A Heuristic Model to Find Optimal or Realistic Target Industry Sectors

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Policymakers or prospective investors recognize a continuing need to find target industry sectors to expand or contract for a sustainably healthy economy or investment portfolios. This paper discusses how to apply an optimal portfolio theory to selecting target industry sectors. With the information technology and the analytical approach in mind, this paper provides an operational and workable framework for selecting target industry sectors for an economy. The application incorporates the capital asset pricing model, ways to find excess return to risk ratios, unsystematic risk measures, etc. First, this paper shows a practical approach to finding the optimal weights for target industry sectors. Second, this paper develops a heuristic framework for analyzing the performance of industry sectors to construct realistic mixes of industry sectors.

Keywords: planning models, portfolio choice

INTRODUCTION AND LITERATURE REVIEW

This paper discusses how to apply optimal portfolio theory to practical applications. With the AI technological advance and sophistication of the portfolio application models, this paper may provide an operational and workable framework for constructing optimal or heuristically realistic portfolios of industry sectors for many useful purposes. The application incorporates the capital asset pricing model, ways to find the excess return to risk ratios, and unsystematic risk measures. Using a spreadsheet model, this paper shows a practical approach to finding the specific weights for optimal or realistic portfolios. It begins by focusing on showing a sequence of steps to follow for an optimal portfolio of components.

This paper supplements the optimal portfolio construction technique originally introduced by Elton, Gruber, and Padberg (Elton, et.al., 1978) (henceforth, the "EGP technique") to incorporate realistic components into the portfolio. Supplementation is necessary because the original EGP technique is not designed to deal with realistic situations for suboptimization. This paper constructs the portfolios with and without the components of forced inclusion using the EGP technique. The operational definition of a "realistic portfolio" is a portfolio with the adjusted components for inclusion; an "optimal portfolio" is a portfolio without modifying the components of forced inclusion dictated by the EGP technique. The heuristic possibilities for portfolio modifications for practitioners are as follows: 1) Practitioners have to exercise the utmost care about what numbers they input to an optimizer. For example, dumping 20 years of monthly data on broad asset classes into an optimizer will earn you what you deserve: poor performance; 2) The correlation coefficients between components should be low; 3) The key to a successful portfolio allocation decision is to have very good estimates for risk and return and the makeup of the portfolio can be determined heuristically through risk-return ratios (Padberg, 2009).

The following section discusses the methodology for portfolio optimization and heuristic modification to portfolio optimization with numerical examples in two tables of optimal and realistic portfolio constructions. It is followed by a conclusion and references.

METHODOLOGY

Applying the conventional capital asset pricing concept, the following model is used:

$$R_i = R_f + (R_m - R_f)\beta_i \quad (1)$$

where: R_i = expected rate of return of i-th industry sector,
R_f = expected risk-free return,
R_m = expected market rate of return,
$ß_i$ = the industry beta; i-th industry's systematic sensitivity of return concerning the overall market (Rm), i.e., all sectors combined to be used as a market proxy.

The first step for determining the optimal portfolio based on the original EGP technique is to find "excess return to beta ratios" for the components under consideration and rank them from highest to lowest. This will rank the components in terms of relative performance based on return per unit of systematic risk contained. However, a problem arises when a component with a low excess return to beta ratio has to be included realistically, maybe due to a strategic reason. However, the EGP technique dictates that this component should be forced to rank low and be excluded from the optimal mix solution. Therefore, this paper will find a solution to this problem by constructing a realistic portfolio to incorporate the forced inclusion of all components.

The essential steps of the EGP technique are as follows. First, find "excess return to beta ratios" for components under consideration; rank them from highest to lowest. This will rank the components in terms of relative performance based on return per unit of systematic risk contained. Second, set the cutoff ratio (C*) to include those components qualified for the optimum mix. The optimum mix will consist of all components for which the individual component's "excess return to beta" ratio is greater than the cutoff ratio Ci (= C*). This optimum cutoff rate is determined by finding the last individual component's so-called C ratio which is less than its "excess return to beta" ratio or its equivalent in the ordered list in the first step. The individual component's C ratio is found by solving a mathematical objective function to maximize the tangency slope of excess return to the component's risk measure with the constraint that the sum of the proportions of individual components included in the mix equals to 1. Third, after finding the cutoff ratio (C*) and the components for the optimum mix, the percentage of each component for the optimum portfolio is calculated as shown in TABLE 1; however, to force including all sectors for consideration in a realistic portfolio, the C* is heuristically 0 (zero) only for the realistic portfolio construction as shown in TABLE 2. The percentage of i-th component (Xi) in the optimum portfolio is:

$$X_i = Z_i / \sum_{i=1}^{N} Z_i * 100 \quad (2)$$

Zi = Bi/σ2e,i*((Ri-Rf)/Bi–C*) (3)

where: $\sigma^2_{e,i}$ = nonmarket variance of i-th industry sector,
Rf = risk-free rate,
Ri = the rate of return of i-th industry sector,
Bi = the systematic risk of i-th industry sector.

The paper uses the following numerical example to explain the procedure for implementing the optimal or realistic portfolio. The average industry betas and standard deviations of return are based on the stock data for the companies included in the industry sector. The average of all sectors to be examined serves as the market proxy. It takes the following specific steps: (1) based on the country's stock market index data, it finds annualized arithmetic mean return, standard deviation, and variance for the market proxy used in the model. (2) It finds an "excess return to beta" ratio for each industry group. The beta and return data for each industry sector represents the projected 3–5-year average return for the industry group. The sector beta and excess return represent each industry sector's projected 3-5 years. The "excess return" means the return over the risk-free rate, in which the annualized 3-month T-bill rate projection for 3-5 years is used as a risk-free rate proxy. The "excess return to beta" ratio is also called the "Treynor ratio." (3) It calculates the nonmarket variance of each industry sector (σ_{ei}^2). The nonmarket variance of each sector is one of the critical variables in the model. This is indirectly calculated by the following equation.

$$\sigma_{ei}^2=\sigma_i^2-ß_i^2*\sigma_m^2 \quad (4)$$

where: σ_i = standard deviation of the industry's return over 3-5 years of the projected period,
σ_m = standard deviation of the market's return over 3-5 years of the projected period,
$ß_i$ = the industry sector beta, i.e., the industry's systematic sensitivity of return concerning the overall market over 3-5 years of the projected period.

(4) It ranks the industries based on the "excess return to beta" ratios and finds the cutoff ratio, C*. In principle, all industries whose excess return-to-risk ratio is above the cut-off rate are selected and those whose ratios are below the cut-off ratio are rejected against inclusion in the optimal composition. (5) It finds the realistic weight for each industry sector inclusively while ignoring the cut-off ratio by setting C* to zero (0). Next, it finds the optimum weight for each industry sector by utilizing the C*. TABLE 1 shows the optimal weights and TABLE 2shows the realistic weights. (6) TABLE 1 and TABLE 2 use the following hypothetical data for the market proxy: mean return, 3.37%; standard deviation, 2.06%; variance, 4.2021%^{2}; the risk-free rate (Rf), 5.7%, which represents a 3-month interest rate on the national government security like Treasury bill.

TABLE 1
DETERMINING OPTIMAL MIXES OF MAJOR INDUSTRY SECTORS OF AN ECONOMY USING THE ELTON-GRUBER-PADBERG TECHNIQUE

Sector Description	**Ci**		**(Ri-Rf)/Bi**	**Zi**	**Xi Weight**
Wholesale Trade	4.033		10.646	0.257	**50.49%**
Finance,Ins.& RE	6.794		10.588	0.171	**33.69%**
Services	8.328	<=C*	9.949	0.08	**15.82%**
Retail Trade	9.464		9.041		
Construction	10.592		8.838		
Transp, Comm.	13.01		8.361		
Manufacturing	13.35		5.846		
Mining	1.14		-0.37		
			SUM OF Zi =>	0.508	100.00%

Footnotes:
(Ri-Rf)/Bi: Treynor ratio for i-th industry sector. C*: the last industry sector's C ratio which is less than its Treynor ratio in the descending order of Treynor ratios.

TABLE 2
DETERMINING REALISTIC MIXES OF MAJOR INDUSTRY SECTORS OF AN ECONOMY USING A MODIFIED ELTON-GRUBER-PADBERG TECHNIQUE

Sector Description	Ci	(Ri-Rf)/Bi	Zi	Xi Weight
Wholesale Trade	4.033	10.646	1.179	**23.96%**
Finance,Ins.& RE.	6.794	10.588	0.803	**16.31%**
Services	8.328	9.949	0.494	10.03%
Retail Trade	9.464	9.041	0.413	8.40%
Construction	10.592	8.838	0.434	8.81%
Transp., Communication	13.01	8.361	1.351	**27.46%**
Manufacturing	13.35	5.846	0.259	5.26%
Mining	1.14	-0.37	-0.012	-0.24%
		SUM OF Zi =>	4.921	100.00%

Footnotes:
(Ri-Rf)/Bi: Treynor ratio for i-th industry sector.
C* =0 for including all sectors in the realistic portfolio construction.

CONCLUSION

This paper demonstrates a methodological framework for finding optimal and realistic mixes of industry sectors of an economy. The paper suggests two levels of recommendation based on the optimal or realistic weights. For example, the recommendation based on the optimal weights would suggest expansion or contraction of the industry sector toward the optimal mix levels identified by the model. For example, as shown in TABLE 1, the model suggests that the industry sectors of Wholesale Trade (50.49%), Finance, Ins, & Real Estate (33.69%), and Services (15.82%) constitute the optimal combination.

Second, the recommendation based on the realistic weights would suggest expansion or contraction of the industry sectors identified by the model. For example, as shown in TABLE 2, the model recommends an emphasis on three industries. That is, Transp, Communication (27.46%), Wholesale Trade (23.96%), and Finance, Ins, & Real Estate (16.31%) would represent three industries to be weighted to the level realistically specified if so desired.

Comparing the current weights with the optimal or realistic weights would generate specific recommendation guidelines: If the current weight is greater than the latter, then one would recommend a contraction of that industry sector; if the current weight is smaller than the latter, then one would recommend an expansion of that industry sector. In sum, the methodological framework presented in this paper will help effectively diversify the industrial base of an economy or an investment portfolio optimally or realistically.

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