Computers & Operations Research 36 (2009) 3187–3203

Contents lists available at ScienceDirect

Computers & Operations Research

journal homepage: www.elsevier.com/locate/cor

A multicriteria methodology for equity selection using financial analysis

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ARTICLE INFO

Available online 27 February 2009

Keywords:
Multiple criteria decision making
Equity portfolio selection
Financial analysis

ABSTRACT

In this article we present a multiple criteria methodology for supporting decisions that concern the selection of equities, on the basis of financial analysis. The ELECTRE Tri outranking classification method is employed for selecting the attractivex equities, through the evaluation of the overall corporate performance of the corresponding firms. The crucial importance issue of the industry/sectoral accounting particularities was strongly taken into account. An elaborate review of coherent research studies is also provided. Finally, the validity of the proposed methodology is tested through a large scale application on the Athens Stock Exchange.

1. Introduction

Multiple criteria decision making (MCDM) approaches are well suited for the study of several financial decision-making problems. The diversified nature of the factors (evaluation criteria, objectives and goals) that affect financial decisions, the complexity of the financial, business and economic environments, the subjective nature of many financial decisions, are only some of the features of financial decisions which are in accordance with the MCDM modeling framework. Portfolio selection and management constitutes one of the most significant domains of financial decision making.

The problem of portfolio selection involves the construction of a portfolio of equities (or securities from other asset classes) that maximizes the investor's utility. The process leading to the construction of such portfolios constitute of two major phases [21]. In the first phase of the process, the decision maker (DM), a private or an institutional investor, has to evaluate and select the equities that are available as investment opportunities. The vast amount of equities traded in international stock markets make this step necessary, in order to focus the analysis on a limited number of the best investment choices. In the second phase of the process, the DM has to decide on the amount of capital that should be invested in each of the selected stocks, thus constructing a portfolio of the selected equities.

In this article the emphasis is laid on the first stage of the above mentioned process and we focus on the security analysis and evaluation phase. We develop a multicriteria methodology for equity selection exploiting the valuable tool of financial analysis (FA), which is the most appropriate evaluation approach regarding investment decisions within a long-term horizon. FA involves the identification of the strengths and weaknesses of firms, mainly through judgemental procedures concerning the qualitative evaluation and interpretation of financial ratios, as these arise from the accounting statements. Moreover, FA can be viewed as the activity of providing inputs to the portfolio construction phase, since it entails the process of analyzing the special characteristics of securities and corresponding firms, leading to final selection recommendations. The paper proceeds as follows: In Section 2 we set the problem and we provide an elaborate review and methodological classification of the corresponding research studies. In Section 3 we present the proposed methodological framework for the equity selection problem. In Section 4 we present an illustrative application from the Athens Stock Exchange (ASE), along with the corresponding results. Finally, the concluding remarks are given in Section 5.

2. Problem setting and review

The portfolio management process is an integrated set of steps undertaken in a consistent manner to create and maintain an appropriate portfolio (combination of assets) to meet clients' stated goals [30]. The three fundamental steps that form the basis for the portfolio management process are: planning, execution and feedback. In the planning step, investment objectives and policies are formulated, capital market expectations are formed and strategic asset allocations are established. In the execution step, the manager constructs the portfolio and integrates investment strategies with capital market expectations to select the specific assets for the portfolio. Finally, in the feedback step, the manager monitors and evaluates the portfolio compared with the plan. Under the same rationale, Spronk

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doi:10.1016/j.cor.2009.02.009

and Hallerbach [59] decompose the investment decision process in the following stages: (a) security analysis to determine the relevant characteristics (or attributes) of the investment opportunities, (b) portfolio analysis to delineate the set of non-dominated or efficient portfolios, (c) portfolio selection to choose the optimal portfolio from the efficient set and (d) preference analysis.

Since the pioneering work of Markowitz [35,36] in the theory of portfolio analysis, based on the mean–variance formulation, several portfolio selection models have been proposed. In the basis of the Markowitz mean–variance formulation, many researchers developed miscellaneous new methodologies. Elton et al. [13] provide a complete overview as far as these methodologies is concerned. Pardalos et al. [43] also provide a review and some computational results of the use of optimization models for portfolio selection.

In recent years, the development of new techniques in operations research and management science, as well as the progress in computer and information technologies gave rise to new approaches for modeling the portfolio selection problem. Several authors utilize MCDM methodologies for portfolio selection. The multidimensional nature of the problem has been emphasized by researchers in finance, as well as by MCDM researchers [19–21,24,62–66,77,83]. In the above studies, elaborate and exhausted justifications are provided for modeling portfolio management problems within the MCDM frame. Indeed, the MCDM framework provides the sound methodological basis to resolve the inherent multicriteria nature of portfolio selection problem. Additionally, it builds realistic models by taking into account, apart of the two basic criteria of return and risk, a number of important other criteria. Furthermore, MCDM have the advantage of taking into account the preferences of any particular investor.

As it has already been mentioned, the portfolio selection problem can be realized as a two-stage process [20,21]: (a) evaluation of the available securities to select the ones that best meet the investor's preferences and (b) specification of the amount of capital to be invested in each of the securities selected in the first stage. As far as the first stage of this multidimensional context is concerned, the MCDM paradigm provides a plethora of appropriate methodologies to support the evaluation of the available securities. The issue of security evaluation has been studied by MCDM researchers using discrete evaluation methods (outranking relations, multi-attribute utility theory (MAUT), preference dissagregation analysis, rough sets, etc.). Studies conducted on this topic have focused on the modeling and representation of the investor's policy, goals and objectives in a mathematical model. The model aggregates all the pertinent factors describing the performance of the securities and provides their overall evaluation. The securities with the higher overall evaluation are selected for participating the next phase of the process (portfolio construction).

Within this frame, FA can be utilized for selecting attractive equities by means of evaluating the overall corporate performance of the corresponding firms, see [12,51]. The evaluation of performance of corporate entities and organizations is an important activity for their management and shareholders as well as for investors and policy makers. Such an evaluation provides the management and shareholders with a tool to assess the strengths and weaknesses of the firm, as well as its competitive advantages over its competitors, thus providing guidance on the choice of the measures that need to be taken to overcome existing problems. Investors (institutional and individual) are interested in the assessment of corporate performance for guidance to their investment decisions, while policy makers may use such an assessment to identify the existing problems in the business environment and take measures that will ensure a sustainable economic growth and social stability. The performance of a firm or an organization is clearly multidimensional, since it is affected by a variety of factors of different nature, such as: (a) financial factors indicating the financial position of the firm/organization, (b) strategic factors of qualitative nature that define the internal operation of the firm and its relation to the market (organization, management, market trend, etc.) and (c) economic factors that define the economic and business environment.

The aggregation of all these factors into a global evaluation index is a subjective process that depends on the DM's values and judgement policy. These findings are in full accordance with the MCDM paradigm, thus leading several operational researchers to the investigation of the capabilities that the MCDM methods provide, regarding the problems of corporate performance evaluation and equity selection. A review of some of the most important studies in the field now follows.

Srinivasan and Ruparel [87] propose the CGX multicriteria intelligent decision support system (DSS) for dealing with credit-granting problems. The credit-granting decision process which is modeled through the analytic hierarchy process (AHP) [50] multicriteria method, aims at deriving the perceived probabilities of default and payment of the loan. The evaluation criteria include both financial ratios (debt capacity ratios, profitability ratios, liquidity ratios, etc.), as well as qualitative criteria (customer background, pay record, geographical location, business potential, etc.).

Diakoulaki et al. [11] utilize the results of the analysis of a MAUT [26], applied to a large sample of Greek pharmaceutical companies, in order to indicate how suitable some common financial ratios are as indices of the firm's overall performance. The results showed that profitability constitutes the most representative measure for the differentiation and ranking of companies. Besides, a sound capital structure is a necessary but not a sufficient condition to ensure the profitable and effective operation of the firm.

Mareschal and Brans [31] present the BANKADVISER, a multicriteria industrial evaluation system, which provides evaluations of individual items such as firms, industries, companies, and industrial clients. The evaluation procedure employs the PROMETHEE [4] method and is based on financial data from each firm's financial statements. The system's aim is to allow the user for managing data about the clients, analyzing their economic profile, detecting their strong and weak features and evaluating any risk associated with them.

Siskos et al. [57] present an integrated DSS for the analysis and financing of firms by an industrial development bank in Greece. Firstly, the system evaluates the financial performance of firms (financial ratios of profitability, managerial performance and solvency) during a 5-year period and allows inferences about their development tendencies. Furthermore, multivariate statistical techniques are available to aid in the identification of the most significant financial ratios and grouping of the firms in coherent categories. Finally, the UTA [23] multicriteria method is used, which ranks the firms from the most solvent to the bankrupt and in this way support the bank to select the less risky for financing.

Zopounidis et al. [85] present the FINEVA multicriteria knowledge-based DSS for the assessment of corporate performance and viability. The FINEVA system consists of an expert system part that offers an initial financial and qualitative evaluation of firms, a principal components analysis part for the identification of the most significant financial ratios, and the multicriteria method UTASTAR [56] combining the results of the expert system and the principal components analysis, providing the final evaluation of firms.

Babic and Plazibat [1] are dealing with the ranking of enterprises according to the achieved level of business efficiency using the PROMETHEE and the AHP methods. The PROMETHEE method is used for final ranking and the AHP to determine the importance of criteria. The main purpose of this work is to present the methodology which at every moment can answer the question about financial standing of a particular enterprise.

Table 1
Applications of MCDM approaches in the assessment of corporate performance.

Methods	Studies	Type of organization
Reviews	Spronk et al. [60]	
	Steuer and Na [61]	
	Zopounidis and Doumpos [83]	
	Zopounidis [77]	
AHP	Lee et al. [28]	Firms
	Jablonski [22]	Firms
MAUT	Yeh et al. [71]	Firms
	Baourakis et al. [2]	Firms
	Diakoulaki et al. [11]	Firms
PROMETHEE	Zmitri et al. [76]	Banks
	Pardalos et al. [42]	Insurances
	Mareschal and Mertens [32,34]	Insurances/banks
UTA	Zopounidis et al. [78]	Banks
	Siskos and Zopounidis [54]	Firms
UTASTAR	Zopounidis et al. [85]	Firms
UTADIS	Kosmidou et al. [27]	Banks
	Spathis et al. [58]	Banks
	Zopounidis and Doumpos [79,82]	Firms
	Voulgaris et al. [68]	Firms
	Michalopoulos et al. [38]	Banks
Combinations of MCDA methods	Babic and Plazibat [1]	Firms
	Colson and Mbangala [6]	Firms

Table 2
MCDSS in the assessment of corporate performance.

Methods	Studies	Type of organization
Reviews	Zopounidis and Doumpos [80,81]	
	Siskos and Spyridakos [55]	
	Zopounidis et al. [84]	
ELECTRE/PROMETHE	Caloghirou et al. [5]	Firms
	Mareschal and Mertens [33]	Banks
	Mareschal and Brans [31]	Firms
UTA	Siskos et al. [57]	Firms
	Zopounidis et al. [86]	Firms
	Siskos and Zopounidis [54]	Firms
	Siskos [53]	Firms
UTASTAR	Zopounidis et al. [85]	Firms
UTADIS	Zopounidis and Doumpos [79,80,81,82]	Firms
Intelligent MCDDS	Matsatsinis et al. [37]	Firms
	Zopounidis et al. [85]	Firms
	Hartvigsen [16]	Firms

Zopounidis and Doumpos [82] propose an alternative approach to the classical statistical methodologies that have been extensively used for the study of financial classification problems. More specifically, they present the FINancial CLASsification (FINCLAS) multicriteria DSS, which utilizes the UTADIS [10] method for assessing the corporate performance and viability of firms. The system incorporates a plethora of financial modeling tools, along with powerful preference disaggregation methods that lead to the development of additive utility models for the classification of the considered alternatives into predefined classes.

Samaras and Matsatsinis [88] propose the Intelligent INVESTOR, an intelligent multicriteria DSS which aims at offering an overall consideration of the portfolio management problem. The system incorporates all the advanced portfolio management tools, such as fundamental analysis, technical analysis, market psychology, and uses both multicriteria analysis methods and rule-based expert systems technology.

Samaras et al. [51] present a multicriteria methodology and the corresponding DSS for the evaluation of stocks from the ASE. The methodology is based on fundamental analysis ratios and utilizes the UTASTAR method in order to rank the stocks from best to worst, taking into account the potential investor's attitude towards risk. The system, which is intended for both institutional and private investors, incorporates a large volume of relevant information and operates in real world conditions, since its data are constantly updated.

An indicative list of articles on the topic is given in Tables 1 and 2. The categorization we adopt here contains:

a. Articles that are classified according its specific methodological approach and the organizational type that is evaluated (this category includes review pieces). The methodological approaches we discern here are: AHP, MAUT, PROMETHEE, UTA, UTASTAR, UTADIS and combinations of MCDM methods (i.e. methodologies in which more than one multicriteria techniques are used), and
b. Articles that present multicriteria decision support systems (MCDSS) within the field of corporate performance evaluation.

3. Proposed methodology

3.1. General description

The aim of the proposed methodology [70] is the selection of equities which reflect to firms characterized by significant financial strength. The approach developed utilizes for this purpose the valuable tool of FA. Within this frame, FA is employed for selecting competitive equities, through the appraisal of the overall corporate performance of the corresponding firms.

One of the methodology's main features is that the firms participate in the evaluation process are categorized in classes (eight classes in total are defined), with respect to their corresponding industry. The ELECTRE Tri multicriteria method is then applied separately, in each one of these classes and finally, the partial results are integrated, considering also the major issue of time trend. The crucial importance issue of the industry/sectoral accounting particularities is strongly taken into account. Every sorting result that the methodology provides has special structure and is based on a specific criteria set (four sets of criteria were constructed in total), which is related to the specific business activity of the firm and also corresponds to the specific accounting plan each company belongs in. This means that there is no uniform sorting of stocks, but specialized sortings per industry. In this way, the huge issue of competition between rival firms is fully taken into consideration, while unreasonable comparisons between them are excluded.

According to Mousseau et al. [40], the ELECTRE Tri method is used in ordered multiple criteria sorting problems for assigning alternatives to predefined categories, by comparing each alternative with the profiles defining the limits of the categories and by exploiting a

preference model of the DM informing on weights and thresholds of criteria. The three categories that are predefined in the current study, i.e. the category of acceptable stocks, the category of stocks to be studied further and the category of unacceptable stocks, allow for a rather satisfactory modeling of the equity selection problem. In Section 3.3 an extended analysis regarding the rationale of choosing the ELECTRE Tri method is provided.

Finally, it has to be mentioned that the proposed methodology was applied in strong cooperation with a panel of experts, financial analysts and portfolio managers. Their contribution was of catalytic impact, in all stages of collaboration: (a) classification of alternatives, (b) construction of criteria sets, (c) application of the 'resistance to change grid' weighting method, (d) determination of categories profiles and thresholds and (e) validation of results. During all the phases of the study, the experts were fully assisted by the authors, as far as the intuitive explanation of the selected multicriteria method's technical aspects and details. As it will be noticed in Section 3.4, the authors in the current case, carried out the role of the 'analyst' or 'fascilitator' in the decision aiding process [49].

The logical diagram of the proposed methodology is graphically depicted in Fig. 1.

A short, step-by-step, description of how the proposed methodology can be applied to the problem of equity selection is now provided:

Step 1. Apply the ELECTRE Tri method to each of the eight defined classes of firms.
Step 2. For each one of the eight sortings, take the overlap of assignment procedures, for each one of categories.
Step 3a. Equities of firms that have been classified in category C_2 in both the optimistic and pessimistic assignment procedures are not proposed for selection (C_2 consists of equities which reflect to firms with medium financial performance, see Section 3.8 for details).
Step 3b. Equities of firms that have been classified in category C_1 in both the optimistic and pessimistic assignment are not proposed for selection (C_1 consists of equities which reflect to firms with bad financial performance, see Section 3.8 for details).
Step 3c. Equities of firms that have been classified in different categories under the two types of assignment are not proposed for selection.
Step 4. Equities of firms that have been classified in category C_3 in both the optimistic and pessimistic assignment are eligible for selection (C_3 consists of equities which reflect to firms with excellent financial performance, see Section 3.8 for details).
Step 5. Apply Steps 1–4 for all years.
Step 6. For each class, take the overlap of those equities of firms that have been classified in category C_3 (in both the optimistic and pessimistic assignment), in at least two out of the three years of the study period. The financial aspect behind this allegation has to do with the fact that, we allow for a firm to perform non-satisfactory financial results, only once within the time period of study (three consecutive years).
Step 7. The final set of equities resulted after applying the Steps 1–6 contains the securities that are proposed to the DM for selection.

In the following paragraphs, all the key-characteristics of the proposed methodology are analyzed in detail.

3.2. The ELECTRE Tri method

The family of ELECTRE methods has been initially introduced by Roy [48], through the development of the ELECTRE I method, the first method to employ the outranking relation concept. Since then several extensions have been proposed, including ELECTRE II, III, IV, IS and Tri [49]. These methods address different types of problems, including choice (ELECTRE I, IS), ranking (ELECTRE II, III, IV) and sorting/classification (ELECTRE Tri). For an excellent and elaborate presentation of the ELECTRE family methods see Rogers et al. [47].

ELECTRE Tri [72], more specifically, is a multiple criteria assignment method, which assigns project options to predefined categories. The assignment of an option α results from a comparison of α with the profiles defining the limits of the categories. Assume F denotes the set of indices of the profiles of the criteria $g_1, g_2, \ldots, g_m$, ($F = \{1, 2, \ldots, m\}$), and B the set of indices of the profiles defining p+1 categories, ($B = \{1, 2, \ldots, p\}$), b_n being the upper limit of category C_h and the lower limit of the category C_{h+1}, $h = 1, 2, \ldots, p$. It is assumed that criteria are monotonically increasing, with preference increasing with increasing criterion value.

3.2.1. Building the outranking relation

ELECTRE Tri builds an outranking relation S which confirms or rejects the assertion aSb_h which implies 'a is at least as good as the reference option b_h'. As with ELECTRE III and IV, preferences are defined through pseudo-criteria. The indifference and preference thresholds ($q_j(b_h)$ and $p_j(b_h)$) constitute the intra-criterion preferential information, and reflect the imprecise nature of the valuations $g_j(a)$. $q_j(b_h)$ specifies the largest difference $g_j(a) - g_j(b_h)$ that preserves indifference between α and b_h on the criterion g_j; $p_j(b_h)$ represents the smallest difference $g_j(a) - g_j(b_h)$ compatible with a preference in favor of α on criterion g_j.

In order to confirm the statement aSb_h, two conditions must be complied with:

- Concordance: for the outranking of b_h by α to be accepted, a sufficient majority of criteria should be in favor of this assertion.
- Non-discordance: when the concordance condition holds, none of the criteria in the minority should oppose the assertion aSb_h in too strong a manner.

The following two inter-criterion parameters are utilized in the construction of the outranking relation S:

- The set of the criterion weightings $(k_1, k_2, \ldots, k_m)$ is used as part of the calculation of concordance through computation of the relative importance of the coalition of criteria supporting the assertion that α outranks b_h.
- The set of veto thresholds $(v_1(b_h), v_2(b_h), \ldots, v_m(b_h))$ is used in the discordance test, representing the smallest difference, which will veto or counteract the outranking of α by b_h.

ELECTRE-Tri builds an index $\sigma(a, b_h) \in [0, 1]$ that represents the degree of credibility of the assertion that α outranks $b_h, \forall a \in A, \forall h \in B$. The assertion aSb_h is considered to be valid if $\sigma(a, b_h) \geqslant \lambda$, where λ is a 'cut-off threshold', such that $\lambda \in [0.5, 1]$.

$\sigma(a, b_h)$ is estimated as follows:

A. Compute the partial concordance index $c_j(a, b_h), \forall j \in F$:

$$c_j(a, b_h) = 0, \quad \text{if } g_j(b_h) - g_j(a) \geqslant p_j(b_h)$$

$$c_j(a, b_h) = 1, \quad \text{if } g_j(b_h) - g_j(a) \leqslant q_j(b_h)$$

$$c_j(a, b_h) = (p_j(b_h) + g_j(a) - g_j(b_h))/(p_j(b_h) - q_j(b_h))$$

otherwise

B. Compute the overall concordance index

$$c(a, b_h) = \sum_{j \in F} k_j c_j(a, b_h) \Big/ \sum_{j \in F} k_j$$

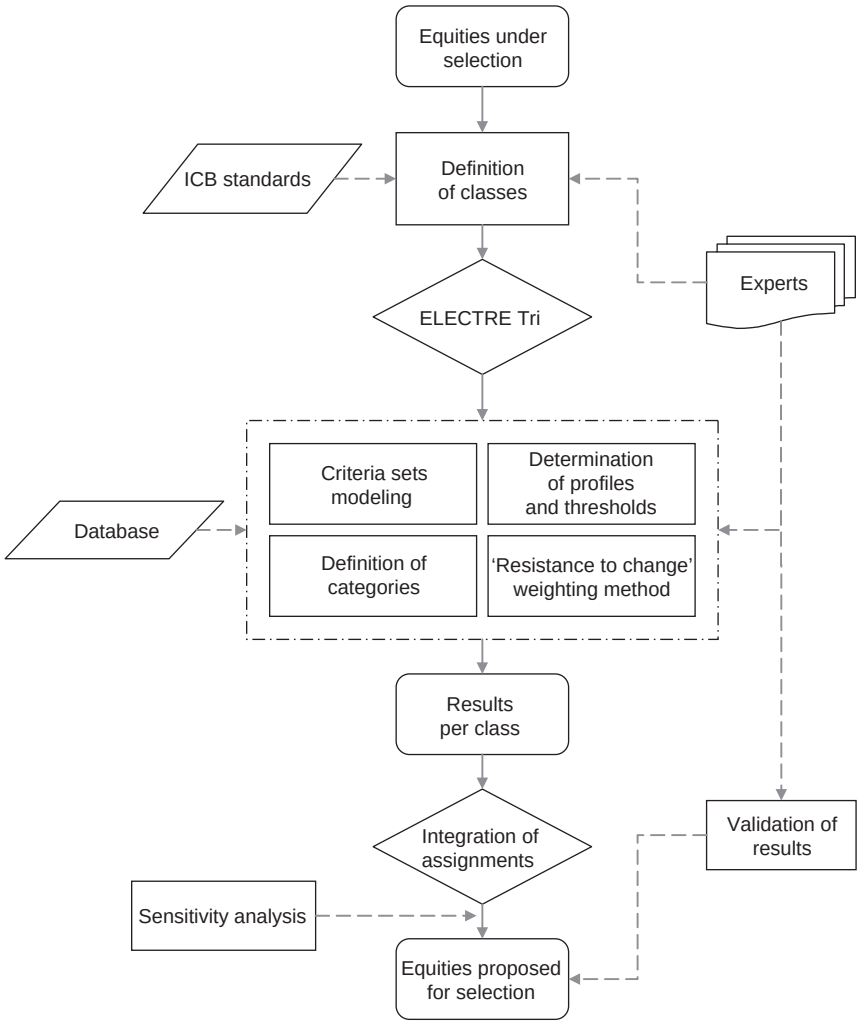

Fig. 1. Logical diagram of the proposed methodology.

C. Compute the discordance indices

$d_j(a,b_h)=0$, if $g_j(a)\leqslant g_j(b_h)+p_j(b_h)$

$d_j(a,b_h)=1$, if $g_j(a)>g_j(b_h)+v_j(b_h)$ otherwise

$d_j(a,b_h)\in[0,1]$

D. Compute the credibility index

$$\sigma(a,b_h)=c(a,b_h)\prod_{j\in\overline{F}}\frac{1-d_j(a,b_h)}{1-c(a,b_h)} \text{ where}$$

$\overline{F}=\{j\in F: d_j(a,b_h)>c(a,b_h)\}$

3.2.2. Exploiting the outranking relation

The values of $\sigma(a,b_h)$, $\sigma(b_h,a)$ and λ determine the preference situation between α and b_h:

- $\sigma(a,b_h)\geqslant\lambda$ and $(b_h,a)\geqslant\lambda$
  $\Rightarrow aSb_h$ and $b_hS_a\Rightarrow aIb_h$, i.e. a is indifferent to b_h
- $\sigma(a,b_h)\geqslant\lambda$ and $\sigma(b_h,a)<\lambda$
  $\Rightarrow aSb_h$ and not $b_hSa\Rightarrow aIb_h$
  $\Rightarrow a>b_h$, i.e. a is preferred to b_h (weakly or strongly)
- $\sigma(a,b_h)<\lambda$ and $\sigma(b_h,a)\geqslant\lambda$
  $\Rightarrow$ not aSb_h and b_hSa
  $\Rightarrow b_h>a$, i.e. b_h is preferred to a (a weakly or strongly)
- $\sigma(a,b_h)<\lambda$ and $\sigma(b_h,a)<\lambda$
  $\Rightarrow$ not aSb_h and not b_hSa
  $\Rightarrow aIb_h\Rightarrow aRb_h$, i.e. a incomparable to b_h

Two assignment procedures are then available.
Pessimistic procedure:

A. Compare α successfully to b_i, for $i=p,p-1,\ldots,0$,
B. b_h being the first profile such that aSb_h,
C. Assign α to category $C_{h+1}(a\rightarrow C_{h+1})$.

The direction of the ranking obtained from the pessimistic procedure is from best to worst.

Optimistic procedure:

D. Compare α successfully to b_i, for $i=1,2,\ldots,p$,
E. b_h being the first profile such that $b_h>a$,
F. Assign α to category $C_h(a\rightarrow C_h)$.

In this case, the direction of the ranking obtained goes from worst to best.

In order to summarize the results from the two procedures, a table can be constructed in which the options are referred to in terms of the categories to which they are assigned by the two procedures.

Whatever assignment procedure is utilized, the following seven requirements must be met:

- No option can be indifferent to more than one reference option.
- Each option must be assigned to one reference category only (uniqueness/unicity).
- The assignment of any one option to its allotted category is not dependent on the assignment of any of the other options (independence).
- The procedure for assigning options to categories must be entirely consistent with the design of the reference options themselves (conformity).
- When two options have the same outranking relationship with a given reference option, they must be assigned to the same category (homogeneity).
- If option α' outranks α, then α' must be assigned to a category at least as good as the one to which α is assigned (monotonicity).
- The grouping together of two neighboring categories must not cause the alteration of options to categories not affected by the alteration (stability).

3.3. Reasons for employing the ELECTRE Tri method

The ELECTRE Tri method incorporates two interesting modeling capabilities: the notion of incomparability and the potential of obtaining two assignment procedures, one optimistic and one pessimistic.

In the classical preference structures, such as the utility functions approach, it is supposed that pairwise comparisons between all the alternatives can be obtained. However, certain situations such as multidimensional and conflicting preferences of the DM, uncertainty and ambiguity or cases where alternatives have very satisfactory values for some criteria and simultaneously very poor values for other, can create incomparabilities [89]. In the case of the ELECTRE Tri method, the notion of incomparability refers to cases where some alternatives belong to different categories within the two assignment procedures, i.e. they are incomparable with one or more reference profiles [47,49]. In other words the incomparability prevents from unrealistic and mandatory comparisons between alternatives.

The ELECTRE Tri method manages incomparability between alternatives in such a way that it will point out those having particularities in their evaluation and for this reason must be examined with further attention. This is a matter of crucial importance within the problem of equity selection [20] and is resolved through the exploitation of the two assignment procedures: its results are compared and important information is elicited for the DM. A better view of the exploitation of the incomparability notion in the current study is given in Section 3.8, where the interpretation of the results is introduced. According to the analysis provided, the corresponding equities of firms that have been classified in different categories under the two types of assignment procedures are not proposed for selection to the DM.

The choice of the ELECTRE Tri methods is also based on its quite extend applicability, regarding problems of modern financial decision making. In the studies of Zopounidis [77], Zopounidis and Doumpos [83], Spronk et al. [60] and Xidonas and Psarras [69] a great number of financial applications within the frame of the outranking relations theory is recorded.

The final reason for utilizing a member of the ELECTRE family methods in the current study has to do with the fact that these methods are easy to perceive by the DM. When an intuitive explanation of the method's technical aspects and details was provided to the experts participated in the study, they expressed their satisfaction regarding its effectiveness, while they characterized it as a quite interesting decision support tool.

However, it has to be stressed at this point that the ELECTRE family methods have a certain difficulty in their use, which require careful manipulations by all the people involved in the decision-making process. As in all the outranking methods, a phase of critical significance is the one related to the proper assignment of parameters, such as the indifference, preference and veto thresholds, in order to reflect the real preferences of the DM. Improper determination of these parameters may lead to inconsistent results that actually do not reflect the DM's preference system. Regarding the proposed methodology, as it will be pointed out in Section 3.8, this certain predicament is addressed by exploiting the experts' valuable experience in security analysis, along with a plethora of statistical data concerning the alternative securities, that were provided by a leading provider of financial and business information in Greece.

3.4. Actors involved in the decision-making process

Decisions are rarely made by a single individual. Even if responsibility for the decision does ultimately rest with a well-identified individual, the decision will generally will be the product of an interaction between this individual's preferences and those of others. Indeed, in many cases, the final decision might not be the responsibility of or influenced by single individuals. It could involve entities, i.e. an elected or appointed body, or a board of directors. It could also involve a group (community) with less than well defined boundaries, i.e. a professional lobby. These actors (individuals, entities, communities) are what we shall call stakeholders, in that they have an important interest in the decision and will intervene to directly affect it through the value systems they possess. Additionally, there are those who do not actively participate in shaping the decision, but who are affected by its consequences and whose preferences must be considered when arriving at a decision (third parties).

The various stakeholders within a decision process might be relatively diverse, having different objectives and conflicting value systems. Therefore, a specific application of decision aiding will rarely be comprehensive enough to benefit all of them. For this reason, decision aiding will almost always require that a particular stakeholder is identified (DM). Identifying a DM entails specifying the objectives under which he operates. Very often, the DM may not have the background to perform the decision aid. In this case, the one performing the aid (analyst or facilitator) is, therefore, generally different from the DM [49].

In the application that is presented afterwards and illustrates the proposed methodology, no real DM, a private or an institutional investor, is involved. The role of the DM was undertaken by the experts who effectively cooperated during both the development and validation of the proposed methodology (see Section 3.1).

3.5. Alternatives

A rather critical issue that the proposed methodology resolves has to do with the fact that provides the flexibility of simultaneously evaluating a significantly large number of firms (alternatives) from a very wide range of business activities.

The methodology's key-characteristic which allows for this convenience is that the firms participate in the evaluation process are categorized in classes, with respect to their corresponding industry. The ASE follows the Industry Classification Benchmark (ICB) standards (www.icbenchmark.com) and in general, this was the pattern adopted for the definition of the classes. As shown in Table 3, the proposed methodology categorizes the firms of the ASE in eight classes.

Table 3
Definition of classes.

Class	Industry	Supersector
a	Consumer goods	Food and beverage Personal and household goods
b	Industrials	Construction and materials Industrial goods and services
c	Technology Telecommunications	Technology Telecommunications
d	Basic materials	Chemicals Basic resources
	Oil and gas	Oil and gas
e	Consumer services	Retail Media Travel and leisure
	Utilities	Utilities
	Health care	Health care
f	Financials	Financial services
g	Financials	Banks
h	Financials	Insurances

This means that the ELECTRE Tri method is applied, separately, in each one of these classes.

It has to be mentioned that the only deviation from the ICB standards, as far as the definition of the classes, had to do with the fact that the number of firms in some industries was fairly low. The rationale adopted in this point is the one that suggests the integration and merger of coherent and contextual industries. For example (see also Table 15), the industry of 'Telecommunications' (3 firms) was embodied in the highly related industry of 'Technology' (22 firms) in order to constitute the unified Class *c*. Under the same rationale, Class *d* consists of the firms belong to industries of 'Basic materials' (25 firms) and 'Oil and gas' (3 firms).

The reason for defining different classes of firms is related to the need of acquiring fair, objective and representative evaluation results, within the frame of comparing alternatives with similar characteristics, i.e. firms with relative business activities. Utilizing this approach, the crucial issue of competition between rival firms is strongly taken into account. Besides, unrealistic and inconsistent comparisons are avoided, i.e. comparing a bank institution to a consumer goods company.

3.6. Criteria modeling

As it has already been stressed, the proposed methodology was developed in strong cooperation with a panel of experts. Their contribution in the identification of the criteria (financial ratios) that are the most appropriate to use in the evaluation of corporate performance was valuable. After a detailed review of the international literature [3,9,12,14,15,18,29,41,44,67], an initial set of financial ratios was chosen, on the basis of their popularity and relevance to the assessment of corporate performance and viability, within the frame of the equity portfolio selection problem. Then, in a series of meetings with the experts, some additional financial ratios were proposed, while some others where considered as not necessary.

With the agreement of all the experts, four sets of financial ratios were constructed, to be used for the assessment of corporate performance (see Tables 4–7). Each criterion set is related to a different type of a generic firm activity. On this basis, the four criteria sets that constructed focus on the evaluation of: (a) industry/commerce firms, (b) financial services firms, (c) banking institutions and (d) insurance firms. The necessity for obtaining objective and representative evaluation results is the reason for employing different criteria sets, since not all firms follow the same accounting plan [51]. Utilizing this approach, the crucial issue of the sectoral accounting particularities is strongly taken into account. The choice of specialized criteria sets is the next safety valve for fair and balanced results, after the initial classification that has been adopted for evaluating firms within the same industry. Finally, it is mentioned that the financial ratios used were categorized in four major groups: profitability ratios, activity ratios, liquidity ratios and solvency/structure ratios.

In conclusion, according the proposed methodology and with respect to Table 3, the connection between the different classes of firms and the criteria sets has as follows:

- Firms which belong to classes *a*, *b*, *c*, *d* and e (consumer goods, industrials, technology, telecommunications, oil/gas, basic materials, consumer services, utilities and health care) are evaluated through the industry/commerce criteria set.
- Firms which belong to class *f* (financial services) are evaluated through the financial services criteria set.
- Firms which belong to class *g* (banks) are evaluated through the banking institutions criteria set.
- Firms which belong to class *h* (insurances) are evaluated through the insurance criteria set.

3.7. The weighting method

The assignment of importance weightings to each criterion is a crucial issue in the application of all versions of the ELECTRE model (with the exception of ELECTRE IV). Because it is a non-compensatory decision aid model, the interpretation of weights is different than for a compensatory system such as MAUT [26]. Within ELECTRE, the weights used are not constant of scale, but are simply a measure of relative importance of the criteria involved. Rogers et al. [47] distinguish four methods which can be employed to weight criteria for use within ELECTRE: (a) the direct weighting system [17], (b) the Mousseau system [39], (c) the 'pack of cards' technique [52] and (d) the 'resistance to change grid' weighting method [46].

The method chosen for the determination of weights was the 'resistance to change grid'. This method represents an improvement in comparison to the other approaches since: (a) it is relatively simple and straightforward, (b) it has a theoretical basis within the psychology of human preference relationships, (c) the weights obtained can be directly connected, in theoretical terms, to the DM's concept of personal importance and (d) the method has been widely in a very large number of real-world applications.

The 'resistance to change grid' is based on a theory from the area of psychology, the so called 'personal construct theory' [25], in an effort to explain how DMs automatically place decision criteria into a hierarchy of relative importance. According to Rogers and Bruen [46], the 'resistance to change grid' is shown to be a simple, comprehensible and legitimate weighting system. These three qualities are, according to Simos [52], essential for a weighting technique in order to be usable in practice, within the frame of the ELECTRE family methods. The weights finally obtained from the method are based on, and can be related back directly to, the concept of relative importance.

The main feature of the 'resistance to change grid' weighting method is that pairwise comparisons between all the criteria are made within a matrix format. In a given cell within the 'resistance to change grid', the following notation is used to signify the result obtained: (a) an 'X' indicates that the column criterion is more

Table 4
The criteria set for the evaluation of industry/commerce firms.

	Criterion	Definition	Criterion direction	Perspective	Measuring unit
$g_{1.1}$	Return on assets	Earnings before interest and taxes divided by total assets	Max	Profitability	Percentage
$g_{1.2}$	Return on equity	Net income divided by shareholders equity	Max	Profitability	Percentage
$g_{1.3}$	Net profit margin	Net income divided by sales	Max	Profitability	Percentage
$g_{1.4}$	Deadline of receivables	(Customers plus accounts receivable) $*$ 365 divided by sales	Min	Activity	Number of days
$g_{1.5}$	Deadline of payables	(Suppliers plus accounts payable) $*$ 365 divided by sales	Min	Activity	Number of days
$g_{1.6}$	Assets turnover	Sales divided by total assets	Max	Activity	Fraction
$g_{1.7}$	Acid liquidity	Current assets minus inventories divided by current liabilities	Max	Liquidity	Fraction
$g_{1.8}$	Cash liquidity	Cash plus cash equivalents divided by current liabilities	Max	Liquidity	Fraction
$g_{1.9}$	Current liabilities to working capital	Current liabilities divided by currents assets minus current liabilities	Min	Liquidity	Fraction
$g_{1.10}$	Solvency ratio	Total liabilities divided by shareholder's equity	Min	Solvency/structure	Fraction
$g_{1.11}$	Leverage ratio	Total assets divided by shareholder's equity	Max	Solvency/structure	Fraction
$g_{1.12}$	Financial expenses coverage	Earnings before interest and taxes divided by interest expenses	Max	Solvency/structure	Fraction

Table 5
The criteria set for the evaluation of financial services firms.

	Criterion	Definition	Criterion direction	Perspective	Measuring unit
$g_{2.1}$	Return on assets	Earnings before interest and taxes divided by total assets	Max	Profitability	Percentage
$g_{2.2}$	Return on equity	Net income divided by shareholders equity	Max	Profitability	Percentage
$g_{2.3}$	Net profit margin	Net income divided by sales	Max	Profitability	Percentage
$g_{2.4}$	Personel's performance	Earnings before interest and taxes divided by numbers of employees	Max	Profitability	Euros
$g_{2.5}$	Assets turnover	Sales divided by total assets	Max	Activity/liquidity	Fraction
$g_{2.6}$	Acid liquidity	Current assets minus inventory divided by current liabilities	Max	Activity/liquidity	Fraction
$g_{2.7}$	Solvency ratio	Total liabilities divided by shareholder's equity	Min	Solvency/structure	Fraction
$g_{2.8}$	Leverage ratio	Total assets divided by shareholder's equity	Max	Solvency/structure	Fraction

Table 6
The criteria set for the evaluation of banking institutions.

	Criterion	Definition	Criterion direction	Perspective	Measuring unit
$g_{3.1}$	Return on assets	Earnings before interest and taxes divided by total assets	Max	Profitability	Percentage
$g_{3.2}$	Return on equity	Net income divided by shareholders equity	Max	Profitability	Percentage
$g_{3.3}$	Interest-bearing assets/liabilities spread	Average interest bearing assets return minus average liabilities interest cost	Max	Profitability	Fraction
$g_{3.4}$	Net interest margin	Net interest income divided by average total assets	Max	Profitability	Percentage
$g_{3.5}$	Efficiency	Total operating expenses divided by operating income	Max	Profitability	Percentage
$g_{3.6}$	Personel's performance	Earnings before interest and taxes divided by numbers of employees	Max	Profitability	Euros
$g_{3.7}$	Equity to total assets	Shareholder's equity divided by total assets	Max	Structure	Percentage
$g_{3.8}$	Interest-bearing assets to total assets	Interest-bearing assets divided by total assets	Max	Structure	Percentage
$g_{3.9}$	Total loans to deposits	Total loans divided by total deposits	Min	Structure	Percentage
$g_{3.10}$	Provisions to total loans	Loan provisions plus other receivable provisions divided by total loans	Min	Structure	Percentage

Table 7
The criteria set for the evaluation of insurance firms.

	Criterion	Definition	Criterion direction	Perspective	Measuring unit
$g_{4.1}$	Return on assets	Earnings before interest and taxes divided by total assets	Max	Profitability	Percentage
$g_{4.2}$	Return on equity	Net income divided by shareholders equity	Max	Profitability	Percentage
$g_{4.3}$	Net profit margin	Net income divided by sales	Max	Profitability	Percentage
$g_{4.4}$	Personel's performance	Earnings before interest and taxes divided by numbers of employees	Max	Profitability	Euros
$g_{4.5}$	Deadline of receivables	(Customers plus accounts receivable) $*$ 365 divided by sales	Min	Activity/liquidity	Number of days
$g_{4.6}$	Acid liquidity	Current assets minus inventory divided by current liabilities	Max	Activity/liquidity	Fraction
$g_{4.7}$	Solvency ratio	Total liabilities divided by shareholder's equity	Min	Solvency/structure	Fraction
$g_{4.8}$	Insurance provisions to liabilities	Total insurance provisions divided by total liabilities	Min	Solvency/structure	Percentage

important in comparison to the row criterion, (b) a 'blank' indicates that the row criterion is more important in comparison to the column criterion and (c) a 'I' indicates that the two criteria are of equal importance.

The scoring mechanism for the matrix involves counting for each criterion, all the 'blanks' in the rows and all the 'X's in the column where the row criterion meets itself. An analytical representation of the 'resistance to change grid' for the criteria set of industry/commerce firms is provided in Table 8 (the weights for the rest of the criteria sets are summarized in Tables 9–11). The following examples illustrate the scoring process: (a) considering criterion $g_{1.1}$ (return on assets), there are 8 row 'blanks', thus the resistance score (sum) is 8, (b) considering criterion $g_{1.2}$ (return on equity), there are 9 row 'blanks' and 1 'X' in the column where the $g_{1.2}$ row criterion meets itself, thus the resistance score is 10, and (c) considering criterion $g_{1.8}$ (cash liquidity), there are 3 row 'blanks' and 2 'X's in the column where the $g_{1.8}$ row criterion meets itself, thus the resistance score is 5. Once the resistance scores for each criterion are obtained, a simple normalization process can be applied to give the final weightings, as shown in Table 8.

The description of the scoring process provided here reflects to a more intuitive and practical explanation approach; however the interested reader can find all the theoretical details in Rogers and Bruen [46] and Rogers et al. [47]. It is finally stressed that the

Table 8
The 'resistance to change grid' for the industry/commerce firms criteria set.

		$g_{1.1}$ Return on assets	$g_{1.2}$ Return on equity	$g_{1.3}$ Net profit margin	$g_{1.4}$ Deadline of receivables	$g_{1.5}$ Deadline of payables	$g_{1.6}$ Assets turnover	$g_{1.7}$ Acid liquidity	$g_{1.8}$ Cash liquidity	$g_{1.9}$ Current liabilities to working capital	$g_{1.10}$ Solvency ratio	$g_{1.11}$ Leverage ratio	$g_{1.12}$ Financial expenses coverage	Banks	X	Sum	Weight
$g_{1.1}$	Return on assets		X	X	X									8	0	8	13.11
$g_{1.2}$	Return on equity			X										9	1	10	16.39
$g_{1.3}$	Net profit margin													9	2	11	18.03
$g_{1.4}$	Deadline of receivables													8	1	9	14.75
$g_{1.5}$	Deadline of payables						X	X	X	I		X	X	1	0	1	1.64
$g_{1.6}$	Assets turnover								I			I		4	1	5	8.20
$g_{1.7}$	Acid liquidity								X			X	I	2	1	3	4.92
$g_{1.8}$	Cash liquidity											I		3	2	5	8.20
$g_{1.9}$	Current liabilities to working capital											X	X	1	0	1	1.64
$g_{1.10}$	Solvency ratio											X		1	0	1	1.64
$g_{1.11}$	Leverage ratio													1	4	5	8.20
$g_{1.12}$	Financial expenses coverage													0	2	2	3.28

experts involved in the application found the 'resistance to change grid' weighting method extremely friendly and perceivable and expressed their satisfaction as far the obtained weighting results is concerned.

3.8. Definition of categories and determination of thresholds

According to the proposed methodology, three categories were determined for the sorting of alternatives. The defined categories are shown in Table 12.

Besides, in Table 13 are presented the four ways defined for the interpretation of the sorting results. The key-idea behind the above issue, was the exploitation of the modeling capabilities that the ELECTRE Tri method incorporates (see paragraph 3.2).

Finally, Table 14 suggestively presents the profiles and thresholds for the firms of class *a* (year 2004). Similar matrices were constructed and utilized for the evaluation of all of the rest classes of firms. One of the experts' major contributions was the determination of all these parameters. Indeed, the methodology's critical success factors were related to their valuable experience in security analysis, along with the plethora of statistical data (such as financial ratios of each firm for three consecutive years and the corresponding industry/sectoral average values) provided by the ICAP databank [ICAP S.A. (www.icap.gr) is the leading provider of financial and business information in Greece]. The availability of such a detailed and elaborate information, gave the experts assistance of crucial importance in their difficult task to make all the necessary assessments and finally obtain the profile and threshold vectors.

4. Application and results

4.1. Field of application

The proposed methodology described in the previous section is applied on data concerning firms whose equities are traded in the ASE. However, it is important to note that the usefulness of the proposed methodology is not affected by the fact that it is applied only to the ASE. The type of data that are employed in this application are also available for the analysts and investors in other countries. Furthermore, no assumptions are made concerning the special characteristics of the stock exchange.

259 firms (90 firms of high capitalization and 169 firms of medium-low capitalization) were considered for the application of the proposed methodology, covering a broad spectrum of business activities. A number of 62 firms were excluded from the study [securities of special stock exchange characteristics (14), securities under supervision (21), securities under suspension (17) and preferred securities (10)]. The time period of study regards three consecutive years (2004–2006). Table 15 summarizes the distribution of the 259 firms in the corresponding industries and supersectors.

Table 16 provides information relative to the correspondence of each firm with its industry and supersector, as well as the capitalization category of each firm (bold type characters for high capitalization securities and non-bold type characters for medium and low capitalizations stocks). Finally, Table 17 suggestively presents the performance evaluation matrix for alternatives (firms) of class *a*. Similar performance matrices are available and were also utilized for the evaluation of all of the rest classes of firms.

4.2. Results

With respect to the implementation steps of the proposed methodology described in Section 3.1, and suggestively for the equities of firms of class *a* (consumer goods), we present in Tables 18–21 the corresponding partial results. More precisely, in

Table 9
Criteria weights for the financial services firms criteria set.

	$g_{2.1}$ Return on assets	$g_{2.2}$ Return on equity	$g_{2.3}$ Net profit margin	$g_{2.4}$ Personel's performance	$g_{2.5}$ Assets turnover	$g_{2.6}$ Acid liquidity	$g_{2.7}$ Solvency ratio	$g_{2.8}$ Leverage ratio
Weight (%)	17.86	17.86	21.43	10.71	14.29	7.14	3.57	7.14

Table 10
Criteria weights for the banking institutions criteria set.

	$g_{3.1}$ Return on assets	$g_{3.2}$ Return on equity	$g_{3.3}$ Interest-bearing assets/ liabilities spread	$g_{3.4}$ Net interest margin	$g_{3.5}$ Efficiency	$g_{3.6}$ Personel's performance	$g_{3.7}$ Equity to total assets	$g_{3.8}$ Interest-bearing assets to total assets	$g_{3.9}$ Total loans to deposits	$g_{3.10}$ Provisions to total loans
Weight (%)	7.32	19.51	19.51	14.63	17.07	7.32	2.44	2.44	7.32	2.44

Table 11
Criteria weights for the insurance firms criteria set.

	$g_{4.1}$ Return on assets	$g_{4.2}$ Return on equity	$g_{4.3}$ Net profit margin	$g_{4.4}$ Personel's performance	$g_{4.5}$ Deadline of receivables	$g_{4.6}$ Acid liquidity	$g_{4.7}$ Solvency ratio	$g_{4.8}$ Insurance provisions to liabilities
Weight (%)	14.81	7.41	25.93	11.11	18.52	14.81	3.70	3.70

Table 12
Definition of categories.

Category	Description
C_3	Firms involved in this category are characterized by excellent financial strength according to their performances in the criteria of all the examined perspectives (profitability, activity, liquidity, solvency and structure). With respect to their rivals in the corresponding industry, they are placed at the top of the ranking for all the ratios employed. These firms are considered to enjoy the best future prospects and constitute the most powerful and reliable investment opportunities during the specific period of analysis. Equities of these firms can be considered for participation in investment portfolios in a medium-long time horizon.
C_2	This category contains firms that are characterized by medium financial strength. The performance of these firms in the examined criteria is rather moderate. In relation to their competitors, they are placed around the industry average values. These firms are not considered as investment opportunities, at least for the specific period of analysis.
C_1	The firms of this category are characterized by extremely poor financial strength within all the examined perspectives (profitability, activity, liquidity, solvency and structure). Relatively to their rivals, they are placed fairly below the industry average values. Equities of these firms do not constitute a rational investment choice for the specific period examined, at least for the medium-long term. In reverse, selection of these equities for participation in portfolios can only be considered within the frame of an aggressive/risky investment policy and only for obtaining short-term profits.

Table 13
Interpretation of results.

Case	Description
First	The corresponding equities of firms that have been classified in category C_3 in both the optimistic and pessimistic assignment are proposed for selection without hesitation. These firms perform satisfactory values for all the criteria set.
Second	The corresponding equities of firms that have been classified in category C_2 in both the optimistic and pessimistic assignment are currently not proposed for selection. This is due to the fact that these firms perform moderate values for all the criteria set. These firms have characteristics that must be studied further.
Third	The corresponding equities of firms that have been classified in category C_1 in both the optimistic and pessimistic assignment are irrevocably not proposed for selection. These firms perform non-satisfactory values for all the criteria set.
Fourth	The corresponding equities of firms that have been classified in different categories under the two types of assignment procedures are currently not proposed for selection. These firms have to be studied further, since the notion of incomparability underlies their particularities.

Table 18 are presented the sorting results (both the pessimistic and optimistic assignments) for year 2004 (Step 1) and in Table 19 is given, for the same year, the overlap of assignment procedures for category C_3 (Step 4). The overlap, for all years, of assignment procedures for category C_3 is presented in Table 20 (Step 5). In Table 21 is presented the overlap of these equities of firms of class a, that have been classified in category C_3 (both optimistic and pessimistic assignment), in at least two out of the three years of the time period of study (Step 6).

In Table 22, is presented the final set of equities that are proposed to the DM for selection (Step 7). This set consists of 100 securities (out of the 259 that initially considered), of which 49 are high

Table 14
Profiles and thresholds for the firms of class *a* (year 2004).

	$g_{1.1}$	$g_{1.2}$	$g_{1.3}$	$g_{1.4}$	$g_{1.5}$	$g_{1.6}$	$g_{1.7}$	$g_{1.8}$	$g_{1.9}$	$g_{1.10}$	$g_{1.11}$	$g_{1.12}$
b_2	6.27	9.17	7.30	122	58	0.66	1.33	0.13	0.97	0.51	2.10	4.09
q_i (b_2)	1.1	4.55	3.31	22	12	0.12	0.29	0.08	0.27	0.15	0.32	0.67
p_i (b_2)	3.72	11.16	11.97	42	34	0.29	1.13	0.34	0.52	0.23	1.24	3.34
b_1	3.44	3.95	3.92	135	96	0.47	0.87	0.03	1.35	1.22	1.74	3.515
q_i (b_1)	0.74	1.2	1.14	3	19	0.08	0.16	0.05	0.16	0.34	0.11	0.22
p_i (b_1)	1.86	2.99	1.54	10	25	0.13	0.32	0.1	0.25	0.49	0.19	0.95

Table 15
Distribution of firms per industry/supersector.

Class	Industry	Supersector	Number of companies per supersector	Number of companies per class
a	Consumer goods	Food and beverage	28	64
		Personal and household goods	36	
b	Industrials	Construction and materials	29	54
		Industrial goods and services	25	
c	Technology	Technology	22	25
	Telecommunications	Telecommunications	3	
d	Basic materials	Chemicals	9	28
		Basic resources	16	
	Oil and gas	Oil and gas	3	
e	Consumer services	Retail	12	49
		Media	11	
		Travel and leisure	14	
	Utilities	Utilities	4	
	Health care	Health care	8	
f	Financials	Financial services	20	20
g	Financials	Banks	14	14
h	Financials	Insurances	5	5

capitalization equities. Table 22 reveals an important feature of the proposed methodology: There is no uniform sorting of stocks, but specialized sortings per industry. In this way, the huge issue of competition between rival firms is fully taken into consideration, while unreasonable comparisons between them are excluded.

The securities proposed for selection reflect to firms that are characterized by excellent financial strength according to their performances in the criteria of all the examined perspectives (profitability, activity, liquidity, solvency and structure). With respect to their rivals in the corresponding industry, they are placed at the top of the ranking for all the ratios employed. These firms are considered to enjoy the best future prospects and constitute the most powerful and reliable investment opportunities during the specific period of analysis. Equities of these firms can be considered by the rational investor, as prudent options for participation in portfolios, within a medium-long time horizon.

4.3. Validation of results

As it has already been mentioned, the proposed methodology contains a final validation stage, where the results were tested in both a qualitative and quantitative level.

The qualitative validation of the results was carried out by the experts. Their contribution was of crucial importance, in this phase too. They expressed their satisfaction as far the final results are concerned and they confirmed that the obtained results were in categorical concurrence with the set of high performance securities, they heuristically manage in their everyday practice. Indeed, among the securities of the final proposed set, they identified almost all the 'winning' equities of the ASE, with respect to the particular time period of the application. Moreover, even in cases of equities of the final proposed set, that were not recognized by experts as, confirmed by the market, direct investment opportunities, both the chances and hints were given for their further study and potential detection of mispriced securities.

Except of the qualitative assessment, a quantitative testing of the final results was also carried out. Our aim was to show that the stocks we propose for selection on the basis of the 3-yrs FA conducted, reflect to securities with satisfactory stock market behavior, i.e. satisfactory actual subsequent stock performance (see [15,18,41,45]). The criteria used for capturing each security's stock market behavior, were the two fundamental risk-return measures of financial theory: the average capital return per share and the standard deviation of return.

More specifically:

- The average capital return per share is given by the formula:
- $$\bar{r} = \sum_{t=1}^{n} \frac{r_t}{n}$$

  where r_t is the capital return per share in period t. The capital return per share in period t is given by the formula:

  $$r_t = \frac{p_t - p_{t-1} + d_t}{p_{t-1}}$$

Table 16
Firms and the corresponding industry/supersector.

No.	OASIS code	Name of firm	Industry	Supersector
1	AAAK	Tria Alpha (CR)	Consumer goods	Personal and household goods
2	ALLK	Allatini (CB)	Consumer goods	Food and beverage
3	ALSIN	Alsinco (CR)	Consumer goods	Personal and household goods
4	VARG	Varagis (CR)	Consumer goods	Personal and household goods
5	VARNI	Varvaresos (CB)	Consumer goods	Personal and household goods
6	VELL	Vell Group (CR)	Consumer goods	Personal and household goods
7	**VIVART**	Vivartia (CR)	Consumer goods	Food and beverage
8	VIOKA	Viocarpet (CR)	Consumer goods	Personal and household goods
9	VOX	Fashion Box (CR)	Consumer goods	Personal and household goods
10	GALAX	Galaxidi (CR)	Consumer goods	Food and beverage
11	GRIGO	Grigoris Mikrogeumata (CR)	Consumer goods	Food and beverage
12	DIXTH	Dias Ihthiokaliergies (CR)	Consumer goods	Food and beverage
13	DOURO	Douros (CR)	Consumer goods	Personal and household goods
14	DROME	Dromeas (CR)	Consumer goods	Personal and household goods
15	EVZ	Elliniki Viomihania Zaharis (CB)	Consumer goods	Food and beverage
16	EVROF	Evrofarma (CR)	Consumer goods	Food and beverage
17	**EEEK**	Coca Cola Tria Epsilon (CB)	Consumer goods	Food and beverage
18	ELVE	Elve Endimaton (CB)	Consumer goods	Personal and household goods
19	ELGEK	Elgeka (CR)	Consumer goods	Food and beverage
20	ELIXTH	Ellinikes Ihthiokaliergies (CR)	Consumer goods	Food and beverage
21	**ELMEK**	Elmec Sport (CR)	Consumer goods	Personal and household goods
22	ELYF	Elliniki Ifadourgia (CR)	Consumer goods	Personal and household goods
23	ELFK	Elfico (CR)	Consumer goods	Personal and household goods
24	EPILK	Epilektos (CB)	Consumer goods	Personal and household goods
25	**EFTZI**	FG Europe (CR)	Consumer goods	Personal and household goods
…		…	…	…
243	**ATE**	Agrotiki Bank (CR)	Financials	Banks
244	ATT	Attica Bank (CR)	Financials	Banks
245	**GTE**	Geniki Bank (CR)	Financials	Banks
246	**EGNAC**	Egnatia Bank (CR)	Financials	Banks
247	**EMP**	Emporiki Bank (CR)	Financials	Banks
248	**ETE**	Ethniki Bank (CR)	Financials	Banks
249	**EUROV**	Eurobank (CR)	Financials	Banks
250	**KYPR**	Kiprou Bank (CR)	Financials	Banks
251	**MARFV**	Marfin Bank (CR)	Financials	Banks
252	**PEIR**	Pireaus Bank (CR)	Financials	Banks
253	**PRO**	Proton Bank (CR)	Financials	Banks
254	**TT**	Tahidromiko Tamieutirio (CR)	Financials	Banks
255	AGRAS	Agortiki Asfalistiki (CR)	Financials	Insurances
256	ASASK	Aspis Pronia (CR)	Financials	Insurances
257	**EEGA**	Ethniki Asfalion (CR)	Financials	Insurances
258	EUVRK	Eurobrokers (CR)	Financials	Insurances
259	EUPIK	Europaiki Pisti (CR)	Financials	Insurances

where p_t is the stock price at the end of period t, p_{t-1} the stock price at the end of period $t-1$ and d_t the dividend that the stock gives to the investor in period t.

- The standard deviation of capital return per share is given by the formula:
-

$$\sigma = \sqrt{\sum_{t=1}^{n} \frac{[r_t - \bar{r}]^2}{n}}$$

where r_t is the capital return per share in period t and $\bar{r}$ the average capital return per share.

Within the frame of the validation process, the time-period for the calculation of the above measures included the record of each security's weekly-based closing prices, between 1/4/2007 and 31/3/2008 (a 3-months time lag between 31/12/2006 and 31/3/2007 was kept before the calculation of the two measures, in order all the companies' financial statements of year 2006 to be published). This specific 1-year horizon follows the time-period of the proposed methodology's application (three consecutive years from 2004 to 2006) and sufficiently captures each security's future stock market performance.

For each one of the eight classes, Tables 23 and 24 summarize the minimum, maximum and mean values of the average capital return and the standard deviation of capital return for: (a) the whole sample of the 259 stocks and (b) the 100 stocks that are proposed for selection according to the methodology.

The first noticeable findings have to do with the fact that, in comparison to the whole sample of the 259 stocks, the set of the 100 stocks proposed for selection perform: (a) higher class-means in 5 out of the 8 classes regarding the average capital return (classes *a*, *b*, *e*, *g* and *h*) and (b) lower class-means in 6 out of the 8 classes (classes *a*–*f*) regarding the standard deviation of capital return. The whole picture becomes clearer when the validation statistics of Table 25 are taken into consideration.

The analysis has shown that 59 out of the 100 stocks that are proposed for selection, perform higher average capital return than the corresponding class-mean values of the whole sample of the 259 stocks. The highest percentage (72.2%) is observed for class *b* (industrials), where 13 out of the 18 stocks proposed for selection, perform better average capital return than the corresponding class-mean of the whole sample. The lowest percentage (52%) is observed for class *a* (consumer goods), where 13 out of the 25 stocks proposed for selection, perform worse average capital return than the corresponding class-mean of the whole sample.

Table 17
Performance matrix for alternatives of class *a* (all years).

No.	Alternatives	Profitability									Activity			...	Solvency/structure								
		$g_{1.1}$ Return on assets			$g_{1.2}$ Return on equity			$g_{1.3}$ Net profit margin			$g_{1.4}$ Deadline of receivables			...	$g_{1.10}$ Solvency ratio			$g_{1.11}$ Leverage ratio			$g_{1.12}$ Financial expenses coverage		
		2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006		2004	2005	2006	2004	2005	2006	2004	2005	2006
1	AAAK	2.32	−6.32	−0.31	1.42	−13.07	−3.76	1.36	−23.09	−3.48	135	372	219	...	0.61	0.84	0.74	1.61	1.92	1.92	1.61	3.43	3.10
2	ALLK	3.44	−0.53	2.09	4.28	−2.96	1.56	4.45	−3.17	2.08	121	136	145	...	0.62	0.73	0.44	1.62	1.92	1.56	4.34	3.43	1.92
3	ALSIN	6.79	3.83	1.95	9.72	2.46	−8.10	3.20	0.83	−2.73	233	244	258	...	2.34	2.65	3.14	3.34	3.49	1.93	1.75	1.23	0.48
4	VARG	−0.83	0.64	−1.23	−1.65	0.62	−2.99	−2.09	0.78	−3.74	82	116	188	...	0.43	0.58	0.77	1.85	1.50	1.94	3.515	2.78	3.20
5	VARNI	4.24	−2.63	−2.81	4.31	−9.45	−12.1	4.74	−10.92	−12.5	96	103	87	...	0.99	1.06	1.17	1.99	1.92	1.90	2.04	3.43	3.00
6	VELL	4.18	−7.51	1.52	7.94	−23.12	−0.62	6.17	−20.82	−0.38	300	368	263	...	1.51	1.69	1.47	2.51	1.92	1.95	4.09	3.43	0.86
7	**VIVART**	5.95	4.63	6.21	7.35	1.78	4.43	106.1	24.90	5.23	132	145	88	...	1.09	2.19	1.18	2.09	2.62	2.18	2.45	1.17	1.49
8	VIOKA	1.46	3.88	3.69	1.32	4.56	4.34	5.08	18.08	13.92	132	354	466	...	0.08	0.49	0.37	1.08	1.30	1.43	6.06	10.51	5.70
9	VOX	7.04	8.32	11.36	13.72	17.24	24.46	5.06	5.33	6.81	135	121	119	...	1.38	1.43	1.60	2.38	2.41	2.52	5.53	7.22	6.84
10	GALAX	0.54	7.08	7.42	−2.63	14.43	15.39	−1.61	8.54	8.49	74	84	91	...	1.45	1.55	1.76	1.85	2.50	2.66	0.33	5.39	4.51
11	GRIGO	9.90	5.10	14.59	39.36	4.10	54.54	5.99	0.59	9.89	132	145	143	...	5.92	6.77	2.72	6.92	7.30	5.16	2.35	1.12	3.63
12	DIXTH	3.76	7.91	21.73	11.70	26.15	23.25	8.55	14.12	76.50	135	85	146	...	2.12	2.47	0.08	3.12	3.31	1.07	3.515	3.43	3.00
13	DOURO	2.82	0.44	0.64	2.38	−0.77	−0.77	3.46	−1.23	−1.22	92	101	88	...	0.31	0.34	0.31	1.31	1.92	1.96	2.80	0.43	0.53
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
52	**SAR**	5.30	6.23	6.63	25.85	23.75	24.16	7.30	8.49	10.71	159	156	146	...	4.62	2.76	2.54	5.62	4.47	3.65	7.56	6.83	3.10
53	SARAN	7.28	−0.74	10.52	15.60	−11.75	26.02	9.79	−7.60	17.58	132	81	175	...	2.12	3.21	2.11	3.12	1.92	3.62	3.20	3.43	3.15
54	SATOK	6.24	8.89	10.86	10.30	15.36	19.10	6.29	9.82	13.51	131	110	115	...	1.61	1.35	1.17	2.61	2.46	2.26	2.73	3.36	4.54
55	SELO	−0.51	10.27	6.60	−3.33	16.36	9.46	−4.93	26.37	11.82	119	155	133	...	0.78	0.84	0.96	1.85	1.81	1.90	3.515	8.34	4.07
56	SENTR	−1.90	6.34	7.02	−7.37	11.39	14.01	−2.36	3.34	4.47	144	147	191	...	1.30	1.71	1.84	1.85	2.51	2.78	3.515	3.52	3.55
57	TEXT	1.04	−9.92	−3.80	0.11	−16.65	−7.34	0.12	−27.34	−9.01	197	182	131	...	0.40	0.55	0.55	1.36	1.92	1.90	1.08	3.43	3.20
58	YALKO	6.43	4.26	6.24	10.47	6.41	10.14	6.26	3.76	5.48	183	203	208	...	1.16	1.28	1.17	2.16	2.22	2.23	4.09	3.10	3.69
59	FIER	1.92	3.07	4.77	1.85	4.45	7.41	1.64	4.12	6.59	118	119	113	...	0.95	0.82	0.74	1.95	1.89	1.78	1.97	4.28	7.80
60	FINTO	2.71	2.30	1.32	1.74	1.17	−0.90	3.03	1.76	−1.27	122	123	125	...	0.63	0.83	0.85	1.63	1.72	1.91	1.65	1.42	0.73
61	**FOLI**	8.06	9.36	7.81	13.77	17.84	13.98	39.00	50.81	44.70	131	157	181	...	1.31	1.25	3.16	2.31	2.28	3.23	3.83	6.12	2.25
62	**FRLK**	17.34	8.09	19.32	19.60	9.04	21.05	5.08	4.17	5.20	132	145	145	...	0.13	0.11	0.11	1.13	1.12	1.11	3.515	3.43	59.05
63	HATZK	6.48	2.16	13.72	6.77	2.26	28.51	320.7	62.03	43.86	132	145	144	...	0.05	0.07	1.97	1.05	1.05	2.08	3.515	280.9	3.00
64	HKRAN	3.78	0.63	0.54	5.15	0.45	0.07	6.60	0.76	0.11	213	283	286	...	0.36	0.35	0.40	1.36	1.35	1.37	3.515	2.12	1.10

Table 18
Class *a* results (year 2004).

Category	Pessimistic assignment					Optimistic assignment				
C_3	2 ALLK	5 VARNI	**7 VIVART**	9 VOX	11 GRIGO	2 ALLK	5 VARNI	**7 VIVART**	9 VOX	11 GRIGO
	12 DICHT	14 DROME	15 EBZ	16 EVROF	**17 EEEK**	12 DICHT	14 DROME	15 EBZ	16 EVROF	**17 EEEK**
	18 ELVE	19 ELGEK	**21 ELMEK**	22 ELYF	**25 EFTZI**	18 ELVE	19 ELGEK	**21 ELMEK**	22 ELYF	**25 EFTZI**
	26 INFIS	27 KANAK	**28 KARD**	29 KATSK	30 KEGO	26 INFIS	27 KANAK	**28 KARD**	29 KATSK	30 KEGO
	31 KEPEN	33 KORRES	35 KRETA	36 KRI	40 MIN	31 KEPEN	33 KORRES	35 KRETA	36 KRI	40 MIN
	42 MPELA	43 MPENK	**46 NHR**	**52 SAR**	53 SARAN	**42 MPELA**	43 MPENK	**46 NHR**	**52 SAR**	53 SARAN
	54 SATOK	58 YALKO	**61 FOLI**	**62 FRLK**	63 HATZK	54 SATOK	58 YALKO	**61 FOLI**	**62 FRLK**	63 HATZK
C_2	3 ALSIN	6 VELL	13 DOURO	32 KMOL	34 KREKA	3 ALSIN	4 VARG	6 BELL	10 GALAX	13 DOURO
	45 NAUP	64 HKARN				24 EPILK	32 KMOL	34 KREKA	37 KTILA	45 NAUP
						48 PERS	50 RINTE	55 SELO	59 FIER	64 HKRAN
C_1	1 AAAK	4 VARG	8 VIOKA	10 GALAX	20 ELICTH	1 AAAK	8 VIOKA	20 ELICTH	23 ELFK	38 LOULI
	23 ELFK	24 EPILK	37 KTILA	38 LOULI	39 MAXIM	39 MAXIM	41 MOUZK	44 MPOKA	**47 OLYMP**	49 RILKE
	41 MOUZK	44 MPOKA	**47 KTILA**	48 PERS	49 RILKE	51 SANYO	56 SENTR	57 TEXT	60 FINTO	
	50 RINTE	51 SANYO	55 SELO	56 SENTR	57 TEXT					
	59 FIER	60 SANYO								

Moreover, as far as the risk dimension is concerned, the analysis has shown that 74 out of the 100 stocks that are proposed for selection, perform lower standard deviation of capital return than the corresponding class-mean values of the whole sample of the 259 stocks. The highest percentage (88%) is observed for class *a* (consumer goods), where 22 out of the 25 stocks proposed for selection, perform better standard deviation of capital return than the corresponding class-mean of the whole sample. The lowest percentage (42.9%) is observed for class *g* (banks), where 3 out of the 7 stocks proposed for selection, perform worse standard deviation of return than the corresponding class-mean of the whole sample.

The above findings are rather encouraging results, since the problem of correlating the actual returns of stocks with the corporate performance of the corresponding firms as it is captured in financial ratios, is one of the most challenging in modern financial decision making, see [15,41]. Moreover, it could also be mentioned that the interesting percentages observed as far as the risk dimension is concerned, indicate the stock market stability of firms enjoying corporate health and financial strength.

4.4. Sensitivity analysis

The sorting of alternatives in the ELECTRE Tri method remains dependent on the values of various thresholds and indices of importance. Therefore, in most cases, sensitivity analysis is recommended.

Table 19
Overlap of assignment procedures for category C_3 of class *a* (year 2004).

Category					
C_3	2 ALLK	5 VARNI	**7 VIVART**	9 VOX	11 GRIGO
	12 DICHT	14 DROME	15 EBZ	16 EVROF	**17 EEEK**
	18 ELVE	19 ELGEK	**21 ELMEK**	22 ELYF	**25 EFTZI**
	26 INFIS	27 KANAK	**28 KARD**	29 KATSK	30 KEGO
	31 KEPEN	33 KORRES	35 KRETA	36 KRI	40 MIN
	42 MPELA	43 MPENK	**46 NHR**	**52 SAR**	53 SARAN
	54 SATOK	58 YALKO	**61 FOLI**	**62 FRLK**	63 HATZK

Table 20
Overlap of assignment procedures for category C_3 of class *a* (all years).

2004	2 ALLK	5 VARNI	**7 VIVART**	9 VOX	11 GRIGO
	12 DICHT	14 DROME	15 EBZ	16 EVROF	**17 EEEK**
	18 ELVE	19 ELGEK	**21 ELMEK**	22 ELYF	**25 EFTZI**
	26 INFIS	27 KANAK	**28 KARD**	29 KATSK	30 KEGO
	31 KEPEN	33 KORRES	35 KRETA	36 KRI	40 MIN
	42 MPELA	43 MPENK	**46 NHR**	**52 SAR**	53 SARAN
	54 SATOK	58 YALKO	**61 FOLI**	**62 FRLK**	63 HATZK
2005	**7 VIVART**	9 VOX	10 GALAX	12 DICTH	15 EBZ
	16 EVROF	**17 EEEK**	19 ELGEK	20 ELICTH	**21 ELMEK**
	22 ELYF	**25 EFTZI**	26 INFIS	27 KANAK	**28 KARD**
	29 KATSK	30 KEGO	32 MOL	33 KORRES	35 KRETA
	36 KRI	40 MIN	**42 MPELA**	43 MPENK	**46 NHR**
	49 RILKE	**52 SAR**	54 SATOK	56 SENTR	58 YALKO
	59 FIER	60 FINTO	**62 FRLK**		
2006	**7 VIVART**	9 VOX	10 GALAX	11 GRIGO	14 DROME
	17 EEEK	**21 ELMEK**	**25 EFTZI**	26 INFIS	27 KANAK
	28 KARD	29 KATSK	30 KEGO	33 KORRES	36 KRI
	40 MIN	**42 MPELA**	**46 NHR**	48 PERS	51 SANYO
	52 SAR	54 SATOK	55 SELO	56 SENTR	58 YALKO
	59 FIER	**62 FRLK**	63 HATZK		

Table 21
Overlap of those equities of firms of class *a*, that have been classified in category C_3 (both optimistic and pessimistic assignment), in at least two out of the three years of the study period.

Class *a*	**7 VIVART**	9 VOX	10 GALAX	11 GRIGO	14 DROME
	17 EEEK	**21 ELMEK**	**25 EFTZI**	26 INFIS	27 KANAK
	28 KARD	29 KATSK	30 KEGO	33 KORRES	36 KRI
	40 MIN	**42 MPELA**	**46 NHR**	**52 SAR**	54 SATOK
	56 SENTR	58 YALKO	59 FIER	**62 FRLK**	63 HATZK

In the application that has been presented, the sensitivity analysis was conducted with respect to the criteria weights. A very large number of different weighting scenarios examined (its generation rationale had to do with low, random and simultaneous fluctuations on the weights of the baseline scenarios), and the obtained sorting results had no or extremely slight variation compared to the results of the baseline scenarios. Besides, it has to be stressed that the ELECTRE Tri method is not a direct pairwise methodology. For each option, the outranking relationships derived are with categories not with the other options under consideration. It thus tends to be less sensitive than pairwise-based ELECTRE methods to the presence of 'clones', i.e. options lying very close to each other on their criterion valuations.

5. Concluding remarks

In this article a multicriteria approach for equity selection was presented. The methodology developed exploits for this purpose the valuable tool of FA. Within this frame, the underlying rationale adopted was that FA can be utilized for selecting attractive equities by means of evaluating the overall corporate performance of the corresponding firms.

The special features and contribution of the approach presented are outlined as follows:

- Incorporation in the decision process of several criteria that in a realistic basis represent the way real decisions are supported and

Table 22
Final results.

Class *a*	**7 VIVART**	9 VOX	10 GALAX	11 GRIGO	14 DROME
	17 EEEK	**21 ELMEK**	**25 EFTZI**	26 INFIS	27 KANAK
	28 KARD	29 KATSK	30 KEGO	33 KORRES	36 KRI
	40 MIN	**42 MPELA**	**46 NHR**	**52 SAR**	54 SATOK
	56 SENTR	58 YALKO	59 FIER	**62 FRLK**	63 HATZK
Class *b*	74 VOSYS	75 GEVKA	80 EKTER	83 ELTK	**86 HERAC**
	91 KLEM	92 KLM	94 LYK	97 MEVA	**99 METK**
	104 NIOUS	**106 OLTH**	107 OLP	109 PETRO	**114 TERNA**
	115 TITK	116 FLEXO	**117 FRIGO**		
Class *c*	119 AGRI	123 BYTE	**129 KOSMO**	**131 KOUES**	**138 PLAIS**
	140 REIN				
Class *d*	145 ALMY	148 DROUK	**152 ELPE**	158 MERKO	**159 MOH**
	161 MYTIL	**162 NEOXH**	**166 SIDE**	167 SIDMA	**171 HAKOR**
Class *e*	173 AVK	176 ANEK	**177 ARAIG**	178 ASKO	**183 VSTAR**
	186 EYAPS	**189 HLEAT**	190 HYATT	**191 IASO**	**194 INLOT**
	195 KAE	**199 LAMPSA**	205 MOTO	**211 OPAP**	**212 OTOEL**
	214 REV	**216 SPRI**	**217 SFA**		
Class *f*	221 AIOLK	222 ALTI	223 ANDRO	224 ASTAK	**226 GEK**
	227 GNEF	228 DIAS	**230 EUPRO**	**231 EHAE**	232 INTER
	235 KOUM	**238 PEA**	**240 SIENS**		
Class *g*	**241 ALFA**	**243 ATE**	**248 ETE**	**249 EUROB**	**250 KYPR**
	252 PEIR	**254 TT**			
Class *h*	255 AGRAS	258 EURBK	259 EUPIK		

Table 23
Min, max and mean values of the average capital return and the standard deviation of capital return for the whole sample of the 259 stocks (per class).

Class	Number of securities	Average capital return			Standard deviation of capital return		
		Min	Mean	Max	Min	Mean	Max
a	64	−3.41	0.155	12.819	3.088	7.572	47.978
b	54	−2.318	−0.46	1.004	1.946	5.987	13.042
c	25	−1.5	1.191	35.502	2.222	8.223	52.123
d	28	−1.84	−0.631	0.278	2.491	5.246	8.877
e	49	−1.692	0.171	1.831	2.428	6.031	12.051
f	20	−1.038	−0.128	2.32	2.041	6.221	34.33
g	14	−0.778	−0.497	-0.14	1.758	4.034	5.519
h	5	−0.847	−0.486	−0.169	4.074	6.187	10.799

Table 24
Min, max and mean values of the average capital return and the standard deviation of capital return for the whole sample of the 100 proposed for selection (per class).

Class	Number of securities	Average capital return			Standard deviation of capital return		
		Min	Mean	Max	Min	Mean	Max
a	25	−1.777	0.171	1.348	3.088	5.858	10.381
b	18	−1.132	−0.1	1.004	1.946	5.144	9.217
c	6	−0.989	0.113	1.199	2.222	6.357	10.514
d	10	−1.84	−0.75	−0.057	3.619	4.85	7.348
e	18	−1.692	0.216	1.831	2.428	5.398	8.484
f	13	−1.038	−0.363	0.064	2.041	4.109	7.772
g	7	−0.762	−0.464	−0.14	3.196	4.095	5.112
h	3	−0.685	−0.366	−0.169	4.074	6.372	10.799

Table 25
Validation statistics.

Class	Number of securities with average capital return above the class-mean	Percentage	Number of securities with standard deviation of return below the class-mean	Percentage
a	13	52.0	22	88.0
b	13	72.2	12	66.7
c	4	66.7	5	83.3
d	6	60.0	7	70.0
e	10	55.6	12	66.7
f	7	53.8	11	84.6
g	4	57.1	3	42.9
h	2	66.7	2	66.7
Total	59	59.0	74	74.0

strategies are implemented. Moreover, the proposed methodology allows for taken into consideration of both the DM's preference system and the analyst's professional experience.

- A significantly large number of firms (alternatives) from a very wide range of business sectors are possible to be simultaneously evaluated. The methodology's key-characteristic which allows for this convenience is that the firms participate in the evaluation process are categorized in classes, with respect to their corresponding industry. The ELECTRE Tri multicriteria method is then applied separately, in each one of these classes and finally, the partial results are integrated, considering also the major issue of time trend.
- The crucial importance issue of the industry/sectoral accounting particularities was strongly taken into account. The sortings provided by the methodology are highly reliable and representative, since every sorting has a different structure and is based on a specific criteria set which correspond to the specific accounting plan each company belongs in.
- There is no uniform sorting of stocks, but specialized sortings per industry. In this way, the huge issue of competition between rival firms is fully taken into consideration, while unreasonable comparisons between them are excluded.

As testified in the bibliographic review part of the article (Section 2), the MCDM paradigm provides a very broad spectrum of methodological approaches for effectively addressing the problem of portfolio selection. Complementally, it seems that the outranking relations theory framework might also provide a rather interesting alternative methodological basis for modeling the initial phase of the portfolio selection problem, i.e. the one which refers to the selection of the most attractive securities, despite its difficulties regarding the assignment of the required technical parameters.

At this point it is necessary to be stressed that the current study constitutes the first stage of an integrated multiple criteria methodological framework developed by the authors, for supporting decisions that concern the construction and selection of equity portfolios. At the second stage of this framework, a mixed-integer multiobjective mathematical programming model is developed, in order to generate the Pareto optimal portfolios, consisted of the dynamic set of securities obtained at the first stage. Since at the first stage of the framework the efforts are focused on detecting the most attractive stocks, on the basis of the corporate performance and viability of the corresponding firms, the aim at the second stage is to synthesize portfolios by taking into consideration all the critical aspects of the portfolio selection problem. To this end, issues such as the diversification effect between securities or the inclusion of certain risk measures (i.e. the standard deviation of stock returns or the beta coefficient), are fully incorporated in the decision process within the second stage of the framework.

Finally, further work that may be considered for broadening and enhancing the methodology proposed in this paper should focus in the following three points: (a) embodiment of the methodology in a web-based decision information system so as real time investment decisions to be supported, (b) expansion of the criteria set towards a qualitative direction, by considering a broader grid of decision parameters, such as the quality of management, the firm's market position etc. and (c) expansion of the methodology's focus so as to include additional asset classes.

Acknowledgements

We would like to express our thanks to the two anonymous referees, whose review directions on an earlier version of the article were a determinant factor for the improvement of its quality. We would also like to express our thanks to Dr. Yiannis Siskos, Professor of the Piraeus University and Dr. Michael Doumpos, Assistant Professor of the Technical University of Crete for their precious comments. We finally thank the ICAP S.A., consulting firm and provider of financial and business information, for the valuable financial data provided.

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