sample and the out-of-the sample predictions is **99.1**%,
- the correlation between the Standard and Poor ratings and the out-of-the sample predictions is **95.6**%.

The very high correlation levels demonstrate clearly that the impressive results of Section 3.1 are not due to chance or overfitting.

3.3 Rating discrepancies between S&P and the proposed model

In this section, we shall identify those countries for which the predictions of the non-recursive regression model disagree with the Standard & Poor ratings. In order to accomplish this, we shall construct confidence intervals for the our predicted ratings[17].

Let us introduce some notations. Let *n* and *p* refer respectively to the number of observations and predictors. The expression $t(1-a/2, n-p)$ refers to the Student test with *(n-p)* degrees of freedom and with upper and lower tail areas of $a/2$. Let X_j be the *p*-dimensional vector of the values taken by the observation Y_j on the *p* predictors, while X'_j be the transposed of X_j. Let the expression $(X'X)^{-1}$ refer to the variance-covariance matrix, i.e. the inverse of the $[p \times p]$-dimensional matrix *(X'X)*. Denoting by *MSE* the mean square of errors in the regression, the estimated variance $s^2[\hat{Y}_j]$ of the predicted rating is:

$$s^2[\hat{Y}_j] = MSE * [X'_j (X'X)^{-1} X_j] \quad (1.2),$$

while the $(1-a)$-confidence interval for the predicted rating $\hat{Y}_j$ is:

$$\{\hat{Y}_j - t(1-a/2, n-p) * s[\hat{Y}_j], \hat{Y}_j + t(1-a/2, n-p) * s[\hat{Y}_j]\} \quad (1.3)$$

We say that there is a discrepancy between the Standard & Poor rating R_j^{SP} of a country *j* and ours, if the Standard & Poor rating is not in the confidence interval, i.e.:

$$R_j^{SP} \notin \{\hat{Y}_j - t(1-a/2, n-p) * s[\hat{Y}_j], \hat{Y}_j + t(1-a/2, n-p) * s[\hat{Y}_j]\} \text{ for } a = 0.1 \quad (1.4)$$

Taking α equal 5%, this formula identifies four discrepancies. Three countries (Iceland, Pakistan and Argentina) are rated higher by the non-recursive regression model than by Standard & Poor, while Colombia is rated higher by Standard & Poor. Subsequently, the Standard & Poor ratings for two of these four countries (Colombia and Pakistan) have been modified in the direction suggested by the regression model. More precisely, Colombia has been downgraded by Standard & Poor twice, moving from BBB- in December 1998 to BB+ in September 1999, and then to BB in March 2000. After being downgraded in January 1999 (SD), Pakistan was upgraded to B- in December 1999. On the other side, Iceland's rating has remained unchanged, and Argentina's rating has endured significant downgrade, but starting only in November 2000.

3.4 Are political variables necessary?

In this section, we test the predictive power of the non-recursive regression model, from which the three political variables are omitted. The *R-square* as well as the adjusted *R-square* of this model are equal to 88.6 % and 86.9 % respectively. These values are lower than the corresponding values for the original non-recursive regression model, indicating a loss in predictive power resulting from the omission of the three political variables. The predicted ratings are given in *Table 12* in the Appendix.

[17] All formulae given in this section as well as those in section 4.3 are from Neter et al. [1996]

Table 3: Regression coefficients

Variables	Unstandardized coefficients	Standard error	Standardized coefficients (Beta)	t-statistic	p-value
(Constant)	1.463	2.631		0.556	0.58
FDE	2.20E-02	0.007	0.192	3.058	0.003
RES	0.194	0.107	0.091	1.818	0.074
IR	1.22E-02	0.034	0.034	0.359	0.721
TB	-5.85E-03	0.006	-0.046	-0.901	0.371
EGR	2.75E-02	0.032	0.039	0.849	0.399
GDPC	4.38E-04	0	0.709	10.776	0
ER	6.933	2.737	0.23	2.533	0.014
FB	0.244	0.083	0.158	2.933	0.005
DGDP	-1.815	0.853	-0.102	-2.129	0.037

It appears that five of the independent variables are statistically significant at a 95% level. These variables are financial and depth efficiency (*FDE*), gross domestic product per capita (*GDPc*), debt to gross domestic product ratio (*DGDP*), exchange rate (*ER*) and fiscal balance (*FB*). The correlation coefficient between the predicted ratings and those of Standard & Poor is equal to 94.14 % and is lower than in the original model. Moreover, the inferior fit of this model results in wider confidence intervals as compared to the original model.

The discrepancies between Standard & Poor's predictions and ours involve four countries (Russia, Pakistan, South Korea and Iceland), all being underrated by Standard & Poor. The ratings of three of these countries (Russia, Pakistan, South Korea) have been modified since, in the direction suggested by our model, while the rating of Iceland has remained unchanged. The evolution of ratings for Pakistan and Russia has already been described in Section 3.3. South Korea has been upgraded three times, moving from BB+ in December 1998 to BBB+ in November 2001.

In conclusion, the model which omits political variables appears to be somewhat less closely related to the S&P model which it is supposed to reflect, but on the other end this apparent weakening is not sufficiently clear to allow us to draw any definite conclusions. It should be added here that the economic variables are easier to obtain than the political ones, which are published less frequently.

4 Stability of the non-recursive regression model

4.1 Consistency with ratings of other agencies

In addition to analyzing the correlation level between Standard & Poor's ratings and those of the proposed non-recursive model, the latter has to be compared with the ratings of other agencies, e.g. Moody's and The Institutional Investor. We present below the results of these comparisons, based on Moody's and The Institutional Investor ratings issued at the end of December 1998 and

in March 1999 respectively. We shall start by presenting a brief description of the rating systems of Moody's and of The Institutional Investor.

Moody's sovereign ratings are defined, as "a measure of the ability and willingness of the country's central bank to make available foreign currency to service debt, including that of central government itself" (Moody's, 1995). Similarly to Standard & Poor, Moody's uses a nominal rating scale (*Table 13* in Appendix), which contains the same number of categories as Standard & Poor's ratings. A large proportion of countries receive the same rating from Moody's and Standard & Poor, and when they are different, the difference is usually not more than one notch.

The Institutional Investor country risk ratings were first compiled in 1979, and are published now regularly, in March and September of every year, for an increasing number of countries, which reached 145 in 2000. The Institutional Investor ratings are numerical, ranging from 0 to 100, with 100 corresponding to the lowest chance of default. The Institutional Investor relies on evaluations of the creditworthiness of the countries to be rated, provided by economists and international banks, each respondent using their own criteria. Responses are aggregated by The Institutional Investor, greater weights being given to responses from institutions with higher worldwide exposure.

The correlation levels between the ratings given by the non-recursive multiple regression model and those given by Standard and Poor, Moody's and The Institutional Investor are reported in *Table 4*.

Table 4: Correlation between the non-recursive model and other ratings

	Non-recursive regression	**Standard & Poor**	**Moody's**	**The Institutional Investor**
Non-recursive regression	1	95.05%	94.56 %	93.60 %
Standard & Poor		1	98.01%	96.18%
Moody's			1	96.31 %
The Institutional Investor				1

It can be seen that the very high correlation levels between the ratings given by the non-recursive regression model and those given by Moody and The Institutional Investor underline the relevance of the proposed model.

4.2 Temporal stability of the non-recursive regression model

4.2.1 1999 data

In order to supplement the indications of stability of the non-recursive regression model provided by cross-validation, we shall test its temporal stability by extending the analysis to the data of the

following year (1999). Using as input the same economic and political variables described in Section 2.3, we shall use the 1999 data in two ways. First, we shall use the model derived from the 1998 data to check the quality of its predictions when applied to the 1999 data. Second, we shall derive a new model based on the 1999 data and check the goodness of its fit.

In this experiment, we have used 1999 data with two exceptions. First, in the 1999 data, 16 out of the 828 variable values (1.9%) are missing; for these missing values, we have substituted their corresponding values taken in the previous year. Second, the political variables, reflecting the perceptions of governance quality by a large number of survey respondents in industrial and developing countries, as well as in non-governmental organizations, are not necessarily compiled and updated on a yearly basis. The indices of Kaufmann et al. (1999a, 1999b & 2002) have been published twice, referring respectively to data of 1998 and 2000-2001, but were not compiled for 1999. The high degree of stability of political variable indices is reflected in the fact that the correlation between the 1998 and the 2000-2001 indices varies between 95% and 98%, depending on the variable. In our calculations, we have approximated the values of the three political variables appearing in our model (corruption, government efficiency and political stability) for 1999, by averaging their values for 1998 and 2000-2001.

4.2.2 Applying the 1998 model to the 1999 data

The purpose of this section is to test the applicability of the non-recursive regression model built on the 1998 data for predicting the 1999 country risk ratings. More precisely, we substitute the 1999 data into the regression model built on the 1998 data, and compare the results obtained in this way with Standard & Poor's 1999 ratings. The new predicted country risk ratings are given in *Table 14* in Appendix.

The most important result of this experiment is the very high level of correlation (94.74%) between the predicted ratings and the 1999 Standard & Poor ratings, confirming the consistency and the temporal stability of the non-recursive regression model.

In order to identify the discrepancies, we have to recalculate the prediction confidence intervals for the new, 1999 observations. Since these observations have not been used in deriving the regression coefficients, formulae (1.2), (1.3) and (1.4) can no longer be used for constructing the confidence intervals. The variance $s^2[pred]$ should now be computed as follows:

$$s^2[pred] = MSE * [1 + X_j^{'}(X'X)^{-1}X_j] \quad (1.5),$$

while the $(1-a)$ confidence interval for $\hat{Y}_{j,n}$ will be given by:

$$\{\hat{Y}_{j,n} - t(1-a/2, n-p) * s[pred], \hat{Y}_{j,n} + t(1-a/2, n-p) * s[pred]\} \quad (1.6)$$

We say that there is a discrepancy between the Standard & Poor rating R_j^{SP} and the non-recursive regression model if :

$$R_j^{SP} \notin \{\hat{Y}_{j,n} - t(1-a/2, n-p) * s[pred], \hat{Y}_{j,n} + t(1-a/2, n-p) * s[pred]\} \text{ for } a = 0.1 \quad (1.7)$$

The results show that there are only three discrepancies between our ratings and those of Standard & Poor involving Argentina, Iceland and Russia, all being underrated by Standard & Poor. The cases of Argentina and Iceland have already been discussed in Section 3.3. As far as

Russia is concerned, it was first downgraded to SD in January 1999, but upgraded afterwards to B-, B and B+ in December 2000, June 2001 and December 2001 respectively.

4.2.3 New model for 1999

To obtain a new non-recursive regression model for 1999, we proceed in the same way as for 1998, using as input the political and economic variables described above and the sovereign risk ratings published by Standard & Poor's at the end of December 1999. As a result, we obtain new regression coefficients that constitute the 1999 model. The 10-folding cross-validation tests performed showed a correlation level of 98.63% between the in-the-sample and out-of-the-sample predicted ratings, thus validating the 1999 model.

The final non-recursive regression model for 1999 is given in *Table 5* and the predicted ratings are given in *Table 15* (in Appendix).

Table 5: Regression results

Variables	Unstandardized coefficients	Standard error	Standardized coefficients	t-statistic	p-value
(Intercept)	9.97	2.065		4.829	0
FDE	0.007446	0.006	0.065	1.312	0.195
RES	-0.002063	0.093	-0.001	-0.022	0.982
IR	-0.0875	0.025	-0.236	-3.454	0.001
TB	-0.005184	0.005	-0.046	-1.003	0.32
EGR	-0.023	0.023	-0.038	-0.989	0.327
GDPC	0.0002413	0	0.406	4.894	0
ER	-0.798	2.274	-0.025	-0.351	0.727
FB	-0.05838	0.071	-0.041	-0.819	0.416
DGDP	-0.856	0.727	-0.048	-1.178	0.244
PS	0.786	0.569	0.108	1.382	0.173
GEF	2.722	0.946	0.422	2.878	0.006
COR	-0.04607	0.792	-0.008	-0.058	0.954

It is important to emphasize that the correlation between the 1999 Standard & Poor ratings and those predicted by the 1999 non-recursive regression model is 96.4% (even exceeding that of 1998). The only discrepancies between the two models, determined using (1.4), concern Iceland and Argentina, which appear to be underrated by Standard & Poor.

4.3 Rating previously non-rated countries

In this section, we test the prediction power of our model on a set of countries which were not used for constructing our model. We have obtained data for four such countries (Ecuador, Guatemala, Jamaica and Papua New Guinea), the ratings of which by Standard & Poor started after December 1998. The ratings of these countries using the 1998 non-recursive regression model (described in Section 3) with 1998 and 1999 data are presented in *Table 6*.

Table 6: Predicted ratings for previously non-rated countries

	Time of the first S&P rating	S&P rating	S&P linear extension	1998 regression model rating using:	
				1998 data	1999 data
Ecuador	07/2000	(SD)	(0)	6.03	5.69
Guatemala	10/2001	(BB)	(10)	8.57	8.14
Jamaica	11/1999	(B)	(7)	6.00	7.16
Papua New Guinea	01/1999	(B+)	(8)	6.93	6.88

Comparing the ratings predicted by the non-recursive regression model with those given by Standard & Poor, it can be seen that the model has a significant predictive power, even when applied to countries not used in constructing the model. Indeed, three of the four countries above (Papua New Guinea, Jamaica and Guatemala) have their first Standard & Poor ratings within the 95% confidence intervals of the predicted ratings. The rating of Ecuador is even more interesting. While the first Standard & Poor rating of that country (SD) is not in the 95% confidence interval of the predicted value, that rating (given in July 2000) was revised after only one month (in August 2000) to B, which falls within the 95% confidence interval of our prediction.

5 Concluding remarks

5.1 Recursive versus non-recursive models

The recent literature on country risk ratings contains several studies (Cantor and Packer, 1996, Haque et al., 1998, Monfort and Mulder, 2000) which use multiple regression. The set of independent variables used by Haque et al. (1998) as well as Monfort and Mulder (2000) includes the lagged sovereign ratings of Standard & Poor, or Moody's, or The Institutional Investor. The correlation levels between the ratings of various agencies and the predicted values or ratings obtained using multiple regression models referenced above are remarkably high.

To illustrate the actual meaning and importance of these results, we shall examine the approach taken by Haque et al. (1998). That paper uses as its eight independent variables seven of the macro-economic variables[18], as well as the lagged rating, i.e. it includes The Institutional Investor ratings both at times *t* and *t-1*, the former as an independent variable, and the latter as a dependent one. It is important to note that country risk ratings are very stable, as shown by the transition probabilities of the ratings published by Standard & Poor (1999) (see *Table 16* in the Appendix) and Nickell et al. (2000).

[18] T-bill rate, GDP growth rate, inflation rate, exports growth rate, ratio current account to GDP, the ratio of external debt to GDP, the ratio of reserves to imports.

The 98% correlation level[19] between The Institutional Investor ratings published respectively in September 1997 and September 1998 confirms the stability property of sovereign ratings. In light of this fact, the excellent correlation levels achieved by utilizing lagged ratings among the independent variables can be attributed to a certain – possibly large – extent to this stability. They may not necessarily give indications about the predictive power of the economic and political variables considered.

Although Cantor and Packer (1996) do not include the lagged ratings in their set of predictors, they create a dummy variable, which is determined by the past ratings issued by Standard and Poor (Claessens and Embrechts, 2002). This dummy variable is defined to be equal to 1 if a country has ever been rated D or SD by Standard & Poor since 1970, and equal to 0 otherwise. Even though their regression *R-square* is above 90%, their results are criticized by Claessens and Embrechts (2002) and Jüttner and McCarthy (2000). Claessens and Embrechts mention that the dates of the explanatory variables are not consistent, e.g. the values of some variables are measured in 1994 or 1995, while that of others are averages for the period 1991-1994 or 1992-1994. On the other hand, Jüttner and McCarthy evaluated the regression model of Cantor and Packer for some other years, concluding that for 1998, it loses its predictive power. A recent paper of Hu et al. (2002) develops a model using ordered probit to estimate country ratings. Their model has an 83% correlation level and relies only on economic variables.

A common feature of the regression models above is the direct or indirect inclusion of information derived from past Standard & Poor ratings (lagged ratings, rating history) among their independent variables. A drawback of such rating models is the impossibility of applying them to not-yet-rated countries.

The non-recursive model developed in this paper, having a 95.5% correlation level with the actual ratings, is distinguished from the previously mentioned ones by its non-reliance on any information derived from the lagged ratings. Therefore, we conclude that the high level of correlation between predicted and actual ratings is a reflection of the relevance and predictive power of the independent variables included in this model.

Additional advantages of the non-recursive nature of the proposed model include its applicability to not-yet-rated countries, and the high transparency of the proposed system, which makes the role of the economic-financial and political variables explicit.

5.2 Qualities of the proposed model

- Non-recursive nature,
- High correlation (95.5%) with Standard and Poor's ratings, as well as with Moody's and The Institutional Investor's,
- Avoidance of overfitting, as demonstrated by the 99.1& correlation between in-the and out-of-the sample rating predictions,
- Significance of independent variables,
- Transparency of the model,

[19] 134 countries are considered.

- Justification of discovered discrepancies, as demonstrated by subsequent changes in Standard and Poor's ratings,
- Temporal stability, as shown by applicability to the following year's data,
- Accuracy of ratings of previously not rated countries, as shown by subsequent Standard and Poor ratings.

5.3 Related studies

The significance of the set of variables identified in this paper as well as the ratings obtained using the non-recursive regression model have been confirmed (Alexe et al., 2003 a and b) by a non-statistical approach using the combinatorics, optimization and logic-based methodology of the *Logical Analysis of Data (LAD)* (Hammer, 1986, Crama et al., 1988 and Boros et al., 2000). This approach relies on LAD for calculating the so-called *relative preferences* R_{ij} between pairs of countries i and j, which indicate whether country i should be rated higher or lower than country j. The relative preferences were used in the above references in two different ways to derive the approximations of ratings. In the first approach (Alexe et al., 2003a), the ratings P_i of various countries i were calculated using multiple regression analysis, based on the assumption that the R_{ij} values provide good approximations of the differences P_i - P_j of the ratings. In the second approach (Alexe et al., 2003b), the ratings P_i were obtained by deriving a linear extension of the partial preorder defined by the relative preferences R_{ij}.

The comparison of the results of the present study with those of the two studies mentioned above shows that – in spite of their qualitatively different data analysis approaches -- the predicted ratings are strongly correlated, at the surprising level of 98-99%.

References

Alexe S., Hammer P. L., Kogan A. and Lejeune M. A. 2003a. Country Risk Rating Based on Pairwise Comparisons. Piscataway, New Jersey, RUTCOR, Rutgers University.

Alexe S., Hammer P. L., Kogan A. and Lejeune M.A. 2003b. A Combinatorial Approach to Country Risk Rating. Piscataway, New Jersey, RUTCOR, Rutgers University.

Altman E.I. and Saunders A. 1997. Credit Risk Measurement: Developments over the Last 20 Years. *Journal of Banking and Finance* **21** (11-12), 1721-1742.

Aylward L. and Thorne R. 1998. Countries' Repayments Performance Vis-à-Vis the IMF", *IMF Staff Papers* **45** (4), 595-619.

Basel Bank for International Settlements. 2000. Credit Ratings and Complement Sources of Credit Quality Information. *Basel Committee on Banking Supervision Working Paper* **3.**

Bilson C. M., Brailsford T.J. and Hooper V.J. 2001. Selecting Macroeconomic Variables as Explanatory Factors of Emerging Stock Market Returns. *Journal of Pacific-Basin Finance Journal* **9** (4), 401-426

Boros E., Hammer P.L., Ibaraki T. and Kogan A. 1997. Logical Analysis of Numerical Data, *Mathematical Programming* **79**, 163-190.

Bourke P. and Shanmugam B. 1990. *An Introduction to Bank Lending.* Addison-Wesley Business Series.

Breiman L. and Spector P. 1992. Submodel Selection and Evaluation in Regression: The X-Random Case. *International Statistical Review* **60**, 291-319.

Brewer T.L. and Rivoli P. 1990. Politics and Perceived Country Creditworthiness in International Banking. *Journal of Money, Credit and Banking* **22**, 357-369.

Brewer T.L. and Rivoli P. 1997. Political Instability and Country Risk. *Global Finance Journal* **8** (2), 309-321.

Cantor R. and Packer F. 1996. Determinants and Impact of Sovereign Credit Ratings. *FRBNY Economic Policy Review*, 37-53.

Citron J.T. and Neckelburg G. 1987. Country Risk and Political Instability. *Journal of Development Economics* **25**, 385-395.

Claessens S. and Embrechts G. 2002. Basel II, Sovereign Ratings and Transfer Risk: External versus Internal Ratings. Presentation at the *Basel II: An Economic Assessment, Bank for International Settlements*, Basel, Switzerland.

Cook W.D. and Hebner K.J. 1993. A Multicriteria Approach to Country Risk Evaluation: With an Example Employing Japanese Data. *International Review of Economics and Finance* **2** (4), 327-348.

Cosset J.C. and Roy J. 1991. The Determinants of Country Risk Ratings. *Journal of International Business Studies* **22**, 135-142.

Cosset J.C., Siskos Y. and Zopounidis C. 1992. Evaluating Country Risk: A Decision Support Approach. *Global Finance Journal* **3**, 79-95.

Crama Y., Hammer P.L. and Ibaraki T. 1988. Cause-Effect Relationships and Partially Defined Boolean Functions. *Annals of Operations Research* **16**, 299-326.

Dailami M. & Leipziger D. 1998. Infrastructure Project Finance and Capital Flows: A New Perspective. *World Development* **26** (7), 1283-1298

Doumpos M. and Zopounidis C. 2001. Assessing Financial Risks Using a Multicriteria Sorting Procedure: The Case of Country Risk Assessment. *Omega* **29**, 97-109.

Easton S.T. and Rockerbie D.W. 1999. What's in a Default ? Lending to LDCs in the Face of Default Risk. *Journal of Development Economics* **58** (2), 319-332.

Eaton J., Gersovitz M. and Stiglitz J.E. 1986, The Pure Theory of Country Risk. *European Economic Review* **30**, 481-513.

Efron B. 1982. *The Jackknife, the Bootstrap and Other Resampling Plans*. Philadelphia, SIAM.

Erb C.B., Harvey C.R. and Viskanta T.E. 1996a. Expected Returns and Volatility in 135 Countries. *Journal of Portfolio Management*, 46-58.

Erb C.B., Harvey C.R. and Viskanta T.E. 1996b. Political Risk, Economic Risk and Financial Risk. *Financial Analysts Journal*, 29-46.

Feder G. and Uy V.U. 1985. The Determinants of International Creditworthiness and their Policy Implications. *Policy Modeling* **7** (1), 133-156.

Ferri G., Liu L-G. and Stiglitz J. 1999. The Procyclical Role of Rating Agencies: Evidence from the East Asian Crisis. *Economic Notes* **3**, 335-355.

Hammer P.L. 1986. Partially Defined Boolean Functions and Cause-Effect Relationships. International Conference on Multi-Attribute Decision Making Via OR-Based Expert Sytems, University of Passau, Passau Germany.

Haque N.U., Kumar M.S., Mark N. and Mathieson D. 1996. The Economic Content of Indicators of Developing Country Creditworthiness. *International Monetary Fund Working Paper* **43** (4), 688-724.

Haque N.U., Kumar M.S., Mark N. and Mathieson D. 1998. The Relative Importance of Political and Economic Variables in Creditworthiness Ratings. *International Monetary Fund Working Paper* **46**, 1-13.

Haque N.U., Mark N. and Mathieson D. 1997. Rating the Raters of Country Creditworthiness. *Finance & Development* **34**, 10-13.

Hjorth J.S.U. 1994. *Computer Intensive Statistical Methods Validation, Model Selection, and Bootstrap*. London, Chapman & Hall.

Hu Y.-T., Kiesel R. and Perraudin W. 2002. The Estimation of Transition Matrices for Sovereign Credit Ratings. *Journal of Banking and Finance* **26** (7), 1383-1406.

Hurvich C.M. and Tsai C.-L. 1989. Regression and Time Series Model Selection in Small Samples. *Biometrika* **76**, 297-307.

Jüttner J.D. and McCarthy J. 2000. Modeling a Rating Crisis. Macquarie University, Unpublished, Sidney, Australia, http://www.econ.mq.edu.au/staff/djjuttner/SOVEIG2.pdf.

Kaufmann D., Kraay A. and Zoido-Lobaton P. 1999a. Aggregating Governance Indicators. *World Bank Policy Research Department Working Paper* **2195**.

Kaufmann D., Kraay A. and Zoido-Lobaton P. 1999b. Governance Matters. *World Bank Policy Research Department Working Paper* **2196**, http://www.worldbank.org/wbi/governance/pdf/govmatrs.pdf.

Kaufmann D., Kraay A. and Zoido-Lobaton P. 2002. Governance Matters II: Updated Indicators for 2000/01. *World Bank Policy Research Department Working Paper* **2772**, http://ideas.repec.org/p/wop/wobago/2772.html.

Kunczik M. 2000. Globalization: News Media, Images of Nations and the Flow of International Capital with Special Reference to the Role of Rating Agencies, Paper presented at the IAMCR Conference, Singapore, 1-49.

Larrain G., Reisen H. and von Maltzan J. 1997. Emerging Market Risk and Sovereign Credit Ratings. *OECD Development Center*, 1-30.

Lee S.H. 1993. Relative Importance of Political Instability and Economic Variables on Perceived Country Creditworthiness. *Journal of International Business Studies* **24**, 801-812.

Mauro P. 1993. Essays on Country Risk, Asset Markets and Economic Growth. Harvard University Dissertation.

Mauro P. 1998. Corruption and the Composition of Government Expenditure. *Journal of Public Economics* **69** (2), 263-279.

Monfort B. and Mulder C. 2000. Using Credit Ratings for Capital Requirements on Lending to Emerging Market Economies: Possible Impact of a New Basel Accord. *IMF Working Paper* WP/00/69.

Moody's. 2001. *Moody's Country Credit Statistical Handbook*, First Edition, New York..

Mulekar M.S. and Mishra S.N. 2000, Confidence Interval Estimation of Overlap: Equal Means Case, *Computational Statistics & Data Analysis* **34**, 121-137.

Neter J., Kutner M.H., Nachtsheim C.J. and Wasserman W. 1996. Applied Linear Statistical Models. Fourth Edition. Irwin/McGraw-Hill.

Nickell P., Perraudin W. and Varotto S. 2000. Stability of Rating Transitions. *Journal of Banking and Finance* **24**, 203-227.

Oral M., Kettani O., Cosset J.-C. and Daouas M. 1992. An Estimation Model for Country Risk Rating. *International Journal of Forecasting* **8** (4), 583-593.

Reisen H. and von Maltzan J. 1998. Sovereign Credit Ratings, Emerging Market Risk and Financial Market Volatility. *Intereconomics* **33** (2), 73-82.

Reisen H. and Von Maltzan J. 1999. Boom and Bust and Sovereign Ratings. *OECD*

Development Center Technical Paper **148.**

Saini K.G. & Bates P.S. 1984. A Survey of the Quantitative Approaches to Country Risk Analysis. *Journal of Banking and Finance* **8**, 341-356.

Shao J. and Tu D. 1995. *The Jackknife and Bootstrap*. New York, Springer-Verlag.

Shao J. 1993. Linear Model Selection by Cross-Validation. *Journal of the American Statistical Association* **88**, 486-494.

Simpson J. 2000. The World Trade Organisation and Basel Accord Membership and Compliance in Relation to International Banking Risk. *Curtin University Working Paper* **35.**

Somerville R.A. and Taffler R.J. 1995. Banker Judgment versus Formal Forecasting Models : The Case of Country Risk Assessment. *Journal of Banking and Finance* **19** (2), 281-297.

Standard & Poor. 2001. *Sovereign Ratings History since 1975.* New York.

Standard & Poor. 2000. Ratings Performance. Standard & Poor. New York.

Tang J.C.S. and Espinal C.G. 1989. A Model to Assess Country Risk. *OMEGA: International Journal of Management Sciences* **17** (4), 363-367.

World Bank. 2000a. *Global Development Finance 2000.* Washington D.C.

World Bank. 2000b. *World Development Indicators 2000.* Washington D.C.

Appendix

Table 7:Economic variables and literature

Variable	Literature
Consumer price index	Larrain et al. [1997], Hu et al. [2002]
Credit claims on central government growth rate	Monfort and Mulder [2000]
Current account balance / GDP	Haque et al. [1996,1998], Larrain et al. [1997], Brewer and Rivoli [1990], Doumpos et al. [2001], Cosset et al.[1992], Cook and Hebner [1993], Tang and Espinal [1990]
Debt[20] / exports	Larrain et al. [1997], Feder and Uy [1985], Aylward and Thorne [1998], Dailami and Leipziger [1997], Cosset and Roy [1991], Cosset et al. [1992], Cantor and Packer [1996], Lee [1993], Doumpos and Zopounidis [2001], Monfort and Mulder [2000], Hu et al. [2002]
Debt[21] / GDP	Haque et al. [1996, 1998], Feder and Uy [1985], Lee [1993], Brewer and Rivoli [1990], Aylward and Thorne [1998], Doumpos and Zopounidis [2001], Cook and Hebner [1993], Hu et al. [2002]
Debt / reserves	Monfort and Mulder [2000]
Dependence on oil exportation	Feder and Uy [1985]
Domestic investment / GDP	Larrain et al. [1997], Monfort and Mulder [2000]
Exports / GDP	Aylward and Thorne [1998]
Exports concentration	Feder and Uy [1985]
Exports growth rate	Haque et al. [1996,1998], Feder and Uy [1985], Doumpos and Zopounidis [2001], Cosset et al.[1992], Monfort and Mulder [2000]
Exports variability	Cosset et al.[1992]
Exports vulnerability to external shocks	Feder and Uy [1985]
External debt / GDP	Larrain et al. [1997}, Brewer and Rivoli [1990], Monfort and Mulder [2000]
Fiscal balance[22]	Larrain et al. [1997], Cantor and Packer [1996], Lee [1993], Monfort and Mulder [2000] , Cook and Hebner [1993]
Foreign investment policy	Cook and Hebner [1993]

[20] Same as for footnote 6.
[21] The word “debt” can encompass foreign, total, debt service or external debt, depending on authors.
[22] Central government spending / GDP, domestic public debt / GDP and are used as a proxy for this variable.

GDP[23] growth rate	Haque et al. [1996,1998], Larrain et al. [1997], Feder and Uy [1985], Cantor and Packer [1996], Doumpos and Zopounidis [2001], Monfort and Mulder [2000], Cook and Hebner [1993], Hu et al.[2002]
GDP per capita	Dailami and Leipziger [1997], Erb et al. [1997], Feder and Uy [1985], Cosset et al. [1991&1992], Larrain et al. [1997], Monfort and Mulder [2000], Tang and Espinal [1990]
GDP per capita growth rate	Lee [1993], Haque et al. [1996], Aylward and Thorne [1998]
Gross investment / GDP	Easton and Rockerbie [1999], Cosset et al. [1991 & 1992], Doumpos and Zopounidis [2001]
Imports / GDP	Haque et al.[1996], Aylward and Thorne [1998]
Imports growth rate	Doumpos and Zopounidis [2001]
Income velocity of money (GDP/M2)	Doumpos and Zopounidis [2001]
Indicator for economic development	Cantor and Packer [1996]
Inflation rate	Haque et al. [1996,1998], Larrain et al. [1997], Dailami and Leipziger [1997], Erb et al. [1997], Aylward and Thorne [1998], Cantor and Packer [1996], Doumpos and Zopounidis [2001], Monfort and Mulder [2000]
International reserves / imports	Haque et al. [1996,1998], Easton and Rockerbie et al. [1999], Dailami and Leipziger [1997], Feder and Uy [1985], Aylward and Thorne [1998], Lee [1993], Doumpos and Zopounidis [2001], Cosset et al.[1992], Monfort and Mulder [2000], Tang and Espinal [1990], Hu et al.[2002]
Long-term Debt / GDP	Easton and Rockerbie et al. [1999]
Oil exportation[24]	Feder and Uy [1985]
Real exchange rate	Haque et al. [1996,1998], Larrain et al.[1997], Monfort and Mulder [2000], Cook and Hebner [1993]
Savings / GDP	Larrain et al. [1997]
Short-term debt / reserves	Dailami and Leipziger [1997]
Short-term debt / total debt	Monfort and Mulder [2000]
Terms of trade	Haque et al. [1996,1998], Easton and Rockerbie [1999], Feder and Uy [1985], Doumpos and Zopounidis [2001], Monfort and Mulder [2000]
Trade openness	Easton and Rockerbie [1999]
Treasury bill rate	Haque et al. [1998], Monfort and Mulder [2000]

[23] Note that authors use GDP as well as GNP.
[24] Represented by a dummy variable.

Table 8: Political variables and literature

Variable	Literature
Anti-governmental demonstrations	Haque et al. [1998]
Armed conflicts (or riots)	Haque et al. [1998], Brewer and Rivoli [1990], Cook and Hebner [1993]
Assassination	Haque et al. [1998]
Corruption	Mauro [1993]
Coups	Haque et al. [1998]
General strikes	Haque et al. [1998]
Guerilla warfare	Haque et al. [1998]
Influence of the middle class	Mauro [1993], Cook and Hebner [1993]
Legal system	Mauro [1993]
Major government crises	Haque et al. [1998]
Political change	Mauro [1993], Brewer and Rivoli [1990]
Political legitimacy	Brewer and Rivoli [1990]
Political stability	Brewer and Rivoli [1990, 1997], Feder and Uy [1985], Citron and Neckelburg [1987], Mauro [1993], Lee [1993], Cosset et al.[1992], Cook and Hebner [1993]
Probability of opposition group takeover	Mauro [1993]
Purges	Haque et al. [1998]
Red tape, bureaucracy	Mauro [1993]
Relationships with neighboring countries	Mauro [1993]
Revolutions	Haque et al. [1998]
Social Stability	Cook and Hebner [1993]
Stability of labor	Mauro [1993]
Terrorism	Mauro [1993]

Table 9: Standard & Poor's country rating system

	Level	Description
INVESTMENT RATING	**AAA**	An obligor rated AAA has extremely strong capacity to meet its financial commitments. AA is the highest issuer credit rating assigned by S&P.
	AA	An obligor rated AA has very strong capacity to meet its financial commitments. It differs from the highest rated obligors only in small degree.
	A	An obligor rated A has strong capacity to meet its financial commitments but is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than obligors in higher-rated categories.
	BBB	An obligor rated BBB has adequate capacity to meet its financial commitments. However, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity of the obligor to meet its financial commitments.
SPECULATIVE RATING	**BB**	An obligor rated BB is less vulnerable in the near term than other lower-rated obligors. However, it faces major ongoing uncertainties and exposure to adverse business, financial, or economic conditions which could lead to its inadequate capacity to meet financial commitments.
	B	An obligor rated B is more vulnerable than the obligors rated BB, but, at the time of the rating, it has the capacity to meet financial commitments. Adverse business, financial, or economic conditions could likely impair its capacity or willingness to meet financial commitments.
DEFAULT RATING	**CCC**	An obligor rated CCC is vulnerable at the time of the rating, and is dependent upon favorable business, financial, and economic conditions to meet financial commitments.
	CC	An obligor rated CC is highly vulnerable at the time of the rating.
	C	An obligor rated C is vulnerable to nonpayment at the time of the rating and is dependent upon favorable business, financial, and economic conditions to meet financial commitments.
	D	An obligator rated D is predicted to default.
	SD	An obligator rated SD (selected default) is presumed to be unwilling to repay.

Table 10: *Standard & Poor's country ratings (end of December, 1998)*

We have converted the Standard & Poor rating scale (columns 1 and 4) into a numerical scale (columns 2 and 5). Such a conversion is not specific to us. Ferri et al.[2001] as well as Monfort and Mulder [2000] proceed similarly. A higher numerical value denotes a higher probability of default. The numerical scale is referred to in this paper as Standard & Poor's preorder.

Rating	Preorder	Country	Rating	Preorder	Country
AAA	21	AUSTRIA	BBB-	12	CROATIA
AAA	21	France	BBB-	12	EGYPT
AAA	21	GERMANY	BBB-	12	LITHUANIA
AAA	21	JAPAN	BBB-	12	MALAYSIA
AAA	21	NETHERLANDS	BBB-	12	POLAND
AAA	21	NORWAY	BBB-	12	THAILAND
AAA	21	SINGAPORE	BBB-	12	TUNISIA
AAA	21	SWITZERLAND	BBB-	12	URUGUAY
AAA	21	UNITED KINGDOM	BB+	11	KOREA
AAA	21	UNITED STATES	BB+	11	PANAMA
AA+	20	BELGIUM	BB+	11	PHILIPPINES
AA+	20	CANADA	BB+	11	SLOVAK REPUBLIC
AA+	20	DENMARK	BB+	11	SOUTH AFRICA
AA+	20	IRELAND	BB+	11	TRINIDAD AND
AA+	20	NEW ZEALAND	BB	10	ARGENTINA
AA+	20	SWEDEN	BB	10	COSTA RICA
AA	19	AUSTRALIA	BB	10	EL SALVADOR
AA	19	FINLAND	BB	10	INDIA
AA	19	ITALY	BB	10	MEXICO
AA	19	PORTUGAL	BB	10	MOROCCO
AA	19	SPAIN	BB	10	PERU
A+	17	CYPRUS	BB-	9	BOLIVIA
A+	17	ICELAND	BB-	9	BRAZIL
A+	17	MALTA	BB-	9	JORDAN
A	16	HONG KONG	BB-	9	LEBANON
A	16	SLOVENIA	BB-	9	PARAGUAY
A-	15	CHILE	B+	8	DOMINICAN REPUBLIC
A-	15	CZECH REPUBLIC	B+	8	KAZAKHSTAN
A-	15	ISRAEL	B+	8	VENEZUELA
BBB+	14	CHINA	B	7	TURKEY
BBB+	14	ESTONIA	B-	6	ROMANIA
BBB	13	GREECE	CCC+	5	INDONESIA
BBB	13	HUNGARY	CCC-	3	RUSSIA
BBB	13	LATVIA	CC	2	PAKISTAN
BBB-	12	COLOMBIA			

Table 11: Non-recursive regression model: predicted country risk ratings and 10-folding

Country	S&P rating	S&P preorder	Predicted country risk rating (in-the-sample)	Cross-validation country risk rating (out-of-the-sample)
ARGENTINA	BB	10.00	12.09	14.01
AUSTRIA	AAA	21.00	19.92	20.85
AUSTRALIA	AA	19.00	20.62	19.51
BELGIUM	AA+	20.00	17.91	16.55
BOLIVIA	BB-	9.00	8.88	8.84
BRAZIL	BB-	9.00	9.62	10.17
CANADA	AA+	20.00	20.20	20.18
CHILE	A-	15.00	14.99	14.63
CHINA	BBB+	14.00	13.37	13.06
HONG KONG	A	16.00	17.61	18.88
COLOMBIA	BBB-	12.00	8.43	7.38
COSTA RICA	BB	10.00	11.82	12.06
CROATIA	BBB-	12.00	11.89	11.62
CYPRUS	A+	17.00	17.16	17.11
CZECH REP	A-	15.00	15.04	15.03
DENMARK	AA+	20.00	20.30	20.30
DOMINICAN REP	B+	8.00	8.82	8.78
EGYPT	BBB-	12.00	10.73	10.38
EL SALVADOR	BB	10.00	9.99	9.88
ESTONIA	BBB+	14.00	12.07	11.92
FINLAND	AA	19.00	19.28	19.20
FRANCE	AAA	21.00	18.42	18.27
GERMANY	AAA	21.00	20.34	20.22
GREECE	BBB	13.00	13.44	13.59
HUNGARY	BBB	13.00	13.28	13.01
ICELAND	A+	17.00	20.39	20.65
INDIA	BB	10.00	8.05	7.48
INDONESIA	CCC+	5.00	5.28	5.48
IRELAND	AA+	20.00	18.91	19.11
ISRAEL	A-	15.00	14.00	14.19
ITALY	AA	19.00	17.30	17.52
JAPAN	AAA	21.00	20.07	19.85
JORDAN	BB-	9.00	9.95	9.73
KAZAKHSTAN	B+	8.00	8.57	8.41
KOREA	BB+	11.00	14.36	14.14
LATVIA	BBB	13.00	11.20	10.82
LEBANON	BB-	9.00	9.86	10.41
LITHUANIA	BBB-	12.00	10.57	10.03

MALAYSIA	BBB-	12.00	14.48	15.00
MALTA	A+	17.00	15.87	15.73
MEXICO	BB	10.00	10.35	10.15
MOROCCO	BB	10.00	10.38	10.70
NETHERLANDS	AAA	21.00	20.62	20.56
NEW ZEALAND	AA+	20.00	19.81	19.49
NORWAY	AAA	21.00	22.60	22.92
PAKISTAN	CC	2.00	5.67	5.94
PANAMA	BB+	11.00	8.87	10.69
PARAGUAY	BB-	9.00	7.46	7.55
PERU	BB	10.00	10.57	10.88
PHILIPPINES	BB+	11.00	10.58	10.94
POLAND	BBB-	12.00	12.95	12.84
PORTUGAL	AA	19.00	17.57	17.37
ROMANIA	B-	6.00	7.93	8.97
RUSSIA	CCC-	3.00	6.37	7.27
SINGAPORE	AAA	21.00	20.12	19.58
SLOVAK REP	BB+	11.00	11.03	11.30
SLOVENIA	A	16.00	14.19	13.80
SOUTH AFRICA	BB+	11.00	11.35	11.57
SPAIN	AA	19.00	17.66	17.75
SWEDEN	AA+	20.00	19.26	19.15
SWITZERLAND	AAA	21.00	23.69	24.07
THAILAND	BBB-	12.00	12.15	12.54
TRINIDAD & TOB	BB+	11.00	11.04	10.75
TUNISIA	BBB-	12.00	11.59	11.65
TURKEY	B	7.00	5.07	2.94
UNITED KINGDOM	AAA	21.00	20.27	20.15
UNITED STATES	AAA	21.00	21.08	23.05
URUGUAY	BBB-	12.00	13.31	13.25
VENEZUELA	B+	8.00	7.44	6.79

Table 12: Country risk ratings based on economic variables

Country	S&P rating	S&P preorder	Predicted country risk rating
Argentina	BB	10	13.25
Australia	AA+	20	20.23
Austria	AAA	21	20.13
Belgium	AA+	20	18.32
Bolivia	BB-	9	8.73
Brazil	B+	8	10.37
Canada	AA+	20	20.53

Chile	A-	15	14.80
China	BBB	13	11.44
Hong Kong	A	16	18.45
Colombia	BB+	11	8.84
Costa Rica	BB	10	12.36
Croatia	BBB-	12	11.52
Cyprus	A	16	17.46
Czech Republic	A-	15	14.45
Denmark	AA+	20	20.13
Dominican Republic	B+	8	8.69
Egypt	BBB-	12	10.01
El Salvador	BB+	11	9.60
Estonia	BBB+	14	13.34
Finland	AA+	20	19.74
France	AAA	21	18.97
Germany	AAA	21	20.44
Greece	A-	15	14.25
Hungary	BBB	13	13.29
Iceland	A+	17	21.03
India	BB	10	9.40
Indonesia	CCC+	5	6.63
Ireland	AA+	20	20.09
Israel	A-	15	14.53
Italy	AA	19	16.90
Japan	AAA	21	19.62
Jordan	BB-	9	11.21
Kazakhstan	B+	8	7.92
Korea, Rep,	BBB	13	14.54
Latvia	BBB	13	11.53
Lebanon	BB-	9	10.07
Lithuania	BBB-	12	12.12
Malaysia	BBB	13	13.83
Malta	A	16	16.03
Mexico	BB	10	9.97
Morocco	BB	10	10.33
Netherlands	AAA	21	21.04
New Zealand	AA+	20	18.96
Norway	AAA	21	20.72
Pakistan	B-	6	7.16
Panama	BB+	11	10.39
Paraguay	B	7	6.57
Peru	BB	10	9.60
Philippines	BB+	11	9.75
Poland	BBB	13	12.68

Portugal	AA	19	16.87
Romania	B-	6	5.49
Russia	SD	0	1.59
Singapore	AAA	21	19.23
Slovak Republic	BB+	11	11.85
Slovenia	A	16	14.80
South Africa	BB+	11	12.04
Spain	AA+	20	18.31
Sweden	AA+	20	19.42
Switzerland	AAA	21	22.81
Thailand	BBB-	12	11.94
Trinidad &Tobago	BBB-	12	12.61
Tunisia	BBB-	12	13.58
Turkey	B	7	4.81
United Kingdom	AAA	21	20.44
United States	AAA	21	22.07
Uruguay	BBB-	12	13.63
Venezuela	B	7	6.55

Table 13: Moody's rating system

	Levels	Meaning		Levels	Meaning
INVESTMENT RATING	**Aaa**	Highest quality	SPECULATIVE RATING	**Ba1**	Likely to fulfill obligations
	Aa1	High quality		**Ba2**	
	Aa2			**Ba3**	Ongoing uncertainty
	Aa3			**B1**	High risk obligations
	A1	Strong payment capacity		**B2**	
	A2			**B3**	
	A3		DEFAULT RATING	**Caa**	Current vulnerability to default or in default
	Baa1	Adequate payment capacity		**Ca**	In bankruptcy or default.
	Baa2			**D**	
	Baa3				

Table 14: Predicting 1999 country risk ratings using 1998 model

Country	S&P rating	S&P preorder	Predicted 1999 country risk rating
Argentina	BB	10	14.19
Australia	AA+	20	21.37
Austria	AAA	21	20.52
Belgium	AA+	20	18.44
Bolivia	BB-	9	8.88
Brazil	B+	8	9.77
Canada	AA+	20	20.85
Chile	A-	15	15.15
China	BBB	13	13.37
Hong-Kong	A	16	18.59
Colombia	BB+	11	8.74
Costa Rica	BB	10	12.42
Croatia	BBB-	12	11.36
Cyprus	A	16	18.14
Czech Republic	A-	15	15.44
Denmark	AA+	20	20.73
Dominican Republic	B+	8	9.65
Egypt, Arab Rep,	BBB-	12	10.71
El Salvador	BB+	11	10.48
Estonia	BBB+	14	12.60
Finland	AA+	20	20.00
France	AAA	21	19.18
Germany	AAA	21	20.96
Greece	A-	15	14.45
Hungary	BBB	13	13.48
Iceland	A+	17	21.40
India	BB	10	8.62
Indonesia	CCC+	5	6.75
Ireland	AA+	20	20.49
Israel	A-	15	14.20
Italy	AA	19	17.36
Japan	AAA	21	20.08
Jordan	BB-	9	10.57
Kazakhstan	B+	8	9.00
Korea, Rep,	BBB	13	15.39
Latvia	BBB	13	11.32
Lebanon	BB-	9	9.34
Lithuania	BBB-	12	10.62
Malaysia	BBB	13	14.23
Malta	A	16	16.13

Mexico	BB	10	10.95
Morocco	BB	10	10.20
Netherlands	AAA	21	21.01
New Zealand	AA+	20	19.66
Norway	AAA	21	22.40
Pakistan	B-	6	6.24
Panama	BB+	11	11.52
Paraguay	B	7	7.48
Peru	BB	10	10.25
Philippines	BB+	11	9.94
Poland	BBB	13	12.90
Portugal	AA	19	17.44
Romania	B-	6	8.32
Russia	SD	0	6.49
Singapore	AAA	21	18.54
Slovak Republic	BB+	11	12.74
Slovenia	A	16	15.28
South Africa	BB+	11	12.87
Spain	AA+	20	18.24
Sweden	AA+	20	19.54
Switzerland	AAA	21	23.76
Thailand	BBB-	12	13.13
Trinidad & Tobago	BBB-	12	12.68
Tunisia	BBB-	12	12.92
Turkey	B	7	6.41
United Kingdom	AAA	21	20.77
United States	AAA	21	23.98
Uruguay	BBB-	12	14.12
Venezuela	B	7	8.42

Table 15: Predicting 1999 country risk ratings using 1999 model

Country	S&P rating	S&P preorder	Predicted 1999 country risk rating
Argentina	BB	10	13.32
Australia	AA+	20	18.19
Austria	AAA	21	18.43
Belgium	AA+	20	17.53
Bolivia	BB-	9	7.95
Brazil	B+	8	7.96
Canada	AA+	20	18.90
Chile	A-	15	12.96
China	BBB	13	12.47

Hong-Kong	A	16	17.63
Colombia	BB+	11	8.11
Costa Rica	BB	10	9.28
Croatia	BBB-	12	10.49
Cyprus	A	16	16.68
Czech Republic	A-	15	13.44
Denmark	AA+	20	18.45
Dominican Republic	B+	8	8.47
Egypt. Arab Rep.	BBB-	12	10.37
El Salvador	BB+	11	9.72
Estonia	BBB+	14	10.82
Finland	AA+	20	17.03
France	AAA	21	17.14
Germany	AAA	21	18.41
Greece	A-	15	12.32
Hungary	BBB	13	9.33
Iceland	A+	17	19.18
India	BB	10	6.29
Indonesia	CCC+	5	4.23
Ireland	AA+	20	18.35
Israel	A-	15	14.60
Italy	AA	19	15.78
Japan	AAA	21	17.58
Jordan	BB-	9	7.73
Kazakhstan	B+	8	6.83
Korea. Rep.	BBB	13	12.27
Latvia	BBB	13	9.55
Lebanon	BB-	9	9.32
Lithuania	BBB-	12	9.03
Malaysia	BBB	13	11.45
Malta	A	16	13.54
Mexico	BB	10	8.40
Morocco	BB	10	8.97
Netherlands	AAA	21	17.85
New Zealand	AA+	20	16.93
Norway	AAA	21	21.10
Pakistan	B-	6	4.07
Panama	BB+	11	9.60
Paraguay	B	7	8.45
Peru	BB	10	9.81
Philippines	BB+	11	6.36
Poland	BBB	13	9.93
Portugal	AA	19	14.91
Romania	B-	6	5.72
Russia	SD	0	4.04

Singapore	AAA	21	17.08
Slovak Republic	BB+	11	10.52
Slovenia	A	16	12.87
South Africa	BB+	11	11.08
Spain	AA+	20	15.40
Sweden	AA+	20	17.52
Switzerland	AAA	21	21.46
Thailand	BBB-	12	10.34
Trinidad & Tobago	BBB-	12	10.41
Tunisia	BBB-	12	8.60
Turkey	B	7	4.52
United Kingdom	AAA	21	18.56
United States	AAA	21	22.90
Uruguay	BBB-	12	10.43
Venezuela	B	7	6.07

Table 16: Standard & Poor's country risk ratings: average one-year transition rates (1975-1999)

	AAA	**AA**	**A**	**BBB**	**BB**	**B**	**CCC**	**SD**
AAA	97.45	2.55	0.00	0.00	0.00	0.00	0.00	0.00
AA	0.71	97.14	0.71	0.00	0.71	0.71	0.00	0.00
A	0.00	4.05	93.24	2.70	0.00	0.00	0.00	0.00
BBB	0.00	0.00	5.33	88.00	5.33	1.33	0.00	0.00
BB	0.00	0.00	0.00	7.06	83.53	7.06	0.00	2.35
B	0.00	0.00	0.00	0.00	14.81	81.48	0.00	3.70
CCC	0.00	0.00	0.00	0.00	0.00	33.33	33.33	33.33

Source: Standard & Poor [2000]