OPTIMAL PORTFOLIO SELECTION DECISION MAKING BEFORE AND AFTER MALAYSIA GENERAL ELECTIONS USING GAME THEORY APPROACH

BY

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ABSTRACT

The change of the Malaysia government during its 14th general election (GE14) has motivated this research to study the general elections impact on the stock market performance. The aim is to determine the impact of Malaysia 13th and 14th general elections towards the chosen stocks in FBMKLCI by using the cooperative game theory approach. The players (sectors) are divided into three groups where each player will have several different strategies (stocks) for the game. The sectors involve are financial services, consumer products and services, and telecommunications and media. The stocks in the financial services sector are AMMB Holding Bhd, CIMB Group Holdings Bhd, Hong Leong Bank Bhd, Hong Leong Financial Bhd, Malayan Banking Bhd, Public Bank Bhd and RHB Capital Bhd. The stocks in the consumer products and services sector are PPB Group Bhd, Genting Bhd, Genting Malaysia Bhd and Petronas Dagangan Bhd. The stocks in the telecommunications and media sector are Axiata Group Bhd, Digi.Com Bhd and Maxis Bhd. The payoff for each sector and its coalition are calculated by averaging the stocks' returns. The value of the game for each sector is obtained by using Nash equilibrium solution concept. Then the values of the game are considered as characteristic functions to obtain the Shapley value solution concepts in cooperative game theory framework. The Shapley value percentages are calculated by normalizing its value with the grand coalition value. The Shapley value percentages for GE13 and GE14 are compared to indicate the impact of GE14 on investment. The aim continues to construct the optimal portfolio selection based on the Shapley value percentages for GE14 only and measure its performance by using Sharpe ratio for one year. The result shows that the Shapley optimal portfolio dominates the market portfolio and the naive diversification portfolio in the period from February 2018 until November 2018. This shows that Shapley optimal portfolio performs better during GE14.

خلاصة البحث

لقد شجع تغير الحكومة الماليزية خلال الانتخابات العامة الرابعة عشرة هذا البحث لدراسة تأثير الانتخابات العامة على أداء سوق الأسهم. كان الهدف هو تحديد تأثير الانتخابات العامة الثالثة عشرة والرابعة عشرة في ماليزيا على الأسهم المختارة في البورصة الماليزية FBMKLCI باستخدام طريقة نظرية اللعب التعاوني. تم تقسيم اللاعبين (القطاعات) إلى ثلاث مجموعات، وكان لكل لاعب العديد من الاستراتيجيات (الأسهم) المختلفة للعبة. شملت القطاعات كلا من الخدمات المالية، والمنتجات والخدمات الاستهلاكية، والاتصالات والإعلام. أسهم قطاع الخدمات المالية تضمنت كلا من: إيه إم إم بي القابضة المحدودة، مجموعة سي أي إم بي القابضة المحدودة، بنك هونغ ليونغ المحدودة، هونغ ليونغ للتمويل المحدودة، مالايان بانكينغ المحدودة، بابلك بانك المحدودة، وآر إتش بي كابيتال المحدودة. أسهم قطاع المنتجات والخدمات الاستهلاكية تضمنت كلا من: مجموعة پـي پـي بي المحدودة، شركة جنتينغ المحدودة، جنتينغ ماليزيا المحدودة، شركة بتروناس التجارية المحدودة. أسهم قطاع الاتصالات والإعلام شملت: مجموعة أزياتا المحدودة، ديجي دوت كوم المحدودة، وماكسيس المحدودة. تم حساب العائد لكل قطاع وأعضاء مجموعته عن طريق حساب متوسط عائدات الأسهم. تم الحصول على قيمة اللعبة لكل قطاع باستخدام مفهوم حل توازن ناش. ثم تم اعتبار قيم اللعبة كوظائف مميزة للحصول على مفاهيم حلول قيمة شيبلي في إطار نظرية اللعب التعاوني. تم حساب النسب المئوية لقيمة شيبلي عن طريق تسوية قيمته مع قيمة المجموعة الكبيرة. تم بعد ذلك تمت مقارنة نسب قيم شيبلي للإنتخابات العامة الرابعة عشر والخامسة عشر للإشارة إلى تأثير الإنتخابات العامة الرابعة عشرة على الاستثمار. استمر الهدف في إنشاء الاختيار الأمثل للمحافظ بناءً على نسب قيمة شيبلي لـلإنتخابات العامة الرابعة فقط وقياس أدائها باستخدام نسبة شيبلي لمدة عام واحد. أظهرت النتائج أن محفظة شيبلي المثلى قد هيمنت على محفظة السوق وحافظة التنويع الساذجة في الفترة من فبراير 2018 حتى نوفمبر 2018. وهذا يدل على أن محفظة شيبلي المثلى قد أدت بشكل أفضل خلال الإنتخابات العامة الرابعة عشرة.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (Computational and Theoretical Sciences).

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Supervisor

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Co-Supervisor

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DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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In the name of Allah SWT, alhamdulillah for His blessing for allowing me to complete this thesis entitled "Optimal Portfolio Selection Decision Making Before And After Malaysia General Elections Using Game Theory Approach" for the degree of Master of Science in Computational and Theoretical Sciences.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND ON GAME THEORY

Game theory is one of the branches under the field of operations research in applied mathematics. It started to gain prominence after the book written by Neumann and Morgenstern (1944) entitled 'Theory of Games and Economic Behavior' was published. The study of game theory is about mathematical models of the strategic interactions between rational players that concern with the actions of decision makers who realize that every step taken will give an impact to each other. It means that the game theory is not applicable for the unrelated and unrational decision makers. Game theory can be divided into two categories; non-cooperative and cooperative games. Non-cooperative game is a game where the competition occurs among players. In contrast, cooperative game is a game where the player will gain benefit in joining binding agreement among players.

Game theory that involves two intelligent adversaries with contradicting objectives in making decisions to compete with each other is called as non-cooperative game theory. Zero-sum game is an example of non-cooperative game theory where a gain of one player is the loss for another player. Their sum of the payoffs will be zero if the total received payoffs of the players are added up and the total losses payoffs are subtracted. In a conflict, each of the two players may have a finite or infinite number of strategies where each strategy associates with their payoff interests (Taha, 2007). Conversely, cooperative game theory describes about fair allocation game, instead of a fight game. A group of players, that is called coalitions, it can be seen as a competition between players that have mutual benefit to agree together rather than between individual player. The coalition intends to achieve higher payoff instead of when they act individually. One of the solution concepts in a cooperative game theory used in this research is Shapley value. It calculates the weightages of each cooperation which in turn is used as the basis in allocating the weight to individual stock in the optimal portfolio (Tataei et al., 2018).

Game theory consists of three basic elements which are the players, strategies and payoffs. The players must be two or more either as individuals, organisations or nature itself (Kelly, 2003) which will make sense to the game, who are making decision in a game. Nature is a sham-player who takes random actions with specified probabilities. There are two assumptions in order to implement a game theory which are rationality and mutual independence. A player is said to be rational when they maximize their interests in a game and vice versa. Eventhough, in reality and complex situation, players seem more to be unrealistic in making any decisions such as emotion and pressure in life. The second assumption is mutual independence. It means that any decision chosen by any player will only affect their payoffs respectively.

A strategy profile is an ordered set that consist of all available strategies for all players in the game. The strategies refer to the information and available actions to be taken by group of individuals. Lastly, the meaning of the payoff is the outcomes to each of the players associate to their chosen strategies. Some examples of payoff are profit, revenue or utility. The essential idea is each player wants to maximize their payoff by choosing plans or strategies that depend on the known information to against their opponents. Their combination in choosing those strategies are called as equilibrium which represents the outcome of the game's stability or saddle point.

1.2 INVESTMENT AND PORTFOLIO SELECTION

An investment is the present commitment of money or other assets in the anticipation of reaping long term benefits in the future (Bodie et al., 2014). Financial assets which are intangible assets, they have no physical presence but in high liquidity, meaning that it can be converted into cash faster and easily. The assets such as stocks and bonds are financial assets values that depend on real assets and generate net income to the economy and allocate income among investors. The problem is aiming on the question on how can we invest based on percentage allocation to each investment tools in selecting a portfolio. Individuals can make a choice either to consume their wealth today or to invest for the future, some individuals are corcerned on cash, property and debt planning to avoid young-age bankruptcy, it is best to allocate money to invest for better rewards in future. One of the way to grow money by placing wealth in financial assets.

The financial market is a trading marketplace which involves securities like equities, bonds and derivatives. Stock prices as act as a benchmark for the firm to raise capital where investor's appraisal of a firm's performance based on the fluctuation of the prices, and encourage investors to invest in a firm if those prices are high. The stock market encourages investors to allocate their capitals in firms that have convincing prospects. An investment portfolio is a collection of investment assets owned by investors. These investors can either be individual investors or institutional investors. There are two type of decisions in constructing portfolios, firstly, is the decision of the asset allocation which is the choice among these assets classes such as stocks, bonds and real estates. Secondly, the decision on security selections, it is the choice of which certain securities to hold within each asset class.

As financial markets are highly competitive, investors will find ways to increase their gains. One of the methods is by diversifying their assets. Diversification means that various assets are held in a portfolio. Diversifying investments leads to a higher expected return and lower standard deviations. In the classical way, investors believe that putting several stocks in their portfolios will lead to a decrease in risk without any consideration of the returns for these stocks. As suggested by the classical approach, investors should invest in many types of stocks that have higher expected returns at a given level of risk and will cooperate to perform better in the market. Since various approaches have been studied to solve the investment portfolio selection problem, this uncertainty was also studied by Harry Markowitz (1952) where his article entitled Portfolio Selection, brought up the modern portfolio theory that an investment's return and risk should not be calculated alone but by using an overview of the entire portfolio.

Portfolio selection is a process of choosing a portfolio by refering to maximize expected return and minimize risk, called optimal portfolio. The expected return of a portfolio is the weighted average of the stocks proportions to its weights and the variance of a portfolio is the weighted sum of the elements of the covariance matrix with the product of the investment proportions as weights (Bodie et al., 2014). 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. The decision in constructing a sectoral portfolio is the choice of which securities to hold within each asset class. The allocation of financial assets is a problem faced by investors in the country as they need to choose their optimal portfolios to maintain a good performance in the financial markets especially pre and post general elections. The investor's objective is choosing a portfolio that can maximize returns at certain risk conditions especially during elections and perform it in abundant in type and number instead of choosing the best investment options individually which may be subject to more risk conditions.

There are two fundamental characteristics in the financial market, the first is competition among market players and the second is uncertainty (Tataei et al., 2018). This means that a player's game will be affected by the other players' total market performance behaviour with the uncertainty conditions of the financial market. Based on these two essential fundamental characteristics, it can be implemented in the game theory part that refers to the optimal decision making by players in evaluating and calculating the payoff of other players by using mathematics. Figure 1.1 shows the implementation of a portfolio selection with game theory based model. Sectors and stocks in the portfolio model indicate players and strategies in the game theory model respectively.

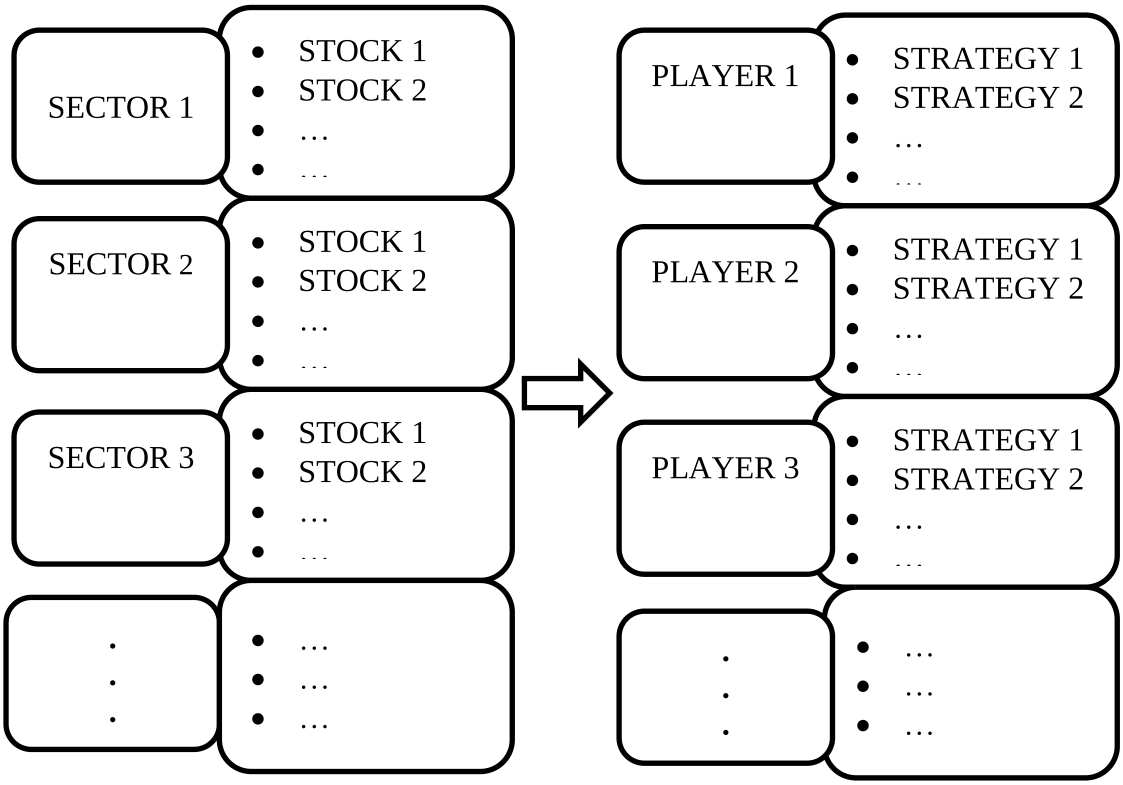

Figure 1.1 The Implementation of Portfolio Selection with Game Theory Based Model.

1.3 POLITICAL ELECTIONS AND FINANCIAL MARKETS

The political election seasonal trend holds significant influence to the security prices anomaly in the stock market (Chandra, 2009). A stock index gives the overall financial conditions on stock market. It is one of the most sensitive benchmarks of business cycle. The sentiment of the investors on political election could create ups and downs investment reaction in the stock market. The minority of the government coalition in parliament seats will make the investors react more volatile manner with short time trading days. Specifically, investor desires all move to invest in stock market if it in the convincing condition, otherwise they will withdraw from the market due to the expectation on implementation of the economic policy of a minority governments country (Bialkowski et al., 2008). Thus, their responses may cause changes in trading volume, volatility and stock prices (Tuyon et al., 2016). The investors' expectations and politics condition has been researched in many countries in various contexts. The unstable politics surrounding during elections initiate the economic uncertainties and raise the investors' risk aversion behaviours. This can be observed through Donald Trump's success in the US presidential election since presidential cycle brings consequences to all across the globe. In response to the US presidential cycle, the American stock market performance seemed to be least affected when comparing to the Asian market (Iskyan, 2016).

Malaysia has undergone fourteen episodes of general election up to 2018. Before the 14th General Election, the Barisan Nasional coalition had won all 13 previous elections. The last two general elections (GE13 and GE14) saw a particularly close competition between Barisan Nasional and Pakatan Rakyat which resulted in a higher chance for Pakatan Rakyat to win the election. After the dissolution of the Pakatan Rakyat, a new party was formed known as the Pakatan Harapan in 2015.

Pakatan Harapan ultimately won a simple majority in parliament to form a new government in 2018. Liew and Rowland (2016) found that during the Malaysia general elections in 2008 and 2013, fluctuations in the stock market return showed that political uncertainty has a significance influence. However, the general election years of 1995, 1999 and 2004 showed that it had no effect on stock market returns.

1.4 RESEARCH MOTIVATION

In general, politic has an influence on financial markets in terms of stocks performances as well as the volatility. General election is a political event that affects stock market return before and after general election phases where both phases are based on the stability on political condition (Liew & Rowland, 2016). In 2018, the 14th Malaysian general election that was held on 9th May witnessed unprecedented victories in Malaysia's election history where the Barisan Nasional party was defeated for the first time by the Pakatan Harapan. Barisan Nasional has ruled Malaysia almost 61 years since its independence in 1957. There are effects on the stock market and political risk in democracy country (Lehkonen & Heimonen, 2015). Fluctuating stock market conditions are common in the investment world. Any increase of prices of stocks in the stock market will be followed by its decline and vise versa. The pattern and trend of stock market conditions are the same unless there is a new event occurs in certain period (Nawaz & Mirza, 2012).

With the victory of Pakatan Harapan in the general election, this research investigates whether some sectors were being influenced in the Malaysia stock market or not, by using a fair allocation of Shapley value in a cooperative game theory. By looking at the stock market's mechanism, this research aims to find an optimal portfolio selection by adapting investors and the market as players with a conflict of interest in a normal form game. The players move simultaneously and cooperative game theory framework is used to suggest each sector's percentage and stocks' weightages allocations.

1.5 RESEARCH OBJECTIVES

The study aimed to achieve the following objectives:

1. To determine the impact of elections to the chosen stocks by using Shapley value solution concept in cooperative game theory approach before and after general elections of GE13 and GE14 in Malaysia.
2. To construct the optimal portfolio selection based on the weightage allocation for GE14 and measure its performance by using Sharpe ratio.

1.6 SCOPE AND LIMITATION OF THE STUDY

This research is limited to 14 chosen stocks among 30 stocks in different sectors that maintain listed in FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBMKLCI) during GE13 and GE14. Those sectors are financial services, consumer products and services, and telecommunications and media. The daily closing prices of stocks are used to calculate the annual average return. This research does not intend to investigate whether the stock market is better or worse after the change of the government. This research proposes an optimal portfolio selection before and after Malaysia GE14 by using a game theory framework and uses Sharpe ratio to compare each portfolio's performance during Malaysia's GE14.

1.7 SIGNIFICANCE OF THE STUDY

The findings of this research contribute to the game theory study in Malaysia. This research also contributes in the investment theory field in which it provides guidance to investors in making any decisions by diversifying their portfolios in order to aim high returns and low risk investment especially during the general election of political unrest.

1.8 THESIS ORGANISATION

Overall, this thesis consists of six chapters. The remaining chapters of this thesis is structured as follows. Chapter 2 firstly reviews the previous literature on the game theory framework and political condition towards stock market performance. Chapter 3 presents the research methodology. The investigation on the sectoral percentage comparison of GE13, period between GE13 and GE14, and GE14 presents in Chapter 4. In Chapter 5, this research shows the result of the Shapley optimal portfolio based on the weightage allocation for GE14 and measure its performance by using Sharpe ratio. Lastly, Chapter 6 provides the conclusion of this research outcomes and research contribution and future research followed by references and appendices.

CHAPTER TWO

LITERATURE REVIEW

2.1 GAME THEORY

Game theory comes up with a formal analytical framework with a number of mathematical instruments to study the complex intersections among rational players (Osborne, 2004). The Theory of Games and Economic Behaviour, a book by John von Neumann and Oskar Morgenstern was first published in 1944. In 1950 and 1951, John Nash's papers about the meaning of equilibrium and proof on modern non-cooperative game theory were introduced, while cooperative game theory by Nash in 1950 and Shapley in 1953 on bargaining game. In the 1950s, game theory models started to be used in political and economic science. In the 1970s, game theory was first used in evolutionary biology. Later, the game theory come to dominate microeconomics theory and also in many other fields of economic and behavioral and social sciences.

The view of the game theory models on the general taxonomy concepts are based on several dimensions. A simultaneous game is a game model that all players will choose decisions simultaneously. By this type of movement, all players will not know the strategies that will be chosen by other players. The representation of this type of game is payoff matrix table. Non-cooperative game is a situation where the players make a decision on their strategy to maximize their payoff. In contrast, cooperative game is a situation where there exist binding agreement among the players through agreements or negotiations. Since the game basically are played under uncertainties and risky conditions, there are many common aspects between financial market and game. The investor and the stock market (FBMKLCI) can be two players opposed each other in the stock market called zero-sum game. The game basically consists of one player that opposes to the nature player whereas the stock market itself represents the nature player with all its features. The condition of the stock market was not solely depend on the overall market since there are some factors such as political, economic condition and social behaviour changes in the stock market.

There are previous studies that involve game theory approaches in stock markets (Colini-Baldeschi et al., 2017; Kocak, 2014; Mussard & Terraza, 2007, 2008; Ozkan, 2015; Shalit, 2017; Slišković & Škrinjarić, 2019; Tataei et al., 2018). However, the studies of Kocak (2014), Ozkan (2015), Shalit (2017), Slišković and Škrinjarić (2019) and Tataei et al. (2018) are detailed in section 2.3. Mussard and Terraza (2007) investigated the new risk indicators that allow one to classify securities of a portfolio depending on their degrees of risk. They used Shapley value to define two risk-trading indexes which are risk-trading index based on Shapley value (RTI) and Gini risk index (RTIG). By using data from five French securities (Accor, Michelin, Carrefour, Wanadoo and TF1) from Cotation Assistée en Continu (CAC 40) French Index and a Gini coefficient as a foundation risk measure, they did an empirical analysis and found that RTI avoided the difficulties related to the Gaussian assumptions and the theory of Markowitz. Meanwhile, RTIG depends on the expected difference between two returns drawn at random with repetition. Mussard and Terraza (2008) and Colini-Baldeschi et al. (2017) explained the possible theoretical part for this methodology application and corresponding Shapley decomposition of the variance solutions.

Huo and Al-Shamaa (2017) studied the impact of noise trading behaviour on Chinese stock market. They applied evolutionary game model to analyse the Chinese stock market growth towards noise trading equilibrium or called as evolutionary stable strategy in game model. The data used is a monthly basis from over 862 public firms retrieved from the stock market and the data are source from Yahoo Finance, Bank of China and Shanghai Stock Exchange databases. They found that the Chinese stock market was evolving towards noise trading equilibrium, but the equilibrium might change as the surroundings change and the maturity of the Chinese stock market develops.

Table 2.1 Summary of Studies on Game Theory Approach.

Year	Author	Title	Objective	Data/Period	Methodology/Model	Conclusion
2007	Mussard and Terraza	New trading risk indexes: application of the Shapley value in finance.	To offer new risk indicators that allow one to classify securities of a portfolio depending to their degrees of risk.	Empirical analysis using closing prices of five French securities from CAC 40 French Index.	-Risk-trading index based on the Shapley value solution concept (RTI) -Risk-trading index based on the Gini coefficient (RTIG).	RTI avoids the difficulties related to the Gaussian assumptions and the theory of Markowitz. RTIG depends on the expected difference between two returns drawn at random with repetition.
2008	Mussard and Terraza	The Shapley decomposition for portfolio risk.	To give an application of the Shapley value to decompose financial portfolio risk.	No data used, theoretical part.	Shapley value solution concept for *n* securities.	Decomposing the covariance risk measure shows relative measures, which allow securities of a portfolio to be classified according to risk scales.

2017	Colini-Baldeschi et al.	Variance allocation and Shapley value.	To suggest an allocation criterion for the variance of the sum of n possibly dependent random variables.	No data used, theoretical part.	Shapley value solution concept for *n* securities with two types of games which are variance game and standard deviation game.	The same criterion is used to allocate the standard deviation of the sum of *n* random variables and a conjecture about the relation of the values in the two games is formulated.
2017	Al-Shamaa	How noise trading affects the Chinese stock market: an evolutionary game theory approach.	To study the impact of noise trading behaviour on Chinese stock market.	Monthly basis data from over 862 public firms Sources of data: Yahoo Finance, Bank of China and Shanghai Stock Exchange databases.	Evolutionary game model.	Chinese stock market was evolving towards noise trading equilibrium, but the equilibrium might change as the surroundings change and the maturity of the Chinese stock market develops.

2.2 POLITICAL CONDITIONS ON STOCK MARKET PERFORMANCE

This is a literature review on the political conditions on stock market performance. There are indications that show the strong relationship between political stability and stock market performance. The hypothesis on the effect of political elections on the stock market has been studied by a number of papers with significant findings which reflect the economic performance of the country. Brooks et al. (1997) have done a study in South Africa on 2 February 1990, after the President de Klerk announced that South Africa would change its political structure. They used autoregressive conditional heteroscedasticity (ARCH) model on stock return data from 20 March 1986 to 23 February 1996. Their findings showed the applicability of ARCH models and suggested greater international integration of the Johannesburg Stock Exchange after 1990s period. Leon et al. (2000) observed the period of political uncertainty of Trinidad and Tobago on the stock market volatility. They used generalized autoregressive conditional heteroscedasticity (GARCH) and exponential generalized autoregressive conditional heteroscedasticity (EGARCH) models and found that after the political stability, a stable stock market performance has been accepted.

There was a study by Floros (2008) on the influence of Greece's political elections on the Athens Stock Exchange by using the ordinary least squares models. Daily data used from the ASE General Price Index during pre and post election periods from 1996 to 2002. It is found that there is a negative effect of the political elections on the ASE. In addition, Abidin et al. (2010) provided evidence that there was no election effect on New Zealand's stock market except in 2002, where there was an increment in market returns after the election rather than prior to the election. However, there was an election effect on the political cycle when the nominal returns on the market index increased when the National Party formed the government seats in contrast to the situation during a Labour Party victory in New Zealand. The data used for this analysis were closing prices of the NZX50 index from 1 July 1986 to 31 August 2009. Besides that, Smales (2014) examined the effect of the Australian federal election cycle's political uncertainty on the financial market uncertainty. They used opinion polling data for five Australian election cycles from 2001 to 2013 and measured by implied volatility. The empirical results showed that the Australian election uncertainty has a significant effect on financial market uncertainty.

There are another important parts on the research on political elections, stock market fluctuation and its performance. A paper written by Lehkonen and Heimonen (2015) examined the effects of democrary and political risk on stock market. They took the Morgan Stanley Capital International (MSCI) Standard Total Return index with reinvested dividend payments, also to evaluate the general development of the world's stock markets, the MSCI World index was used. The model used to study the interaction effects is pooled ordinary least squares and generalized method of moments. There is significant evidence that the stock market returns of 49 emerging countries markets are affected by political uncertainty. Therefore, this will lead to the case where the low risk in political policy, higher returns will be gained. Lean (2015) examined the impact of political general elections on the stock returns with control for time-varying volatility of daily returns using the daily closing prices of the FBMKLCI that obtained from Yahoo Finance. The changes were examined for one month before and one month after the election dates to look at the stock price fluctuation during the election periods (9th, 10th, 11th and 12th GEs). Ordinary least square model with a dummy variable was used to examine the pre-election and post-election effects separately while the generalized autoregressive conditional heteroscedasticity (GARCH) model was employed to control for the time-varying of stock returns. The political general election gives significant effect to Malaysia's stock performance where there is a positive effect before the election dates and a negative effect after the election dates.

Celis and Shen (2015) examined the presence of a political cycle in Malaysia stock market returns and volatilities that included seven different general election periods. They used tests of equality, regression analysis and generalized autoregressive conditional heteroscedasticity (GARCH) models to test each effect on significant nature of a political cycle. The finding showed that the presence of a political cycle in Malaysia stock market volatilities is statistically significant but not in stock market returns. Also, a previous study showed that there was a significant election effect on the Malaysian stock market's volatility during the 12th and 13th general elections (Lean & Yeap, 2016).

Koulakiotis et al. (2016) investigated the stock price index response around the election dates and the effects of change in the ruling political party in Greece on the return and risk in the Athens Stock. Data used were collected from Dissemination Information Department of the Athens Stock Exchange from January 1985 to February 2008. The models used were mean-adjusted return and autoregressive conditional heteroscedasticity. The empirical results indicated a positive stock market reaction on the last working day before the election date and negative on the first day after the election date. It also found that this is significantly affected by the transition of the ruling party. Wong and Hooy (2016) investigated whether stock market returns of the government-owned banks and private banks in Indonesia, Malaysia and Thailand differ during before and after elections from year 2000 to 2013 with range 20 days before election and 60 days after election. The data used were obtained from Datastream. There were 11 elections involved during this studied period. The cumulative average abnormal return (CAAR) of 30 banks in those countries were calculated and for robustness test, regression analysis using CAAR as dependent variable was conducted. During election, government-owned banks respond more to the election results compared to private banks. It is because there is a significantly positive CAAR for both types of banks but lower for private banks. CAAR of the government-owned banks was also found continuously significant for the subsequent 60 days after the election.

In addition, another paper by Liew and Rowland (2016) used statistical analysis ordinary least squares regression model for the sample period ranges from 1995 to 2013. They studied the phase before and after general election effect which covers the most recent five general elections (GE9 to GE13), and found that each election had a different effect on the daily returns of the FBMKLCI for every election studied in their research. About 40% of the time the stock market reacted positively before the elections, whereas 60% of the time the market reacted positively after the elections. Due to the fact that the ruling party (BN) has been leading for more than half a century, there is no study on which parties give effect to the returns of stock index value. Jiun (2018) used the exponential generalized autoregressive conditional heteroscedasticity (EGARCH) model to find the relation between stock market volatility and Malaysian general elections, GE12 and GE13. The political uncertainty during elections significantly affected investors respond. This study found that there was a significant higher stock volatility during pre general election effect in all selected stock indices volatility but not in stock returns. In the post general election period, there were only two stocks indices (FTSE Bursa Malaysia Hijrah Shariah Index and FTSE Bursa Malaysia Top 100 Index) showed lower stock volatility. This showed up that political uncertainty has significant role in influencing the stock market before elections.

Table 2.2 Summary of Studies on Political Conditions in Stock Market Performance.

Year	Author	Title	Objective	Data/Period	Methodology/Model	Conclusion
1997	Brooks et al.	An examination of the effects of major political change on stock market volatility: the South African experience.	To investigate the time-varying behaviour of stock market volatility.	A study in South Africa on 2 February 1990, after the President de Klerk announced that South Africa would change its political structure. Stock return data from 20 March 1986 to 23 February 1996.	Autoregressive Conditional Heteroscedasticity (ARCH) model.	The finding showed the applicability of ARCH models and suggested greater international integration of the Johannesburg Stock Exchange after 1990s period.
2000	Leon et al.	Testing volatility on the Trinidad and Tobago Stock Exchange.	To observe the period of political uncertainty of Trinidad and Tobago on the stock market volatility.	Weekly data from 1984 to 1995. Trinidad and Tobago Stock Exchange.	Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model. Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model.	It is found that after the political stability, a stable stock market performance has been accepted.

2008	Floros	The influence of the political elections on the course of the Athens Stock Exchange.	To study the influence of Greece's political elections on the Athens Stock Exchange.	Daily data used from the ASE General Price Index during pre and post election periods from 1996 to 2002.	Ordinary least squares model.	It is found that there is a negative effect of the political elections on the ASE.
2010	Abidin et al.	Effects of New Zealand general elections on stock market returns.	To examine the existence of the political cycle effect on stock returns under both National and Labour governments in New Zealand.	The data used for this analysis were closing prices of the NZX50 index from 1 July 1986 to 31 August 2009.	Regression model.	There was no election effect on New Zealand's stock market except in 2002, where there was an increment in market returns after the election rather than prior to the election. There was an election effect on the political cycle when the nominal returns on the market index increased when the National Party formed the government seats in contrast to the situation during a Labour Party victory in New Zealand.
2014	Smales	Political uncertainty and financial market uncertainty in an Australian context.	To examine the effect of the Australian federal election cycle's	Opinion polling data were used for five Australian election cycles from 2001 to 2013.	Implied volatility and regression model.	The empirical results showed that the Australian election uncertainty has a significant effect on financial market uncertainty.

			political uncertainty on the financial market uncertainty.			
2015	Lehkonen and Heimonen	Democracy, political risks and stock market performance.	To examine the effects of democrary and political risk on stock market.	Morgan Stanley Capital International (MSCI) Standard Total Return index with reinvested dividend payments and aslo use the MSCI World index to evaluate the general development of the world's stock markets.	Pooled ordinary least squares and generalized method of moments model.	There is significant evidence that the stock market returns of 49 emerging countries markets are affected by political uncertainty. Therefore, this will lead to the case where the low risk in political policy, higher returns will be gained.
2015	Lean	Political general election and stock performance: the Malaysian evidence.	To examine the impact of political general elections on the stock returns with control for time-varying volatility of daily returns.	Daily closing prices of the FBMKLCI were used and obtained from Yahoo Finance. The changes were examined for one month before and one month after the election dates to	Ordinary least square model with a dummy variable model was used to examine the pre-election and post-election effects separately Generalized Autoregressive	The political general election gives significant effect to Malaysia's stock performance where there is a positive effect before the election dates and a negative effect after the election dates.

				look at the stock price fluctuation during the election periods (9th, 10th, 11th and 12th GEs).	Conditional Heteroscedasticity (GARCH) model was employed to control for the time-varying of stock returns.	
2015	Celis and Shen	Political cycle and the stock market - the case of Malaysia.	To examine the presence of a political cycle in Malaysia stock market returns and volatilities.	Included seven different general election periods from February 1982 to April 2012. Daily returns of FBMKLCI were used and retrieved from the Financial Times database.	Tests of equality, regression analysis and generalized autoregressive conditional heteroscedasticity (GARCH) models were used to test each effect on significant nature of a political cycle.	The presence of a political cycle in Malaysia stock market volatilities is statistically significant but not in stock market returns.
2016	Koulakiotis et al.	Political elections, abnormal returns and stock price volatility: the case of Greece.	To investigate the stock price index response around the election dates and the effects of change in the ruling political party on the return and risk in the Athens Stock.	Data used were collected from Dissemination Information Department of the Athens Stock Exchange from January 1985 to February 2008.	The models used were mean-adjusted return and autoregressive conditional heteroscedasticity.	The empirical results indicated a positive stock market reaction on the last working day before the election date and negative on the first day after the election date. It also found that this is significantly affected by the transition of the ruling party.

2016	Wong and Hooy	The impact of election on stock market returns of government-owned banks: the case of Indonesia, Malaysia and Thailand.	To investigate whether stock market returns of the government-owned banks and private banks in Indonesia, Malaysia and Thailand differ during before and after elections.	The data used were obtained from Datastream from year 2000 to 2013 with range 20 days before election and 60 days after election. There were 11 elections involved during this studied period.	The cumulative average abnormal return (CAAR) of 30 banks in those countries were calculated and for robustness test, regression analysis using CAAR as dependent variable was conducted.	During election, government-owned banks respond more to the election results compared to private banks. It is because there is a significantly positive CAAR for both types of banks but lower for private banks. CAAR of the government-owned banks was also found continuously significant for the subsequent 60 days after the election.
2016	Liew and Rowland	The effect of Malaysia general election on stock market returns.	To study the phase before and after general election effect which covers the most recent five general elections (GE9 to GE13).	The daily FBMKLCI data was collected from Datastream and the election dates were obtained from the Electoral Commission of Malaysia. The sample period ranges from 1995 to 2013.	Statistical analysis ordinary least squares regression model.	About 40% of the time the stock market reacted positively before the elections, whereas 60% of the time the market reacted positively after the elections. Due to the fact that the ruling party (BN) has been leading for more than half a century, there is no study on which parties give effect to the returns of stock index value.
2018	Jiun	The Effect of Political Elections on Stock Market	To find the relation between stock market	Daily closing values of seven selected indices (FBM Hijrah	Exponential Generalized Autoregressive Conditional	The political uncertainty during elections significantly affected investors respond.

		Volatility in Malaysia.	volatility and Malaysian general elections, GE12 and GE13.	Shariah Index, FBMKLCI Index, FBM Top 100 Index, FBM EMAS Shariah Index FBM EMAS Index, FBM Mid 70 Index and FBM Small Cap Index) in Bursa Malaysia were used. The sample period covers the 12^{th} and 13^{th} Malaysian general elections. All data were obtained from Bursa Malaysia.	Heteroscedasticity (EGARCH) model.	There was a significant higher stock volatility during pre general election effect in all selected stock indices volatility but not in stock returns. In the post general election period, there were only two stocks indices (FTSE Bursa Malaysia Hijrah Shariah Index and FTSE Bursa Malaysia Top 100 Index) showed lower stock volatility.

2.3 STOCK PORTFOLIO

This is a literature review on the stock portfolio. Previous traditional understanding on reducing the risk depends on the various stocks in a portfolio without having the knowledge on the returns and calculation of the risks by each stocks. Modern Portfolio Theory studied by Harry Markowitz (1952) developed a model that based on Mean-Variance Model whereas variance as the risk and the investor is defined to be risk averse in order to overcome this uncertainty. He argued that minimizes the variance of stocks will not be enough to invest especially stocks with high covariances among themselves. He suggested diversification of stocks across industries with different economic features will have lower covariances than stocks within an industry. Hassan et al. (2012) examined the determination of portfolio composition based on maximin criterion[1] during economic crisis in Malaysia from year 1997 to 2001. They constructed a portfolio decision analysis by using maximin criterion model. They found that 10 out of 24 stocks in the constructed portfolio have non zero different weights. This model is most appropriate for investors with risk aversion. Mohamad et al. (2006) used daily data over the period September 1993 to December 2002. The data for daily stock price of 6 industry indices are sourced from Kuala Lumpur Stock Exchange. They found in their research that there is an unstable correlation of return across industries yet investment will get benefit in diversifying across industries and reducing risk for longer time period.

Most of the previous studies (Brooks et al., 1997; Celis & Shen, 2015; Floros, 2008; Jiun, 2018; Lehkonen & Heimonen, 2015; Leon et al., 2000; Liew & Rowland, 2016) used statistical analysis and were unable to suggest which sectors showed

[1] Maximin criterion is the way to choose the best strategy among the worst possibilities by two-step process. The first step is to determine the worst outcome (smallest payoff) for each decision strategy, followed by the second step to choose the best strategy among the worst outcome.

changes during both phases (before and after). By using cooperative game theory approach, Habip Kocak (2014) conducted a research on the portfolio partnership optimality return with three different types of risky groups of stocks from Financial Times and Stock Exchange. The results showed that the return was allocated according to the weight of each stock in the portfolio by using the method of Shapley value. While, Tataei et al. (2018) investigated ways of maximizing the outcome of the player and the model of optimal portfolio selection by using cooperative game theory by shifting the payoff to avoid negative values. The study used society data and statistical sample and found that the proposed portfolio by using cooperative game theory had a better performance most of the time as they try to defeat the market through coalition. They also investigated optimal portfolio performance from 2006 to 2017 with respect to the index performance by using Sharpe and Treynor ratios. They found that the performance was significantly better than the market portfolio for 9 years among 12 examined periods. The cooperative game portfolio significantly outperformed the market in all 12 years (2006-2017) based on both Sharpe and Treynor indexes.

Shalit (2017) calculated the Shapley value risk measure for six classes of United States assets by using optimal Markowitz global minimum variance portfolio. He used two approaches, first is the variance of global minimum variance portfolio for each subset of assets when calculating marginal contribution of an asset to risk. However, he compared risks at different yield levels. Second approach is to calculate the marginal contribution by using portfolio from efficient frontier with a fixed expectation yet it is questionable on how to choose level of expectation. In addition, Slišković and Škrinjarić (2019) also used Shapley value solution concept to evaluate the risk of each individual asset in a portfolio by using the Zagreb Stock Exchange data. The risk used as a cost needs to be divided fairly among individual asset that depends on the contribution to total risk of a portfolio. Also, Nesrin Ozkan (2015) examined portfolio optimization in Borsa Istanbul by using a game theoretic approach to analyze relative performances of sectoral portfolios. He used zero-sum game to be converted into linear programming model. The investors and the stock market are competing players in the model. He tested the performances of the sectoral by using Sharpe Performance Index and Variation Coefficient. He found that the model can be used in portfolio optimization since the technology sector has the highest return with the lowest portfolio concentration and its relative performance is higher compared to the other sectors in the research.

Table 2.3 Summary of Studies on Stock Portfolio.

Year	Author	Title	Objective	Data/Period	Methodology/Model	Conclusion
2006	Mohamad et al.	Diversification across economic sectors and implication on portfolio investments in Malaysia.	To analyze the opportunity for diversification across different economic sectors for long-term investment using sectorial indices.	Daily data over the period September 1993 to December 2002. The data for daily stock price of 6 industry indices are sourced from Kuala Lumpur Stock Exchange (now known as Bursa Malaysia).	Autoregressive Integrated Moving Average (ARIMA) and Sharpe ratio.	They found in their research that there is an unstable correlation of return across industries yet investment will get benefit in diversifying across industries and reducing risk for longer time period.
2012	Hassan et al.	Portfolio decision analysis with maximin criterion in the Malaysian stock market.	To examine the determination of portfolio composition based on maximin criterion during economic crisis in Malaysia.	Weekly return of 24 stocks included in the KLCI from July 1997 until December 2001 during the Malaysian economic crisis were obtained from Bursa Malaysia.	Maximin criterion model.	10 out of 24 stocks in the constructed portfolio have non zero different weights. This model is most appropriate for investors with risk aversion.
2014	Habip Kocak	Canonical coalition game theory for optimal portfolio selection.	To conduct a research on the portfolio partnership optimality return with three different types of risky groups of stocks.	Financial Times and Stock Exchange.	Shapley value solution concept method.	The results showed that the return was allocated according to the weight of each stock in the portfolio.

2015	Nesrin Ozkan	Analysis of sectoral performance in Borsa Istanbul: a game theoretic approach.	To examine portfolio optimization in Borsa Istanbul by using a game theoretic approach to analyze relative performances of sectoral portfolios.	The monthly data for the period between 2009 and 2014 were obtained from Borsa Istanbul where the returns from four sector indexes: fiscal, industrial, service and technology.	Zero-sum game to be converted into linear programming model and Sharpe Performance Index and Variation Coefficient model.	The model can be used in portfolio optimization since the technology sector has the highest return with the lowest portfolio concentration and its relative performance is higher compared to the other sectors in the research.
2017	Shalit	The Shapley value decomposition of optimal portfolios.	To calculate the Shapley value risk measure for six classes of United States assets.	Monthly returns data from January 1926 to April 2014 that involve six indices of US assets.	Shapley value solution concepts on global minimum variance portfolio mean-Gini portfolio.	Shapley value gives the contribution of each asset to all the possible coalitions more than the standard beta analysis when it comes to decomposition of portfolio risk.
2018	Tataei et al.	Outperforming the market portfolio using coalitional game theory approach.	To investigate ways of maximizing the outcome of the player and the model of optimal portfolio selection. The cooperative game portfolio significantly outperformed the market in all 12	The study used society data and statistical sample.	Cooperative game theory method.	The proposed portfolio by using cooperative game theory had a better performance most of the time as they try to defeat the market through coalition. The optimal portfolio performance was significantly better than the market portfolio for 9 years among 12 examined periods

			years (2006-2017) based on both Sharpe and Treynor indexes.			by using Sharpe and Treynor ratios.
2019	Slišković and Škrinjarić	Asset Risk Evaluation Using Shapley Value.	To evaluate the risk of each individual asset in a portfolio.	Using the Zagreb Stock Exchange data.	Shapley value solution concept.	The risk used as a cost needs to be divided fairly among individual asset that depends on the contribution to total risk of a portfolio.

2.4 REVIEW OF THE LITERATURE REVIEW

This is a review of the literature review section. Based on the previous studies tabled in Section 2, there were a few studies used game theory approaches in stock markets such as Colini-Baldeschi et al. (2017), Kocak (2014), Mussard and Terraza (2007;2008) Ozkan (2015), Shalit (2017), Slišković and Škrinjarić (2019), and Tataei et al. (2018). With that, with the best to our knowledge, there is no game theory approach is being used to study the general elections specifically in Malaysia, thus this study aims to provide such approach of game theory in Malaysia stock market.

Given the political unrest and the uncertainties of economic situation during elections particularly the impact on stock market, this study take the opportunity to use the Shapley value solution concept in cooperative game theory to study the 13th and 14th Malaysia general elections, Consequently, this study constructs a Shapley optimal portfolio and comparing the performance of this portfolio with the market and the naive diversification portfolios.

CHAPTER THREE

DATA AND RESEARCH METHODOLOGY

In this chapter, introduction to Bursa Malaysia and the data of this research is provided in sections 3.1 and 3.2 respectively. In section 3.2, this research focuses on the normal form game, pure and mixed strategies and Nash equilibria. In section 3.3, this research focuses on the preliminaries on game theory, mathematical model of cooperative game and Shapley value solution concept and its axioms. Lastly, section 3.4 discusses the methodology of this research and Sharpe ratio of the portfolios.

3.1 BURSA MALAYSIA

Bursa Malaysia is the stock exchange in Malaysia. It was renamed Bursa Malaysia from Kuala Lumpur Stock Exchange (KLSE) on 14th April 2004. Some examples of Bursa Malaysia's indices are FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBMKLCI), FBM Mid 70 Index, FBM Top 100 Index, FBM EMAS Index and FBM Small Cap Index. The FBMKLCI or previously known as KLCI was adopted on 6th July 2009.

3.2 DATA

FTSE Bursa Malaysia Kuala Lumpur Composite Index (FBMKLCI) is the main index to reflect the performance of Malaysia's stock market. FBMKLCI is a group of 30 stocks listed on the main market of the Bursa Malaysia with the highest market capitalization. Three sectors have been chosen in this research based on their consistently listed in FBMKLCI during GE13 and GE14. Table 3.1 summarizes those stocks consistently listed in both periods of elections (see Appendix A).

Table 3.1 List of the Consistently Listed Stocks in FBMKLCI During GE13 and GE14.

Sector	Stock Name
Financial Services	AMMB Holdings Berhad CIMB Group Holdings Berhad Hong Leong Bank Berhad Hong Leong Financial Group Berhad Malayan Banking Berhad Public Bank Berhad RHB Capital Berhad
Consumer Products and Services	PPB Group Berhad Genting Berhad Genting Malaysia Berhad Petronas Dagangan Berhad
Telecommunications and Media	Axiata Group Berhad Digi.Com Berhad Maxis Berhad
Plantation	IOI Corporation Berhad Kuala Lumpur Kepong Berhad
Utilities	Tenaga Nasional Berhad Petronas Gas Berhad
Industrial Products and Services	Petronas Chemicals Group Berhad
Property	Sime Darby Berhad
Health Care	IHH Healthcare Berhad
Transportation and Logistics	MISC Berhad

Since this research follows the methodology done by Kocak (2014) and Tataei et al. (2018), there are only three sectors are chosen out of nine sectors with its highest market capitalization. Kocak (2014) used three players while Tataei et al. (2018) used four players. However, the fourth player which is a risk-free player in Tataei et al. (2018) only take one investment tool. Thus, this research only take three players from top three sectors from the list of consistently listed stocks in FBMKLCI. Those sectors are financial services sector, consumer products and services sector, and telecommunications and media sector.

The data used in this research consists of historical daily closing prices of 14 stocks (see Table 3.2) from the three chosen sectors. All the data are obtained from Eikon Datastream database for empirical evidence. Table 3.3 shows that the analysis is run between the period of 6 months before and after for GE13, period between GE13 and GE14, and GE14 where the period of 6 months before general election and after general election are set according to the important dates of the elections in order to get the whole impact of these general elections. Total trading days for each study period is 282 days.

Table 3.2 Players and Strategies.

Players/Sectors	Strategies/Stocks	Name	Code
Player A : Financial Services	A1	AMMB Holdings Berhad	1015.KL
	A2	CIMB Group Holdings Berhad	1023.KL
	A3	Hong Leong Bank Berhad	5819.KL
	A4	Hong Leong Financial Berhad	1082.KL
	A5	Malayan Banking Berhad	1155.KL
	A6	Public Bank Berhad	1295.KL
	A7	RHB Capital Berhad	1066.KL
Player B : Consumer Products and Services	B1	PPB Group Berhad	4065.KL
	B2	Genting Berhad	3182.KL
	B3	Genting Malaysia Berhad	4715.KL
	B4	Petronas Dagangan Berhad	5681.KL
Player C : Telecommunications and Media	C1	Axiata Group Berhad	6888.KL
	C2	Digi.Com Berhad	6947.KL
	C3	Maxis Berhad	6012.KL

Table 3.3 Study Period for GE13, Period Between GE13 and GE14, and GE14.

General Election 13	Period Date	Trading Day
Before	1/11/2012 – 3/5/2013	132
After	6/5/2013 – 29/11/2013	150
Period between GE13 and GE14	**Period Date**	**Trading Day**
Before	3/11/2014 – 1/5/2015	151
After	5/5/2015 – 30/11/2015	131
General Election 14	**Period Date**	**Trading Day**
Before	1/11/2017 – 8/5/2018	135
After	10/5/2018 – 30/11/2018	147

Since this research is focusing on the short-term investment and volatility of the closing price during elections, the collected data of the three sectors are reorganized into two periods – before and after for each GE. The sectors will be the players and the stocks will be the available strategies for players. The periods of this research will be the column strategies. The three sectors are determined as follows:

A : Financial services

B : Consumer Products and Services

C : Telecommunications and Media

While the nature player is the stock market (FBMKLCI) who has two strategies which are determined as follows:

P1 : Period before general election

P2 : Period after general election

3.2.1 DESCRIPTIVE STATISTICS

For the returns series on each stock, this research calculates a number of descriptive statistics. Specifically, the statistics calculated are mean, standard error, median, mode, standard deviation, sample variance, kurtosis, skewness, range, minimum and maximum. In Table 3.4 to Table 3.6, are the summaries of descriptive statistics for GE13, period between GE13 and GE14, and GE14, respectively.

Table 3.4 shows that the highest average mean of 0.123% comes from Petronas Dagangan Berhad (B4) with standard deviation of 1.14%, The skewness of AMMB Holdings Berhad (A1), CIMB Group Holdings Berhad (A2), PPB Group Berhad (B1), Genting Berhad (B2), Genting Malaysia Berhad (B3) and Petronas Dagangan Berhad (B4) are right-skewed due to more large positive returns than negative returns while others are slightly left-skewed.

Table 3.5 shows that the highest average mean of 0.072% comes from Petronas Dagangan Berhad (B4) with standard deviation of 1.60%, The skewness of CIMB Group Holdings Berhad (A2), Hong Leong Financial Berhad (A4), RHB Capital Berhad (A7), PPB Group Berhad (B1), Genting Berhad (B2), Axiata Group Berhad (C1) and Digi.Com Berhad (C2) are right-skewed due to more large positive returns than negative returns while others are slightly left-skewed.

Table 3.6 shows that the highest average mean of 0.087% comes from Hong Leong Bank Berhad (A3) with standard deviation of 1.29%, The skewness of Hong Leong Bank Berhad (A3), Hong Leong Financial Berhad (A4), Public Bank Berhad (A6), PPB Group Berhad (B1), Petronas Dagangan Berhad (B4) and Digi.Com Berhad (C2) are right-skewed due to more large positive returns than negative returns while others are slightly left-skewed.

Table 3.4 Summary Statistics for GE13.

	A1	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*B1*	*B2*	*B3*	*B4*	*C1*	*C2*	*C3*
Mean	0.00053	-0.00002	-0.00014	0.00072	0.00028	0.00051	0.00005	0.00035	0.00051	0.00059	0.00123	0.00010	-0.00031	0.00004
Standard Error	0.00048	0.00068	0.00050	0.00077	0.00051	0.00027	0.00061	0.00072	0.00081	0.00097	0.00068	0.00060	0.00062	0.00038
Median	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Mode	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Standard Deviation	0.00810	0.01145	0.00846	0.01294	0.00863	0.00457	0.01025	0.01201	0.01355	0.01630	0.01144	0.01015	0.01038	0.00641
Sample Variance	0.00007	0.00013	0.00007	0.00017	0.00007	0.00002	0.00011	0.00014	0.00018	0.00027	0.00013	0.00010	0.00011	0.00004
Kurtosis	2.39169	17.53752	2.83654	1.01386	7.06285	3.10812	4.27937	1.75472	4.30495	0.84227	4.93201	7.61398	5.51409	4.92574
Skewness	0.21747	1.59149	-0.17150	-0.20012	-0.74146	-0.60036	-0.50561	0.25065	0.02234	0.30010	0.74549	-0.54093	-0.62709	-0.12373
Range	0.06491	0.13874	0.06272	0.07955	0.08693	0.03523	0.08966	0.07998	0.12861	0.10631	0.10440	0.09609	0.09731	0.05426
Minimum	-0.02935	-0.04588	-0.02994	-0.04362	-0.04707	-0.02132	-0.05343	-0.03919	-0.06369	-0.04763	-0.04399	-0.05256	-0.05429	-0.02506
Maximum	0.03556	0.09287	0.03277	0.03593	0.03986	0.01390	0.03623	0.04079	0.06491	0.05868	0.06041	0.04352	0.04302	0.02920
Sum	0.14831	-0.00652	-0.03888	0.20411	0.07979	0.14493	0.01461	0.09889	0.14393	0.16641	0.34575	0.02868	-0.08650	0.01001
Count	282	282	282	282	282	282	282	282	282	282	282	282	282	282

Note: Please refer to Table 3.2 for the notations of A1 to A7, B1 to B4 and C1 to C3.

Table 3.5 Summary Statistics for Period Between GE13 and GE14.

	A1	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*B1*	*B2*	*B3*	*B4*	*C1*	*C2*	*C3*
Mean	-0.00138	-0.00130	-0.00015	-0.00085	-0.00054	-0.00003	-0.00150	0.00000	-0.00108	0.00008	0.00072	-0.00050	-0.00076	-0.00010
Standard Error	0.00079	0.00107	0.00046	0.00083	0.00065	0.00044	0.00086	0.00085	0.00106	0.00099	0.00095	0.00068	0.00070	0.00070
Median	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00220	0.00000	0.00000	0.00000	0.00000	0.00000
Mode	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Standard Deviation	0.01329	0.01793	0.00779	0.01388	0.01085	0.00745	0.01450	0.01421	0.01781	0.01660	0.01596	0.01143	0.01175	0.01168
Sample Variance	0.00018	0.00032	0.00006	0.00019	0.00012	0.00006	0.00021	0.00020	0.00032	0.00028	0.00025	0.00013	0.00014	0.00014
Kurtosis	4.03092	11.77942	2.29864	1.79999	2.04887	2.66640	1.58916	3.60093	3.24919	1.93352	7.62509	11.61975	4.15311	18.06160
Skewness	-0.75692	1.39930	-0.29606	0.11376	-0.71543	-0.30995	0.26639	0.64088	0.67165	-0.09736	-0.70009	0.84832	0.66015	-0.44562
Range	0.10651	0.20258	0.05333	0.10542	0.06961	0.05898	0.10802	0.11837	0.15455	0.12742	0.16237	0.13437	0.09387	0.16499
Minimum	-0.06337	-0.06895	-0.02923	-0.05133	-0.04073	-0.02817	-0.05084	-0.03613	-0.06454	-0.07852	-0.09382	-0.06172	-0.04248	-0.08853
Maximum	0.04314	0.13363	0.02409	0.05409	0.02888	0.03081	0.05718	0.08224	0.09001	0.04890	0.06855	0.07265	0.05138	0.07646
Sum	-0.39010	-0.36618	-0.04118	-0.23930	-0.15346	-0.00867	-0.42335	-0.00121	-0.30319	0.02299	0.20334	-0.13983	-0.21350	-0.02707
Count	282	282	282	282	282	282	282	282	282	282	282	282	282	282

Note: Please refer to Table 3.2 for the notations of A1 to A7, B1 to B4 and C1 to C3.

Table 3.6 Summary Statistics for GE14.

	A1	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*B1*	*B2*	*B3*	*B4*	*C1*	*C2*	*C3*
Mean	-0.00002	-0.00023	0.00087	0.00051	0.00005	0.00070	0.00012	0.00082	-0.00130	-0.00200	0.00026	-0.00140	-0.00058	-0.00032
Standard Error	0.00097	0.00087	0.00077	0.00081	0.00057	0.00049	0.00075	0.00044	0.00087	0.00145	0.00070	0.00133	0.00090	0.00068
Median	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Mode	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Standard Deviation	0.01631	0.01468	0.01294	0.01355	0.00954	0.00826	0.01260	0.00745	0.01466	0.02427	0.01176	0.02235	0.01515	0.01146
Sample Variance	0.00027	0.00022	0.00017	0.00018	0.00009	0.00007	0.00016	0.00006	0.00022	0.00059	0.00014	0.00050	0.00023	0.00013
Kurtosis	6.24490	4.88352	16.66052	2.84765	5.84555	7.43025	0.97146	14.04286	4.81745	37.18336	15.74678	9.31482	3.29315	3.41691
Skewness	-1.07665	-0.83764	1.75899	0.20269	-0.30885	0.23622	-0.14330	2.18416	-0.69536	-4.33914	1.62617	-1.64623	0.38778	-0.09767
Range	0.14615	0.12315	0.15480	0.10950	0.08258	0.07764	0.07487	0.07834	0.13105	0.29253	0.13734	0.19952	0.12955	0.09412
Minimum	-0.09223	-0.07318	-0.04944	-0.05301	-0.04395	-0.03765	-0.04012	-0.02676	-0.07835	-0.22922	-0.04456	-0.13580	-0.05728	-0.05241
Maximum	0.05392	0.04997	0.10536	0.05649	0.03863	0.03999	0.03475	0.05159	0.05270	0.06331	0.09278	0.06372	0.07227	0.04171
Sum	-0.00468	-0.06389	0.24572	0.14366	0.01502	0.19720	0.03292	0.23006	-0.36539	-0.56460	0.07399	-0.39531	-0.16487	-0.09145
Count	282	282	282	282	282	282	282	282	282	282	282	282	282	282

Note: Please refer to Table 3.2 for the notations of A1 to A7, B1 to B4 and C1 to C3.

3.3 PRELIMINARIES ON GAME THEORY

Fundamentally, three basic elements in game theory are players, strategies and payoffs. The first element is the player. The player who must be rational enough to take his strategy in maximizing his payoff in a game. Rational behavior to make decision is based on the optimal payoff in a game. The normal form game is a game in which all players make decisions simultaneously. Hence, the player has no knowledge of the decision made by other players before making their own decision.

Definition 3.1. (Tadelis, 2013) A normal form game includes three components as follows:

- A finite set of players, $N = \{1, 2, ..., n\}$.
- A collection of sets of pure strategies, $S_i = \{s_1, \mathrm{s}_2, ..., \mathrm{s}_k\}$.
- A set of payoff functions, $v_i = \{v_1, v_2, ..., v_k\}$.

The representation of this type of game is in matrix form. In matrix form, one player is the row player and the other will be the column player. Each row or column represents a strategy where the payoff will be in the combinations of the columns and the rows. This type of game is solved by using the concept of Nash equilibrium. Nash equilibrium is the equilibrium where the strategy of each player is optimal given the strategies of all other players. Nash equilibrium is a game theory solution that consists more than one player where each player is aware of the player's stable state strategy and there is no player will change his profit by unilateral strategy change.

In equation (3.1) matrix form below, rows represent player 1's strategies, if there are i strategies in S_i then the matrix will have i rows. Columns represent player 2's strategies, if there are j strategies in S_j then the matrix will have j columns. Since the fundamental of game theory consists of players, strategies and payoff, assume that player 1 has i strategies (rows) and player 2 has j strategies (columns), the payoff matrix as given below,

$$payoff = \begin{pmatrix} a_{1,1} & \cdots & a_{1,j} \\ \vdots & \ddots & \vdots \\ a_{i,1} & \cdots & a_{i,j} \end{pmatrix} \tag{3.1}$$

where the entries a_{ij} of the matrix is the gain of player 1 and loss of player 2 if both players play strategy i and j respectively, called as zero-sum game.

In a zero-sum game, the gain of one player is other players' loss and vice versa. The minimum profit for each player is the maximum gain of the rival. If player 1 chooses a strategy i, the minimum profit would be $\min_j a_{ij}$. Player 1 adopts a strategy to turn the minimum profit to maximum. Thus the expected profit is $\max_i \min_j a_{ij}$. In contrast to player 1's maximum profit, it would be minimum profit to player 2. Then player 2 chooses a strategy j that will minimize the maximum profit of player 1, so the maximum profit would be $\max_i a_{ij}$. Player 2 adopts a strategy to turn the maximum profit to minimum. and the expected payoff is $\min_j \max_i a_{ij}$. The balance among these two players will exist if the state of Nash equilibrium equation below is true.

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

However, mostly in games, a player does not want the other players to expect his behavior. Thus the player will choose strategies with some probabilities. Based on the possible strategies the players can choose, there are two type of strategies called pure strategy and mixed strategy (Barron, 2013). Pure strategy involves each of the player has a best response, s_i^* is called a saddle point (or equilibrium point). While, mixed strategy involves the player who do not has a best response. Since the player will not have a best response, they will choose a strategy with probability to get the value of the game.

Definition 3.2. (Tadelis, 2013) A player needs to solve decision problem with a payoff function $v_i(.)$ over strategies, is rational if he chooses an strategy $s_i \in S_i$ that maximizes his payoff. That is, $s_i^* \in S_i$ is chosen if and only if $v\left(s_i^*\right) \geq v\left(s_i\right)$ for all $s_i \in S_i$.

Definition 3.3. (Tadelis, 2013) A pure strategy for player i is a deterministic plan of strategy. The set of all pure strategies for player i is denoted S_i. A profile of pure strategies $S_i = \{s_1, s_2, ...s_k\}$, $s_i \in S_i$ for all $i = 1, 2, ..., k$ describes a particular combination of pure strategies chosen by all n players in the game.

Definition 3.4. (Gibbons, 1992) In the normal form game $G = \{s_i, s_2, ..., s_k; v_1, v_2, ..., v_k\}$, suppose $S_i = \{s_{i,1}, s_{i,2}, ..., s_{i,k}\}$. Then a mixed strategy for player i is a probability distribution $P_i = \{p_{i,1}, p_{i,2}, ..., p_{i,k}\}$, where $0 \leq p_{i,\mathrm{K}} \leq 1$ for $K = \{1, 2, ..., k\}$ and $\sum_{i=1}^{k} p_{i,\mathrm{K}} = 1$.

Payoff of player 1 chooses strategy i with probability of p_i is v and maximize it as following:

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

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

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

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

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

By calculating Nash equilibrium, the probability of occurrences any p_i strategy and any q_j strategy by opponent player, the value of the game is calculated for each player. Then, the value of the game is calculated for each player by using equation (3.2) as follows:

$$v(S)=\sum_{i=1}^{n}\sum_{j=1}^{m}p_i^* q_j^* a_{i,j} \tag{3.2}$$

After describing the way to represent a game, this research proceeds on how to solve a normal form game. The method is iterated dominance. The elimination of dominated strategies is commonly used to simplify payoff matrix of any game (Gibbons, 1992; Rasmusen, 2006; Tadelis, 2013). Dominant strategies are better than other strategy, no matter what other players might do. There are two kinds of strategic dominance. First is strictly dominant strategy and second is weakly dominant strategy. The strategy that always provides greater payoff to a player, no matter what the other player's strategy is called strictly dominant strategy. While, weak dominant strategy is a strategy that provides at least the same or strictly greater payoff for all the other player's strategies. Any dominant strategy equilibrium is known as Nash equilibrium. However, not all Nash equilibria are dominant strategy equilibria.

Definition 3.5. (Tadelis, 2013) Let $s_i, s_i^{'} \in S_i$ be possible strategies for player i. We say that $s_i^{'}$ is strictly dominated by s_i if for any possible combination of the other players' strategies that denoted as $s_{-i} \in S_{-i}$, player i's payoff from $s_i^{'}$ is strictly less than that from s_i. That is, $v_i(s_i, s_{-i}) > v_i(s_i^{'}, s_{-i})$ for all $s_{-i} \in S_{-i}$.

Definition 3.6. (Gibbons, 1992) In the n-player normal form game $G=\{s_i, s_2, ..., s_k; v_1, v_2, ..., v_k\}$, the strategies $(s_1^*, s_2^*, ..., s_n^*)$ are Nash equilibria, for each player i, s_i^* is player i's best response to the strategies specified for the $n-1$ other players, $(s_1^*, ..., s_{i-1}^*, s_{i+1}^*, ..., s_n^*)$:

$v_i\left(s_1^*,...,s_{i-1}^*,s_i^*,s_{i+1}^*,...,s_n^*\right) > v_i\left(s_1^*,...,s_{i-1}^*,s_i,s_{i+1}^*,...,s_n^*\right)$ for every feasible strategy $s_i \in S_i$;

that is, s_i^* solves $\max_{s_i \in S_i} v_i\left(s_1^*,...,s_{i-1}^*,s_i^*,s_{i+1}^*,...,s_n^*\right)$.

Theorem 3.1. (Nash, 1950) : In the n **-**player normal-form game $G=\{s_i,s_2,...,s_k;v_1,v_2,...,v_k\}$, if n is finite and s_i is finite for every i then there exists at least one Nash equilibrium, possibly involving mixed strategies.

The relation between iterated dominance and Nash equilibrium is that Nash equilibrium is a stronger solution concept than iterated elimination of strictly dominated strategies. The iterated elimination of strictly dominated strategies does not eliminate all but a single combination of strategies. It can be seen that the strategies are a Nash equilibrium then they survive iterated elimination of strictly dominated strategies. Yet there can be strategies that survive iterated elimination of strictly dominated strategies but are not part of any Nash equilibrium.

3.3.1 MATHEMATICAL MODEL OF COOPERATIVE GAME

Cooperative game theory is one of the branch in game theory field. The study is about games in coalition form that has been introduced by von Neumann and Morgenstern in 1944. There are two types of payoffs in cooperative games which are transferable and nontransferable payoffs. Transferable payoff means that there is a medium of exchange between the players and the gain of each coalition can be expressed as one number for instance, money that can be a profit or a cost. It can be distributed in any conceivable way to all players in a coalition. However, nontransferable payoff means that there is no such medium of exchange. Each member in a coalition receives individual payoff which does not come from the coalition’s payoff. This research is focusing on cooperative game with transferable payoff.

The main focus in a cooperative game theory is to create possible coalitions among players that be defined as C. Each subset for a set of players can be considered as a coalition C except an empty set. This coalition form is based on the characteristic function of the game (Tijs, 2003). The values of the game from equation (3.2) are used as a characteristic function and can be defined as v while the worth of C is defined as $v(C)$ since the coalition is created to gain higher payoff when working together for each $C \subseteq N$. Therefore, C coalition plays non-cooperative game with opposite players outside the coalition. Cooperative game theory is used to divide the worth of a coalition to its player members.

A characteristic function game G is given by a pair (N,v) where N is the set of players and $v: 2^{[N]} \to \mathbb{R}$ is a characteristic function for a game with transferable payoff specifies $v(C)$ for every subset $C \subseteq N$ which maps every coalition of players to a payoff.

Definition 3.7. (Barron, 2013) A cooperative game theory in a characteristic function form is an ordered pair (N,v) where N is the set of players $\{1,2,...,n\}$ and the characteristic function $v: 2^{[N]} \to \mathbb{R}$ with $v(\phi) = 0$.

This section builds a simple cooperative game model. Cooperative game is a game where the players make a binding agreement as opposed to non-cooperative game, in which they do not form a coalition. The main focus on cooperative game theory is a game in which the players join together to receive more utilities. The possible cooperations created will receive added benefits among all players through this bond. The cooperation formed is at least has to make sure the values obtained by the coalitions are more profitable and be defined as superadditivity. This means that the worth of the cooperation is equal to at least the worth of if they act individually. This means that for any two disjoint coalitions, $C_1 \cap C_2 = \varnothing$, the following inequality holds as follows:

$$v\left(C_1 \cup C_2\right) \geq v\left(C_1\right) + v\left(C_2\right),\ \forall C_1 \subset N,\ \forall C_2 \subset N \tag{3.3}$$

3.3.2 THE SHAPLEY VALUE

The Shapley value (Shapley, 1953) is one of the well-known single-valued solution concepts in cooperative game theory which assigns to each player its expected marginal contribution. The possible orders of entrance of the players to the grand coalition occur with equal probability.

Definition 3.8. (Roth, 1988) The Shapley value of a transferable payoff of a game is the payoff allocation $\phi_i(v)$ of player i defined as follows:

$$\phi_i(v) = \sum_{C \subseteq N, \mathrm{i} \in \mathrm{C}} \frac{\left(|N| - |C|\right)!\left(|C| - 1\right)!}{|N|!}\left[v(C) - v\left(\mathrm{C} \backslash \{i\}\right)\right] \tag{3.4}$$

The value $v\left(C \setminus \{i\}\right)$ represents coalition without player i. This equation describes the expected marginal contribution of player i to the coalition in following arrival order of players. As an example, there are two possible orders of arrival for two players case. First is player 1 arrives first then player 2 and second is player 2 arrives first then player 1. Player i will be paid based on his marginal contribution when joining the coalition of earlier arrivers C. The solution concept of Shapley value encompasses fairness by following four axiomatic characterizations.

Axiom 1. Efficiency : $\sum_{i \in N} \phi_i(v) = v\left(N\right)$.

Axiom 2. Symmetry : *If for two players* i *and* j, $v(C \cup \{i\}) = v(C \cup \{j\})$ *holds for every* C, *where* $C \subset N$ *and* $i, j \notin C$, *then* $\phi_i(v) = \phi_j(v)$.

Axiom 3. Dummy : *If* $v(C \cup \{i\}) = v(C)$ *holds for every* C, *where* $C \subset N$ *and* $i \notin C$ *, then* $\phi_i(v) = 0$.

Axiom 4. Additivity : *For any pair of games* v, w *:* $\phi(v + w) = \phi(v) + \phi(w)$, *where* $(v + w)(C) = v(C) + w(C)$ *for all* C.

Theorem 3.2. (Shapley, 1953) The Shapley value is a unique value that satisfies efficiency, symmetry, dummy player and additivity.

The explanation of efficiency is the distribution of the solution should be maximum total payoff. The symmetry axiom is the payoff paid refers to individual player's contribution. Dummy axiom is any player who does not contribute to the coalition should get nothing as his value. Additivity axiom is by adding solution of two games will produce the solution of the sum of these games.

There are studies that applied the Shapley value solution concept in various fields. Seog and Shin (2009) compared cooperative game theory approaches and financial approaches to allocate risk capital in insurance firms. They used Shapley value solution concept with a single effect decision and Aumann-Shapley value if the effect of a decision is continuous. Rene et al. (2015) combined cooperative game theory framework and linear programming techniques. This combination suggested alternative model to Shapley value and applied to the social networks problems by ranking the nodes. Liao et al. (2015) compared the Shapley value method with carbon emission benchmark and grandfathering allocation methods in order to simulate the initial allocation of carbon emission allowance of three power plants in Pudong New District, Shanghai, China. The result showed that the allocation of the benchmark was similar with Shapley value allocation. Mohebbi and Li (2015) developed a model for suppliers' dynamic coalition formation by using cooperative game theory. They proposed cooperation algorithm of suppliers to solve conflicts among network members. The efficiency of the proposed approach is compared to Shapley value and proportional fairness**.**

Karaś (2017) explained joint-stock company on stockholders meeting as an example of cooperative game theory. Voting at the general meeting of shareholders is a special kind of cooperative game theory framework where Shapley value used to measure the potential of each marginal contribution of shareholder to form majority votes in achieving victory. Kolker (2017) studied the cost allocation problems in which work as a team occurs such as healthcare providers who have to coordinate patient care in order to reduce the cost and improve the quality of care. The study focused on the Shapley value for cost allocation between cooperating providers of care applied to the bundled payment model.

3.4 METHODOLOGY

This research uses 14 chosen stocks (as in Table 3.2) in FBMKLCI during GE13 and G14 for the first objective of the study. Firstly, this research examines the impact of elections to the chosen stocks by using Shapley value solution concept. Secondly, this research constructs the optimal portfolio selection based on the weightage allocation for GE14 and measures its performance by using Sharpe ratio. This research adopted the methodologies applied in Kocak (2014) and Tataei et al. (2018) papers in applying cooperative game theory approach towards portfolio selection. The methodologies in this research are described below. Flow chart of this study is presented in Figure 3.1.

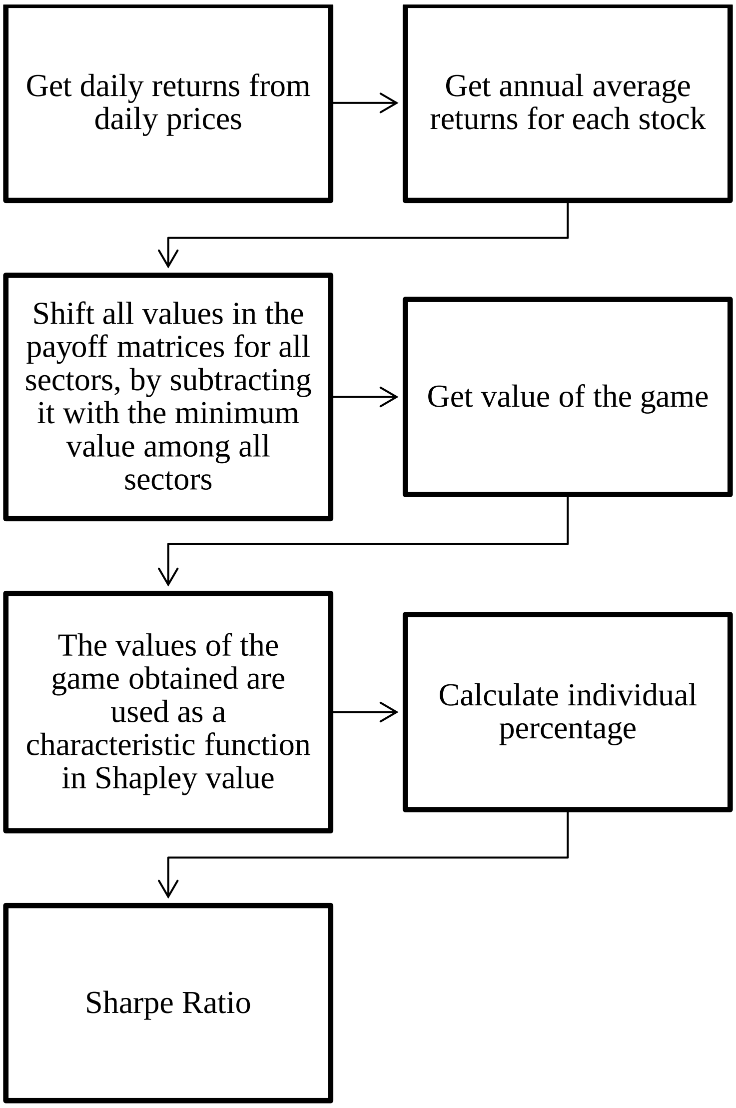

Figure 3.1 Brief Flow Chart on Applying Game Theory Framework into Optimal Portfolio Selection.

The aim of this research is to find an optimal solution for portfolio selection by explaining the behavior of investors in the cooperative game framework. Therefore, the model of this research is zero-sum game where the players are between investors and the stock market, and a cooperative game in a static game model as the movements of the investors and market are affected simultaneously. The daily prices of each stock is used to calculate the return of each stock. The returns are expressed in logarithmic form as follows:

$$R_t = \ln(P_t) - \ln(P_{t-1}) \tag{3.5}$$

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 $t-1$.

The annual average return of each stock, $\overline{R}$ are calculated as follows:

$$\overline{R} = \frac{\sum_{t=1}^{n} R_t}{n} \tag{3.6}$$

where,

n is the number of trading days.

The return prices for each stock are calculated by using equation (3.5) and the average return prices are formed from equation (3.6). The average returns have positive and negative values. Hence, to avoid negative values in calculation of Shapley value, all the values are shifted in the payoff matrices for all sectors, by subtracting it with the minimum value among all sectors. The shifted average return values are then evaluated in Production and Operations Management – Quantitative Methods (POM - QM) for Windows software to get the values of game for each sector.

The value of game obtained are distributed by using Shapley value equation (3.4) (using Lingo software, Appendices B, C and D) to evaluate the expected marginal contribution for each sector. The value of game is then used to get the percentages allocation to each sector during GE13, period between GE13 and GE14, and GE14 by normalizing the expected marginal contribution to the grand coalition value,

$v\left(\left\{A,B,C\right\}\right)$. The probability of occurring strategies of each company in the optimal solution $v\left(S\right)$ in equation (3.2) are defined as α_i^*, β_j^* and γ_k^* where $i=\left\{1,2,...,\mathrm{m}\right\}$, $j=\left\{1,2,...,\mathrm{n}\right\}$, $k=\left\{1,2,...,\mathrm{o}\right\}$. The individual weightage is calculated by using the respective equations as follows:

$$\begin{aligned} w_i &= P(A)\alpha_i^*\sum_{j,k}\beta_j^*\gamma_k^* \\ w_j &= P(\mathrm{B})\beta_j^*\sum_{\mathrm{i},k}\alpha_i^*\gamma_k^* \\ w_k &= P(\mathrm{C})\gamma_k^*\sum_{\mathrm{i,j}}\alpha_i^*\beta_j^* \end{aligned} \tag{3.7}$$

Based on the weightage of each stock calculated in equation (3.7), an optimal portfolio is obtained.

3.4.1 SHARPE RATIO

In this section, we compare empirical example of the optimal portfolio performance that is based on the Shapley value solution concepts (hereafter this text is used as Shapley optimal portfolio) towards the market portfolio (FBMKLCI) and naive diversification portfolio, in which weightages are evenly distributed. Investors allocate their wealth across N assets by using naive diversification weightage, $w_i = 1/N$ rule where $i = 1,2,...,N$ (Thaler & Benartzi, 2001). The Sharpe ratio (Sharpe, 1994) is calculated for each optimal allocation as it can be argued whether the Shapley optimal portfolio can defeat the naive diversification portfolio and the market portfolio or not. DeMiguel et al. (2007) concluded in their findings that $1/N$ strategy of naive diversification always dominates some others optimal allocation in terms of Sharpe ratio. The $1/N$ strategy allocates the portfolio's weightages evenly across the assets. Hence, this research wants to show that Shapley optimal portfolio can dominate their argument. In order to calculate Sharpe ratio, the expected returns of portfolio is calculated as follows (Bodie et al., 2014):

$$E\left(r_p\right)=\sum_{i=1}^{n} w_i E\left(r_i\right) \tag{3.8}$$

where,

r_p is the return of the portfolio,

r_i is the daily return of asset i,

$E(r_p)$ is the expected return of portfolio,

$E(r_i)$ is the expected daily return of asset i.

The variance of portfolio is calculated as follows:

$$\sigma_p^2=\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j cov\left(r_i, r_j\right) \tag{3.9}$$

The Sharpe ratio, S_r is calculated by using the formula as follows:

$$S_r=\frac{E\left(r_p\right)-RFR}{\sigma_p} \tag{3.10}$$

where,

RFR is the risk-free rate,

σ_p is the standard deviation of portfolio.

The evaluation of the portfolio performance is based on Sharpe ratio. If the Sharpe ratio value is greater than one, then the portfolio performance is good. However, if the value of the Sharpe ratio is less than one, then the portfolio performance is bad. To conclude the higher the Sharpe ratio is, the better is the portfolio performance.

CHAPTER FOUR

RESULT AND DISCUSSION: COMPARING GE13, PERIOD BETWEEN GE13 AND GE14, AND GE14

This chapter presents the result and discussion. Section 4.1 provides characteristic function for GE13, section 4.2 provides characteristic function for period between GE13 and GE14, and section 4.3 provides characteristic function for GE14. Section 4.4 presents the comparison performance of the percentages for all periods with three types of sectors in 2013 and 2018.

4.1 GENERAL ELECTION 13

General Election 13 (GE13) was held on Sunday, 5th May, 2013. Barisan Nasional (BN) is one of the political coalition parties in Malaysia that has faced challenges from opposition party, Pakatan Rakyat (PR) after dominating Malaysian politics for over 60 years. A total of 222 Parliament seats, BN resumed its domination to the federal government with 133 seats won. While, the opposition party, PR took only 89 seats. The date range of this research for GE13 is from 1st November 2012 until 29th November 2013 with a total of 282 trading days.

The shifted average return values for GE13 are solved in Production and Operations Management – Quantitative Methods (POM - QM) for Windows software by using equation (3.2) in order to get the value of the game for each of the payoff matrix. The payoff matrices formed for players A (financial services sector), B (consumer products and services sector) and C (telecommunications and media sector) with columns of P1 (period before GE) and P2 (period after GE) are shown in Tables 4.1 to 4.3 below.

Table 4.1 Payoff Matrix for Player A (GE13).

	P1	P2
A1	1.36E-03	1.80E-03
A2	1.05E-03	1.05E-03
A3	8.72E-04	9.86E-04
A4	2.36E-03	1.29E-03
A5	1.53E-03	1.20E-03
A6	1.28E-03	1.86E-03
A7	1.94E-03	4.05E-04

Table 4.2 Payoff Matrix for Player B (GE13).

	P1	P2
B1	5.71E-04	2.17E-03
B2	1.99E-03	1.22E-03
B3	1.18E-03	2.09E-03
B4	1.45E-03	3.05E-03

Table 4.3 Payoff Matrix for Player C (GE13).

	P1	P2
C1	1.15E-03	1.19E-03
C2	0.00E+00	1.44E-03
C3	8.39E-04	1.34E-03

The values of the game for player A (financial services sector), player B (consumer products and services sector) and player C (telecommunications and media sector) are 0.00166, 0.00181 and 0.00115 respectively. The results are obtained for GE13 period as follows:

$$v(\{A\}) = 0.00166$$
$$v(\{B\}) = 0.00181$$
$$v(\{C\}) = 0.00115$$

The payoff matrices formed for players' coalitions; players A and B, players A and C, players B and C, and players A, B and C are shown in Tables 4.4 to 4.7 below.

Table 4.4 Payoff Matrix for Coalition of Players A and B (GE13).

	P1	P2
A1B1	1.93E-03	3.97E-03
A1B2	3.35E-03	3.03E-03
A1B3	2.54E-03	3.89E-03
A1B4	2.81E-03	4.85E-03
A2B1	1.62E-03	3.22E-03
A2B2	3.04E-03	2.27E-03
A2B3	2.23E-03	3.13E-03
A2B4	2.50E-03	4.09E-03
A3B1	1.44E-03	3.16E-03
A3B2	2.86E-03	2.21E-03
A3B3	2.05E-03	3.07E-03
A3B4	2.32E-03	4.03E-03
A4B1	2.93E-03	3.46E-03
A4B2	4.35E-03	2.52E-03
A4B3	3.54E-03	3.38E-03
A4B4	3.81E-03	4.34E-03
A5B1	2.10E-03	3.37E-03
A5B2	3.52E-03	2.42E-03
A5B3	2.70E-03	3.29E-03
A5B4	2.97E-03	4.25E-03
A6B1	1.85E-03	4.03E-03
A6B2	3.27E-03	3.08E-03
A6B3	2.45E-03	3.94E-03
A6B4	2.72E-03	4.90E-03
A7B1	2.51E-03	2.58E-03
A7B2	3.93E-03	1.63E-03
A7B3	3.11E-03	2.49E-03
A7B4	3.38E-03	3.45E-03

Table 4.5 Payoff Matrix for Coalition of Players A and C (GE13).

	P1	P2
A1C1	2.51E-03	2.99E-03
A1C2	1.36E-03	3.24E-03
A1C3	2.20E-03	3.15E-03
A2C1	2.20E-03	2.24E-03
A2C2	1.05E-03	2.48E-03
A2C3	1.89E-03	2.39E-03
A3C1	2.02E-03	2.18E-03
A3C2	8.72E-04	2.42E-03
A3C3	1.71E-03	2.33E-03
A4C1	3.52E-03	2.48E-03
A4C2	2.36E-03	2.73E-03
A4C3	3.20E-03	2.64E-03
A5C1	2.68E-03	2.39E-03
A5C2	1.53E-03	2.64E-03
A5C3	2.37E-03	2.54E-03
A6C1	2.43E-03	3.05E-03
A6C2	1.28E-03	3.29E-03
A6C3	2.12E-03	3.20E-03
A7C1	3.09E-03	1.60E-03
A7C2	1.94E-03	1.84E-03
A7C3	2.78E-03	1.75E-03

Table 4.6 Payoff Matrix for Coalition of Players B and C (GE13).

	P1	P2
B1C1	1.72E-03	3.36E-03
B1C2	5.71E-04	3.61E-03
B1C3	1.41E-03	3.51E-03
B2C1	3.14E-03	2.41E-03
B2C2	1.99E-03	2.66E-03
B2C3	2.83E-03	2.56E-03
B3C1	2.33E-03	3.28E-03
B3C2	1.18E-03	3.52E-03
B3C3	2.01E-03	3.43E-03
B4C1	2.60E-03	4.24E-03
B4C2	1.45E-03	4.48E-03
B4C3	2.28E-03	4.39E-03

Table 4.7 Payoff Matrix for Coalition of Players A, B and C (GE13).

	P1	P2
A1B1C1	3.08E-03	5.17E-03
A1B1C2	1.93E-03	5.41E-03
A1B1C3	2.77E-03	5.32E-03
A1B2C1	4.50E-03	4.22E-03
A1B2C2	3.35E-03	4.46E-03
A1B2C3	4.19E-03	4.37E-03
A1B3C1	3.69E-03	5.08E-03
A1B3C2	2.54E-03	5.33E-03
A1B3C3	3.38E-03	5.23E-03
A1B4C1	3.96E-03	6.04E-03
A1B4C2	2.81E-03	6.29E-03
A1B4C3	3.65E-03	6.19E-03
A2B1C1	2.77E-03	4.41E-03
A2B1C2	1.62E-03	4.65E-03
A2B1C3	2.46E-03	4.56E-03
A2B2C1	4.19E-03	3.46E-03
A2B2C2	3.04E-03	3.70E-03
A2B2C3	3.88E-03	3.61E-03
A2B3C1	3.38E-03	4.32E-03
A2B3C2	2.23E-03	4.57E-03
A2B3C3	3.07E-03	4.48E-03
A2B4C1	3.65E-03	5.28E-03
A2B4C2	2.50E-03	5.53E-03
A2B4C3	3.34E-03	5.43E-03
A3B1C1	2.59E-03	4.35E-03
A3B1C2	1.44E-03	4.59E-03
A3B1C3	2.28E-03	4.50E-03
A3B2C1	4.01E-03	3.40E-03
A3B2C2	2.86E-03	3.65E-03
A3B2C3	3.70E-03	3.55E-03
A3B3C1	3.20E-03	4.27E-03
A3B3C2	2.05E-03	4.51E-03
A3B3C3	2.89E-03	4.42E-03
A3B4C1	3.47E-03	5.22E-03
A3B4C2	2.32E-03	5.47E-03
A3B4C3	3.16E-03	5.37E-03
A4B1C1	4.09E-03	4.66E-03
A4B1C2	2.93E-03	4.90E-03
A4B1C3	3.77E-03	4.81E-03
A4B2C1	5.50E-03	3.71E-03
A4B2C2	4.35E-03	3.95E-03

Continued		
A4B2C3	5.19E-03	3.86E-03
A4B3C1	4.69E-03	4.57E-03
A4B3C2	3.54E-03	4.82E-03
A4B3C3	4.38E-03	4.72E-03
A4B4C1	4.96E-03	5.53E-03
A4B4C2	3.81E-03	5.78E-03
A4B4C3	4.65E-03	5.68E-03
A5B1C1	3.25E-03	4.56E-03
A5B1C2	2.10E-03	4.81E-03
A5B1C3	2.94E-03	4.71E-03
A5B2C1	4.67E-03	3.62E-03
A5B2C2	3.52E-03	3.86E-03
A5B2C3	4.35E-03	3.77E-03
A5B3C1	3.85E-03	4.48E-03
A5B3C2	2.70E-03	4.73E-03
A5B3C3	3.54E-03	4.63E-03
A5B4C1	4.12E-03	5.44E-03
A5B4C2	2.97E-03	5.68E-03
A5B4C3	3.81E-03	5.59E-03
A6B1C1	3.00E-03	5.22E-03
A6B1C2	1.85E-03	5.46E-03
A6B1C3	2.69E-03	5.37E-03
A6B2C1	4.42E-03	4.27E-03
A6B2C2	3.27E-03	4.51E-03
A6B2C3	4.11E-03	4.42E-03
A6B3C1	3.60E-03	5.13E-03
A6B3C2	2.45E-03	5.38E-03
A6B3C3	3.29E-03	5.29E-03
A6B4C1	3.88E-03	6.09E-03
A6B4C2	2.72E-03	6.34E-03
A6B4C3	3.56E-03	6.24E-03
A7B1C1	3.66E-03	3.77E-03
A7B1C2	2.51E-03	4.01E-03
A7B1C3	3.35E-03	3.92E-03
A7B2C1	5.08E-03	2.82E-03
A7B2C2	3.93E-03	3.06E-03
A7B2C3	4.77E-03	2.97E-03
A7B3C1	4.27E-03	3.68E-03
A7B3C2	3.11E-03	3.93E-03
A7B3C3	3.95E-03	3.83E-03
A7B4C1	4.54E-03	4.64E-03
A7B4C2	3.38E-03	4.89E-03
A7B4C3	4.22E-03	4.79E-03

The payoff matrix for each player's coalition above are solved in QM for Windows software, the values of game are obtained as follows:

$$v(\{AB\}) = 0.00393$$
$$v(\{AC\}) = 0.00284$$
$$v(\{BC\}) = 0.00297$$
$$v(\{ABC\}) = 0.00509$$

The values of the game obtained are then used as characteristic function for GE13 as shown in Table 4.8 below.

Table 4.8 Characteristic Function for GE13.

Characteristic Function	Value
$v(\{\phi\})$	0.00000
$v(\{A\})$	0.00166
$v(\{B\})$	0.00181
$v(\{C\})$	0.00115
$v(\{AB\})$	0.00393
$v(\{AC\})$	0.00284
$v(\{BC\})$	0.00297
$v(\{ABC\})$	0.00509

By using Shapley value equation (3.4), the expected marginal contribution for each sector is calculated using Lingo software (for Lingo software see Appendix B). The expected marginal contribution for each player increases the payoff and 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 grand coalition value $v(\{A,B,C\}) = 0.00509$, to obtain sectors' percentages. The results for Shapley values payoff allocation of player i, which is μ_i for GE13 period are as follows:

$$\mu_i = (0.001895, 0.002035, 0.00116)$$

The results for Shapley values for player A (financial services sector), player B (consumer products and services sector) and player C (telecommunications and media sector) are 0.001895, 0.002035 and 0.00116 respectively. As normalization of the Shapley values, the sectors' percentages are as follows:

$$P(A) = 37\%, P(B) = 40\%, P(C) = 23\%$$

The percentages of financial services, consumer products and services, and telecommunications and media sectors are 37%, 40% and 23% respectively in GE13 period.

4.2 PERIOD BETWEEN GE13 AND GE14

Period between General Election 13 (GE13) and General Election 14 (GE14) is chosen as a benchmark in this research. The date range of this research for period between GE13 and GE14 is from 3rd November 2014 until 30th November 2015 with a total of 280 trading days.

The shifted average return values for period between GE13 and GE14 are solved in POM - QM for Windows software by using equation (3.2) in order to get the value of the game for each of the payoff matrix. The payoff matrices formed for players A (financial services sector), B (consumer products and services sector) and C (telecommunications and media sector) with columns of P1 (period before GE) and P2 (period after GE) are shown in Tables 4.9 to 4.11 below.

Table 4.9 Payoff Matrix for Player A (Period Between GE13 and GE14).

	P1	P2
A1	1.97E-03	0.00E+00
A2	1.58E-03	5.03E-04
A3	2.02E-03	2.29E-03
A4	1.46E-03	1.45E-03
A5	1.91E-03	1.63E-03
A6	2.69E-03	1.92E-03
A7	1.48E-03	2.06E-04

Table 4.10 Payoff Matrix for Player B (Period Between GE13 and GE14).

	P1	P2
B1	2.07E-03	2.51E-03
B2	1.48E-03	1.01E-03
B3	2.31E-03	2.46E-03
B4	2.68E-03	3.35E-03

Table 4.11 Payoff Matrix for Player C (Period Between GE13 and GE14).

	P1	P2
C1	1.96E-03	1.68E-03
C2	2.08E-03	1.08E-03
C3	2.53E-03	1.93E-03

The values of the game for player A (financial services sector), player B (consumer products and services sector) and player C (telecommunications and media sector) are 0.00219, 0.00268 and 0.00115 respectively. The results are obtained for period between GE13 and GE14 as follows:

$$v(\{A\}) = 0.00219$$
$$v(\{B\}) = 0.00268$$
$$v(\{C\}) = 0.00115$$

The payoff matrices formed for players' coalitions; players A and B, players A and C, players B and C, and players A, B and C are shown in Tables 4.12 to 4.15 below.

Table 4.12 Payoff Matrix for Coalition of Players A and B (Period Between GE13 and GE14).

	P1	P2
A1B1	4.05E-03	2.51E-03
A1B2	3.45E-03	1.01E-03
A1B3	4.28E-03	2.46E-03
A1B4	4.65E-03	3.35E-03
A2B1	3.65E-03	3.01E-03
A2B2	3.05E-03	1.51E-03
A2B3	3.89E-03	2.97E-03
A2B4	4.25E-03	3.85E-03
A3B1	4.09E-03	4.79E-03
A3B2	3.50E-03	3.30E-03
A3B3	4.33E-03	4.75E-03
A3B4	4.70E-03	5.63E-03
A4B1	3.53E-03	3.96E-03
A4B2	2.93E-03	2.46E-03

Continued		
A4B3	3.77E-03	3.92E-03
A4B4	4.13E-03	4.80E-03
A5B1	3.98E-03	4.14E-03
A5B2	3.39E-03	2.64E-03
A5B3	4.22E-03	4.09E-03
A5B4	4.59E-03	4.98E-03
A6B1	4.76E-03	4.43E-03
A6B2	4.17E-03	2.93E-03
A6B3	5.00E-03	4.38E-03
A6B4	5.37E-03	5.27E-03
A7B1	3.55E-03	2.71E-03
A7B2	2.96E-03	1.21E-03
A7B3	3.79E-03	2.67E-03
A7B4	4.16E-03	3.55E-03

Table 4.13 Payoff Matrix for Coalition of Players A and C (Period Between GE13 and GE14).

	P1	P2
A1C1	3.94E-03	1.68E-03
A1C2	4.06E-03	1.08E-03
A1C3	4.51E-03	1.93E-03
A2C1	3.54E-03	2.18E-03
A2C2	3.66E-03	1.59E-03
A2C3	4.11E-03	2.44E-03
A3C1	3.98E-03	3.96E-03
A3C2	4.10E-03	3.37E-03
A3C3	4.55E-03	4.22E-03
A4C1	3.42E-03	3.13E-03
A4C2	3.54E-03	2.54E-03
A4C3	3.99E-03	3.39E-03
A5C1	3.87E-03	3.31E-03
A5C2	3.99E-03	2.71E-03
A5C3	4.44E-03	3.57E-03
A6C1	4.65E-03	3.60E-03
A6C2	4.77E-03	3.00E-03
A6C3	5.22E-03	3.86E-03
A7C1	3.44E-03	1.88E-03
A7C2	3.56E-03	1.29E-03
A7C3	4.01E-03	2.14E-03

Table 4.14 Payoff Matrix for Coalition of Players B and C (Period Between GE13 and GE14).

	P1	P2
B1C1	4.04E-03	4.18E-03
B1C2	4.15E-03	3.59E-03
B1C3	4.61E-03	4.44E-03
B2C1	3.44E-03	2.69E-03
B2C2	3.56E-03	2.09E-03
B2C3	4.01E-03	2.94E-03
B3C1	4.27E-03	4.14E-03
B3C2	4.39E-03	3.55E-03
B3C3	4.84E-03	4.40E-03
B4C1	4.64E-03	5.02E-03
B4C2	4.76E-03	4.43E-03
B4C3	5.21E-03	5.28E-03

Table 4.15 Payoff Matrix for Coalition of Players A, B and C (Period Between GE13 and GE14).

	P1	P2
A1B1C1	6.01E-03	4.18E-03
A1B1C2	6.13E-03	3.59E-03
A1B1C3	6.58E-03	4.44E-03
A1B2C1	5.41E-03	2.69E-03
A1B2C2	5.53E-03	2.09E-03
A1B2C3	5.98E-03	2.94E-03
A1B3C1	6.25E-03	4.14E-03
A1B3C2	6.36E-03	3.55E-03
A1B3C3	6.82E-03	4.40E-03
A1B4C1	6.61E-03	5.02E-03
A1B4C2	6.73E-03	4.43E-03
A1B4C3	7.18E-03	5.28E-03
A2B1C1	5.61E-03	4.69E-03
A2B1C2	5.73E-03	4.09E-03
A2B1C3	6.18E-03	4.94E-03
A2B2C1	5.02E-03	3.19E-03
A2B2C2	5.14E-03	2.60E-03
A2B2C3	5.59E-03	3.45E-03
A2B3C1	5.85E-03	4.64E-03
A2B3C2	5.97E-03	4.05E-03
A2B3C3	6.42E-03	4.90E-03
A2B4C1	6.22E-03	5.53E-03
A2B4C2	6.34E-03	4.93E-03
A2B4C3	6.79E-03	5.78E-03
A3B1C1	6.06E-03	6.47E-03
A3B1C2	6.17E-03	5.87E-03
A3B1C3	6.63E-03	6.73E-03
A3B2C1	5.46E-03	4.97E-03
A3B2C2	5.58E-03	4.38E-03
A3B2C3	6.03E-03	5.23E-03
A3B3C1	6.29E-03	6.42E-03
A3B3C2	6.41E-03	5.83E-03
A3B3C3	6.86E-03	6.68E-03
A3B4C1	6.66E-03	7.31E-03
A3B4C2	6.78E-03	6.71E-03
A3B4C3	7.23E-03	7.57E-03
A4B1C1	5.49E-03	5.64E-03
A4B1C2	5.61E-03	5.04E-03
A4B1C3	6.06E-03	5.89E-03
A4B2C1	4.90E-03	4.14E-03
A4B2C2	5.02E-03	3.55E-03

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A4B2C3	5.47E-03	4.40E-03
A4B3C1	5.73E-03	5.59E-03
A4B3C2	5.85E-03	5.00E-03
A4B3C3	6.30E-03	5.85E-03
A4B4C1	6.10E-03	6.48E-03
A4B4C2	6.22E-03	5.88E-03
A4B4C3	6.67E-03	6.73E-03
A5B1C1	5.95E-03	5.82E-03
A5B1C2	6.06E-03	5.22E-03
A5B1C3	6.52E-03	6.07E-03
A5B2C1	5.35E-03	4.32E-03
A5B2C2	5.47E-03	3.72E-03
A5B2C3	5.92E-03	4.57E-03
A5B3C1	6.18E-03	5.77E-03
A5B3C2	6.30E-03	5.18E-03
A5B3C3	6.75E-03	6.03E-03
A5B4C1	6.55E-03	6.65E-03
A5B4C2	6.67E-03	6.06E-03
A5B4C3	7.12E-03	6.91E-03
A6B1C1	6.73E-03	6.11E-03
A6B1C2	6.84E-03	5.51E-03
A6B1C3	7.30E-03	6.36E-03
A6B2C1	6.13E-03	4.61E-03
A6B2C2	6.25E-03	4.01E-03
A6B2C3	6.70E-03	4.86E-03
A6B3C1	6.96E-03	6.06E-03
A6B3C2	7.08E-03	5.47E-03
A6B3C3	7.53E-03	6.32E-03
A6B4C1	7.33E-03	6.94E-03
A6B4C2	7.45E-03	6.35E-03
A6B4C3	7.90E-03	7.20E-03
A7B1C1	5.52E-03	4.39E-03
A7B1C2	5.63E-03	3.79E-03
A7B1C3	6.09E-03	4.65E-03
A7B2C1	4.92E-03	2.89E-03
A7B2C2	5.04E-03	2.30E-03
A7B2C3	5.49E-03	3.15E-03
A7B3C1	5.75E-03	4.34E-03
A7B3C2	5.87E-03	3.75E-03
A7B3C3	6.32E-03	4.60E-03
A7B4C1	6.12E-03	5.23E-03
A7B4C2	6.24E-03	4.63E-03
A7B4C3	6.69E-03	5.49E-03

The payoff matrix for each player's coalition above are solved in QM for Windows software, the values of game are obtained as follows:

$$v(\{AB\}) = 0.00530$$
$$v(\{AC\}) = 0.00422$$
$$v(\{BC\}) = 0.00521$$
$$v(\{ABC\}) = 0.00745$$

The values of the game obtained are then used as characteristic function for period between GE13 and GE14 as shown in Table 4.16 below.

Table 4.16 Characteristic Function for Period Between GE13 and GE14.

Characteristic Function	Value
$v(\{\phi\})$	0.00000
$v(\{A\})$	0.00219
$v(\{B\})$	0.00268
$v(\{C\})$	0.00115
$v(\{AB\})$	0.00530
$v(\{AC\})$	0.00422
$v(\{BC\})$	0.00521
$v(\{ABC\})$	0.00745

By using Shapley value equation (3.4), the expected marginal contribution for each sector is calculated using Lingo software (for Lingo software see Appendix C). The expected marginal contribution for each player increases the payoff and 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 grand coalition value $v(\{A, B, C\}) = 0.00745$, to obtain sectors' percentages. The results for Shapley values payoff allocation of player i, μ_i for period between GE13 and GE14 are as follows:

$$\mu_i = (0.002425, 0.003165, 0.00186)$$

The results for Shapley values for player A (financial services sector), player B (consumer products and services sector) and player C (telecommunications and media sector) are 0.002425, 0.003165 and 0.00186 respectively. As normalization of the Shapley values, the sectors' percentages are as follows:

$$P(A) = 33\%, P\left(B\right) = 42\%, P\left(C\right) = 25\%$$

The percentages of financial services, consumer products and services, and telecommunications and media sectors are 33%, 42% and 25% respectively in period between GE13 and GE14.

4.3 GENERAL ELECTION 14

General Election 14 (GE14) was held on Wednesday, May 9, 2018. The victory of a new party, Pakatan Harapan (PH) ending 60 years of Barisan Nasional (BN) rule with 121 out of 222 parliament seats to form a new federal government. The date range of this research for GE14 is from 1st November 2017 until 30th November 2018 with a total of 282 trading days.

The shifted average return values for GE14 are solved in QM for Windows software by using equation (3.2) in order to get the value of game for each of the payoff matrix. The payoff matrices formed for players A (financial services sector), B (consumer products and services sector) and C (telecommunications and media sector) with columns of P1 (period before GE) and P2 (period after GE) are shown in Tables 4.17 to 4.19 below.

The shifted average return values for GE14 are solved in POM - QM for Windows software by using equation (3.2) in order to get the value of game for each of the payoff matrix. The payoff matrices formed for players A, B and C are shown in Tables 4.17 to 4.19 below.

Table 4.17 Payoff Matrix for Player A (GE14).

	P1	P2
A1	2.80E-03	4.76E-03
A2	4.71E-03	2.61E-03
A3	4.99E-03	4.46E-03
A4	4.79E-03	3.95E-03
A5	4.92E-03	2.95E-03
A6	4.99E-03	4.13E-03
A7	4.11E-03	3.81E-03

Table 4.18 Payoff Matrix for Player B (GE14).

	P1	P2
B1	4.82E-03	4.50E-03
B2	3.46E-03	1.70E-03
B3	3.84E-03	0.00E+00
B4	4.56E-03	3.68E-03

Table 4.19 Payoff Matrix for Player C (GE14).

	P1	P2
C1	3.70E-03	1.28E-03
C2	3.22E-03	3.29E-03
C3	3.27E-03	3.74E-03

The values of the game for player A (financial services sector), player B (consumer products and services sector) and player C (telecommunications and media sector) are 0.00452, 0.00450 and 0.00334 respectively. The results are obtained for period GE14 as follows:

$$v(\{A\}) = 0.00452$$
$$v(\{B\}) = 0.00450$$
$$v(\{C\}) = 0.00334$$

The payoff matrices formed for players' coalitions; players A and B, players A and C, players B and C, and players A, B and C are shown in Tables 4.20 to 4.23 below.

Table 4.20 Payoff Matrix for Coalition of Players A and B (GE14).

	P1	P2
A1B1	7.63E-03	9.27E-03
A1B2	6.27E-03	6.46E-03
A1B3	6.64E-03	4.76E-03
A1B4	7.36E-03	8.45E-03
A2B1	9.53E-03	7.12E-03
A2B2	8.17E-03	4.31E-03

Continued		
A2B3	8.55E-03	2.61E-03
A2B4	9.26E-03	6.30E-03
A3B1	9.82E-03	8.96E-03
A3B2	8.45E-03	6.16E-03
A3B3	8.83E-03	4.46E-03
A3B4	9.55E-03	8.14E-03
A4B1	9.61E-03	8.45E-03
A4B2	8.25E-03	5.65E-03
A4B3	8.63E-03	3.95E-03
A4B4	9.35E-03	7.63E-03
A5B1	9.74E-03	7.46E-03
A5B2	8.38E-03	4.65E-03
A5B3	8.76E-03	2.95E-03
A5B4	9.48E-03	6.64E-03
A6B1	9.81E-03	8.63E-03
A6B2	8.45E-03	5.83E-03
A6B3	8.83E-03	4.13E-03
A6B4	9.54E-03	7.82E-03
A7B1	8.94E-03	8.32E-03
A7B2	7.58E-03	5.52E-03
A7B3	7.95E-03	3.81E-03
A7B4	8.67E-03	7.50E-03

Table 4.21 Payoff Matrix for Coalition of Players A and C (GE14).

	P1	P2
A1C1	6.50E-03	6.04E-03
A1C2	6.03E-03	8.05E-03
A1C3	6.07E-03	8.50E-03
A2C1	8.41E-03	3.89E-03
A2C2	7.93E-03	5.90E-03
A2C3	7.98E-03	6.35E-03
A3C1	8.69E-03	5.73E-03
A3C2	8.22E-03	7.74E-03
A3C3	8.26E-03	8.20E-03
A4C1	8.49E-03	5.23E-03
A4C2	8.01E-03	7.23E-03
A4C3	8.06E-03	7.69E-03
A5C1	8.62E-03	4.23E-03
A5C2	8.14E-03	6.24E-03
A5C3	8.19E-03	6.69E-03
A6C1	8.69E-03	5.41E-03
A6C2	8.21E-03	7.42E-03
A6C3	8.26E-03	7.87E-03
A7C1	7.81E-03	5.09E-03
A7C2	7.34E-03	7.10E-03
A7C3	7.38E-03	7.56E-03

Table 4.22 Payoff Matrix for Coalition of Players B and C (GE14).

	P1	P2
B1C1	8.53E-03	5.78E-03
B1C2	8.05E-03	7.79E-03
B1C3	8.10E-03	8.24E-03
B2C1	7.17E-03	2.98E-03
B2C2	6.69E-03	4.99E-03
B2C3	6.73E-03	5.44E-03
B3C1	7.54E-03	1.28E-03
B3C2	7.06E-03	3.29E-03
B3C3	7.11E-03	3.74E-03
B4C1	8.26E-03	4.96E-03
B4C2	7.78E-03	6.97E-03
B4C3	7.83E-03	7.43E-03

Table 4.23 Payoff Matrix for Coalition of Players A, B and C (GE14).

	P1	P2
A1B1C1	1.13E-02	1.05E-02
A1B1C2	1.08E-02	1.26E-02
A1B1C3	1.09E-02	1.30E-02
A1B2C1	9.97E-03	7.74E-03
A1B2C2	9.49E-03	9.75E-03
A1B2C3	9.54E-03	1.02E-02
A1B3C1	1.03E-02	6.04E-03
A1B3C2	9.87E-03	8.05E-03
A1B3C3	9.91E-03	8.50E-03
A1B4C1	1.11E-02	9.73E-03
A1B4C2	1.06E-02	1.17E-02
A1B4C3	1.06E-02	1.22E-02
A2B1C1	1.32E-02	8.39E-03
A2B1C2	1.28E-02	1.04E-02
A2B1C3	1.28E-02	1.09E-02
A2B2C1	1.19E-02	5.59E-03
A2B2C2	1.14E-02	7.60E-03
A2B2C3	1.14E-02	8.06E-03
A2B3C1	1.22E-02	3.89E-03
A2B3C2	1.18E-02	5.90E-03
A2B3C3	1.18E-02	6.35E-03
A2B4C1	1.30E-02	7.58E-03
A2B4C2	1.25E-02	9.58E-03
A2B4C3	1.25E-02	1.00E-02
A3B1C1	1.35E-02	1.02E-02
A3B1C2	1.30E-02	1.22E-02
A3B1C3	1.31E-02	1.27E-02
A3B2C1	1.22E-02	7.44E-03
A3B2C2	1.17E-02	9.44E-03
A3B2C3	1.17E-02	9.90E-03
A3B3C1	1.25E-02	5.73E-03
A3B3C2	1.21E-02	7.74E-03
A3B3C3	1.21E-02	8.20E-03
A3B4C1	1.33E-02	9.42E-03
A3B4C2	1.28E-02	1.14E-02
A3B4C3	1.28E-02	1.19E-02
A4B1C1	1.33E-02	9.73E-03
A4B1C2	1.28E-02	1.17E-02
A4B1C3	1.29E-02	1.22E-02
A4B2C1	1.20E-02	6.93E-03
A4B2C2	1.15E-02	8.94E-03

Continued		
A4B2C3	1.15E-02	9.39E-03
A4B3C1	1.23E-02	5.23E-03
A4B3C2	1.19E-02	7.23E-03
A4B3C3	1.19E-02	7.69E-03
A4B4C1	1.31E-02	8.91E-03
A4B4C2	1.26E-02	1.09E-02
A4B4C3	1.26E-02	1.14E-02
A5B1C1	1.34E-02	8.73E-03
A5B1C2	1.30E-02	1.07E-02
A5B1C3	1.30E-02	1.12E-02
A5B2C1	1.21E-02	5.93E-03
A5B2C2	1.16E-02	7.94E-03
A5B2C3	1.17E-02	8.40E-03
A5B3C1	1.25E-02	4.23E-03
A5B3C2	1.20E-02	6.24E-03
A5B3C3	1.20E-02	6.69E-03
A5B4C1	1.32E-02	7.92E-03
A5B4C2	1.27E-02	9.92E-03
A5B4C3	1.28E-02	1.04E-02
A6B1C1	1.35E-02	9.91E-03
A6B1C2	1.30E-02	1.19E-02
A6B1C3	1.31E-02	1.24E-02
A6B2C1	1.22E-02	7.11E-03
A6B2C2	1.17E-02	9.12E-03
A6B2C3	1.17E-02	9.57E-03
A6B3C1	1.25E-02	5.41E-03
A6B3C2	1.20E-02	7.42E-03
A6B3C3	1.21E-02	7.87E-03
A6B4C1	1.32E-02	9.09E-03
A6B4C2	1.28E-02	1.11E-02
A6B4C3	1.28E-02	1.16E-02
A7B1C1	1.26E-02	9.60E-03
A7B1C2	1.22E-02	1.16E-02
A7B1C3	1.22E-02	1.21E-02
A7B2C1	1.13E-02	6.80E-03
A7B2C2	1.08E-02	8.80E-03
A7B2C3	1.08E-02	9.26E-03
A7B3C1	1.17E-02	5.09E-03
A7B3C2	1.12E-02	7.10E-03
A7B3C3	1.12E-02	7.56E-03
A7B4C1	1.24E-02	8.78E-03
A7B4C2	1.19E-02	1.08E-02
A7B4C3	1.19E-02	1.12E-02

The payoff matrix for each player's coalition above are solved in QM for Windows software, the values of game are obtained as follows:

$$v(\{AB\}) = 0.00907$$
$$v(\{AC\}) = 0.00821$$
$$v(\{BC\}) = 0.00812$$
$$v(\{ABC\}) = 0.01275$$

The values of the game obtained are then used as characteristic function for GE14 as shown in Table 4.24 below.

Table 4.24 Characteristic Function for GE14.

Characteristic Function	Value
$v(\{\phi\})$	0.00000
$v(\{A\})$	0.00452
$v(\{B\})$	0.00450
$v(\{C\})$	0.00334
$v(\{AB\})$	0.00907
$v(\{AC\})$	0.00821
$v(\{BC\})$	0.00812
$v(\{ABC\})$	0.01275

By using Shapley value equation (3.4), the expected marginal contribution for each sector is calculated using Lingo software (for Lingo software see Appendix D). The expected marginal contribution for each player increases the payoff and 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 grand coalition value $v(\{A, B, C\}) = 0.01275$, to obtain sectors' percentages. The results for Shapley values payoff allocation of player i, μ_i for GE14 period are as follows:

$$\mu_i = (0.004623, 0.004568, 0.003558)$$

The results for Shapley values for player A (financial services sector), player B (consumer products and services sector) and player C (telecommunications and media sector) are 0.004623, 0.004568 and 0.003558 respectively. As normalization of the Shapley values, the sectors' percentages are as follows:

$$P(A) = 36\%, P\left(B\right) = 36\%, P\left(C\right) = 28\%$$

The percentages of financial services, consumer products and services, and telecommunications and media sectors are 36%, 36% and 28% respectively in GE14 period.

To conclude this section, all the values of game in GE13, period between GE13 and GE14, and GE14 show increments after coalitions and this result in line with Kocak (2014).

4.4 COMPARISON OF GE13, PERIOD BETWEEN GE13 AND GE14, AND GE14

In this subsection, this research describes the changes of the sectoral percentages during GE13, period between GE13 and GE14, and GE14 by using Shapley value solution concept in cooperative game theory. The percentage for each sector results obtained in subsection 4.1, subsection 4.2 and subsection 4.3 are used in subsection 4.4 to show the best strategy for each sector during GE13, period between GE13 and GE14, and GE14 as well as changes in strategies after the government changed.

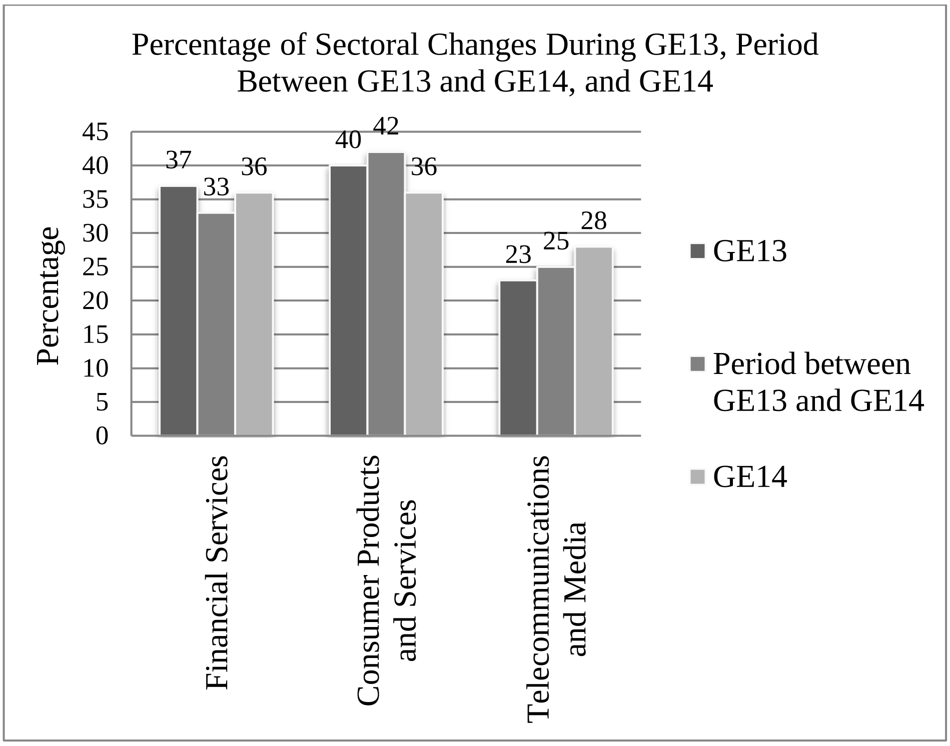

Figure 4.1 Percentages of Sectoral Changes During GE13, Period Between GE13 and GE14, and GE14

The bar graph represents the percentage comparison between two periods of general elections in Malaysia and one benchmark period in between GE13 and GE14, with three types of sectors in 2013 and 2018. In GE13, the best strategy is obtaining the percentages of stocks which are 37% from the financial services sector, 40% from the consumer products and services sector, and 23% from the telecommunications and media sector. While in period between GE13 and GE14, the best strategy is 33% from the financial services sector, 42% from the consumer products and services sector, and 25% from the telecommunications and media sector. In contrast, during GE14, the best strategy is 36% from both the financial services and consumer products and services sectors, and 28% from the telecommunications and media.

Financial services sector dropped sharply its share from 37% in GE13 to 33% in the benchmark period. However, there is 3% rise in percentage during GE14. The consumer products and services sector has the highest percentage (42%) in the benchmark period, higher 2% from GE13's percentage, however it decreased to 36% in GE14. The telecommunications and media sector increased its proportion to 28% in 2018 from 25% during the benchmark period and 23% during the previous general election.

The changes of the financial services and consumer products and services sectors may due to the different economic agendas, resulting from the frequent economic policy modifications. This situation is an uncertainty condition to investors and discourages them from taking risks. The reason is that the new government would implement a new fiscal and monetary policies, bringing to an increase in uncertainties (Amirah et al., 2019). Pakatan Harapan (PH) promised to reform and improve fiscal responsibility, abolish goods and services tax (GST), lifting monopolies and build a good governance environment in a new Malaysia era that may increase the people's believes towards their new government.

All sectors except telecommunications and media showed a decrease in percentage after the new government ruled the country for 6 months.

Telecommunications and media sector is made up stocks that give global scale connection to the world such as telephones or smartphones, radio, television, computer and mobile devices. These technological advances change the lifestyle and business matter to the people. Because of that, people get more trends in using smartphones and internet services provided. The increment of the percentage of telecommunications and media sector can be seen as the increment of internet usage nowadays. These changes will not be studied in this research and can be investigated further by other studies.

CHAPTER FIVE

RESULT AND DISCUSSION: OPTIMAL PORTFOLIO SELECTION DURING GE14

In this chapter, the research focuses on GE14 only. The sectors' percentages result as shown in Subsection 4.2 are used to calculate the individual weightage of each stock, where $P(A)$ and $P(B)$ are 36% and $P(C)$ is 28%.

Equation (3.7) is used to calculate the individual's sector weightage. The probabilities of occurring strategies of each company in the optimal solution $v(S)$ in equation $v(S)=\sum_{i=1}^{n}\sum_{j=1}^{m} p_i^* q_j^* a_{i,j}$ are defined as α_i^* , β_j^* and γ_k^* where $i=\{1,2,...,7\}$, $j=\{1,2,3,4\}$, $k=\{1,2,3\}$. Table 5.1, Table 5.2 and Table 5.3 show the values of game result for financial services sector, consumer products and services sector and telecommunications and media sector respectively. All the values in Tables 5.1 to 5.3 are in $\times 10^{-3}$.

Table 5.1 Value of Game Result from QM for Windows Software for Financial Services Sector.

	P1	P2	Row Mix (α_i^*)
A1 (AMMB Holdings Berhad)	2.8	4.76	0.21
A2 (CIMB Group Holdings Berhad)	4.71	2.61	0
A3 (Hong Leong Bank Berhad)	4.99	4.46	0.79
A4 (Hong Leong Financial Berhad)	4.79	3.95	0
A5 (Malayan Banking Berhad)	4.92	2.95	0
A6 (Public Bank Berhad)	4.99	4.13	0
A7 (RHB Capital Berhad)	4.11	3.81	0
Column Mix	0.12	0.88	
Value of game (to row)	4.52		

Table 5.2 Value of Game Result from QM for Windows Software for Consumer Products and Services Sector.

	P1	P2	Row Mix (β_j^*)
B1 (PPB Group Berhad)	4.82	4.5	1
B2 (Genting Berhad)	3.46	1.7	0
B3 (Genting Malaysia Berhad)	3.84	0	0
B4 (Petronas Dagangan Berhad)	4.56	3.68	0
Column Mix	0	1	
Value of game (to row)	4.5		

Table 5.3 Value of Game Result from QM for Windows Software for Telecommunications and Media Sector.

	P1	P2	Row Mix (γ_k^*)
C1 (Axiata Group Berhad)	3.7	1.28	0.16
C2 (Digi.Com Berhad)	3.22	3.29	0
C3 (Maxis Berhad)	3.27	3.74	0.84
Column Mix	0.85	0.15	
Value of game (to row)	3.34		

Based on the possible row strategies (stocks) from Tables 5.1 to 5.3, there are two types of strategies occurred, first is pure strategy and second is mixed strategy. If the probability of occurring strategies α_i^*, β_j^* or γ_k^* is equal to one, it is called pure strategy with one suggestion of the strategy to choose by a player. If the value of the probability of occurring strategies is equal to zero, the strategy is not suggested to a player. However, if the value of probability of occurring strategies is between zero and one, then mixed strategy occurs with more than one suggestion of the strategies to choose by a player.

Table 5.1 and Table 5.3 show the values of the game for financial services sector and telecommunications and media sector are mixed strategy solution (see definition 3.4). It is because no saddle point solution then the player needs to play with probability to choose any strategy in a game. From these solutions, it suggests for financial and services sector, two stocks which are A1 (AMMB Holdings Berhad) and A3 (Hong Leong Bank Berhad) with the probability of occurrences of 0.21 and 0.79 respectively, while telecommunications and media sector, also two stocks which are C1 (Axiata Group Berhad) and C3 (Maxis Berhad) with the probability of occurrences 0.16 and 0.84, respectively, to be in a portfolio. However, Table 5.2 shows the value of the game for consumer products and services sector is pure strategy solution (see definition 3.3) because there is a saddle point solution. It suggests exactly only one stock which is B1 (PPB Group Berhad) with the probability of occurrences 1.0 to be in a portfolio.

Therefore, the Shapley optimal portfolio is constructed in Table 5.4 by using equation (3.7), probability of each sector and probability of occurrences strategies in Tables 5.1 to 5.3. It suggests the following percentages included in the portfolio: 8% of A1, 28% of A3 and others are 0% among the strategies for financial services sector, 36% of B1, 0% of B2, B3 and B4 among the stocks in the consumer products and services sector and lastly 4% of C1, 0% of C2, and 24% of C3 among telecommunications and media. The results of Shapley optimal portfolio weightage are presented in Table 5.4 as follows:

Table 5.4 Weightage Allocation for Shapley Optimal Portfolio.

Sector	Strategy	Stock name	Weightage
Player A: Financial Services	A1	AMMB Holdings Berhad	8%
	A2	CIMB Group Holdings Berhad	0%
	A3	Hong Leong Bank Berhad	28%
	A4	Hong Leong Financial Berhad	0%
	A5	Malayan Banking Berhad	0%
	A6	Public Bank Berhad	0%

	A7	RHB Capital Berhad	0%
Player B : Consumer Products and Services	B1	PPB Group Berhad	36%
	B2	Genting Berhad	0%
	B3	Genting Malaysia Berhad	0%
	B4	Petronas Dagangan Berhad	0%
Player C : Telecommunications and Media	C1	Axiata Group Berhad	4%
	C2	Digi.Com Berhad	0%
	C3	Maxis Berhad	24%

Next, this research compares the performance of the Shapley optimal portfolio whether it can defeat market portfolio (FBMKLCI) and naive diversification portfolio or not. From the weightage allocation of Shapley optimal portfolio above, the Sharpe ratio is obtained from the equation (3.10) to compare the portfolio performances. Firstly, the expected return and the standard deviation of Shapley optimal portfolio are calculated from equation (3.8) and (3.9) respectively regarding its weightage allocation in Table 5.4.

Next, the expected return and the standard deviation of naive diversification portfolio are also calculated from equation (3.8) and (3.9) respectively regarding its weightage allocation by using naive diversification weightage, $w_i = 1/14$ rule where $i = 1, 2, ..., 14$. Lastly, the return of market portfolio (FBMKLCI) is calculated by finding the daily return by using equation (3.5) and its expected return using equation (3.6), and its standard deviation.

From above calculation, the expected return of market portfolio is -0.0117% with standard deviation 0.6614%, the expected return of naive diversification is -0.018% with standard deviation 0.743% and the expected return of Shapley optimal portfolio is 0.040% with standard deviation 0.668%. Risk free rate are assumed as 0% in this research. The Sharpe ratio results are tabulated in Table 5.5 below. The

Shapley optimal portfolio outperform the market portfolio and naive diversification portfolio.

Table 5.5 Sharpe Ratio of Market Portfolio, Naive Diversification and Shapley Optimal Portfolios.

	Market portfolio	Naive diversification portfolio	Shapley optimal portfolio
Expected return	–0.0117%	–0.018%	0.040%
Standard deviation	0.6614%	0.743%	0.668%
Sharpe ratio	–0.018	–0.0243	0.0594

5.1 THE HYPOTHETICAL EXAMPLE

The hypothetical example is used to highlight that Shapley optimal portfolio outperformed the market portfolio and the naive diversification portfolio. The initial amount of money invested is RM 100 000 and below is the summary of the results:

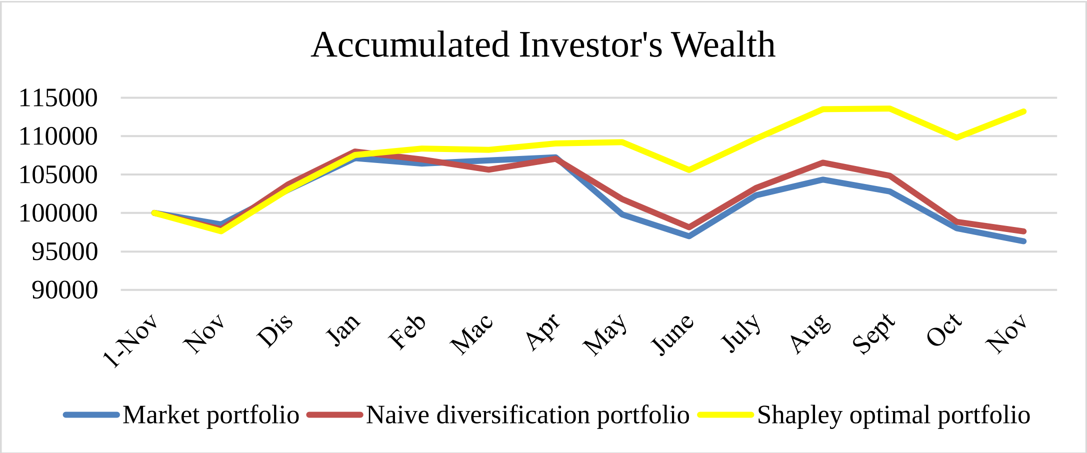

Figure 5.1 The Accumulated Wealth of Investor.

As shown in Figure 5.1, the Shapley optimal portfolio has dominated the market portfolio and the naive diversification portfolio after February 2018 until November 2018. This shows that Shapley optimal portfolio performed better during GE14. This research also calculates the Sharpe ratio for those portfolios after the amount RM 100 000 is invested into the portfolios. Table 5.3 shows Sharpe ratios for market portfolio, naive diversification portfolio and Shapley optimal portfolio after RM100 000 is invested. Expected return of the market portfolio is -0.2879% with standard deviation 3.626%, the expected return of the naive diversification portfolio is -0.1858% with standard deviation 3.780% and expected return of the Shapley optimal portfolio is 0.9541% with standard deviation 2.902%.

The Sharpe ratios for market portfolio, naive diversification portfolio and Shapley optimal portfolio are -0.0794, -0.0492 and 0.3287 respectively. The Sharpe ratio shows that the Shapley optimal portfolio outperformed other two portfolios during GE14 (also shown in Figure 5.1).

Table 5.6 Sharpe Ratio of Market Portfolio, Naive Diversification and Shapley Optimal Portfolios After RM 100 000 Invested.

	Market portfolio	Naive diversification portfolio	Shapley optimal portfolio
Expected return	-0.2879%	-0.1858%	0.9541%
Standard deviation	3.626%	3.780%	2.902%
Sharpe ratio	-0.0794	-0.0492	0.3287

CHAPTER SIX

CONCLUSION

6.1 RESEARCH OUTCOMES

Game theory is one of the decision making knowledge. It can gives suggestions on how to diversify our assets under cooperative game approach in order to increase profits and reducing lossess in the financial market. Non-cooperative game is used to find the values of game while cooperative game is used to get the marginal contribution for each sector. This research has chosen three sectors in FBMKLCI that maintain listed during GE13 and GE14.

This research found the values of game by using Nash equilibrium and then the values of game are used in characteristic function in cooperative game theory (Shapley value solution concept). The probability of each sector obtained in subsection 4.1, subsection 4.2 and subsection 4.3 are used in subsection 4.4 to show the best strategy for each sector during GE13 and GE14 as well as its benchmark period between GE13 and G14 after the government changed. The result showed the changes of the sectoral percentages during GE13, period between GE13 and GE14, and GE14 by using Shapley value solution concept in cooperative game theory. Based on the Shapley value solution concept results, there are sectoral strategies from the financial services sector, consumer products and services sector, and telecommunications and media sector, after Malaysia GE14 compared to GE13.

This research continued in Chapter 5 to examine the performance of Shapley optimal portfolio by allocating indvidual stocks' weightages. The findings showed that the Shapley optimal portfolio outperformed the market portfolio and naive diversification portfolio before and after Malaysia's GE14 by using Sharpe ratio. The stocks suggested by Shapley optimal portfolio are 8% of A1 (AMMB Holdings Berhad) and 28% of A3 (Hong Leong Bank Berhad) from the financial services sector, 36% of PPB Group Berhad from the consumer products and services sector, and 4% of Axiata Group Berhad and 24% of Maxis Berhad from the telecommunications and media sector.

Finally, this research showed hypothetical example by assuming RM 100 000 amount of money invested. The intention is to highlight that Shapley optimal portfolio performed better than the market portfolio and the naive diversification portfolio. The Sharpe ratio showed that the Shapley optimal portfolio outperformed other two portfolios during GE14. Henceforth, this research has contradicts with the claim made by previous study of DeMiguel et al. (2007) that the naive diversification always dominates some others optimal allocation in terms of Sharpe ratio.

6.2 RESEARCH CONTRIBUTION AND FUTURE RESEARCH

This research will contribute to the game theory study in Malaysia for investment theory on how to make any decision by diversifying their portfolios in order to get high return and low risk based on the findings of this research. To the best of our knowledge, this study is the first research conducted in Malaysia by using game theory approach on optimal portfolio. This research can be done further to optimize portfolio during political changes happen with a different type of assets and bigger number of players.

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LIST OF CONFERENCE, SYMPOSIUM AND PUBLICATIONS

CONFERENCE PAPER PRESENTATION

1. Oral Presenter,
   The 7th International Conference and Workshop on Basic and Applied Sciences (ICOWOBAS 2019)
   16th-17th July 2019
   KSL Hotel, Johor Bahru, Malaysia.

SYMPOSIUM PRESENTATION

1. Poster Presenter,
   Kuantan Research Day 2019 (KRD 2019)
   23rd October 2019
   Office of Campus Director, International Islamic University Malaysia.

ARTICLES

1. Muhammad Akram Ramadhan bin Ibrahim, Pah Chin Hee, Mohd Aminul Islam and Hafizah Bahaludin (2020) The Portfolio Optimization Performance during Malaysia's 2018 General Election by Using Noncooperative and Cooperative Game Theory Approach. Modern Applied Science, Vol. 14, No 4. https://doi.org/10.5539/mas.v14n4p1

2. Muhammad Akram Ramadhan bin Ibrahim, Pah Chin Hee, Mohd Aminul Islam and Hafizah Bahaludin (2020) Cooperative Game Theory Approach for Portfolio Sectoral Selection Before and After Malaysia General Elections: GE13 Versus GE14. Saudi Journal of Economics and Finance, Vol. 4, No. 8. Scholars Middle East Publishers, UAE.

APPENDICES

APPENDIX A: LIST OF STOCKS CONSISTENTLY LISTED IN FBMKLCI DURING GE13 AND GE14

Table A: A List of Stocks in FBMKLCI During GE13 and GE14.

Stock's Name (GE13, 2013)	Stock's Name (GE14, 2018)	Consistently Listed Companies in GE13 and GE14	Type of Sector
AMMB Holdings Berhad	AMMB Holdings Berhad	AMMB Holdings Berhad	Financial Services
CIMB Group Holdings Berhad	CIMB Group Holdings Berhad	CIMB Group Holdings Berhad	Financial Services
Hong Leong Bank Berhad	Hong Leong Bank Berhad	Hong Leong Bank Berhad	Financial Services
Hong Leong Financial Group Berhad	Hong Leong Financial Group Berhad	Hong Leong Financial Group Berhad	Financial Services
Malayan Banking Berhad	Malayan Banking Berhad	Malayan Banking Berhad	Financial Services
Public Bank Berhad	Public Bank Berhad	Public Bank Berhad	Financial Services
RHB Capital Berhad	RHB Capital Berhad	RHB Capital Berhad	Financial Services
PPB Group Berhad	PPB Group Berhad	PPB Group Berhad	Consumer Products and Services
Genting Berhad	Genting Berhad	Genting Berhad	Consumer Products and Services
Genting Malaysia Berhad	Genting Malaysia Berhad	Genting Malaysia Berhad	Consumer Products and Services

Continued

Petronas Dagangan Berhad	Petronas Dagangan Berhad	Petronas Dagangan Berhad	Consumer Products and Services
Axiata Group Berhad Digi.Com Berhad Maxis Berhad	Axiata Group Berhad Digi.Com Berhad Maxis Berhad	Axiata Group Berhad Digi.Com Berhad Maxis Berhad	Telecommunications and Media Telecommunications and Media Telecommunications and Media
IOI Corporation Berhad Kuala Lumpur Kepong Berhad	IOI Corporation Berhad Kuala Lumpur Kepong Berhad	IOI Corporation Berhad Kuala Lumpur Kepong Berhad	Plantation Plantation
Tenaga Nasional Berhad Petronas Gas Berhad	Tenaga Nasional Berhad Petronas Gas Berhad	Tenaga Nasional Berhad Petronas Gas Berhad	Utilities Utilities
Petronas Chemicals Group Berhad	Petronas Chemicals Group Berhad	Petronas Chemicals Group Berhad	Industrial Products and Services
Sime Darby Berhad	Sime Darby Berhad	Sime Darby Berhad	Property
IHH Healthcare Berhad	IHH Healthcare Berhad	IHH Healthcare Berhad	Health Care

Continued

MISC Berhad	MISC Berhad	MISC Berhad	Transportation and Logistics Industrial
SapuraKencana Petroleum Berhad			Products and Services
Telekom Malaysia Berhad			Telecommuni cations and Media
British American Tobacco (Malaysia) Berhad			Consumer Products and Services
YTL Corporation Berhad			Utilities
Felda Global Ventures Holdings Berhad			Plantation
UMW Holdings Berhad			Consumer Products and Services
Astro Malaysia Holdings Berhad			Telecommuni cations and Media
UEM Sunrise Berhad			Property
	Malaysia Airport Holdings Berhad		Transportation and Logistics
	Press Metal Aluminium Holdings Berhad		Industrial Products and Services
	Top Glove Corporation Berhad		Health Care
	Sime Darby Plantation Berhad		Plantation

Continued

	Dialog Group Berhad		Energy
	Nestle (Malaysia) Berhad		Consumer Products and Services
	Hartalega Holdings Berhad		Health Care
	Hap Seng Consolidated Berhad		Industrial Products and Services

Source: Information obtained from FTSE Bursa Malaysia KLCI etf (Annual Reports: 31 December 2013 and 31 December 2018)

APPENDIX B: LINGO CODE FOR GE13

```
! Compute the Shapley value for players in a coalition, using
LINGO.
 ! Keywords: Shapley value, game theory, cooperative game,
     n-person game;
SETS:
 ! A version hard coded for up to 3 players;
 player: v1, shval;
 s2(player,player)| &1 #lt# &2: v2;
 s3( s2, player)  | &2 #lt# &3: v3;

ENDSETS
DATA:
 player = A  B  C ;
! Values of various coalitions. This is really
  a 3 player game. ;
 v1 =
!A; 1.66
!B; 1.81
!C; 1.15;
 v2 =
! A B; 3.93
! A C; 2.84
! B C; 2.97;
 v3 =
! A B C; 5.09;

ENDDATA

! Compute Shapley value for each player. For n
  players, there are n factorial sequences, so
  for 3 players there are 6 sequences;

@FOR( player(i):
  shval(i) = (
 ! Sequences with player i first(there is only 1 set of 1
containing i);
         v1(i)*2 +
 ! Sequences with player i second(there are 3 sets of 2
containing i);
        (@SUM(s2(i1,i2)| i2 #eq# i: v2(i1,i) - v1(i1)) +
         @SUM(s2(i1,i2)| i1 #eq# i: v2(i,i2) - v1(i2))) +
 ! Sequences with player i third(3 sets of 3 containing i);
        (@SUM(s3(i1,i2,i3)| i3 #eq# i: v3(i1,i2,i ) -
v2(i1,i2)) +
         @SUM(s3(i1,i2,i3)| i2 #eq# i: v3(i1, i,i3) -
v2(i1,i3)) +
         @SUM(s3(i1,i2,i3)| i1 #eq# i: v3(i, i2,i3) -
v2(i2,i3)))*2)/6;
);
```

```
Feasible solution found.
Total solver iterations:                         0
Elapsed runtime seconds:                      0.11

Model Class:                                 . . .

Total variables:                 0
Nonlinear variables:             0
Integer variables:               0

Total constraints:               0
Nonlinear constraints:           0

Total nonzeros:                  0
Nonlinear nonzeros:              0


                               Variable           Value
                                V1( A)         1.660000
                                V1( B)         1.810000
                                V1( C)         1.150000
                             SHVAL( A)         1.895000
                             SHVAL( B)         2.035000
                             SHVAL( C)         1.160000
                             V2( A, B)         3.930000
                             V2( A, C)         2.840000
                             V2( B, C)         2.970000
                          V3( A, B, C)         5.090000

                                   Row    Slack or Surplus
                                     1         0.000000
                                     2         0.000000
                                     3         0.000000
```

APPENDIX C: LINGO CODE FOR PERIOD BETWEEN GE13 AND GE14

```
! Compute the Shapley value for players in a coalition, using
LINGO.
 ! Keywords: Shapley value, game theory, cooperative game,
     n-person game;
SETS:
 ! A version hard coded for up to 3 players;
 player: v1, shval;
 s2(player,player)| &1 #lt# &2: v2;
 s3( s2, player)  | &2 #lt# &3: v3;

ENDSETS
DATA:
 player = A  B  C ;
! Values of various coalitions. This is really
  a 3 player game. ;
 v1 =
!A; 2.19
!B; 2.68
!C; 1.15;
 v2 =
! A B; 5.3
! A C; 4.22
! B C; 5.21;
 v3 =
! A B C; 7.45;

ENDDATA

! Compute Shapley value for each player. For n
  players, there are n factorial sequences, so
  for 3 players there are 6 sequences;

@FOR( player(i):
  shval(i) = (
 ! Sequences with player i first(there is only 1 set of 1
containing i);
         v1(i)*2 +
 ! Sequences with player i second(there are 3 sets of 2
containing i);
        (@SUM(s2(i1,i2)| i2 #eq# i: v2(i1,i) - v1(i1)) +
         @SUM(s2(i1,i2)| i1 #eq# i: v2(i,i2) - v1(i2))) +
 ! Sequences with player i third(3 sets of 3 containing i);
        (@SUM(s3(i1,i2,i3)| i3 #eq# i: v3(i1,i2,i ) -
v2(i1,i2)) +
         @SUM(s3(i1,i2,i3)| i2 #eq# i: v3(i1, i,i3) -
v2(i1,i3)) +
         @SUM(s3(i1,i2,i3)| i1 #eq# i: v3(i, i2,i3) -
v2(i2,i3)))*2)/6;
);
```

```
Feasible solution found.
Total solver iterations:                         0
Elapsed runtime seconds:                      0.09

Model Class:                                 . . .

Total variables:                  0
Nonlinear variables:              0
Integer variables:                0

Total constraints:                0
Nonlinear constraints:            0

Total nonzeros:                   0
Nonlinear nonzeros:               0



                                Variable           Value
                                 V1( A)         2.190000
                                 V1( B)         2.680000
                                 V1( C)         1.150000
                              SHVAL( A)         2.425000
                              SHVAL( B)         3.165000
                              SHVAL( C)         1.860000
                              V2( A, B)         5.300000
                              V2( A, C)         4.220000
                              V2( B, C)         5.210000
                           V3( A, B, C)         7.450000

                                     Row    Slack or Surplus
                                       1           0.000000
                                       2           0.000000
                                       3           0.000000
```

APPENDIX D: LINGO CODE FOR GE14

```
! Compute the Shapley value for players in a coalition, using
LINGO.
 ! Keywords: Shapley value, game theory, cooperative game,
     n-person game;
SETS:
 ! A version hard coded for up to 3 players;
 player: v1, shval;
 s2(player,player)| &1 #lt# &2: v2;
 s3( s2, player)  | &2 #lt# &3: v3;

ENDSETS
DATA:
 player = A  B  C ;
! Values of various coalitions. This is really
  a 3 player game. ;
 v1 =
!A; 4.52
!B; 4.5
!C; 3.34;
 v2 =
! A B; 9.07
! A C; 8.21
! B C; 8.12;
 v3 =
! A B C; 12.75;

ENDDATA

! Compute Shapley value for each player. For n
  players, there are n factorial sequences, so
  for 3 players there are 6 sequences;

@FOR( player(i):
  shval(i) = (
 ! Sequences with player i first(there is only 1 set of 1
containing i);
         v1(i)*2 +
 ! Sequences with player i second(there are 3 sets of 2
containing i);
        (@SUM(s2(i1,i2)| i2 #eq# i: v2(i1,i) - v1(i1)) +
         @SUM(s2(i1,i2)| i1 #eq# i: v2(i,i2) - v1(i2))) +
 ! Sequences with player i third(3 sets of 3 containing i);
        (@SUM(s3(i1,i2,i3)| i3 #eq# i: v3(i1,i2,i ) -
v2(i1,i2)) +
         @SUM(s3(i1,i2,i3)| i2 #eq# i: v3(i1, i,i3) -
v2(i1,i3)) +
         @SUM(s3(i1,i2,i3)| i1 #eq# i: v3(i, i2,i3) -
v2(i2,i3)))*2)/6;
);
```

```
Feasible solution found.
Total solver iterations:                         0
Elapsed runtime seconds:                      0.11

Model Class:                                  . . .

Total variables:                  0
Nonlinear variables:              0
Integer variables:                0

Total constraints:                0
Nonlinear constraints:            0

Total nonzeros:                   0
Nonlinear nonzeros:               0



                                Variable           Value
                                 V1( A)         4.520000
                                 V1( B)         4.500000
                                 V1( C)         3.340000
                              SHVAL( A)         4.623333
                              SHVAL( B)         4.568333
                              SHVAL( C)         3.558333
                              V2( A, B)         9.070000
                              V2( A, C)         8.210000
                              V2( B, C)         8.120000
                           V3( A, B, C)         12.75000

                                    Row    Slack or Surplus
                                      1         0.000000
                                      2         0.000000
                                      3         0.000000
```

Source: The source code for GE13, period between GE13 and GE14, and GE14 are obtained from Lindo Systems Inc.

APPENDIX E: PROBABILITY OF OCCURENCES FOR GE14

Game Theory Results

	P1	P2	Row Mix
A1	2.8	4.76	.21
A2	4.71	2.61	0
A3	4.99	4.46	.79
A4	4.79	3.95	0
A5	4.92	2.95	0
A6	4.99	4.13	0
A7	4.11	3.81	0
Column Mix--->	.12	.88	
Value of game (to row)	4.52		

Game Theory Results

	P1	P2	Row Mix
B1	4.82	4.5	1
B2	3.46	1.7	0
B3	3.84	0	0
B4	4.56	3.68	0
Column Mix--->	0	1	
Value of game (to row)	4.5		

Game Theory Results

	P1	P2	Row Mix
C1	3.7	1.28	.16
C2	3.22	3.29	0
C3	3.27	3.74	.84
Column Mix--->	.85	.15	
Value of game (to row)	3.34		