Selection of Socially Responsible Portfolios Using Hedonic Prices

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1 Introduction

Various initiatives have been launched to assess the SEE dimensions in investment decisions [1–4]. The majority of the measures of responsible and irresponsible corporate behaviour presented in the literature are constructed from the databases of independent agencies (Vigeo, EIRIS, KLD ...) that to a large extent rely on publicly observable events (e.g. newspaper articles, Non-Governmental Organization reports, regulatory reports or company rankings) together with studies based on questionnaires to and interviews with stakeholder groups. The aim of this research is to provide a framework for constructing portfolios containing conventional and SRI assets, based on the application of the HPM [5] for the monetary valuation of socially responsible characteristics of financial assets [6]. We use multi-objective programming as a suitable mathematical technique for solving the portfolio selection problem, including several criteria in decision-making processes [7–10] in which the investment opportunities are described in terms of a set of attributes, with part of this set intended to capture and express the effects on society [4, 8, 11].

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2 Optimality of SRI Portfolios: A Multi-objective Programming Model

2.1 An Evaluation of Social Criteria for Portfolio Selection: Application of Hedonic Price Methodology

In this paper, a measurement strategy that evaluates the social responsibility of a portfolio based on the HPM [5] is constructed. The HPM breaks away from the traditional view that goods are the direct objects of utility; on the contrary it assumes that utility is derived from the properties or characteristics of the goods themselves. This method allows us to relate the price of SRI funds with their SEE characteristics and to obtain a monetary valuation for these features according to market. This is the so-called hedonic price of the characteristic. The theoretical foundations of the hedonic pricing model are based on what is known as the New Approach to Consumer Theory [13]. Our application of the hedonic pricing method to the financial market of SRI funds assumes that these funds are different due to their financial and social responsibility characteristics; in addition, the market values them on the basis of such characteristics. These prices are used to define the criteria of social responsibility for a portfolio of mutual funds as exposed below.

Let x_i denote the units to be allocated to the mutual fund i. If we consider a market of n mutual funds, a portfolio is represented by the n-dimensional vector $x = (x_1, \ldots, x_n)$. For the portfolio x, its exposure to a certain attribute f can be calculated as a weighted average of the attribute exposures of the individual mutual funds contained in this portfolio [11]. In our research this is done in the following way:

$$SR_f(x) = \sum_{i=1}^{n} pt_{if} P_{iT} x_i \tag{1}$$

where pt_{if} denotes the score of mutual fund i on the attribute f and P_{iT} denotes the price at the investment date T of the generic i-th mutual fund. The uni-dimensional functions (1) are combined in a linear aggregation using the hedonic price of each attribute f:

$$SR(x) = \sum_{f=1}^{F} h_f^* SR_f(x) \tag{2}$$

where h_f^* denotes the normalized hedonic price of attribute f. The expression (2) determines the objective of social responsibility that will be maximized in the portfolio selection.

2.2 An Evaluation of Financial Criteria for Portfolio Selection

The financial objective employed in this work is the final absolute wealth i.e. the value of the portfolio at the investment horizon. In this work, the certainty-equivalent is used as a preference index and the variance as risk measure, other risk measures as the CVaR (Conditional Value at Risk) [14] can be used. With regard to the constraints, the usual ones have been considered; the budget constraint and short sales are not allowed.

$$\left.\begin{array}{ll} max & EVE(x) = \sum_{i=1}^{n} E[P_i]x_i \\ min & RM(x) \\ max & SR(x) = \sum_{f=1}^{F} h_f^* SR_f(x) \\ s.t. & \\ & x \in X \end{array}\right\} \text{(PS-SRI)} \quad (3)$$

where $EVE(x)$ is the Expected Value of the portfolio x at the end of the investment horizon, $E[P_i]$ is the expected price of asset i and $RM(x)$ denotes a Risk Measure of the portfolio x.

3 A Procedure for SRI Portfolio Selection

A two-stage procedure based on a financial reference point and the maximization of SR criterion is built.

- Stage 1: *The Best Financial Performance Portfolio.* This stage is carried out in two steps: Step 1: An approximation of the $EVE - RM$ efficient frontier is obtained by applying ϵ-constraint method to the corresponding bi-objective problem.
  Step 2: The certainty-equivalent of final wealth is used to obtain the portfolio of maximum financial satisfaction [15]. The expected utility of each portfolio is calculated (Monte Carlo simulations) using sample prices, and on the basis of this information, the certainty-equivalent of each portfolio is estimated. The maximum certainty-equivalent provides the portfolio of maximum financial satisfaction for which EVE and RM values are denoted by EVE^* and RM^*, respectively.
- Stage 2: *The Best Socially Responsible Portfolio.* In this stage, a multi-objective problem is solved by the ϵ-constraint method. The objective is the maximization of the SR and the bounds of the EVE and RM values are closer to those of the maximum financial satisfaction portfolio that have been found in Step 2 of Stage 1, such bounds being denoted by EVE^*_{-1} and RM^*_{+1} . This problem is solved and then, we test whether the solution of problem is efficient with regards to the financial satisfaction and social responsibility criterion; otherwise, a better portfolio on the financial efficient frontier is selected.

4 Application to the Case of the Spanish Market

This study uses a data set consisting of 142 conventional funds and 18 SRI funds domiciled in Spain. Therefore, $n = 160$. We have daily prices from March 10, 2006 to December 31, 2009; thus, 995 observations for each mutual fund are available. Setting an estimation horizon of one week (i.e. 5 trading days), the investment time is $T = 196$ (December 31, 2009). The investment horizon has been set equal to one month (four weeks). As market invariants, we have chosen the non-overlapping weekly compounded. After describing our market, we will obtain the SRI portfolio. The SEE characteristics are included in the investment policy of SRI funds published by the Spanish National Securities Market (CNMV). There is a long list of SEE characteristics for SRI products. The principal components factor analysis technique is used by Bilbao and Canal [6] in order to reduce the number of these characteristics and correct the collinearity which exists between them prior to estimating the hedonic function. A factor is calculated as the un-weighted average value of the characteristics involved. The four resulting factors (*Product Responsibility Area*, *Labor Rights Area*, *Environmental Area* and *Gender Equality and Community Relations Area*) are used as the inputs for the multi-objective portfolio model. The prices obtained from estimating the hedonic regression for the four areas of social responsibility, expressed in millions of Euros are:

$$\left.\begin{array}{l} h_1 = 19,5393 \; h_2 = 19,5393 \\ h_3 = 22,3017 \; h_4 = -14,3475 \end{array}\right\} \text{(Hedonic Prices)} \tag{4}$$

To construct an objective that measures the Socially Responsible Quality of the portfolio according to a specific market, we use only the positive hedonic prices that consider a set of SEE characteristics for which the market is willing to pay.

4.1 Markowitz's Approach (EVE-Variance)

In order to determine the reference portfolio (with Initial wealth = 100), i.e. the maximum financial satisfaction portfolio, we have approximated the EVE-Variance financial efficient frontier and the certainty-equivalent has been used with an exponential utility function: $U = -exp(-(\frac{f(x)}{5}))$ where $f(x)$ is the final wealth and 0.2 is the Arrow-Pratt risk aversion (other types of utility functions can be used). The maximum certainty–equivalent on efficient portfolios determines the reference portfolio whose composition and characteristics are included in following tables (Tables 1, 2).

Once the portfolio of maximum satisfaction on the efficient frontier is obtained, we calculate the SRI optimal portfolio by solving the following uni–objective problem:

Table 1 Composition of the reference portfolio

Creacion de Cultura en Espanol FI	11.43
Banif global 3-98 FI	34.76
AC inversion selectiva FI	2.84
Metropolis renta FI	32.69
Prismafondo FI	10.00
Banif 2011 FI	8.28

Table 2 Characteristics of the reference portfolio

Variance = 0.526	EVE = 100.382
SR = 6.201	Satisfaction = 100.293

Table 3 Composition of the SRI–optimal portfolio

Creacion de Cultura en Espanol FI	11.40
Santander responsab. conserv. FI	44.95
Banif global 3-98 FI	32.45
AC inversion selectiva FI	4.13
Banif 2011 FI	7.06

Table 4 Characteristics of the SRI–optimal portfolio

Variance = 0.7520	EVE = 100.368
SR = 133.008	Satisfaction = 100.244

$$\left.\begin{array}{ll} max & SR(x) = \sum_{f=1}^{3} h_f^* SR_f(x) \\ s.t. & \\ & EVE(x) \geq 100.3582 \\ & Variance(x) \leq 0.752 \\ & x \in X \end{array}\right\} \tag{5}$$

in which the bounds of the EVE and the variance correspond to the "closest" point to that of the maximum financial satisfaction portfolio. The solution to the problem (5) is shown in the following tables (Tables 3, 4).

5 Conclusion

This paper presents an approach for portfolio selection based on the market valuation of the social responsibility of financial assets and multi–objective programming tools. The particular characteristics of our framework are: A multi-dimensional description of the investment opportunities together with the reduction data in order to identify the dimensions of SRI is used. A new measure of SRI which is not restricted to a particular investor, group of experts or stakeholders is proposed. The procedure is applicable to a broad public and should not require detailed a priori preference information from the investor. The method could be extended to any market because

it is based on public information. It provides information about the losses suffered by those investing in funds with SRI criteria and this supports the choice between conventional versus SRI investments. The model has been applied to a sample of 160 SRI and conventional funds domiciled and managed in Spain. Empirical results show that the financial sacrifice for investing in socially responsible funds is relatively small for "cautious" investors. These results could be good news for socially responsible investors.

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