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Corporate social responsibility in portfolio selection: A "goal games" against nature approach

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ABSTRACT

Nowadays, there is an uprising social pressure on big companies to incorporate into their decision-making process elements of the so-called social responsibility. Among the many implications of this fact, one relevant one is the need to include this new element in classic portfolio selection models. This paper meets this challenge by formulating a model that combines goal programming with "goal games" against nature in a scenario where the social responsibility is defined through the introduction of a battery of sustainability indicators amalgamated into a synthetic index. In this way, we have obtained an efficient model that only implies solving a small number of linear programming problems. The proposed approach has been tested and illustrated by using a case study related to the selection of securities in international markets.

1. Introduction

Markowitz (1952), more than sixty years ago, published an outstanding paper that established the foundations of modern finance theory in general, and of the portfolio selection problem in particular. His basic idea was to determine the investment opportunity set as a bi-criteria optimization problem that establishes the well-known mean–variance (E–V) frontier. Since then, Markowitz's seminal ideas have been preserved but, at the same time, they have been extended in many fertile directions. Kolm, Tütüncü, and Fabozzi (2014), is an updated analysis of how the Markowitz model has evolved throughout the last 60 years.

One improvement of the basic E–V model in this sense has consisted of the incorporation of additional criteria into the expected returns and their variance. This fertile line has connected the classic portfolio selection problem to the multiple criteria decision-making (MCDM) paradigm. A good state-of the art derived from this type of hybridization can be seen in Steuer and Na (2003). An assessment of this orientation from the point of view of decision system design can be seen in Zopounidis and Doumpos (2013). Finally, on these lines, when the MCDM tool used is specifically for goal programming (GP), some interesting operational results have been obtained (Aouni, Colapinto, & La Torre, 2014).

On the other hand, one important and relatively recent problem in business economics is the uprising social pressure on companies to incorporate into their decision-making processes elements of the so-called corporate social responsibility. It is obvious that these new elements must also be incorporated in one way or another into the portfolio selection problem. This considerably increases the complexity of the analysis since it requires the combination of financial, social and environmental criteria. Some authors (e.g., Bilbao-Terol, Arenas-Parra, and Cañal Fernández (2012, 2013)) have addressed this problem by making the portfolio selection among a set of companies that are considered *a priori* as being socially responsible. Afterwards, the performance of the portfolios obtained are compared with those derived from a selection process among a more general set of companies (i.e., those socially responsible or not). Another authors follow a slightly different orientation by undertaking the portfolio selection problem from conventional as well as from socially responsible mutual funds for comparative purposes (see Utz, Wimmer, Hirschberger, and Steuer (2014)).

In this paper, we have addressed the problem of the incorporation of corporate social responsibility by following a different orientation. Thus, we did not exclude companies due to their possible unethical economic activity (e.g., tobacco, gambling, etc) or we did not include companies for ethical reasons, but each company considered in the selection process has been assessed according to financial as well as environmental responsibility criteria. To undertake that task, a synthetic sustainability index was attached

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to each company considered. This index was obtained by aggregating different indicators measuring environmental and social sustainability aspects. The complexity attached to the combination of criteria of such a different nature requires the use of flexible analytical tools. We will explore this orientation with the help of a relatively new analytical approach known as "goal games" Against Nature. As a first step in our presentation the foregoing of this approach will be briefly described.

The inclusion of multiple pay-offs in game-theoretic models is a line of research with a long tradition (e.g., Bergstresser and Yu (1977), Corley (1985), Zeleny (1976)). However, most of this seminal research deals with the generalization of Nash equilibrium points for games with multiple pay-offs. A different research direction consists of incorporating the multiple pay-offs in "games-against-nature" models. In this way, the analytical structure known as "goal games-against nature" arises (Rehman & Romero, 2006). It is interesting to note that this approach is underpinned by a Simonian satisficing philosophy within an environment of bounded rationality (Simon, 1956; Simon, 1979). For those reasons, it seems interesting to explore the portfolio selection problem within a context of corporate social responsibility with the help of this type of goal games.

The paper is organized as follows. Section 2 is devoted to the presentation of the analytical structure of the proposed model. In Section 3 the main features of the case study chosen are described. Section 4 presents and discusses the results obtained. Finally, Section 5 shows the main conclusions derived from the research and highlights possible lines for future research.

2. The model

For a portfolio selection problem within a context of corporate social responsibility, the following criteria seem to be suitable:

(a) The maximization of the expected returns of the portfolio.
(b) The minimization of the variability of the returns of the portfolio. As a variability index the negative semi-variance of the returns was chosen.
(c) The minimization of the maximum "regret".
(d) The maximization of a sustainability index of the portfolio.

Criteria (a) and (b) are the traditional criteria for the Markowitzean models, but using here the negative semi-variance instead of the variance as was suggested by Markowitz (1970, pp. 188–201). The inclusion of the Savage criterion implies that the investor feels a dissatisfaction quantified by the difference between the return actually achieved and the maximum possible return. Hence, the investor wishes to minimize the maximum possible value of this regret or opportunity cost. Finally, the sustainability index was obtained by aggregating a battery of sustainability indicators for each of the companies considered in the analysis.

Consequently, in this section, we have built a model capable of dealing with a portfolio selection problem involving the above set of criteria. For this purpose, the following notations are used:

n = number of securities under consideration (1,. . .i,. . .,n).
m = number of periods of time or sates of nature analyzed (1,. . .j,. . .m)
x_i = fraction of the portfolio invested in the ith security.
R_{ij} = generic element of the matrix of outcomes; i.e., returns obtained by the ith security under period of time (state of nature) jth.
S_{ij} = generic element of the "Savage matrix"; i.e., the "regrets" obtained by calculating the differences between the returns actually achieved by the ith security and the maximum return for the jth state of nature.
E_i = expected return of the ith security. Obviously, we have:

$$E_i = \frac{1}{m}\sum_{j=1}^{m} R_{ij}$$

V_i = negative semi-variance for the returns of the ith security. This variability index will be equal to:

$$V_i = \frac{1}{m}\sum_{j=1}^{m}(R_{ij} - E_i)^2, \text{being } R_{ij} \le E_i$$

I_i = Sustainability index attached to the ith security. In the next section some guidelines on how to calculate this index will be provided.
W_S, S = preferential weight and "satisficing" target value, respectively, for the "Savage criterion".
W_E, E = preferential weight and "satisficing" target value, respectively, for the "expected return criterion".
W_V, V = preferential weight and "satisficing" target value, respectively, for the "negative semi-variance criterion".
W_I, I = preferential weight and "satisficing" target value, respectively, for the "sustainability criterion".

The basic structure of the "goal games" against nature is the following (see for technical details Rehman and Romero (2006)).

Goals:

$$\sum_{i=1}^{n} E_i x_i + n_E - p_E = E \tag{1}$$

$$\sum_{i=1}^{n} S_{ij} x_i + n_{Sj} - p_{Sj} = S \quad j \in \{1,\ldots,m\} \tag{2}$$

$$\sum_{i=1}^{n} V_i x_i + n_V - p_V = V \tag{3}$$

$$\sum_{i=1}^{n} I_i x_i + n_I - p_I = I \tag{4}$$

Constraints:

$$\sum_{i=1}^{n} x_i = 1 \tag{5}$$

$$x_{i\min} \le x_i \le x_{i\max} \quad i \in \{1,\ldots n\} \tag{6}$$

The above constraints guarantee that all the wealth will be invested as well as that there are possible upper and lower bounds for the fraction invested in each security as is usual in the financial practice.

Regarding the block of goals, it is of interest to note that the negative deviation variables n_E, n_{Sj}, n_V and n_I quantify the under-achievement with respect to the target values, while the positive deviation variables p_E, p_{Sj}, p_V and p_I quantify the opposite effect, that is, the over-achievement from the target values. Since the expected returns and the sustainability criteria derive from attributes of the type "more is better", then the unwanted deviation variables to be minimized will be the negative ones (i.e., n_E and n_I) and as the "regret" and the semi-variance criteria derive from attributes of the type "less is better", then the unwanted deviation variables to be minimized will be the positive ones (i.e., p_{Sj} and p_V). Consequently in order to obtain a "satisficing" portfolio, a certain function of these unwanted deviation variables has to be minimized as follows:

$$\text{MIN} = F(n_E, \sum_{j=1}^{m} p_{Sj}, \text{pv}, n_I) \tag{7}$$