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COMPARISON OF PERFORMANCE BETWEEN MARKOWITZ MODEL AND ENHANCED INDEX TRACKING MODEL

(Perbandingan Prestasi antara Model Markowitz dengan Model Penjejakan Indeks Dipertingkat)

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ABSTRACT

The rapid growth of exchange-traded fund (ETF) in Malaysia and recommendation of investment professionals raise doubt on whether a portfolio which tracks the performance of an index will perform better than a carefully built portfolio, such as the one built by using the classical Markowitz Model. Thus, the composition of an optimal portfolio built based on the Markowitz model and enhanced index tracking model using the data of finance, plantation and industrial indices of the Malaysian stock market from 2012-2017 will be investigated. Comparisons are made on their risk-adjusted performance using expected return, the Sharpe ratio and information ratio. The study found that the Markowitz portfolio includes only 31.43% to 33.33% of the respective index components inside the portfolio built. Overall, the Markowitz model outperforms the enhanced index tracking model in constructing an optimal portfolio with a higher expected return, Sharpe ratio and information ratio in finance and industrial sectors.

Keywords: Optimal portfolio; Sharpe ratio; Information ratio

ABSTRAK

Pertumbuhan pesat dalam Dana Dagangan Bursa (ETF) di Malaysia dan saranan pakar pelaburan telah menimbulkan keraguan sama ada portfolio yang menjejaki indeks akan mempunyai prestasi yang lebih baik daripada portfolio yang dibina secara teliti dengan menggunakan model Markowitz. Oleh itu, komposisi portfolio optimum yang dibina berdasarkan model Markowitz dan model penjejakan indeks dipertingkat menggunakan data indeks kewangan, perladangan dan perindustrian pasaran saham Malaysia dari tahun 2012-2017 akan dikaji. Perbandingan dibuat berdasarkan prestasi kedua-dua model yang disesuaikan dengan risiko menggunakan pulangan jangkaan, nisbah Sharpe dan nisbah informasi. Kajian ini mendapati bahawa portfolio Markowitz hanya merangkumi 31.43% hingga 33.33% dari komponen indeks masing-masing dalam portfolio yang dibina. Secara keseluruhannya, prestasi model Markowitz mengatasi model penjejakan indeks dipertingkat dalam pembinaan suatu portfolio optimum dengan pulangan jangkaan, nisbah Sharpe dan nisbah Informasi yang lebih tinggi dalam sektor kewangan dan perindustrian.

Kata kunci: Portfolio optimum; nisbah Sharpe; nisbah Informasi

1. Introduction

A study by Fama and French (2010) found that out of the 3,156 actively managed mutual funds in the US, the average return for the period of 1984-2006 was 0.81% lower than the market return per year. Additionally, the iconic investor, Buffett (2016) suggested that investment in passive instruments such as a mutual fund or exchange-traded fund (ETF), which tracks the major stock index such as S&P 500, is a practical investment decision (Buffett 2016). At the same time, in the local financial market development, there was a 66% growth in the total volume of ETF Malaysia, with 28.9 million traded units in 2015 compared to only 17.4 million units in the previous year (Dhesi 2016). Combined with the findings in Fama and French (2010) and the local market development, Buffett's suggestion raises a doubt whether the performance of a passive investment can outperform a carefully built portfolio, such as the one built using Markowitz model.

The objectives of the study are to build an optimal portfolio using an enhanced index tracking model and Markowitz model; and to compare the performance of the portfolios via expected return, Sharpe ratio and information ratio. An optimal portfolio is defined as the one that generates the maximum expected return per unit of risk (Bilir 2016). Markowitz model is a classical model that uses the "expected returns-variance of returns" rule (E-V rule) in portfolio construction. Under this model, we construct a portfolio with a set of E-V combinations whereby the portfolio has minimum variance at a given expected return or maximum expected return at a given return variance (Markowitz 1952).

On the other hand, a portfolio created under the index tracking model can produce returns similar to the benchmark index with relatively fewer stocks (Jansen & van Dijk 2002; Roll 1992). Arising from the index tracking concept, the enhanced index tracking concept aims to generate excess returns over the benchmark index similar risk-adjusted performance of a market index (Canakgoz & Beasley 2009). Lam *et al*. (2017) recently proposed an enhanced index tracking model with two-stage mixed-integer programming that could be used to build an equity portfolio with a higher return and information ratio compared to the existing single-stage model.

2. Materials and Methods

In this study, the model proposed by Lam *et al*. (2017) is adopted to construct the portfolios. Then the portfolios' performance will be compared with three sectoral indices from the Malaysian financial market as the benchmark. The financial, plantation, and industrial sectors' data, dated 21 September 2018, consists of the price of sectoral indices, the price of each index component, and the three-month average discount rate on Treasury bills.

2.1 *Markowitz Model*

The Markowitz model can be formulated by maximizing the Sharpe ratio given by $\frac{R_P - R_f}{\sigma_P}$ subject to $\sum_{i=1}^{N} w_i = 1$ and $w_i \geq 0$ (see Estrada (2010) for example). In this formulation, R_P is the return of the optimal portfolio, R_f is the average risk-free rate of return, σ_P is the standard deviation of the optimal portfolio, w_i is the weight of component i in sectoral index and N is the number of stocks selected in optimal portfolio.

2.2 *Enhanced Index Tracking Model*

The enhanced index tracking model with a two-stage mixed-integer programming model as proposed by Lam *et al.* (2017) is formulated as the following:

First stage:

$$\text{Minimize } E = \sqrt{\frac{1}{T}\sum_{i=1}^{T}\left(R_{Pt} - R_{It}\right)^2} \tag{1}$$

subject to the following constraints:

$$\sum_{i=1}^{N} Z_i = K, \quad Z_i = \{0,1\}$$
$$L_i Z_i \leq x_i \leq U_i Z_i$$
$$\sum_{i=1}^{N} x_i = 1, \quad x_i \geq 0.$$

Second stage:

$$\max r_P = \sum_{i=1}^{N} r_i x_i \tag{2}$$

subject to constraints

$$\sum_{i=1}^{N} Z_i = K, \quad Z_i = \{0,1\}$$
$$L_i Z_i \leq x_i \leq U_i Z_i$$
$$\sum_{i=1}^{N} x_i = 1, \quad x_i \geq 0$$
$$E^* - \delta \leq E \leq E^* + \delta.$$

In this model, E is the tracking error, T is the number of periods, R_{Pt} is the return of the optimal portfolio at time t, R_{It} is the return of the benchmark index at time t, Z_i is the binary integer, with $Z_i = 1$ indicates that the stock i is included in the optimal portfolio and $Z_i = 0$ otherwise. K is the number of stocks selected in tracking the benchmark index, L_i and U_i are the lower and upper bounds of the fund proportion respectively on stock i, E^* is the optimal value of the tracking error obtained from the first stage, and δ is the allowable tolerance for tracking error. We set other parameters at $\delta = 0.0001$, $L_i = 0.001$ and $U_i = 1.00$ as suggested in Lam et al. (2017). However, the value of K will be set according to the number of stocks selected in portfolio construction under the Markowitz model for respective sectors.

2.3 *Evaluation of Optimal Portfolio Performance*

To evaluate the performance of the optimal portfolios, we first compute the expected return, Sharpe ratio and information ratio of each portfolio built. We then compare the performance between optimal portfolios built by different models. The expected return and the information ratio are given by (3) and (4), while the Sharpe ratio has been given in Section 2.1.

$$R_P = \sum_{i=1}^{N} w_i R_i \tag{3}$$

$$\text{Information Ratio} = \frac{R_P - R_B}{\sigma_{P-B}} \tag{4}$$

where R_i is the average return of component i, R_B is the average return of the benchmark index and σ_{P-B} is the standard deviation of the portfolio return in excess of the benchmark return. While both the Sharpe ratio and information ratio are the risk-adjusted return, Sharpe ratio measures the risk-adjusted return over the risk-free rate. It is applicable to any portfolio in general. Information ratio, on the other hand, measures the risk-adjusted return above the benchmark return and is more suitable for actively managed portfolios.

3. Results and Discussion

In this section, the results and analysis of the models applied on stocks in the three sectors, i.e., the financial, plantation, and industrial sectors. In total, each sector contains 31, 43 and 18 stocks.

3.1 *Optimal Portfolio*

Table 1 shows the optimal portfolio composition consisting of the stocks in the financial sector, together with their weightings in both models. Stocks that show a weighting value of 0.000000, simply imply that they were not selected under the respective model:

Table 1: Weights of components in the financial portfolio

Component	**Symbol**	**Serial Number**	**Weight**	
			Markowitz	Index Tracking
Allianz Malaysia Bhd	AINM	1163	0.181694	0.040029
AMMB Holdings Bhd	AMMB	1015	0.000000	0.030880
Aeon Credit Service Bhd	ANCR	5139	0.034142	0.000000
Apex Equity Holdings Bhd	APES	5088	0.009347	0.000000
BIMB Holdings Bhd	BIMB	5258	0.018468	0.047222
Bumiputra - Commerce Holdings Bhd	CIMB	1023	0.000000	0.144291
Hong Leong Bank Bhd	HLBB	5819	0.186270	0.087800
Hong Leong Financial Group Bhd	HLCB	1082	0.000000	0.070339
Johan Holdings Bhd	JHHS	3441	0.008466	0.000000
Kuchai Develop Bhd	KCDS	2186	0.024402	0.000000
LPI Capital Bhd	LOND	8621	0.104138	0.025172
MAA Group Bhd	MAAS	1198	0.039914	0.000000
Malayan Banking Bhd	MBBM	1155	0.000000	0.263129
Malaysia Building Society Bhd	MBSS	1171	0.000000	0.011513
Public Bank Bhd	PUBM	1295	0.000000	0.230448
RCE Capital Berhad	REDI	9296	0.048918	0.000000
RHB Bank Bhd	RHBC	1066	0.000000	0.049180
Syarikat Takaful Malaysia Bhd	TAKA	6139	0.344241	0.000000
Number of stocks selected from the sector			11	11

Table 1 shows that TAKA has the highest weight (0.344241) in the Markowitz portfolio, while JHHS has the lowest weight (0.008466). For the enhanced index tracking model, MBBM dominates the portfolio with a weight of 0.263129, while MBSS has the lowest weight of 0.011513 in the portfolio. Four stocks that were commonly selected by both models in portfolio construction are AINM, BIMB, HLBB and LOND.

Table 2: Weights of components in the plantation portfolio

Component	Symbol	Serial Number	Weight Markowitz	Weight Index Tracking
Boustead Plantations Bhd	BOPL	5254	0.011700	0.000000
Batu Kawan Bhd	BTKW	1899	0.031359	0.090883
Dutaland Bhd	DUTA	3948	0.015139	0.000000
Felda Global Ventures Holdings Bhd	FGVH	5222	0.000000	0.062282
Genting Plantations Bhd	GENP	2291	0.051956	0.095418
Gopeng Bhd	GOPK	2135	0.099876	0.016219
IJM Plantations Bhd	IJMP	2216	0.000000	0.030974
Innoprise Plantations Bhd	INNO	6262	0.162293	0.019603
IOI Corporation Bhd	IOIB	1961	0.000000	0.257230
Kuala Lumpur Kepong Bhd	KLKK	2445	0.000000	0.229912
Kluang Rubber Company Malaya	KLRK	2453	0.094764	0.017182
Kretam Holdings Bhd	KREK	1996	0.007015	0.026287
PLS Plantations Bhd	PLSB	9695	0.005118	0.010751
Riverview Rubber Estates Bhd	RVWL	2542	0.059345	0.000000
Sungei Bagan Rubber Malaya	SBRK	2569	0.034198	0.000000
Sin Heng Chan (Malaya) Bhd	SHCS	4316	0.022256	0.000000
TSH Resources Bhd	TSHR	9059	0.000000	0.056571
United Plantations Bhd	UTPS	2089	0.404980	0.086686
Number of stocks selected from the sector			13	13

Table 2 shows that the Markowitz portfolio allocates the highest weightage of 0.404980 to stock UTPS for the IOIB plantation sector, as opposed to the IOIB stock which has the highest composition (0.257230) under the enhanced index tracking portfolio. The PLSB counter was given the lowest allocation under both the Markowitz and enhanced index tracking models, i.e., 0.005118 and 0.010751, respectively. Eight stocks that were included in both portfolios are BTKW, GENP, GOPK, INNO, KLRK, KREK, PLSB, and UTPS.

Table 3: Weights of components in the industrial portfolios

Component	Symbol	Serial Number	Weight Markowitz	Weight Index Tracking
British American Tobacco Malaysia Bhd	BATO	4162	0.000000	0.135609
Hap Seng Consolidated Bhd	HAPS	3034	0.540518	0.100383
Heineken Bhd	HEIN	3255	0.147938	0.000000
Lafarge Malayan Cement Bhd	LAFA	3794	0.000000	0.084229
MISC Bhd	MISC	3816	0.000000	0.175088
Malaysian Pacific Industries	MPIM	3867	0.146266	0.000000
PPB Group Bhd	PEPT	4065	0.000000	0.161669

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Petronas Gas Bhd	PGAS	6033	0.000000	0.343022
Pan Malaysia Corporation Bhd	PMCS	4081	0.018894	0.000000
Petron Malaysia Refining Marketing	PTMR	3042	0.093554	0.000000
Leon Fuat Bhd	LEON	5232	0.052829	0.000000
Number of stocks selected from the sector			6	6

Table 3 shows the composition and stock weightage of both portfolios. Under the Markowitz portfolio, the highest weight was allocated to HAPS (0.540518), and the lowest allocation is PMCS (0.018894). Under the enhanced index tracking model, the portfolio constructed is dominated by PGAS with a weight of 0.343022, while LAFA has the least allocation of 0.084229. Out of the six stocks selected, only HAPS was included in both portfolios built.

3.2 *Markowitz vs. Two-Stage Enhanced Index Tracking Models – Portfolio Performance Comparison*

The risk-adjusted performance of both models for each sector, in addition to considering their average return will be compared.

Table 4: Comparison of portfolio performance for the financial portfolios

Portfolio	Average Return	Standard Deviation	Sharpe Ratio	Information Ratio
Financial Index	4.49%	-	-	-
Markowitz	23.29%	0.125786	1.6139	1.6838
Index Tracking	6.23%	0.090871	0.3569	1.3752

Table 4 shows the significant difference between the average return of the Markowitz portfolio and the enhanced index-tracking portfolio with an average return of the financial sector. The average return of the Markowitz model is very high (23.29%) while the average return of the enhanced index tracking model only stands at 6.23%. Despite the capability of the Markowitz model in generating a high expected return for the portfolio constructed, the standard deviation of its portfolio is also higher (0.125786) than the one built by using an enhanced index tracking model (0.090871). The result shown is quite consistent with the trade-off between expected return and risk, whereby a high expected return will come along with high risk or vice versa.

In terms of the Sharpe ratio, the Markowitz model outperforms the enhanced index tracking model with a value of 1.613893. Meanwhile, the Information ratio of the Markowitz portfolio (1.6838) is also higher than the enhanced index-tracking portfolio (1.3752). As the information ratio serves as the indicator of portfolio performance’s consistency, the result reflects that the Markowitz portfolio could maintain the good performance of the portfolio consistently.

Table 5: Comparison of portfolio performance for the plantation portfolios

Portfolio	Average return	Standard Deviation	Sharpe Ratio	Information Ratio
Plantation Index	-0.31%			
Markowitz	9.05%	0.108297	0.559625	0.819406
Index Tracking	2.85%	0.109315	-0.012520	1.550318

Table 6: Comparison of portfolio performance for the industrial portfolios

Portfolio	Average Return	Standard Deviation	Sharpe Ratio	Information Ratio
Industrial Index	3.93%			
Markowitz	27.25%	0.135211	1.7944	1.7077
Index Tracking	5.67%	0.108789	0.2462	0.3661

For the plantation sector in Table 5, the average returns of portfolios built by using both models are higher than the average return of the benchmark index which has a negative value of 0.31%. Even though the Markowitz portfolio has a higher average return of 9.05%, its standard deviation (0.108297) is lower than the one built by using the enhanced index-tracking model (0.109315). If the average return and risk is the only consideration, the Markowitz portfolio for the plantation sector is more attractive as the average return generated is higher with relatively low risk.

The enhanced index-tracking portfolio has a negative Sharpe ratio which indicates that the return of the portfolio is even lower than the risk-free rate of return. The Markowitz portfolio's Sharpe ratio value which is less than one indicates that the return generated is less than the risk borne.

It is quite obvious that the enhanced index-tracking portfolio's information ratio is higher than that of the Markowitz portfolio. This shows that the enhanced index-tracking model is more capable of constructing a portfolio that generates excess returns consistently.

From Table 6, the industrial portfolios display a similar trait of portfolio performance as the financial portfolios from the perspectives of average return, standard deviation and Sharpe ratio. The optimal portfolio created by using the Markowitz model has a higher value for these three elements in comparison to the enhanced index-tracking portfolio. The high Sharpe ratio value for the Markowitz portfolio (1.7944) implies that it could provide a higher return per unit of risk assumed which is desirable to the investors in comparison to the enhanced index-tracking portfolio.

The Markowitz portfolio has a high Sharpe ratio and information ratio, reflecting that the portfolio manages to produce consistent excess returns. Although the average return of the enhanced index-tracking portfolio (5.67%) is not as high as the Markowitz portfolio (27.25%), it is higher than the average return of the industrial index, implying that a full replication of the index is a less effective investment strategy.

4. Conclusions

In this study, the results show that the Markowitz model will choose at most a third of the number of stocks available in the index to construct a portfolio. For both the financial and industrial sectors, not more than half of the stocks will be included in the optimal portfolio of two different models. The different ways of selecting stocks resulted in different returns generated under each model.

Overall, the Markowitz model is proven to be more efficient in portfolio optimization for two portfolios (the financial and industrial), as shown by the higher risk-adjusted return consistently relative to the enhanced index-tracking portfolios. Nevertheless, the lower Sharpe ratio and information ratio of the enhanced index-tracking portfolio could be improved had the number of stocks to be chosen is not constrained to the Markowitz' maximum selection.

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