Modern Applied Science; Vol. 14, No. 4; 2020
ISSN 1913-1844 E-ISSN 1913-1852
Published by Canadian Center of Science and Education

The Portfolio Optimization Performance during Malaysia's 2018 General Election by Using Noncooperative and Cooperative Game Theory Approach

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Received: February 10, 2020 Accepted: February 28, 2020 Online Published: March 4, 2020

doi:10.5539/mas.v14n4p1 URL: https://doi.org/10.5539/mas.v14n4p1

Abstract

Game theory approach is used in this study that involves two types of games which are noncooperative and cooperative. Noncooperative game is used to get the equilibrium solutions from each payoff matrix. From the solutions, the values then be used as characteristic functions of Shapley value solution concept in cooperative game. In this paper, the sectors are divided into three groups where each sector will have three different stocks for the game. This study used the companies that listed in Bursa Malaysia and the prices of each stock listed in this research obtained from Datastream. The rate of return of stocks are considered as an input to get the payoff from each stock and its coalition sectors. The value of game for each sector is obtained using Shapley value solution concepts formula to find the optimal increase of the returns. The Shapley optimal portfolio, naive diversification portfolio and market portfolio performances have been calculated by using Sharpe ratio. The Shapley optimal portfolio outperformed the naive diversification portfolio and market portfolio in 6 months before and after the GE14.

Keywords: cooperative game theory, GE 14, portfolio optimization, shapley value

1. Introduction

Malaysia has undergone fourteen episodes of general election as of today. Since its independence, the Barisan Nasional (BN) coalition managed to win in all elections except the General Election 14 (GE14). However, during the last two episodes (GE13 and GE14) of general elections, the competition among the BN coalition and the Pakatan Rakyat (PR) was so close so that the chance for PR to win the election was higher. In GE13, the opposition PR party managed to secure 40.09% of the parliament seats that showed almost equal chance for the opposition party to win (Teik, 2013). After the dissolution of PR's component parties, a new Pakatan Harapan (PH) party was formed in 2015.

During the general election years of 2008 and 2013, the market fluctuation due to political uncertainty did show its significance influence on stock market return compared to the general election years of 1995, 1999 and 2004 (Liew & Rowland, 2016). Hence the stock market return was unaffected during the general election atmosphere around 1995, 1999 and 2004, but political uncertainty in 2008 and 2013 affected the stock market return. Notably these two general election years (2008 and 2013) did show the BN had been fiercely challenged by its opponent (PR). This brought to PH achievement after the dissolution of PR party, a simple majority in parliament to form the current federal government in year 2018. The change of the government affects the perception and the decision of the investors in constructing a portfolio. This paper is focusing on the optimal portfolio selection during GE14 and its performance after the changes of ruling government BN by PH.

Portfolio is a group of financial assets such as stocks, bonds and cash where the choice depends on the return and risk of individual securities. While portfolio selection is a process of choosing a portfolio by refering to maximize expected return and minimize risk, which is called optimal portfolio. This process can be divided into two, first is observation and second is beliefs about the future performances of portfolio. This uncertainty beliefs on future performances of portfolio was studied by Harry Markowitz (Markowitz, 1952) in 1952 in his article that portfolio which give the highest return for a certain risk level. It can reduce the total risk of the investment by diversification of the assets yet avoiding individually calculation. The objectives of an investor in the stock market are (i) an investor has certain amount of money to invest and choose different investment stocks, (ii) the investment decision based on the maximize returns at a certain level of risk or at the certain level of return, it provide the lowest risk and (iii) can cooperate together in the best way. The problem of portfolio selection is based on the question of which investment tools and at what weightage will be suggested in the portfolio performed.

1.1 Game Theory

The game theory shows a mathematically strategical evaluation of behaviour in game. It is one of the branch in mathematics under operations research field of logic optimization in decision making. The three basic properties applicable are (i) two or more players or decision makers, (ii) strategies where each player has choices two or more ways of acting and (iii) possible outcomes of the interaction depends on the strategy chosen by all players that called payoff (Colman, 2013). The objective of mathematical game theory is to pursue players interest rationally and maximize the outcome that they will get after choosing certain strategies.

There are two types of game which are noncooperative and cooperative game. Noncooperative game means that player with different interest make decision to maximize their payoff in order to compete with each other. Despite the different interest of each player, there is a situation where each player can cooperate together and have binding agreement in order to increase the outcomes or payoffs.

Since the games are basically played under risky and uncertainty conditions, there are some common aspects between game and financial market. By looking at the mechanism of stock market, this paper’s aim is to find an optimal portfolio selection in the framework of cooperative game. The relationship of the investor and the market is modelled as zero sum game where one player’s gain is the losses of other players. The situation of the market does not completely depend on the overall market since there are some factors such as political, economic condition and social behaviour changes in the market.

1.2 Political Changes and Optimal Portfolio Selection

The pre election phase can cause the changes in stock prices because of the observation on the campaign by the political parties. However, post election phase can contributes to the stock market prices change because of the new government since it showed positively reacted towards after GE13 (Liew & Rowland, 2016). This will lead to the changes in trading volume, volatility and return of the stocks itself (Tuyon, Ahmad, & Matahir, 2016).

When the investor are attracted on the stability of the economy due to the changes of the ruling government, the number of investors are increasing in the stock market. On the contrary, if investors feel the performance of the future economy will not be well, they will withdraw from it. There are studies showed how strongly related the stock market performance and the stability of political condition. Based upon research, the hypothesis on the effect to the stock market by the political elections that had been studied by numerous papers with significant findings which reflects the economic performance. The stock market can be affected by the political election due to the expectation of investors (Bialkowski, Gottschalk, & Wisniewski, 2008).

In addition, Abidin, Old, & Martin (Abidin, Old, & Martin, 2010) showed evidence that there was increment on market return after the election rather than prior election. However, there was an election effect in political cycle when nominal returns on the market index increase when the transition from the labour party to national party that won the government’s seats. Smales (Smales, 2014) examined the effect of Australian federal election cycle political uncertainty on the financial market uncertainty. The empirical results of the Australian election uncertainty showed a significant impact on the financial market.

Lehkonen and Heimonen (Lehkonen & Heimonen, 2015) examined the significant effects of democracy and political risk on stock market. They found that the lower the political risk in democracy country, the higher the return. Another paper by Amirah, Karmila Hanim and Siti Masitah studied the effect of US Presidential Election 2016 on Malaysian stock market by using OLS regression to see the effect. The result shows that KLCI slipped by 1% during Presidential Election which is negatively affected by the day of election (Amirah, Karmila Hanim, & Siti Masitah, 2019). In Malaysia specifically, the previous study showed that there was significant election effect on the volatility of the Malaysia stock market during GE12 and GE13 (Lean & Yeap, 2016). Shin (Shin, 2018) found that there was different result of election relationship between Access, Certainty, Efficiency (ACE) Market and Main Market before and after the election. The results showed a significant positive relationship before the election in the ACE market and the Main Market.

Most of the studies before the election used statistical analysis and they failed to suggest which sectors show optimal portolio selection during GE14. There are studies on cooperative game theory and optimal portfolio selection. Habip Kocak (Kocak, 2014) conducted a research on the portfolio partnership optimality return by using Shapley value. The result showed that the return was allocated according to their weight of each stock in the portfolio by scaling the payoffs to avoid negative return values. In Tataei et al. (Tataei, Roudposhti, Nikoumaram, & Hafezolkotob, 2018), also studied optimal portfolio selection by using Shapley value to examine on how to maximize the outcome. The result showed that the proposed portfolio by using Shapley value in cooperative game theory performed better in most studied times as they try to defeat the market through coalition.

Besides that, Nesrin Ozkan (Ozkan, 2015) examined portfolio optimization in Borsa Istanbul by using linear programming approach. He analysed the performance of each sectoral portfolios' returns and risks by using Sharpe performance index to compare sectoral portfolios and indices. He found that the technology sector attained the highest return with lowest portfolio concentration and its relative performance was higher compared to the other sectors in the research. Recently, game theory approach only gives suggestion to investors' preferences on portfolio selection with different risk groups. To conclude, this study will use Shapley value in cooperative game theory to the companies that maintain listed among 30 companies in KLCI from GE13 and GE14 periods.

This research will contribute to the game theory study in Malaysia for investment theory on how to make decision by diversifying their portfolio in order to get higher return and lower risk, particularly during changes of the government. To the best of our knowledge, this study is the first research conducted in Malaysia by using game theory approach on optimal portfolio. This paper is organized as follows. In the next section, we presents the data and methodology followed by results and discussion in section 3. Finally, the section 4 provides conclusion from the results obtained.

2. Data and Methodology

Bursa Malaysia is the largest stock exchange in Malaysia. The Kuala Lumpur Composite Index (KLCI) is a share index of the 30 companies listed on the Bursa Malaysia with the highest market capitalization. This research obtained the data from Datastream database and the daily closing price returns of 9 companies that maintain listed in KLCI during GE13 until GE14 are included. The Shapley value method is used in order to calculate the optimal portfolio before and after GE14. The three main sectors that consistent listed in KLCI during GE14 are categorized under the following groups.

A : Financial services

B : Consumer Products and Services

C : Telecommunication and Media

The opposite player is nature market (KLCI) has two strategies which are determined as follows:

P1 : Period before 14th general election

P2 : Period after 14th general election

The analysis is done between the period of 6 months before and after GE14 as shown in Table 1 and the companies of each sector is tabulated as shown in Table 2 below.

Table 1. Study period

General Election 14	*Period Date*	*Trading Day*
Before	1/11/2017 – 8/5/2018	135
After	10/5/2018 – 30/11/2018	147

Table 2. Players and strategies

Sector	*Strategy*	*Stock Name*
	A1	Hong Leong Bank Bhd.
Financial Services	A2	Hong Leong Financial Bhd.
	A3	Public Bank Bhd.
Consumer Products and Services	B1	PPB Group Bhd.
	B2	Genting Bhd.
	B3	Petronas Dagangan Bhd.
Telecommunications and Media	C1	Axiata Group Bhd.
	C2	Digi Bhd.
	C3	Maxis Bhd.

This paper is following Kocak's (Kocak, 2014) and Tataei's (Tataei et al., 2018) papers. The first step is to find the equilibrium solutions for each payoff matrix by using Nash equilibrium in noncooperative game. Payoff matrices are structured as a zero sum game where one player is the row player and the other will be the column player. Each row or column represents a strategy where the payoff $a_{i,j}$ will be in the combinations of columns and rows. In payoff matrix form below, rows represent player 1's strategies if there are i strategies while columns represent player 2's strategies if there are j strategies. The payoff matrix is as follows.

$$payoff = \begin{pmatrix} a_{1,1} & \cdots & a_{1,j} \\ \vdots & \ddots & \vdots \\ a_{i,1} & \cdots & a_{i,j} \end{pmatrix}$$

In order to get the payoff values in the payoff matrix for each sector, the daily prices of stocks are used to calculate the return for each stock by calculating the log return for each sector. The log returns of stocks are calculated as follows:

$$R_t = \ln(P_t) - \ln(P_{t-1}) \tag{1}$$

where,

R_t is the daily return of the stock at time t,

P_t is the daily stock price at time t,

P_{t-1} is the daily stock price at time $t-1$.

Annual average return of each stocks then are calculated as follows:

$$\overline{R} = \frac{\sum_{t=1}^{n} R_t}{n} \tag{2}$$

where,

$\overline{R}$ is the average return,

R_t is the daily return of the stock,

n is the number of trading days.

After all the payoff values are obtained for the payoff matrices of each sector, the payoffs were shifted by subtracting it with the lowest average return values among all sectors. This is to avoid prices that have negative payoff values during the cooperation calculation in Shapley value later. Next, Nash equilibrium is used in this study to get the value of game of each payoff matrix. The state of Nash equilibrium is as follows:

$$\min_j \max_i a_{i,j} = \max_i \min_j a_{i,j} \tag{3}$$

In Nash equilibrium, not all the values of the game can be obtained by using equation (3). However, there is a situation where a player's strategy that is not expected by the opponent player. In such games, it is a situation that no player wants the opponent player to accurately expect their behaviour. So, player 1 chooses strategy i

with probability of p_i is v and maximize it as follows:

$$v = \max\left(\min_i\left(\sum_{i=1}^{n} a_{i,1}p_{i,1}, \sum_{i=1}^{n} a_{i,2}p_{i,2}, ..., \sum_{i=1}^{n} a_{i,m}p_{i,m}\right)\right)$$
$$s.t.$$
$$\sum_{i=1}^{n} p_i = 1, p_i \geq 0 \forall i$$

Conversely, player 2 chooses strategy j with probability of q_j is u and minimize it as follows:

$$u = \min\left(\max_i\left(\sum_{j=1}^{m} a_{1,j}q_{1,j}, \sum_{j=1}^{m} a_{2,j}q_{2,j}, ..., \sum_{j=1}^{m} a_{n,j}q_{n,j}\right)\right)$$
$$s.t.$$
$$\sum_{j=1}^{m} q_j = 1, q_j \geq 0 \forall j$$

In the Nash equilibrium, both players take their strategy with the assumption of the balance between players. The overall equilibrium of a game will be determined by the following optimization model as follows:

$$Max(v-u)$$
$$st:$$
$$u \leq \sum_{j=1}^{m} a_{1,j}q_{1,j} \quad \forall i$$
$$v \leq \sum_{i=1}^{n} a_{i,1}p_{i,1} \quad \forall j$$
$$\sum_{i=1}^{n} p_i = 1, \sum_{j=1}^{m} q_j = 1$$
$$p_i \geq 0 \ \forall i, q_j \geq 0 \ \forall j$$

By finding the Nash equilibrium, the value of game $v(S)$ for every subset $S \subseteq N$ which maps every coalition of players to a payoff with the probability of occurrences any p_i strategy and any q_j strategy by the opponent player are calculated by using formula (4) as follows:

$$v(S) = \sum_{i=1}^{n}\sum_{j=1}^{m} p_i^* q_j^* a_{i,j} \tag{4}$$

In order to solve Nash equilibrium, the shifted average return values are calculated in Production and Operations Management – Quantitative Methods (POM - QM) for Windows software to get the values of game for each payoff matrix.

2.1 Mathematical Model of Cooperative Game

The values of game obtained from Nash equilibrium are used as characteristic functions for Shapley value solution concepts calculations in cooperative game. Lloyd Shapley (Roth, 1988) in 1953 proposed the numerical way on how to allocate value of the game among players where $N = \{1, 2, ..., n\}$ and a real-valued characteristic function v that maps every coalition to a payoff, where $v: 2^{[N]} \rightarrow \mathbb{R}$. A characteristic function game is given by a pair (N, v). The meaning of v is the number v(S) is the worth of the coalition of any subset S of N, where the payoff values of members of S can divide among themselves (if all of them agree) so that their sums will not more than v(S). This means that the worth of the coalition $S_1 \cup S_2$ is equal to at least the worth of its parts acting individually that can be defined as superadditivity. Defined superadditivity as follows:

$$v(S_1 \cup S_2) \supset \left\{x \in \mathbb{R}^{|S_1 \cup S_2|} / (x_i)_{i \in S_1} \in v(S_1), (x_j)_{j \in S_1} \in v(S_2)\right\}$$
$$\forall S_1 \subset N, \forall S_2 \subset N, S_1 \cap S_2 = \emptyset$$

$$v(S_1 \cup S_2) \geq v(S_1) + v(S_2)$$
$$\forall S_1 \subset N$$
$$\forall S_2 \subset N$$
$$S_1 \cap S_2 = \varnothing \tag{5}$$

The values of game obtained will be distributed by using Shapley value in order to get the percentages allocation to each sector during GE14. Let $\mu_i(v)$ be the Shapley value of player i. The Shapley value formula for any coalition as follows:

$$\mu_i(v) = \sum_{S \subseteq N, i \in S} \frac{(|N| - |S|)!(|S| - 1)!}{|N|!} \left[v(S) - v(S \setminus \{i\}) \right] \tag{6}$$

Next, to calculate individual percentages of each companies, the probability of occurring strategies of each player in optimal solution $v(S)$ are defined as α_i^*, β_j^* and γ_k^* where $i, j, k = \{1, 2, 3\}$. The individual weightage is calculated by using these three respective equations:

$$w_i = P(A)\alpha_i^* \sum_{j,k} \beta_j^* \gamma_k^*$$
$$w_j = P(\mathrm{B})\beta_j^* \sum_{\mathrm{i},k} \alpha_j^* \gamma_k^*$$
$$w_k = P(\mathrm{C})\gamma_k^* \sum_{\mathrm{i,j}} \alpha_i^* \beta_j^* \tag{7}$$

2.2 Portfolio Selection and Performance

The performance of portfolio based on the Shapley weightages can be argued whether it can defeat the market by using game theory or not. From the sectors' percentages, the individual weightage was calculated by averaging the mean of end month prices and divide to its total sector average end month prices times with its sector percentage. After evaluating the portfolio of stocks, the percentage results proposed were compared to the market performance index of KLCI historical price data by using Sharpe ratio. The formula for Sharpe ratio, S_r as follows:

$$S_r = \frac{R - RFR}{\sigma} \tag{8}$$

where,

R is the average return of portfolio,

RFR is the risk-free rate,

σ is the standard deviation of portfolio.

Lastly, the optimal portfolio performance based on the game theory approach is compared by using Sharpe ratio to the performance of the naive diversification portfolio and market portfolio during GE14. Naive diversification allocates its weightage equally by using $1/N$ where N is number of assets.

3. Results and Discussions

In this section, the payoff matrices of GE14 are formed for players A, B and C are shown in Tables 3 to 5 below.

Table 3. Payoff matrix structured for player A

Financial services sector	*P1*	*P2*
A1	3.71E-03	3.18E-03
A2	3.51E-03	2.67E-03
A3	3.71E-03	2.85E-03

Table 4. Payoff matrix structured for player B

Consumer products and services sector	*P1*	*P2*
B1	3.54E-03	3.22E-03
B2	2.18E-03	4.23E-04
B3	3.28E-03	2.41E-03

Table 5. Payoff matrix structured for player C

Telecommunications and media sector	*P1*	*P2*
C1	2.42E-03	0.00E+00
C2	1.94E-03	2.01E-03
C3	1.99E-03	2.46E-03

The payoff matrices above are solved in QM for Windows software, the values of game are obtained by using formula (4) as follows:

$$v(\{A\}) = 0.00318$$
$$v(\{B\}) = 0.00322$$
$$v(\{C\}) = 0.00206$$

The payoff matrices for coalitions formed by player A and B, player A and C, player B and C and player A, B and C are shown in Tables 6 to 9 below.

Table 6. Payoff matrix structured for coalition of player A and B

	P1	*P2*
A1B1	7.26E-03	6.40E-03
A1B2	5.90E-03	3.60E-03
A1B3	6.99E-03	5.58E-03
A2B1	7.05E-03	5.89E-03
A2B2	5.69E-03	3.09E-03
A2B3	6.79E-03	5.07E-03
A3B1	7.25E-03	6.08E-03
A3B2	5.89E-03	3.27E-03
A3B3	6.99E-03	5.26E-03

Table 7. Payoff matrix structured for coalition of player A and C

	P1	*P2*
A1C1	6.14E-03	3.18E-03
A1C2	5.66E-03	5.18E-03
A1C3	5.71E-03	5.64E-03
A2C1	5.93E-03	2.67E-03
A2C2	5.45E-03	4.68E-03
A2C3	5.50E-03	5.13E-03
A3C1	6.13E-03	2.85E-03
A3C2	5.65E-03	4.86E-03
A3C3	5.70E-03	5.31E-03

Table 8. Payoff matrix structured for coalition of player B and C

	P1	*P2*
B1C1	5.97E-03	3.22E-03
B1C2	5.49E-03	5.23E-03
B1C3	5.54E-03	5.69E-03
B2C1	4.61E-03	4.23E-04
B2C2	4.13E-03	2.43E-03
B2C3	4.18E-03	2.89E-03
B3C1	5.70E-03	2.41E-03
B3C2	5.22E-03	4.41E-03
B3C3	5.27E-03	4.87E-03

Table 9. Payoff matrix structured for coalition of player A, B and C

	P1	*P2*
A1B1C1	9.68E-03	6.40E-03
A1B1C2	9.20E-03	8.41E-03
A1B1C3	9.25E-03	8.86E-03
A1B2C1	8.32E-03	3.60E-03
A1B2C2	7.84E-03	5.61E-03
A1B2C3	7.89E-03	6.06E-03
A1B3C1	9.42E-03	5.58E-03
A1B3C2	8.94E-03	7.59E-03
A1B3C3	8.99E-03	8.04E-03
A2B1C1	9.48E-03	5.89E-03
A2B1C2	9.00E-03	7.90E-03
A2B1C3	9.05E-03	8.36E-03
A2B2C1	8.12E-03	3.09E-03
A2B2C2	7.64E-03	5.10E-03
A2B2C3	7.69E-03	5.55E-03
A2B3C1	9.21E-03	5.07E-03
A2B3C2	8.73E-03	7.08E-03
A2B3C3	8.78E-03	7.54E-03
A3B1C1	9.67E-03	6.08E-03
A3B1C2	9.20E-03	8.08E-03
A3B1C3	9.24E-03	8.54E-03
A3B2C1	8.31E-03	3.27E-03
A3B2C2	7.83E-03	5.28E-03
A3B2C3	7.88E-03	5.74E-03
A3B3C1	9.41E-03	5.26E-03
A3B3C2	8.93E-03	7.26E-03
A3B3C3	8.98E-03	7.72E-03

The payoff matrices for each player's coalition above are solved in QM for Windows software by using formula (4), the values of game are obtained as follows:

$$v(\{A,B\}) = 0.00640$$
$$v(\{A,C\}) = 0.00564$$
$$v(B,C) = 0.00556$$
$$v(\{A,B,C\}) = 0.00886$$

All the values of game obtained then are used as characteristic function for GE14 as shown in Table 10 below:

Table 10. Characteristic function

Characteristic Function	*Value*
$v(\{\emptyset\})$	0.00000
$v(\{A\})$	0.00318
$v(\{B\})$	0.00322
$v(\{C\})$	0.00206
$v(\{AB\})$	0.00640
$v(\{AC\})$	0.00564
$v(\{BC\})$	0.00556
$v(\{ABC\})$	0.00886

By using Shapley value equation (6), the expected marginal contributions for each sector is calculated using Lingo software. The expected marginal contribution value of each sector are as follows:

$$\mu_A = 0.00329 , \mu_B = 0.00327 , \mu_C = 0.00231$$

It can be seen that the increment of the return by an individual player with comparing to the game that consist the coalitions of players by 0.011% , 0.005% and 0.025% respectively. It shows the rationality for each player to join the coalitions. As the normalization calculation of the Shapley values, the expected marginal contribution of each sector is divided with the grand coalition $v(A,B,C)$ in order to get percentage of each sector. The percentages of each sector after Shapley value have been normalized are 37% for both financial and services sector and consumer products and services sector, and 26% for telecommunications and media sector.

$$P(A) = 37\% , P(B) = 37\% , P(\mathrm{C}) = 26\% .$$

After the percentages of each sector are obtained, the Shapley optimal portfolio is evaluated from equation (7) that suggest the following percentages included in the portfolio: 37% of A1, 0% of A2 and A3 among the strategies for financial services sector; 37% of B1, 0% of B2 and B3 companies among consumer products and services sector, and lastly 4% of C1, 0% of C2, and 22% of C3 among telecommunications and media sector. Table 11 shows the weightages of companies in the Shapley optimal portfolio.

Table 11. Weightage of companies in the Shapley optimal portfolio.

Sector	*Strategy*	*Stock Name*	*Weightage*
Financial Services	A1	Hong Leong Bank Bhd	37%
	A2	Hong Leong Financial Bhd	0%
	A3	Public Bank Bhd	0%
Consumer Products and Services	B1	PPB Group Bhd	37%
	B2	Genting Bhd	0%
	B3	Petronas Dagangan Bhd	0%
Telecommunications and Media	C1	Axiata Group Bhd	4%
	C2	Digi Bhd	0%
	C3	Maxis Bhd	22%

The expected return of the Shapley optimal portfolio is 0.038% and its standard deviation is 0.694% after one year. By assuming risk free rate 0%, the Sharpe ratio of the Shapley optimal portfolio is 0.0543. The results of all the portfolios are tabulated in Table 12 as follows:

Table 12. Sharpe ratio of market portfolio, naive diversification portfolio and Shapley optimal portfolio.

	Market portfolio	*Naive diversification portfolio*	*Shapley optimal portfolio*
Expected return	−0.0117%	0.012%	0.038%
Standard deviation	0.6614%	0.710%	0.694%
Sharpe ratio	−0.018	0.0169	0.0543

3.1 Hypothetical Example

This paper uses hypothetical example to highlight the outperform Shapley optimal portfolio towards the naive diversification portfolio and market portfolio by assuming RM 100 000 amount of money invested. Below is the summary of the results:

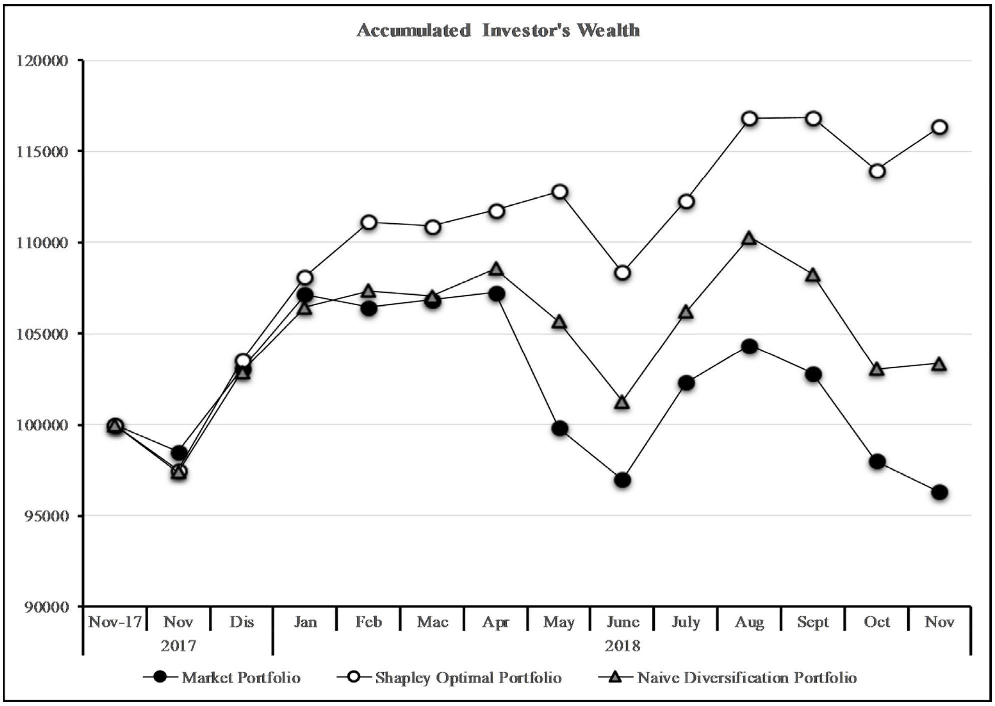

Figure 1. The accumulated wealth of investor.

As shown in Figure 1, the Shapley optimal portfolio has dominated the naive diversification portfolio and market portfolio after December 2017 until end of the studied period. This shows that Shapley optimal portfolio performed better during GE14. This paper also calculates the Sharpe ratio for those portfolios after the amount RM 100 000 is invested into the portfolios.

Table 13 shows Sharpe ratios for market portfolio, naive diversification portfolio and Shapley optimal portfolio after RM100 000 is invested. Expected return of the market portfolio return is -0.2879% with standard deviation 3.626%, the expected return of the naive diversification portfolio is 0.2541% with standard deviation 3.422%, and expected return of the Shapley optimal portfolio is 1.1654% with standard deviation 2.991%.

The Sharpe ratio for market portfolio, naive diversification portfolio and Shapley optimal portfolio are -0.0794, 0.0743 and 0.3897 respectively. The sharpe ratio shows that the Shapley optimal portfolio ~~is~~ outperformed other two portfolios during GE14 (also shown in Figure 1).

Table 13. Sharpe ratio of portfolio market index, naive diversification portfolio and Shapley optimal portfolio after RM 100 000 invested.

	Market portfolio	*Naive diversification portfolio*	*Shapley optimal portfolio*
Expected return	–0.2879%	0.2541%	1.1654%
Standard deviation	3.626%	3.422%	2.991%
Sharpe ratio	–0.0794	0.0743	0.3897

4. Conclusion

Game theory is one of the decision making knowledge. It can give suggestions on how to diversify our assets under cooperative game approach in order to increase profits and reducing lossess in the financial market. This paper is limited to nine chosen stocks from three different sectors that maintain listed in KLCI during the period before and after GE14 by using Shapley value method to allocate indvidual weightage. The findings show that the portfolio performed better the market before and after Malaysia's GE14 as shown in Sharpe ratio. This study can be further extended applied to optimize portfolio selection during political changes with a different type of assets and bigger number of player.

Acknowledgement

We wish to thank the anonymous reviewers for their valuable comments and suggestions in improving further the quality of this paper.

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