Constructing Portfolios Using Argumentation Based Decision Making and Performance Persistence of Mutual Funds

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Abstract

This paper proposes an argumentation based tool for the selection of mutual funds and then the composition of efficient portfolios based on the performance persistence of the mutual funds. Argumentation allows for combining different contexts and preferences in a way that can be optimized. It allows for defining a set of different investment policy scenarios and supports the investor/portfolio manager in composing efficient portfolios that meet his profile. Moreover, the proposed methodological approach and the obtained portfolios are validated through their comparison to the return of the Market Index and with portfolios obtained using a traditional performance index. This approach is applied on data of Greek domestic equity mutual funds over the period 2000-2011 with encouraging results.

KEYWORDS

Decision making, Argumentation, Performance Persistence, Mutual Funds, Portfolio Management

1. INTRODUCTION

The traditional portfolio theory developed by Markowitz (1959), accommodates the portfolio selection problem on the basis of the existing trade-offs of risk and return in the mean-variance context. On the same mean-variance basis several other approaches for the evaluation of funds portfolios have been developed, including the Capital Asset Pricing Model-CAPM (Mossin, 1969), the Arbitrage Pricing Theory-APT (Ross, 1976), single and multi-index models, average correlation models, mixed models, utility models, etc (see Elton and Gruber, 1995). Many of these models were based on a unidimensional nature of risk approach, and did not capture the complexity presented in the data. The portfolio selection problem is often addressed through a two-stage procedure. At a first stage an evaluation of the available securities is performed. This involves the selection of the most proper securities on the basis of the decision makers' investment policy. At a second stage, the portfolio composition is performed which involves the computation of the proportion of the initial budget that should be allocated in the selected funds.

The present study extends our previous work (Pendaraki and Spanoudakis, 2012), which uses argumentation-based decision making (Kakas and Moraitis, 2003) for selecting the proper securities, in our case, mutual funds (MF). Our approach gives the opportunity to an investor/portfolio manager to define different investment scenarios according to his preferences, attitude (aggressive or moderate) and the financial environment (e.g. bull or bear market), in order to select the best mutual funds which will compose the final portfolios.

The contribution of this work is the validation of our hypothesis that composing portfolios taking into account the past performance of mutual funds is more efficient than our naïve approach. Firstly, we confirmed our findings that there is statistically significant performance persistence for 1-year and 4-years holding periods through the "winner-winner, winner-loser" methodology developed by Brown and Goetzmann (1995), Goetzmann and Ibbotson (1994), and Malkiel (1995). Then we used two different strategies, the naïve portfolio with equal weights and the portfolio participation based to the fund's performance in the past in order to define the magnitude of its participation in the final portfolio.

To illustrate the validity of the proposed approach we compare our findings with those using a traditional performance index (the Sharpe index) and a broad domestic market index (the Athens Stock Exchange General Index). To our knowledge, this study uses, for the first time, the combination of argumentation-based decision making for selecting the proper funds and the "winner-winner, winner-loser" methodology for composing efficient portfolios that outperform the market.

In what follows, we firstly present our data set, and then sections three and four discuss the proposed methodology. Section five presents our obtained results, while section six concludes.

2. DATA SET DESCRIPTION

The sample used in the present study is provided from the Association of Greek Institutional Investors and consists of daily data of domestic equity mutual funds over the period January 2000 to December 2011. Based on this information, we compute five fundamental variables that measure the performance and risk of the MFs:

(1) *Return of the funds*: The return on a MF investment in a given time period is calculated by taking into account the change in a fund's net asset value. The fund's return in period *t* is defined as follows:

$$R_{pt} = \frac{NAV_t + DIST_t - NAV_{t-1}}{NAV_{t-1}},$$

where R_{pt} is the return of a mutual fund *p* in period *t*, NAV_t is the closing net asset value of the fund on the last trading day of the period *t*, NAV_{t-1} is the closing net asset value of the fund on the last trading day of the period *t-1*, and $DIST_t$ is the income and capital distributions (dividend of the fund) taken during period *t*.

(2) The *standard deviation* is the most commonly used measure of variability. For a MF the standard deviation σ is used to measure the variability of its daily returns and is defined as follows:

$$\sigma = \sqrt{(1/T)\sum(R_{pt} - \bar{R}_{pt})^2},$$

where σ is the standard deviation of the MF in period *t*, $\bar{R}_{pt}$ is the average return in period *t*, and *T* is the number of observation (days) in the period for which the standard deviation is being calculated.

(3) The *beta coefficient* (*β*) is a measure of a fund's risk in relation to the capital risk. The *β* coefficient shows the sensitivity of mutual funds' value on the increasing and decreasing ratings of financial market and is defined as follows: $\beta = cov(R_{pt}, R_{Mt}) / var(R_{Mt})$, where $cov(R_{pt}, R_{Mt})$ is the covariance of the daily return of a MF with the daily return of the market portfolio (Athens Stock Exchange), and $var(R_{Mt})$ is the variance of the daily return of the market portfolio.

(4)The *Sharpe index* (Sharpe, 1966) is used to measure the expected return of a fund per unit of risk, defined by the standard deviation. This measure is defined as the ratio $(R_{pt} - R_{ft}) / \sigma$ where R_{ft} is the return of the risk free portfolio in period *t*, which is calculated from the three month Treasury bill.

(5) The *Treynor index* (Treynor, 1965) is obtained by simply substituting volatility for variability in the Sharpe index. This measure is defined as the ratio $(R_{pt} - R_{ft}) / \beta$. The evaluation of MFs with these two indices shows that a MF with higher performance per unit of risk is the best-managed fund, while a MF with lower performance per unit of risk is the worst managed fund.

The examined funds are classified in three homogeneous groups for each one of the aforementioned variables. The three groups are defined according to the value of the examined variables for each MF. For example, we have funds with high, medium and low performance (return), funds with high, medium and low beta coefficient, etc. Thus, we have 180 groups (12 years x 3 groups x 5 variables) in total.

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3. ARGUMENTATION BASED DECISION FRAMEWORK

Argumentation can be abstractly defined as the principled interaction of different, potentially conflicting arguments, for the sake of arriving at a consistent conclusion. In our work we adopt the argumentation framework proposed by Kakas and Moraitis (2003), where the deliberation of a decision making process is captured through an argumentative evaluation of arguments and counter-arguments. A theory expressing the knowledge under which decisions are taken compares alternatives and arrives at a conclusion that reflects a certain policy. It is a rule-based approach, where rules also define context-based priorities between rules.

Briefly, an argument attacks (or is a counter argument to) another when they derive a contrary conclusion. These are conflicting arguments. A conflicting argument is admissible if it counter-attacks all the arguments that attack it. It counter-attacks an argument if it takes along priority arguments and makes itself at least as strong as the counter-argument.

In defining the decision maker's theory we specify three rule levels. The first level defines the (background theory) rules that refer directly to the subject domain, called the *Object-level Decision Rules*. In the second level we have the rules that define priorities over the first level rules for each *role* that the decision maker can assume or *context* that he can be in (including a *default context*). Finally, the third level rules define priorities over the rules of the previous level (which context is more important) but also over the rules of this level in order to define *specific contexts*, where priorities change again.

For capturing the experts knowledge we consulted the literature but also the empirical results of applying the found knowledge in the Greek market. We identified several contexts, i.e. two types of investors, *aggressive* and *moderate*, an investor policy (selection of portfolios with *high performance per unit of risk*), and two market contexts, *bull* (rising market) and *bear* (declining market).

In a bull market context, funds which give larger returns in an increasing market (those with high systematic or total risk) are selected. On the other hand, in a bear market, funds which give lower risk and their returns are changing more smoothly than market changes (those with low systematic and total risk) are selected.

An aggressive investor is placing his capital upon funds with high return levels and high systematic risk (risking for higher returns). A moderate investor prefers funds with high return levels and low or medium systematic risk.

Some types of investors select portfolios with high performance per unit of risk. Such portfolios are characterized by high reward-to-variability ratio (Sharpe ratio) and high reward-to-volatility ratio (Treynor ratio). These portfolios are the ones with the best managed funds.

The specific contexts are formed by combining the above roles and contexts. Priorities over possibly conflicting rules are defined. For the details of the combined contexts the reader can consult Pendaraki and Spanoudakis (2012).

4. PERFORMANCE PERSISTENCE AND PORTFOLIO COMPOSITION

An analysis of the persistence of equity mutual funds is conducted for the twelve year period (2000-2011), where a fund is defined to persist, if for consecutive time periods, it has returns above the median of the examined sample, relative to comparable funds. This study applies the "winner-winner, winner-loser" methodology, which is complemented with three contingency table tests precisely the Z-test for repeat winners (Malkiel, 1995), the Odds Ratio Z-statistic (Brown and Goetzann, 1995) and the Chi-Square statistic (Khan and Rudd, 1995), already applied in the financial literature (Vicente and Ferruz, 2005; Vidal-García, 2013).

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A contingency table is used in order to identify the frequency with which funds are defined as winners (W–a fund with returns above the median) and losers (L–a fund with returns below the median) over successive time periods. The three statistical tests used to examine the performance persistence of the examined funds are described below.

Malkiel's Z-test (1995): $= (\text{Y-np}) / \sqrt{(\text{np(1-p)})}$, which shows the proportion of repeat winners (WW) to winner-losers(WL),where Z is the statistic variable that follows a normal distribution (0,1), Y is the number of winner funds in two consecutive periods, n is the sum of WW+WL, p is the probability of a winner fund in one period to repeat as a winner in the subsequent period.

Brown and Goetzann Odds Ratio (OR) (1995): $= (\text{WW*LL})/(\text{WL*LW})$. Using this ratio, the statistical significance of the OR is determined applying a Z-test to the following Z variable which follows a normal distribution (0,1), $Z = \ln(\text{OR})/\sigma_{\ln(\text{OR})}$.

Khan and Rudd Chi-Square statistic (1995):

$$x^2 = \sum_{i=1}^{n}\sum_{j=1}^{n}(O_{ij} - E_{ij})^2 / E_{ij} \ ,$$

where O_{ij} and E_{ij} are the actual and expected frequency of the *i*th row and the *j*th column in the contingency table respectively.

Table 1 shows the contingency table of fund returns along with the results of the statistical tests of the null hypothesis of no performance persistence between consecutive periods. Thus, 53% of all winners in any year are winners in the next year (called Repeat Winners-RW), i.e. 179 (WW) of 336 (WW+WL). The percentage of RW for 2, 3 and 4 years are 52%, 51% and 59% respectively. The results of the examined tests show strong evidence of statistical significance performance persistence for 1-year and 4-years holding periods. More precisely, according to the first two tests, the percentage of RW is above 50% while the Z-test is also above zero and statistical significant, thus is indicative of performance persistence. The same results come from the OR ratio that is greater than one and the Z-stat which is also statistical significant. Thus, the results of the test statistics show that, at the overall level, there is evidence of performance persistence according to all three criteria for 1-year and 4-years holding periods.

Having selected the funds that will compose the investment portfolios through the argumentation-based reasoning phase, we then had the challenge of choosing the participation percentage of each one of them to the final portfolio through two different strategies. Firstly, the naïve portfolio with equal weights, $w_i = 1/N$ where w_i is the proportion of the available capital invested in the selected funds and N is the number of the selected funds. Secondly, the portfolio participation based on the fund's performance persistence:

$$w_i = \sum_{y=y_h}^{y_0} h_i^y / \sum_{j=1}^{N}\sum_{y=y_h}^{y_0} h_j^y \ ,$$

where y_h is the year from which we have historical data, y_0 is the year of the investment, H^y contains the returns of funds above the median and r_i^y is the return of the fund *i* for year *y*.

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Table 1: Overall Performance Persistence

YEAR	N	WW	LW	WL	LL	LG	WG	RW	Z-TEST	OR	σ	Z-STAT	CHI-Sq
Consecutive	712	179	141	157	171	40	24	0.53	1.20 (0.23)	1.38	0.16	2.05* (0.04)	10.40** (0.00)
2 year lag	661	148	123	134	140	64	52	0,52	0.83 (0.41)	1.26	0.17	1.33 (0.18)	22.51** (0.00)
3 year lag	604	121	106	118	109	84	66	0,51	0.19 (0.85)	1.05	0.19	0.28 (0.78)	37.36** (0.00)
4 year lag	539	115	77	81	102	88	76	0,59	2.43* (0.02)	1.88	0.21	3.02** (0.00)	63.09** (0.00)

*A fund that ceases operation and was a winner or loser during the previous year is defined as winner-gone (WG) or loser-gone (LG), σ-the standard error of the logarithmic Odds Ratio, P-values in parenthesis, *5% significant, **1% significant.*

Table 2: Argumentation vs Sharpe: Average Risk and Return of Naïve and Performance Persistence (PP) based Portfolios

	Argumentation-Naïve		**Sharpe-Naïve**		**Argumentation-PP**		**Sharpe-PP**	
Contexts	**Variance**	**Return**	**Variance**	**Return**	**Variance**	**Return**	**Variance**	**Return**
General	246.33	-9.73	262.89	-10.06	250.49	-9.30	283.93	-9.69
Bull Market	241.73	-10.00	327.26	-10.16	263.76	-9.42	316.71	-9.86
Bear Market	185.20	-8.98	341.00	-10.96	179.73	-8.94	336.33	-10.88
Moderate	234.78	-10.19	271.07	-9.69	235.93	-9.66	287.54	-9.31
Moderate - Bull	245.64	-9.57	314.93	-8.81	242.43	-9.22	314.08	-8.06
Moderate – Bear	201.96	-9.53	349.50	-11.48	194.73	-9.35	346.63	-11.03
Aggressive	292.81	-9.62	379.66	-10.38	297.26	-9.21	369.36	-9.65
Aggressive – Bull	241.73	-10.00	327.25	-10.16	263.76	-9.42	316.71	-9.86
Aggressive – Bear	241.58	-9.00	294.34	-9.86	241.35	-8.88	298.37	-9.51
High Performance	264.90	-9.68	323.81	-9.91	279.63	-9.32	313.92	-9.71
High Perf. – Bear	243.09	-9.12	326.07	-9.73	249.97	-8.79	319.35	-9.40
High Perf. – Aggressiv	274.34	-9.67	311.07	-10.18	288.16	-9.31	303.58	-9.94
High Perf. – Bull	264.96	-9.68	323.81	-9.91	279.63	-9.32	313.92	-9.71
High Perf. - Moderate	250.44	-9.76	272.63	-10.04	252.55	-9.30	291.88	-9.74
ASE	434.61	-12.74	434.61	-12.74	434.61	-12.74	434.61	-12.74

5. EMPIRICAL RESULTS AND SYSTEM VALIDATION

For evaluating our results we defined scenarios for the last years of our data set (2006-2011) so that we had the possibility to exploit performance persistence. That resulted to 13 different scenarios run for 5 years each. Each one of the examined scenarios leads to the selection of different number and combinations of MFs. Table 2 presents the average performance of the constructed portfolios (risk and return), for the period (2006-2011) for all different contexts and for the naïve and the performance persistence-based portfolio participation strategies. Investors are assumed to measure the level of return by computing the expected value of the distribution, using the probability distribution of expected returns for a portfolio, while risk is assumed to be measurable by the variability around the expected value of the probability distribution of returns, the variance. The portfolio return is the weighted average return of the funds included in the portfolio, while the variance of a portfolio combination of funds is equal to the weighted average covariance of the returns on its individual funds.

The evaluation of the proposed approach and the obtained portfolios in year *t*, is performed through their comparison to the performance of the Athens Stock Exchange General Index (final row of Table 2), in year *t+1*. Table 2 validates both our claims. Firstly, it provides evidence that argumentation-based funds selection is better than traditional approaches, comparing our portfolios with those obtained when we select an equal number of funds based on their performance using the traditional financial performance

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index, the Sharpe index, and also comparing them with the Athens Stock Exchange index. Secondly, it provides evidence that performance persistence based portfolio composition leads to better performing portfolios than the naïve choice.

6. CONCLUSION

This contribution presents a tool, which allows a decision maker (fund manager) to construct effective multi-portfolios of MFs under different, possibly conflicting contexts. The empirical results of our study showed that our tool is well suited for this type of applications giving answers to two important questions: (1) which MFs are the most suitable to invest in, and (2) what portion of the available capital should be invested in each of these funds. The proposed approach gives the opportunity to a decision maker (fund manager) to construct multi-portfolios of MFs in period *t*, that have the ability to achieve higher returns than the ones achieved from the ASE-GI in the next period, *t+1*. The proposed tool has been validated using the data set described in this paper and is available for demonstration at the Applied Mathematics and Computers Laboratory (AMCL) of the Technical University of Crete, Greece. It is intended for use by banks, investment institutions and consultants, and the public sector.

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