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Assessing Global Investing Risk: A Multicriteria Preference Disaggregation Approach

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Abstract

The emergence of many new markets in fast-growing regions presents fertile areas for investment growth but also an abundance of obvious and hidden risks. A framework is developed for assessing investment risk in foreign countries. Both multi-variate statistical methods and multi-criteria decision analysis are employed and compared. The latter include the UTADIS family based on disaggregation analysis and a new method, Multi-group Hierarchical DIScrimination (M.H.DIS). They are used to assess investing risk in 51 countries having stock exchanges, according to 27 criteria. The parameters of the developed models are determined so that the results best match the risk rating of those countries by international experienced investors.

1. Introduction

The investment landscape has become increasingly global and interdependent in recent years. Multinational companies pursue foreign markets with increased vigour and make major investments to those countries. Within the context of economic globalization, financial institutions, firms and investors face an expanded investment environment that provides numerous opportunities all around the world. These investment opportunities often encompass significant risks that are evident not only for the emerging markets but for the developed ones as well. Stock market gyrations have demonstrated the interdependence of financial markets around the world and have made clear the risks that any kind of investor faces in global investing. These risks are mainly due to the specific characteristics of each country concerning its economic performance, as well as the operation and efficiency of its markets. Any individual and corporate investor or international agencies making investments or loans to other countries seek assessment of foreign investment risk. Many studies have been published at the individual firm and industry sector levels, for the prediction of financial

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risks. See for example Dimitras et. al. (1996) for a review of international applications of statistical and multicriteria procedures for predicting business failures. Considerable research has been conducted on the country risk evaluation problem, namely evaluation of the creditworthiness and the economic performance of various countries, by examining their global business, economic and financial environment, but more is needed on the financial risks of investing in individual countries.

Several attempts have been made, mainly by banks, to establish efficient procedures for estimating country risk. These procedures were initially based on devising checklist systems which proved to be insufficient due to the difficulty in selecting the economic indicators and determining their relative importance (Saini and Bates, 1984). Two magazines, Euromoney and Institutional Investor, started offering country risk ratings in the early 80's. Euromoney's credit rating score is a simple weighted average of three factors: a) Market indicators 40% (bond market access, selldown performance, and trade finance access); b) Analytical indicators 40% (political risk, economic indicators and performance forecasts); c) Credit indicators 20% (payment record and rescheduling difficulties). The Institutional Investor's score for a country's creditworthiness is based on ratings on a scale 0-100 obtained from 75-100 leading international banks, which are then weighted, in some undisclosed way, according to the perception of each bank's global prominence and detailed country-analysis systems. More sophisticated multivariate statistical techniques have been proposed, including discriminant analysis (Frank and Cline, 1971; Grinols, 1976; Saini and Bates, 1978; Taffler and Abassi, 1984; Somerville and Taffler, 1995), factor analysis (Mumpower et al., 1987), regression analysis and regression trees (Cosset and Roy, 1988 and 1991), cluster analysis (Mumpower et al., 1987), logit analysis (Feder and Just, 1977; Mayo and Barret, 1977; Saini and Bates, 1978; Taffler and Abassi, 1984; Somerville and Taffler, 1995), and principal components analysis (Dhonte, 1975). Saini and Bates (1984) provide a comprehensive review and criticism of the application of such statistical and econometric techniques in country risk evaluation. Cook and Hebner (1993) suggested a pure ordinal model to rank countries according to a few criteria, while Tang and Espinal (1989) employed one S-type utility and Delphi-assessed weights to measure country risk. Recently, alternative non-parametric techniques, such as fuzzy logic (Levy and Yoon, 1995) and multicriteria decision aid, have been also applied in this field (Oral et al., 1992; Cosset et al., 1992; Anastassiou and Zopounidis, 1997). A comprehensive review regarding the applications of multicriteria decision aid techniques in country risk assessment can be found in Zopounidis et al. (1998).

However, all this previous research has adopted a rather «macroeconomic» perspective. The macroeconomic criteria examined, as well as the political and social factors are, of course, of major importance in determining the creditworthiness of the countries and their associated likelihood of default. However, such an evaluation on its own does not necessarily lead to the evaluation of the overall investment environment in a country.

Actually, there are many determinants of global investing risk, both quantitative and judgmental, influenced by a country's economy and creditworthiness, as well as the investment opportunities that each country provides (e.g., stock market), and its regulatory/ transaction environment. Developing an aggregate measure of risk, then, becomes a multivariate statistical analysis or a multi-attribute decision analysis prob-

lem. The advantage of the second approach over statistical analysis is that it does not require restrictive statistical assumptions and it can easily accommodate qualitative judgments in addition to hard numerical data. For a given decision matrix $X=\{X_{ij}\}$, the simplest form of a multicriteria decision analysis model is $Y_i = \Sigma W_j X_{ij.}$ This is determined via an aggregation (elicit user input Ws to predict Ys) or disaggregation approach (user provided Ys to estimate Ws). Here we employ the latter approach for synthesizing different types of investing risk elements (X) and categorizing countries according to their overall investing risk (Y=1,2,3...).

In this case study we utilise information on twenty seven variables for fifty countries and their investing risk level, provided by international expert managers polled by the Wall Street Journal. Several classification models are developed, employing the family of UTADIS preference disaggregation methods and a new method, Multi-group Hierarchical Discrimination (M.H.DIS), and compared to each other and to discriminant analysis. It should be noted that such models do not replace the decision-maker. By replicating the final ratings of experts, these models identify the important criteria (not disclosed by the experts), thus extracting unspecified human expertise and, more importantly, insight into the nature of the problem, e.g. main reasons explaining a country's risk category. Naturally, these model results will be as good as the experts employed.

The next section summarises the preference disaggregation approaches, presenting the UTADIS family and the new M.H.DIS method. This is followed by a description of the problem data, criteria and models. Analysis of results and conclusions complete the presentation.

2. Preference Disaggregation Methods

The preference disaggregation approach refers to the analysis (disaggregation) of the global preferences (judgment policy) of the decision maker in order to identify the criteria aggregation model that underlies the preference result (ranking or classification/sorting). Similarly to multiattribute utility theory (Keeney and Raiffa, 1993), preference disaggregation analysis uses common utility decomposition forms to model the decision maker's preferences. Nevertheless, instead of employing a direct procedure for estimating the global utility model, as in multiattribute utility theory, preference disaggregation analysis uses regression–based techniques (indirect estimation procedure). More specifically, in preference disaggregation analysis the parameters of the utility decomposition model are estimated through the analysis of the decision maker's overall preference on some reference alternatives, which may involve either examples of past decisions or a small subset of the alternatives under consideration. The decision maker is asked to provide a ranking or a classification of the reference alternatives according to his/her decision policy (global preferences). Then, using regression-based techniques the global preference model is estimated so that the ranking or classification specified by the decision maker can be reproduced as consistently as possible through the decision model. The use of linear programming to solve linear regression problems was suggested in the 1950's (e.g. see Wagner 1959). A comprehensive bibliography on preference disaggregation methods can be found in the works of Jacquet-Lagrθze and Siskos (1983) and Pardalos et al. (1995).

The preference disaggregation analysis methods that are employed in this case study include the family of the UTADIS methods (UTilitıs Additives DIScriminantes) and a new method, the M.H.DIS method (Multi-group Hierarchical DIScrimination; Zopounidis and Doumpos, 2000). Both approaches lead to the development of a classification model in the form of an additive utility function. The general scheme of the procedure used to develop the classification model through the UTADIS methods and M.H.DIS is as follows. Initially, a reference set A consisting of n alternatives a_1, a_2, ..., a_n, classified into q ordered classes $C_1 \succ C_2 \succ ... \succ C_q$ (C_1 is preferred to C_2, C_2 is preferred to C_3, etc.) is used for model development. The alternatives are described (evaluated) along a set of m evaluation criteria $\underline{g} = \{g_1, g_2, ..., g_m\}$. The evaluation of an alternative a on criterion g_i is denoted as $g_i(a)$. The set of criteria may include both criteria of increasing and decreasing preference. In the former case higher values of the criteria are preferred, while in the latter case lower values are preferred. Without loss of generality all subsequent discussion will focus on criteria of increasing preference[1]. The development of the classification model is performed so as to respect the pre–specified classification, as much as possible. Once, this is achieved the classification model can be used for extrapolation purposes involving the classification of a new alternative. This is a common model development procedure that is widely used in statistics and econometrics (e.g., in discriminant, logit and probit analysis), as well as in other MCDA preference disaggregation approaches too (Jaquet-Lagrıze and Siskos, 1982, Mousseau and Slowinski, 1998).

The specific features of the model development procedure in the family of the UTADIS methods (UTADIS, UTADIS I, UTADIS II and UTADIS III; Zopounidis and Doumpos, 1997, 1999; Doumpos and Zopounidis, 1998; Zopounidis, Doumpos and Zanakis, 1999) and M.H.DIS are briefly outlined in the following subsections.

2.1 The family of the UTADIS methods

The application of the general regression-based scheme of preference disaggregation analysis, that was described above, within the context of the UTADIS methods leads to the development of an additive utility function of the form:

$$U(\underline{g}) = \sum_{i=1}^{m} p_i u_i(g_i) \tag{1}$$

where p_i is the weight of criterion g_i and $u_i(g_i)$ is the corresponding marginal utility function normalized between 0 and 1. If the marginal utilities are not normalized then the additive utility function can be equivalently written as:

$$U(\underline{g}) = \sum_{i=1}^{m} u_i(g_i) \tag{2}$$

[1] Criteria of decreasing preference can be transformed into increasing preference through sign reversal.

On the basis of this additive utility function the global utility $U(\underline{g}_a)$ of every alternative a can be estimated. The global utility serves as an index used to decide upon the classification of the alternatives into the predefined classes. The classification is performed through the comparison of the global utilities of the alternatives to some utility thresholds that define the lower bound of each class, as follows:

$$\left.\begin{array}{ll} U(\underline{g}_a) \geq u_1 & \Rightarrow a \in C_1 \\ u_2 \leq U(\underline{g}_a) < u_1 & \Rightarrow a \in C_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots & \\ u_k \leq U(\underline{g}_a) < u_{k-1} & \Rightarrow a \in C_k \\ \ldots\ldots\ldots\ldots\ldots\ldots & \\ U(\underline{g}_a) < u_{q-1} & \Rightarrow a \in C_q \end{array}\right\} \quad (3)$$

Thus, the development of the classification model through the utadis methods requires the determination of the marginal utility functions to obtain the specific form of the global utility function, as well as selection of the utility thresholds ui. The determination of these parameters of the model is performed using mathematical programming techniques, in order to minimize the differences between the actual classification of the alternatives and the classification that is estimated by the classification model, as described above. The differences between the four UTADIS methods (UTADIS, I, II and III) involve the measure of the quality of classification that is obtained through the additive utility model developed, as opposed to the actual classification of the alternatives. In utadis (Zopounidis and Doumpos, 1999) the quality of the obtained classification is measured indirectly through the magnitude of violations of the classification rules (3) is considered. In addition to the magnitude of the classification errors, UTADIS I (Doumpos and Zopounidis, 1998) also considers the distances of the correctly classified alternatives from the utility thresholds. The maximization of these distances is similar to the maximization of the among-groups variance in traditional discriminant analysis, i.e., its aim is to place the alternatives of the one class as far as possible from the alternatives of the other classes. UTADIS II (Zopounidis and Doumpos, 1998) employs more direct measures to estimate the quality of the resulting classification, leading to the minimization of the number of misclassified alternatives. Finally, UTADIS III (Zopounidis and Doumpos, 1997), combines this objective with the maximization of the distances of the correctly classified alternatives from the utility thresholds, similar to that in utadis I method.

2.2 The M.H.DIS Method

As in the family of the UTADIS methods, M.H.DIS also employs a utility-based approach in addressing the classification problem. However, both the procedure that is employed in developing the classification model, as well as the way that it is used to decide on the classification of the alternatives, differ. The objective of the method is to distinguish the groups progressively, starting by discriminating the first group (best alternatives) from all the others, and then proceeding to the discrimination between the objects belonging to the other groups. At each

stage of this process two additive utility functions are developed that are used to decide upon the classification of the alternatives. Assuming that the classification of the alternatives should be made into q ordered classes ($C_1 \succ C_2 \succ ... C_q$), the number of additive utility functions to be developed is 2(q–1). Figure 1 illustrates the hierarchical discrimination process in the M.H.DIS method. $U^{C_k}(a)$ and $U^{\sim C_k}(a)$ denote the global utility of a decision regarding the classification of an alternative a into class C_k and not C_k respectively at stage k of the hierarchical discrimination process. For instance $U^{C_1}(a)$ is the global utility of a decision regarding the classification of an alternative a into class C_1 at the first stage of the hierarchical discrimination process, while $U^{\sim C_1}(a)$ is the global utility of a decision regarding the classification of an alternative a not into C_1, indicating that a belongs into one of the classes C_2, C_3, ..., or C_q (the specific classification will be determined in the next stages of the hierarchical discrimination process).

The development of the additive utility functions in the M.H.DIS method is achieved through mathematical programming techniques. Two linear and one mixed–integer programming problems are solved at each stage of the hierarchical discrimination process that was described above, to estimate the «optimal» classification, where the term «optimal» refers both to the total number of misclassifications as well as to the clarity of the discrimination that is obtained. Initially, a linear programming problem (LP1) is solved to minimize the magnitude of the classification error (in distance terms). Then, a mixed-integer programming problem (MIP) is solved to minimize the total number of misclassifications among the misclassifications that occur after the solution of LP1, while retaining the correct classifications. Finally, a second linear programming problem is solved to maximize the clarity of the classification that is obtained after the solution of LP1 and MIP. A detailed description of mathematical programming formulations that are employed in the M.H.DIS method can be found in Zopounidis and Doumpos (2000).

3. Data, Criteria and Approach

A special report on Global Investing of The Wall Street Journal (6/26/1997), entitled "The Game of Risk", featured the following headline: To understand the traps of global investing, you have to first know were they' re hidden. In order to cope with these hidden dangers, one must look at market risk, trading costs, political risk and a pro-shareholder equity culture. The Wall Street Journal and a US investment consulting firm conduct a survey of investment managers to determine which countries are riskier for investors. The experts were asked to evaluate 51 countries with respect to their market risk, the investment opportunities that they provide to foreign investors, the available quantity and quality of information on their market, the investors' protection and administrative details such as custody, settlement and taxes. The following 27 evaluation criteria were considered in the survey, along with the corresponding data for each country compiled from a variety of sources[2]:

[2] **a:** World Bank, IMF, OECD and International Finance Corp. Emerging Markets Database Factbook

A. Economic Indicators
   1 GNP per capita (US $)
   2 Real GDP growth rate (5-year average, %)
   3 Projected GDP growth rate (%)
   4 Projected inflation rate (%)
   5 Short-term interest rate (%)

B. Depth & Liquidity
   6 Market capitalization (millions US $)
   7 Turnover (annual trading volume as % of market capitalization)
   8 Total number of listed companies
   9 Total public ADRs or ordinary shares available in U.S.
   10 Country fund available in U.S. (yes or no)

C. Performance & Value
   11 Compound 3-year annual total return in $ US (%)
   12 Compound 3-year annual total return in local currency (%)
   13 Price / earnings ratio
   14 Forward price / earnings ratio
   15 Historic 5-year average earnings growth (%)
   16 Projected 5-year average earnings growth (%)
   17 Dividend yield (%)

D. Economic & Market Risk
   18 S&P long-term foreign currency credit rating (AAA, AA, etc.)
   19 Moody's long-term foreign currency credit rating (AAA, Aa1, etc.)
   20 Volatility (5-year annualized standard deviation)
   21 Correlation with U.S. (5-year average)

E. Regulation & Efficiency
   22 Settlement efficiency (Trade size and failed trade frequency rating out of 100)
   23 Safekeeping efficiency (Dividend collection & shareholder rights rating out of 100)
   24 Operational costs (Average annual impact in basis points)
   25 Withholding tax on dividend for US-based investors (%)
   26 Settlement lag (days)
   27 Year stock exchange established

On the basis of these criteria the countries were classified by the investment experts into five risk categories:

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b: NYSE, NASDAQ, American Stock Exchange, Lipper Analytical Services, Bank of New York & International Finance Corp.)

c: DJ Global Indexes, IBES International & Morgan Stanley Capital International

d: S&P and Moody's ratings (recoded as consecutive integers starting with 1 as the lowest rating for each), International Finance Corp., and Ennis Knupp & Associates

e: indexes developed by London-based GSCS Benchmark Ltd., Ennis/Knupp Associates, International Finance Corp. and Liechtenstein Global Trust Asset Management.

1. Most safe – similar to U.S.	:	Australia, Canada, Denmark, France, Germany, Ireland, Netherlands, New Zealand, Sweden, Switzerland, U.K.
2. Developed	:	Austria, Belgium, Finland, Hong Kong, Italy, Japan, Norway, Singapore, Spain
3. Mature Emerging Markets	:	Argentina, Brazil, Chile, Greece, Korea, Malaysia, Mexico, Philippines, Portugal, South Africa, Thailand
4. New Emerging Markets	:	China, Columbia, Czech Republic, Hungary, India, Indonesia, Israel, Poland, Sri Lanka, Taiwan, Venezuela
5. Frontier -- the shakiest	:	Egypt, Jordan, Morocco, Nigeria, Pakistan, Peru, Russia, Turkey, Zimbabwe

This survey of the Wall Street Journal was the main motivation for this research, whose aim is to explore ways to develop real-time evaluation models that can reproduce, as accurately as possible, the risk classification of the countries defined by the expert investment managers. A second objective was to identify the most influential criteria affecting these classifications.

A small portion of the data (9.6%) was missing. Since these empty cells were scattered, elimination of criteria (columns) or countries (rows) was deemed undesirable, for it would reduce the criteria and/or the already small sample size. Instead, we chose to estimate these missing data using three imputation procedures for each variable: a) Mean overall countries; b) Mean of all countries in risk group; and c) EM algorithm of Dempster, Laird and Rubin (1977). In step E, this algorithm computes the expected log-likelihood value, and in step M it maximizes this function to provide new estimates. Likelihood-based methods are generally preferred, even when the underlying normality assumptions do not hold or data are missing at random (Little, 1992).

Our analysis aimed at developing and comparing real-time evaluation models to aggregate the evaluation criteria into a single index, which can be used to rate the investment risk of the countries and to obtain their classification into one of the five predefined risk groups.

4. Analysis and results

A preliminary analysis was first conducted on the initial data, using correlation matrix, parametric and non-parametric ANOVA, overlap of 95% confidence intervals for the five groups, and factor analysis. The results are summarized in Table 1. The 3-year compound annual total return in local currency was excluded because it contained many missing values and it is highly correlated to the same variable measured in US $. Five other weak variables, denoted in italics in Table 1 (# 2, 8, 15, 25 and 26), were not part of the data input to the UTADIS and MHDIS methods. The rational was to include the most relevant criteria, rather than developing a 27-variable model, which may be hardly applicable in practice. The input to Discriminant Analysis (DA) was slightly different, influenced more by the results of factor analysis, whose 12 factors accounted for 93.6% of the total variance. Correlation with U.S. could be viewed as a "biased" variable for risk classification and it was excluded, given that it is better represented by market capitalization within the same factor (#2).

Table 1: *Criteria significance via ANOVA and factor analysis. Complete sample of all countries.*

No	CRITERION	Correl. Risk	ANOVA Signif	K-W Signif.	Conf Inter Overlap	Max Load	In Factor*
1	**GNP per capita**	-0.804	0.000	0.000	0.212	0.618	1
2	**Real GNP growth rate**	0.365	0.132	0.160	0.697	0.899	7
3	**Projected GNP growth**	0.406	0.005	0.010	0.464	0.818	8
4	**Projected inflation rate**	0.497	0.018	0.000	0.592	0.819	1
5	**Short term interest rate**	0.644	0.002	0.000	0.573	0.721	1
6	**Market capitalization**	-0.314	0.079	0.000	0.775	0.963	2
7	**Turnover**	-0.300	0.560	0.052	0.807	0.920	9
8	**Total listed companies**	-0.267	0.487	0.254	0.942	0.975	2
9	**Tot. public ADRs or ordinary shares**	-0.387	0.032	0.038	0.356	0.972	10
10	**Country fund available**	-0.237	0.063	0.082	0.608	0.704	6
11	**3-yr comp. annual tot. return (US $)**	0.039	0.000	0.001	0.428	0.655	4
12	**3-yr comp. annual tot. ret.(local)**	-	-	-	-	-	-
13	**Price/earnings ratio**	-0.381	0.072	0.022	0.734	0.861	4
14	**Forward price/earnings ratio**	-0.461	0.004	0.001	0.577	0.789	4
15	**Historic earnings growth**	0.091	0.708	0.261	0.873	0.873	6
16	**Projected earnings**	0.532	0.001	0.052	0.830	0.549	5
17	**Dividend yield**	0.257	0.000	0.159	0.840	0.845	12
18	**S&P l.t. foreign curr. credit rating**	-0.828	0.000	0.000	0.234	0.842	1
19	**Moody l.t. foreign curr credit rate**	-0.840	0.000	0.000	0.191	0.837	1
20	**Volatility**	0.541	0.001	0.001	0.582	0.829	5
21	**Correlation with US**	-0.507	0.004	0.005	0.303	0.709	2
22	**Settlement efficiency**	-0.385	0.074	0.003	0.693	0.828	3
23	**Safekeeping efficiency**	-0.317	0.073	0.013	0.800	0.858	11
24	**Operational costs**	0.569	0.000	0.003	0.749	0.748	3
25	**Withhold tax on divid. US-investors**	-0.090	0.337	0.272	0.776	0.727	1
26	**Settlement lag**	0.060	0.802	0.825	0.923	0.865	3
27	**Year stock exchange established**	0.725	0.000	0.000	0.197	0.643	5

** : These 12 factors accounted for 93.6% of total variance.*
Note: *Criteria names in italics were not used in UTADIS/MHDIS runs.*

For information/contrast purposes, we provide the criteria weights for the UTADIS methods, in Tables 2 and 3, for the data with missing values estimated by overall averages and group averages respectively. Complete results for all methods are shown in Tables 4-7, for the data with missing values estimated more appropriately by the EM algorithm. These are discussed in more detail below, first for the criteria importance (Tables 4-7) and then for marginal and global utilities (Figures 2-8), and classification accuracies (Tables 8-10).

Table 2: *Criteria weights produced by each UTADIS method. Complete sample of all countries (missing values estimated by overall average for each criterion).*

No.	CRITERION	UTADIS	UTADIS I	UTADIS II	UTADIS III
1	**GNP per capita**	18.54%	16.82%	16.80%	16.45%
3	**Projected GNP growth**	3.53%	1.72%	5.89%	5.43%
4	**Projected inflation rate**	4.27%	0.05%	4.22%	1.67%
5	**Short term interest rate**	0.39%	0.08%	2.63%	1.95%
6	**Market capitalization**	0.00%	0.00%	0.08%	0.00%
7	**Turnover**	2.69%	2.39%	6.91%	5.94%
9	**Total public ADRs**	0.24%	4.49%	0.27%	2.23%
10	**Country fund available**	0.00%	0.00%	0.01%	0.00%
11	**3-yr compound annual total return (US $)**	1.02%	4.08%	2.54%	2.76%
13	**Price/earnings ratio**	0.00%	0.00%	0.03%	0.00%
14	**Forward price/earnings ratio**	7.30%	3.91%	5.12%	6.14%
16	**Projected earnings**	0.00%	0.64%	0.23%	0.00%
17	**Dividend yield**	0.00%	0.00%	0.15%	0.00%
18	**S&P lt foreign currency credit rating**	0.30%	0.02%	4.08%	2.89%
19	**Moody's lt foreign currency credit rating**	27.81%	31.29%	26.59%	27.99%
20	**Volatility**	0.01%	3.88%	1.65%	1.66%
22	**Settlement efficiency**	9.95%	10.65%	5.51%	6.31%
23	**Safekeeping efficiency**	5.53%	3.33%	5.88%	4.88%
24	**Operational costs**	4.51%	3.46%	2.07%	2.43%
27	**Year stock exchange established**	13.92%	13.20%	9.34%	11.27%
	Overall accuracy	**94.12%**	**88.24%**	**98.04%**	**98.04%**

Table 3: *Criteria weights produced by each UTADIS method. Complete sample of all countries (missing values estimated by group averages for each criterion).*

No.	CRITERION	UTADIS	UTADIS I	UTADIS II	UTADIS III
1	**GNP per capita**	12.60%	14.17%	12.64%	12.61%
3	**Projected GNP growth**	2.32%	0.02%	1.98%	1.90%
4	**Projected inflation rate**	0.57%	0.01%	0.57%	0.01%
5	**Short term interest rate**	7.89%	21.29%	8.57%	19.48%
6	**Market capitalization**	0.53%	0.00%	0.53%	0.00%
7	**Turnover**	3.96%	4.28%	3.56%	4.45%
9	**Total public ADRs**	1.38%	0.39%	1.49%	1.19%
10	**Country fund available**	0.53%	0.00%	0.20%	0.00%
11	**3-yr compound annual total return (US $)**	5.15%	1.02%	5.44%	4.91%
13	**Price/earnings ratio**	0.35%	0.01%	0.35%	0.00%

14	**Forward price/earnings ratio**	11.80%	13.60%	10.67%	5.81%
16	**Projected earnings**	2.74%	0.34%	2.59%	1.83%
17	**Dividend yield**	0.68%	0.01%	0.73%	0.02%
18	**S&P lt foreign currency credit rating**	0.96%	2.34%	1.05%	1.29%
19	**Moody's lt foreign currency credit rating**	18.11%	13.04%	19.14%	15.53%
20	**Volatility**	8.16%	13.21%	7.92%	11.38%
22	**Settlement efficiency**	1.12%	0.78%	1.60%	1.46%
23	**Safekeeping efficiency**	9.55%	4.76%	9.11%	8.91%
24	**Operational costs**	6.95%	4.61%	7.34%	2.02%
27	**Year stock exchange established**	4.65%	6.14%	4.55%	7.20%
	Overall accuracy	**100.00%**	**94.12%**	**100.00%**	**100.00%**

Table 4: *Criteria weights produced by each UTADIS method. Complete sample of all countries (missing values estimated by EM).*

No.	CRITERION	UTADIS	UTADIS I	UTADIS II	UTADIS III
1	**GNP per capita**	2.88%	0.28%	8.01%	6.75%
3	**Projected GNP growth**	0.00%	0.06%	0.72%	0.29%
4	**Projected inflation rate**	0.00%	0.01%	0.33%	0.01%
5	**Short term interest rate**	0.00%	0.01%	0.35%	0.01%
	A. Economic Indicators Total	***2.88%***	***0.36%***	***9.41%***	***7.07%***
6	**Market capitalization**	0.00%	0.00%	0.28%	0.00%
7	**Turnover**	4.51%	0.02%	5.27%	3.80%
9	**Total public ADRs**	0.00%	2.03%	3.17%	0.66%
10	**Country fund available**	0.00%	0.00%	0.13%	0.00%
	B. Depth & Liquidity Total	***4.52%***	***2.06%***	***8.85%***	***4.47%***
11	**3-yr compound annual total return**	3.08%	1.38%	2.56%	3.50%
13	**Price/earnings ratio**	0.00%	0.00%	0.26%	0.01%
14	**Forward price/earnings ratio**	21.12%	18.59%	16.70%	18.60%
16	**Projected earnings**	7.63%	6.76%	5.86%	5.31%
17	**Dividend yield**	0.08%	0.01%	0.33%	0.31%
	C. Performance & Value Total	***31.92%***	***26.74%***	***25.71%***	***27.73%***
18	**S&P long term foreign currency credit rating**	3.12%	0.14%	1.88%	28.21%
19	**Moody's long term foreign currency credit rating**	18.65%	28.27%	16.23%	11.53%
20	**Volatility**	2.53%	2.86%	2.61%	0.06%
	D. Economic & Market Risk Total	***24.31%***	***31.26%***	***20.72%***	***39.79%***
22	**Settlement efficiency**	0.00%	0.01%	0.27%	0.06%
23	**Safekeeping efficiency**	7.62%	7.03%	5.25%	10.11%

24	**Operational costs**	17.13%	10.59%	16.01%	2.81%
27	**Year stock exchange established**	11.63%	21.95%	13.80%	7.97%
	E. Regulation & Efficiency Total	36.38%	39.57%	35.32%	20.95%
	Overall accuracy	**90.20%**	**90.20%**	**94.12%**	**98.04%**

Table 5: *Unstandardized DA function coefficients (missing values estimated by EM)*

No.	CRITERION	FUNCTIONS			
		1	**2**	**3**	**4**
2	**Real GNP growth rate**	14.1488	-11.2701	12.6776	31.7907
3	**Projected GNP growth**	8.3370	4.8468	-46.5927	-42.0170
4	**Projected inflation rate**	0.1080	1.4891	-2.3404	2.7936
6	**Market capitalization**	0.0000	0.0000	0.0000	0.0000
7	**Turnover**	0.0035	0.0106	-0.0107	0.0103
9	**Total public ADRs**	-0.0088	0.0047	-0.0074	0.0032
10	**Country fund available**	0.3363	-1.6078	1.6191	-1.5393
11	**3-yr comp. annual tot. return (US $)**	0.5091	6.7384	2.3289	-2.0186
14	**Forward price/earnings ratio**	0.1045	-0.1069	0.1164	0.0954
15	**Historic earnings growth**	0.2616	-2.0272	2.4939	-0.1674
17	**Dividend yield**	26.5244	41.7779	9.1928	4.4259
19	**Moody's l.t.foreign curr. cred. rate**	-0.4819	-0.0378	-0.0705	0.0899
20	**Volatility**	2.6925	-3.5112	0.4733	2.6262
22	**Settlement efficiency**	-0.0086	-0.0044	0.0138	-0.0103
23	**Safekeeping efficiency**	-0.0297	0.0489	-0.0881	-0.0611
	(Constant)	2.9840	-1.1107	3.9675	5.7983
	Overall accuracy		***82.00%***		

Table 6: *Criteria weights produced by the M.H.DIS method*
Complete sample of all countries (missing values estimated by EM)

		Function 1	Function 2	Function 3	Function 4	Function 5	Function 6	Function 7	Function 8
		Group 1	Groups 2-5	Group 2	Groups 3-5	Group 3	Groups 4-5	Group 4	Group 5
1	**GNP per capita**	**20.957%**	0.500%	**40.113%**	**42.913%**	**18.513%**	0.300%	**27.903%**	**15.156%**
3	**Projected GNP growth**	0.330%	12.028%	0.280%	0.280%	0.210%	0.210%	4.499%	**23.574%**
4	**Projected inflation rate**	0.420%	0.420%	0.340%	0.340%	0.280%	0.280%	0.190%	0.190%
5	**Short term interest rate**	0.490%	0.490%	**12.104%**	**27.859%**	5.323%	0.300%	0.190%	0.190%
	A. Economic Indicators Total	22.197%	13.438%	52.837%	71.391%	24.326%	1.090%	32.781%	39.110%
6	**Market capitalization**	3.210%	**13.822%**	**13.444%**	0.470%	0.300%	**29.753%**	0.190%	0.190%
7	**Turnover**	3.850%	**18.727%**	2.650%	0.390%	0.300%	0.300%	5.014%	5.483%
9	**Total public ADRs**	0.370%	2.870%	0.270%	0.270%	0.220%	3.095%	**22.244%**	0.160%
10	**Country fund available**	0.010%	0.010%	0.010%	0.010%	0.010%	0.010%	0.010%	0.010%
	B. Depth & Liquidity Total	7.440%	35.429%	16.374%	1.140%	0.830%	33.158%	27.458%	5.843%
11	**3-yr compound annual total return**	0.490%	**28.561%**	1.250%	0.390%	0.300%	0.300%	0.190%	0.190%
13	**Price/earnings ratio**	0.430%	0.430%	0.340%	0.340%	0.270%	0.270%	0.190%	0.190%
14	**Forward price/earnings ratio**	0.400%	0.400%	0.340%	0.340%	**38.571%**	7.180%	0.180%	14.886%
16	**Projected earnings**	0.420%	0.420%	0.350%	0.350%	4.238%	4.950%	0.180%	0.180%
17	**Dividend yield**	**18.397%**	**10.429%**	0.260%	0.260%	0.230%	**14.865%**	0.180%	0.180%
	C. Performance & Value Total	20.137%	40.240%	2.540%	1.680%	43.609%	27.566%	0.920%	15.626%
18	**S&P lt. foreign currency credit rating**	0.100%	0.100%	0.500%	0.100%	0.090%	0.090%	0.070%	0.070%
19	**Moody's lt. foreign currency credit rating**	0.130%	0.130%	0.130%	0.130%	0.100%	0.100%	**23.484%**	**14.926%**
20	**Volatility**	**42.453%**	0.480%	0.380%	0.380%	8.890%	2.375%	0.190%	**23.734%**
	D. Economic & Market Risk Total	42.683%	0.710%	1.010%	0.610%	9.080%	2.565%	23.744%	38.730%
22	**Settlement efficiency**	0.310%	0.310%	0.280%	10.654%	0.260%	0.260%	0.190%	0.190%
23	**Safekeeping efficiency**	0.220%	6.049%	0.210%	0.210%	0.180%	0.180%	0.160%	0.160%
24	**Operational costs**	5.979%	3.415%	0.300%	0.300%	**14.665%**	**24.773%**	0.180%	0.180%
27	**Year stock exchange established**	1.035%	0.410%	**26.449%**	**14.014%**	7.050%	10.408%	**14.566%**	0.160%
	E. Regulation & Efficiency Total	7.544%	10.184%	27.239%	25.179%	22.155%	35.621%	15.096%	0.690%

Overall accuracy 100%

The most influential criteria according to all UTADIS methods are forward price/earnings ratio and Moody's long term foreign currency credit rating. Other criteria weighted highly are operational costs and age of the stock exchange (not for UTADIS III), and to a lesser extent safekeeping efficiency, projected earnings, turnover, 3-year compound total return in US $ and GNP per capita (which was very strong when using overall or group estimates of missing observations). The prominent criteria for the MHDIS method are volatility (group 1 & 5), GNP per capita (group 2-5), forward price/earning ratio (group 3 & 5), total public ADRs (group 4), Moody's long term foreign currency credit rating (group 4 & 5), and projected GNP growth (group 5). According to the DA method the most discriminating criteria are Moody's long term foreign currency credit rating, real GNP growth rate, projected GNP growth, safekeeping efficiency, and country fund available (the first three identified also by MHDIS).

It is clear from Table 4 that approximately 90% of the total weight in any UTADIS model is shared by the last three classes of criteria, namely Performance & Value, Economic & Market Risk (dominant in UTADIS III), and Regulation & Efficiency (dominant in UTADIS, UTADIS I & II). The MHDIS results, however, place emphasis on the economic indicators across risk groups, and selectively to others criteria classes; e.g. Depth/Liquidity criteria for group 4, economic/market risk criteria for groups 1, 4 and 5, and regulation/efficiency criteria for groups 2 and 3.

The marginal utilities of each method help discriminate between alternatives, as illustrated in the following graphs. In all graphs, the horizontal axis represents the range of a criterion, whereas the vertical axis represents its marginal utility. Figure 2 illustrates the marginal utility for Moody's long term foreign currency credit rating in the case of the UTADIS methods. It basically shows three-step utility functions, differentiating between all UTADIS methods in the higher two steps. Countries whose foreign currency credit rating by Moody is between Ba1 and Aa3 receive the same score by a given UTADIS method (always higher than 0.1, expect for the UTADIS III), and so do countries with high ratings Aa1 and Aaa. On the other hand, countries with ratings B2, B1 and Ba2 are evaluated almost equally poorly (in utility terms) by all models.

Figure 1. *Hierarchical discrimination procedure in the M.H.DIS method*

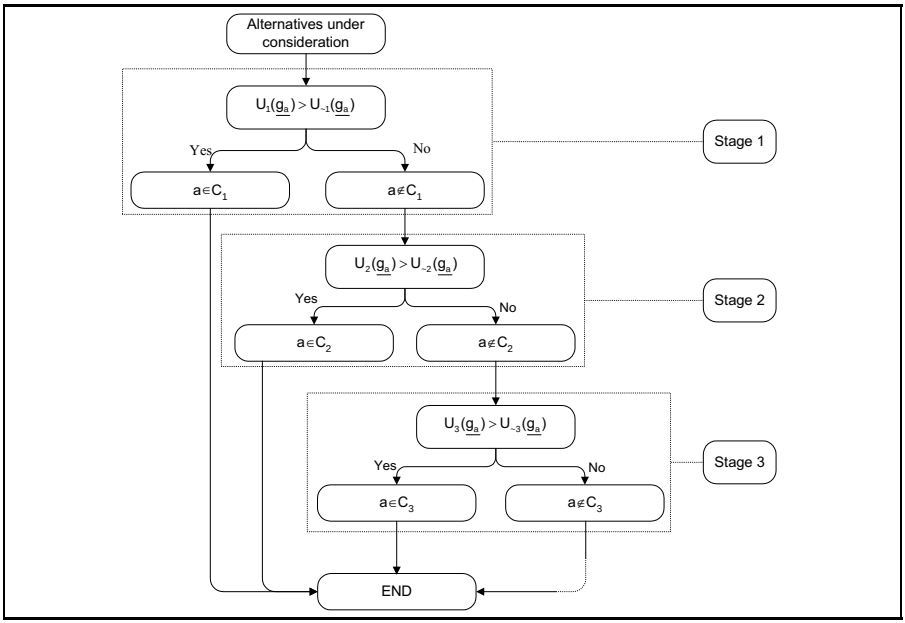
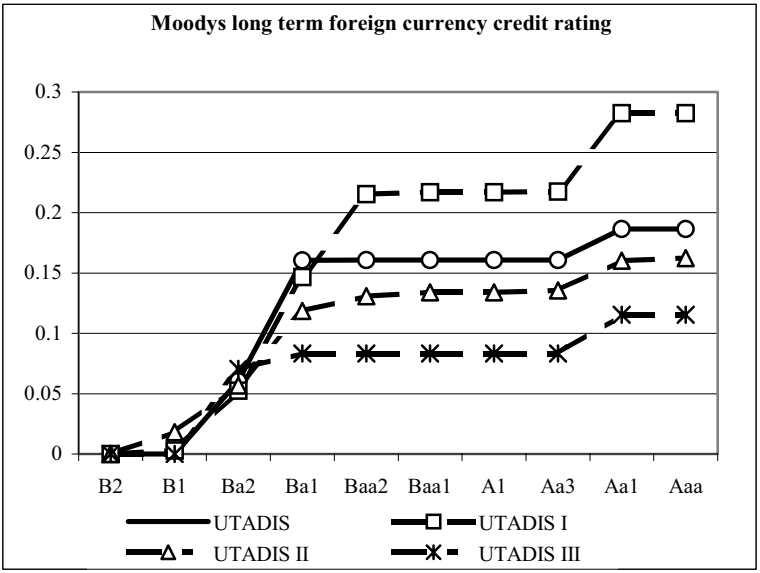


Figure 2. *Marginal utility of Moody's long term foreign currency credit rating for the UTADIS methods*



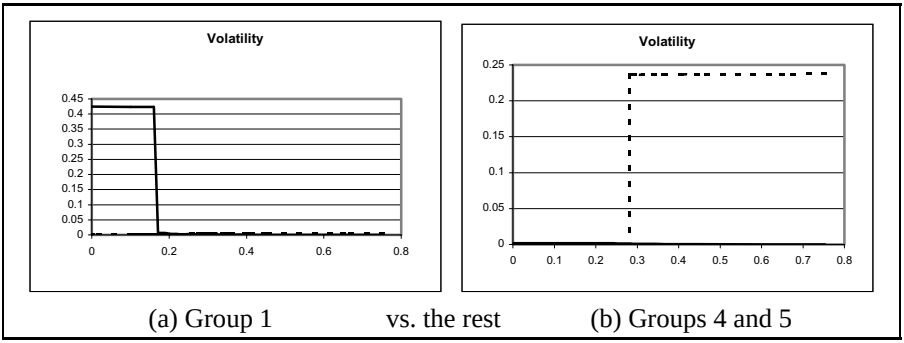
Similar marginal utility graphs for the MHDIS method show clearly its power to discriminate between risk groups according to a criterion, like volatility (Figure 3). The solid line in Figure 3a corresponds to the classification of the countries into group1. The form of the corresponding marginal utility function indicates that countries with low volatility (lower than 0.18) are very likely to be classified into group 1, since in this case their marginal utility increases sharply above 0.4. However, high volatility can not be considered as a general characteristic of the rest of the countries that do not belong into group 1. This is indicated by the form of the marginal utility function represented through the dotted line, which approximates the horizontal axis. Thus, it is possible to conclude that while low volatility is a significant feature of countries belonging into group 1, it does not describe the remaining four groups as a whole. A similar situation is also encountered during the discrimination of countries belonging into group 4 from the countries of group 5, as shown in Figure 3b. The dotted marginal utility function provides a clear indication that high volatility (higher than 0.28) characterizes the countries of group 5, while the same criterion is almost of no importance in describing countries of group 4 (marginal utility function represented through the solid line).

The behavior of other strong discriminating criteria according to the MHDIS method are shown in other graphs:

- Figure 4a-d, discriminating between all groups according to GNP per capita.
- Figure 5, separating group 1 from the rest, based on a dividend yield higher than 0.04, and group 2 from the rest based on a 3-year compound annual return of over 20% (in US $).
- Figure 6a&b, portraying turnover higher than 40 as a good separator of group 2 from 3-5, but weaker (non-step) discrimination among groups 3 and 4-5.
- Figure 7, identifying group 3 from 4-5, by a forward P/E ratio of more than 10, and the year that the stock exchanges were established (stock exchanges established after 1900 imply higher risks, i.e., groups 4 and 5).
- Figure 8, projected GNP growth of less than 0.055, more than 5 total public ADRs, and Moody's long term foreign currency credit rating of 5 (Ba1), discriminate group 4 from group 5.

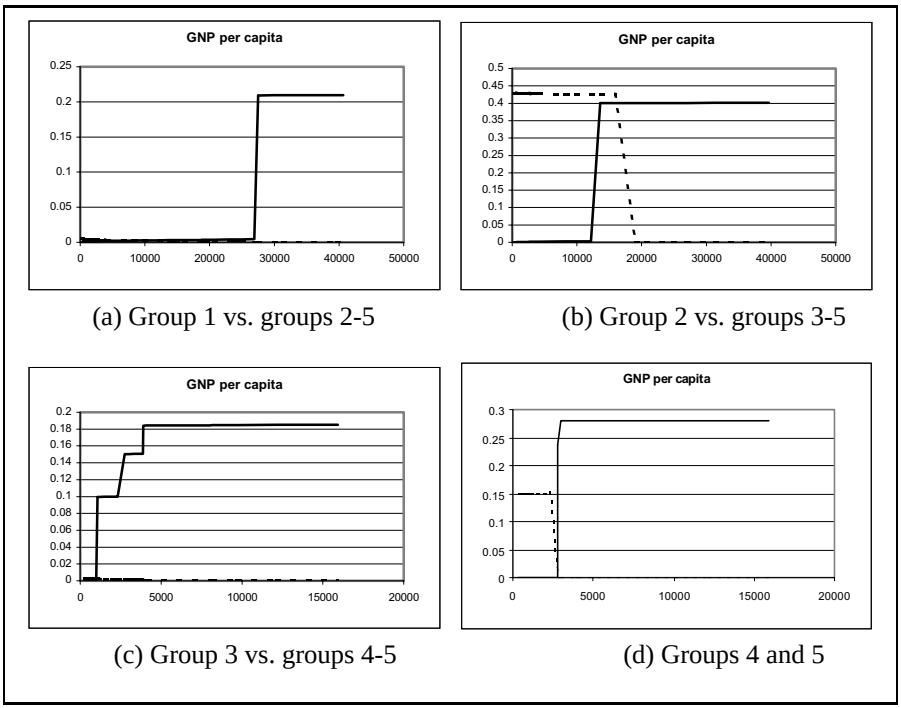
In this way the marginal utility functions developed through the MHDIS method, can help in the determination of the factors (evaluation criteria) that best describe each risk group, as summarized in Table 7.

Figure 3. *Marginal utility of Volatility for the MHDIS method*



(a) Group 1 vs. the rest (b) Groups 4 and 5

Figure 4. *Marginal utility of GNP per capita (MHDIS method)*



(a) Group 1 vs. groups 2-5 (b) Group 2 vs. groups 3-5

(c) Group 3 vs. groups 4-5 (d) Groups 4 and 5

Figure 5. *Marginal utilities for dividend yield and 3-yr compound annual return (MHDIS)*

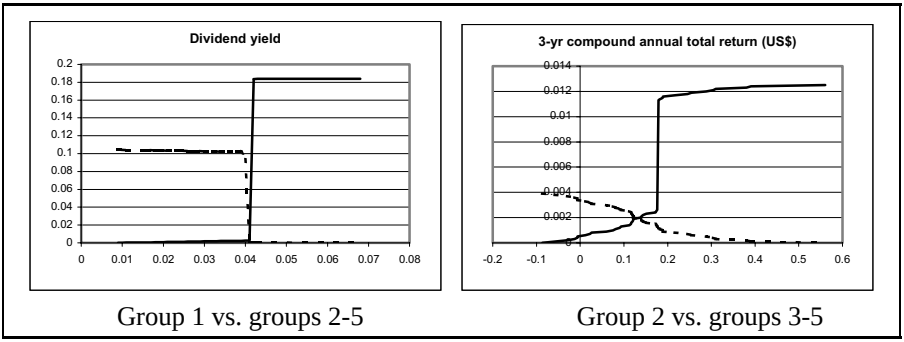


Figure 6. *Marginal utility of Turnover (M.H.DIS)*

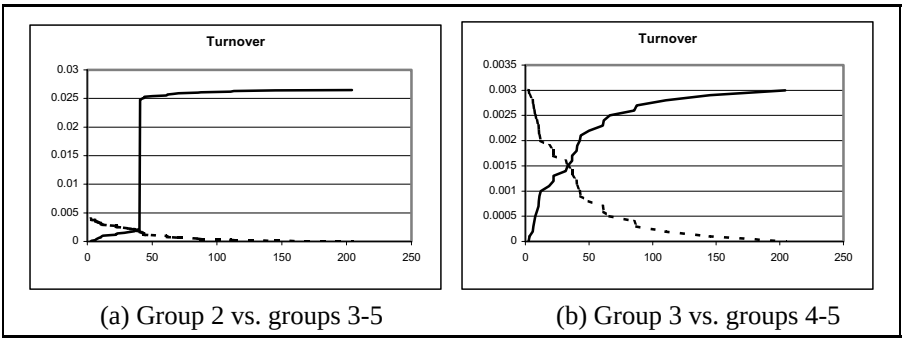


Figure 7. *Marginal utilities of Forward P/E Ratio and Year Stock Exchange (M.H.DIS)*

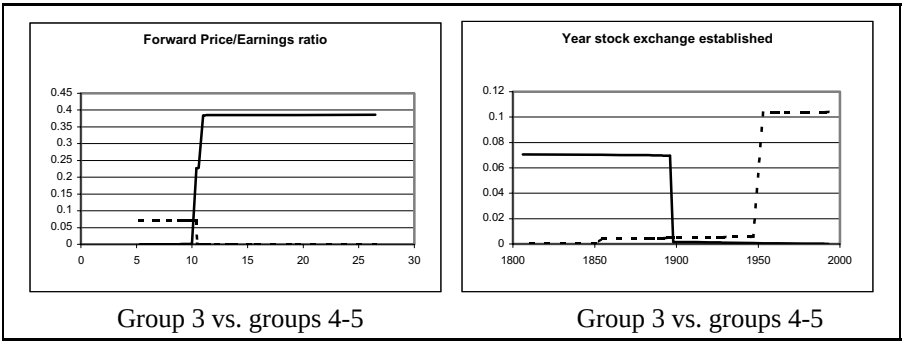


Figure 8. *Marginal utility of Projected GNP Growth, Total Public ADRs and Moody's Foreign Currency Credit Rating (M.H.DIS: Groups 4 and 5)*

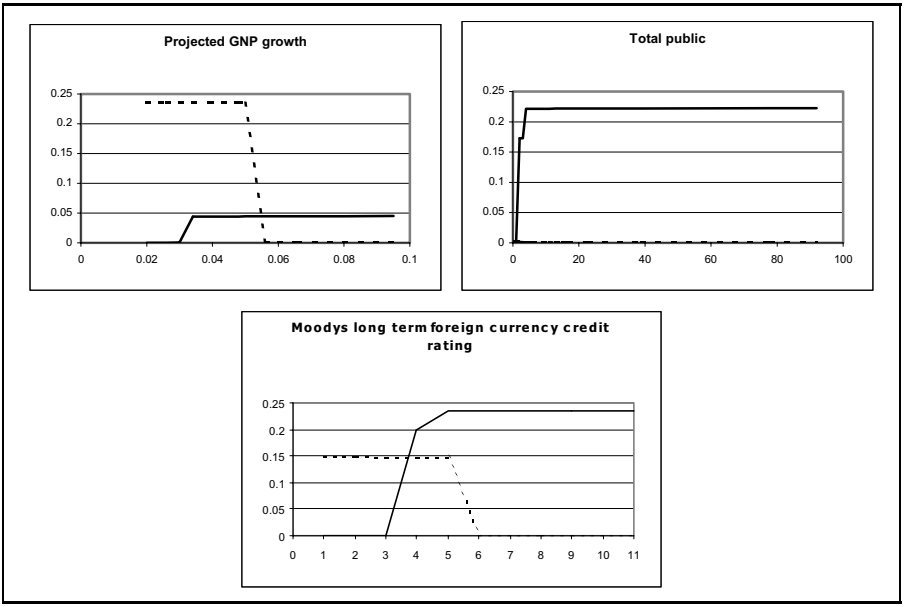


Table 7: *Criteria identifiers of risk groups according to M.H.DIS marginal utilities (complete sample of all countries, missing values estimated by EM)*

No.	CRITERION	Group 1	Group 2	Group 3	Group 4	Group 5
1	**GNP per capita**	***>27,000***	***>17,000***	***>5,000***	***>3,000***	***<3,000***
3	**Projected GNP growth**	(>0.05)	(>0.05)	(>0.05)	>0.05	<0.05
4	**Projected inflation rate**	(<0.06)	(<0.10)	(<0.10)	(<0.10)	(>0.10)
5	**Short term interest rate**	(<0.08)	<0.10	<0.2	(<0.08)	(>0.08)
6	**Market capitalization**	>150,000	>120,000	-	(>20,000)	(<20,000)
7	**Turnover**	>50	***>40***	***>40***	>10	<10
9	**Total public ADRs**	>30	(>20)	(>65)	***>5***	-
11	**3-yr compound annual total return (US $)**	(>0.25)	***>0.20***	(>0.13)	(>0.20)	(<0.20)
13	**Price/earnings ratio**	(>16)	(>15)	(>14)	(>13)	(<13)
14	**Forward price/earnings ratio**	(>13)	(>12)	***>10***	(>8)	<8
16	**Projected earnings**	(<0.15)	(<0.15)	(<0.13)	(<0.19)	(>0.19)
17	**Dividend yield**	***>0.04***	(>0.04)	(>0.04)	(>0.03)	(<0.03)
18	**S&P l.t. foreign currency credit rating**	>6 (BBB+)	>6 (BBB+)	>6 (BBB+)	>5 (BBB)	<5 (BBB)
19	**Moody's l.t. foreign currency credit rate**	>8 (Baa1)	>8 (Baa1)	>6 (Baa3)	***>5 (Ba1)***	***<5 (Ba1)***
20	**Volatility**	***<0.18***	(<0.3)	<0.33	-	>0.28
22	**Settlement efficiency**	(>80)	(>90)	(>70)	(>60)	(<60)
23	**Safekeeping efficiency**	(>90)	(>90)	(>90)	(>90)	(<90)
24	**Operational costs**	<40	(<80)	<70	(<85)	(>85)
27	**Year stock exchange established**	<1860	<1920	***<1900***	<1950	-

( ) : Indicates weaker or gradual discrimination.
Numbers without parenthesis denote stronger or step discrimination.
***Italics**: See figures of marginal utilities*
- : Could not discriminate

The global utilities for each method (with missing values estimated by the EM algorithm) provide a risk group estimate for each country. Countries misclassified from group 1, all to group 2, are New Zealand (by UTADIS, UTADIS I & II) and Sweden (UTADIS, UTADIS II). From group 2 only Belgium is misclassified to group 1 (by UTADIS, UTADIS I & II), and from group 3 only Brazil is misclassified to group 4 (by UTADIS, UTADIS II). From group 4 Sri Lanka is classified incorrectly to group 5 (by UTADIS I), while Taiwan is placed in group 3 by UTADIS and UTADIS I, but elevated to group 2 by UTADIS III (the only two-level misclassification). All UTADIS methods classified properly all countries of group 5. The MHDIS method classified the countries of all groups correctly.

The classification accuracies of all methods, for each missing data imputation approach, are summarized in Tables 8-10. MHDIS is the only method that consis-

tently produces 100% accuracies in classifying correctly all countries with all three imputation approaches. UTADIS III has the same perfect accuracy, except in group 4 where it misclassified only one country when the missing values were imputed using the overall averages and EM algorithm (the misclassified country is Taiwan in both cases). A few more classification results are worth observing from Table 10. UTADIS III' s overall accuracy (98%) is close behind MHDIS, followed by UTADIS II (94%), UTADIS I and UTADIS (both 90%), and DA (82%). It should be noted that earlier experimentation with other (correlated) criteria only increased DA accuracy to 86%. Furthermore, DA was the only method that classified US incorrectly (not in group 1) for all three imputation approaches. It is interesting to observe that whereas UTADIS I and III were least accurate in group 4, UTADIS and UTADIS II were least accurate in groups 1-2 (the latter predicting correctly the other three groups). A two-way ANOVA confirmed significant differences (p-val=0.000) in average accuracy between methods, groups and their interactions. Furthermore, application of all models to classify U.S. is shown at the bottom of Tables 8-10. All UTADIS and MHDIS models classified U.S. correctly into group 1, while DA failed to do so in all cases.

Table 8: *Classification accuracy (%) for complete sample of all countries (missing values estimated by overall average for each criterion)*

		Predicted Group by DA					**Predicted Group by MHDIS**				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
	1	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0
	2	22.2	**77.8**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0
A	**3**	0.0	9.1	**90.9**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0
c	**4**	0.0	9.1	18.2	**72.7**	0.0	0.0	0.0	0.0	**100.0**	0.0
t	**5**	0.0	0.0	0.0	11.1	**88.9**	0.0	0.0	0.0	0.0	**100.0**
u		**Predicted Group by UTADIS**					**Predicted Group by UTADIS I**				
a	**1**	**90.9**	9.1	0.0	0.0	0.0	**90.9**	9.1	0.0	0.0	0.0
l	**2**	11.1	**88.9**	0.0	0.0	0.0	11.1	**88.9**	0.0	0.0	0.0
	3	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**81.8**	18.2	0.0
G	**4**	0.0	0.0	9.1	**90.9**	0.0	0.0	0.0	9.1	**90.9**	0.0
r	**5**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	11.1	**88.9**
o		**Predicted Group by UTADIS II**					**Predicted Group by UTADIS III**				
u	**1**	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0
p	**2**	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0
	3	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0
	4	0.0	9.1	0.0	**90.9**	0.0	0.0	9.1	0.0	**90.9**	0.0
	5	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**

Overall Classification Accuracy:

DA: 86.3%, UTADIS: 94.1%, UTADIS I: 88.2%,
UTADIS II: 98.0%, UTADIS III: 98.0%, MHDIS: 100%

USA predicted group:

DA: 2, UTADIS: 1, UTADIS I: 1, UTADIS II: 1, UTADIS III: 1, MHDIS: 1

Table 9: *Classification accuracy (%) for complete sample of all countries (missing values estimated by group average for each criterion)*

		Predicted Group by DA					Predicted Group by MHDIS				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
	1	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0
	2	22.2	**77.8**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0
A	**3**	0.0	9.1	**90.9**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0
C	**4**	0.0	0.0	18.2	**81.8**	0.0	0.0	0.0	0.0	**100.0**	0.0
T	**5**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**
U		**Predicted Group by UTADIS**					**Predicted Group by UTADIS I**				
A	**1**	**100.0**	0.0	0.0	0.0	0.0	**90.9**	9.1	0.0	0.0	0.0
L	**2**	0.0	**100.0**	0.0	0.0	0.0	11.1	**88.9**	0.0	0.0	0.0
	3	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**90.9**	9.1	0.0
G	**4**	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0
R	**5**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**
O		**Predicted Group by UTADIS II**					**Predicted Group by UTADIS III**				
U	**1**	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0
P	**2**	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0
	3	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0
	4	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0
	5	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**

Overall Classification Accuracy:
DA: 90.2%, UTADIS: 100%, UTADIS I: 94.1%,
UTADIS II: 100%, UTADIS III: 100%, MHDIS: 100%
USA predicted group: *DA: 4, UTADIS: 1, UTADIS I: 1, UTADIS II: 1, UTADIS III: 1, MHDIS: 1*

Table 10: *Classification accuracy (%) for complete sample of all countries (missing values estimated by EM)*

		Predicted Group by DA					Predicted Group by MHDIS				
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
	1	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0
	2	22.2	**77.8**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0
A	**3**	0.0	9.1	**72.7**	18.2	0.0	0.0	0.0	**100.0**	0.0	0.0
c	**4**	0.0	0.0	18.2	**72.7**	9.1	0.0	0.0	0.0	**100.0**	0.0
t	**5**	0.0	0.0	0.0	11.1	**88.9**	0.0	0.0	0.0	0.0	**100.0**
u		**Predicted Group by UTADIS**					**Predicted Group by UTADIS I**				
a	**1**	**81.8**	18.2	0.0	0.0	0.0	**90.9**	9.1	0.0	0.0	0.0
l	**2**	11.1	**88.9**	0.0	0.0	0.0	11.1	**88.9**	0.0	0.0	0.0
	3	0.0	0.0	**90.9**	9.1	0.0	0.0	0.0	**90.9**	9.1	0.0
G	**4**	0.0	0.0	9.1	**90.9**	0.0	0.0	0.0	9.1	**81.8**	9.1
r	**5**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**
o		**Predicted Group by UTADIS II**					**Predicted Group by UTADIS III**				
u	**1**	**81.8**	18.2	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0
p	**2**	11.1	**88.9**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0
	3	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0
	4	0.0	0.0	0.0	**100.0**	0.0	0.0	9.1	0.0	**81.8**	0.0
	5	0.0	0.0	0.0	0.0	**100.0**	0.0	0.0	0.0	0.0	**100.0**

Overall Classification Accuracy:
DA: 82.3%, UTADIS: 90.2%, UTADIS I: 90.2%,
UTADIS II: 94.1%, UTADIS III: 98%, MHDIS: 100%
USA predicted group: *DA: 5, UTADIS: 1, UTADIS I: 1, UTADIS II: 1, UTADIS III: 1, MHDIS: 1*

5. Conclusions

In this paper we developed a framework for rating global investing risk and applied it to a real case. We proposed different methods to analyze this classification problem and applied them to Wall Street Journal data (6/26/1997), in which fifty countries were classified by expert investment managers into five risk categories for global investing, based on twenty seven criteria. Missing data were estimated in three different ways (most appropriately by the EM algorithm). The multicriteria methods consistently outperformed discriminant analysis (DA) in classifying countries into risk categories for global investing. Furthermore, DA is less attractive because it requires restrictive statistical assumptions of multivariate normal distribution with equal covariance matrices and no multicollinearity, which are often violated in financial data (Zanakis and Walter, 1994). Saini and Bates (1984) list additional shortcomings of statistical techniques in the context of country risk analysis, namely definition of dependent variable, model/method selection, forecasting ability and data requirements. Among the six methods examined in this study, only one (MHDIS) classified correctly all countries into the appropriate risk groups. Thus, this model is able to reproduce consistently the risk evaluations of the expert investment managers that took part in the Wall Street Journal survey.

The most important criteria were also identified, that exert major influence on global risk investing. Economic indicators affected risk across groups (MHDIS), depth/liquidity issues played a major role for groups 1, 4 and 5, while regulation/efficiency criteria were dominant mainly in groups 2 and 3. The most influential criteria were Moody's long term foreign currency credit rating (especially for groups 4 and 5), forward price/earnings ratio (mostly group 3), volatility (MHDIS for group 1), GNP per capita (all groups, mostly # 2), operational costs (principally groups 4-5), and age of stock exchange (mainly in groups 2 and 4). The marginal utilities of the criteria helped identify strong and weaker thresholds for each risk group. Finally, the global utility (overall score) for each country represents the strength of its classification into the corresponding risk group.

Care should be exercised in extrapolating our findings due to study limitations beyond our control. We analyzed information obtained by the Wall Street Journal (countries, criteria and experts). There is no reason to doubt the validity of this information or the Journal's knowledge to identify the experts (although the basis for selecting these experts was not disclosed). Our models should be viewed as explanatory rather than predictive. The small number of countries in each category (9-11) precluded any meaningful model validation. Partitioning them randomly into a learning and holdout sample would make either sample or both too small for satisfactory model development *and* testing. However, these data are available to other researchers interested in similar or different types of analyses.

The value of models like the ones developed here is that they can lead to real time investment decision support systems, such as the FINEVA and FINCLAS systems developed for credit risk assessment (Zopounidis et al., 1996; Zopounidis and Doumpos, 1998). They could assess investing risk in one of

these countries in the future or under different circumstances, or even in a country other than those considered in this case study. Furthermore, the encouraging results of the MHDIS and UTADIS preference disaggregation methods in this study offer promising avenues for assessing country risk, credit scoring, bankruptcies and other real-world sorting and classification problems.

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