EFFECTIVENESS OF MARTINGALE STRATEGY IN GAMBLING AND INVESTMENT

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DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the research project.

(4) The word count of this research report is 13,316.

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DEDICATION

We dedicated this research to:

(1) Our beloved supervisor, Dr. Eng Yoke Kee that guide and support us.

(2) Our families and friends for their love and strong support.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AM	Anti-Martingale Strategy
EMU	European Economic and Monetary Union
EUR	Euro
GBP	Great Britain Pound
JPY	Japanese Yen
KLCI	Kuala Lumpur Composite Index
M	Martingale Strategy
S&P500S	Standard & Poor's 500

PREFACE

A perfect strategy is always what all the investors, traders and gamblers are looking for which can make them rich. This seems to be unrealistic but dating all the way back to the 18th century in France, a perfect strategy seems to exist. This is the Martingale Strategy, a theoretically perfect strategy which can be 100% profitable that can never make them lose. Martingale Strategy is the only strategy known to give the casino a run for its money. Such is the power of the martingale. With the presence of this strategy, casinos have no choice but to impose table limits to ensure their own survival. However, whether martingale strategy is profitable in gambling and investing in 21st century is still a big question. The ultimate goal of this research is to answer this important question.

ABSTRACT

This research examines the effectiveness of martingale strategy in gambling and investing. A popular casino game called Sic Bo and two other financial markets which are stock market and foreign exchange market were selected to carry out the study. Simulations have been run on Microsoft Excel using historical market data and self-generated data to provide quantitative evidence for our study. The findings indicate that Martingale Strategy is perfectly profitable in both short run and long run if two conditions are met: i) unlimited capital and ii) no restriction on the number and amount of bets. This implies that Martingale strategy is more favorable to high net worth individuals and financial institutions that are closer to fulfilling the conditions.

CHAPTER 1 : RESEARCH OVERVIEW

1.0 Introduction

All the investors, traders and gamblers are always looking for an unbeatable investing, trading or gambling strategy that is practically 100% profitable which can never make them lose. This seems to be unrealistic but dating all the way back to the 18th century in France, a perfect strategy seems to exist. This is a strategy that is based on probability theory, and if a person's capital is huge enough, he/she has a near to 100% success rate. This powerful strategy is known as Martingale Strategy.

The simplest of martingale strategy was created for a game in which the gambler wins his bet if a coin comes up heads and loses it if the coin comes up tails. The gambler who applies martingale strategy will need to double his bet after every loss, so that all the previous losses will be recovered and win a profit equal to the original stake once he wins. Martingale strategy may achieve 100% winning probability given that the person who applies this strategy has a very big capital; in some cases, the capital must be infinitely big. Surprisingly, emerge of martingale strategy even made all the casinos to impose a new policy for their games, the betting minimum and maximum limits to limit the odds of this powerful strategy.

Theoretically, martingale strategy is a flawless strategy with a near to 100% success rate to investors, traders and gamblers with enough capital based on the probability theory. Practically, not all investors are using martingale strategy and it does not seem to be as perfect as what probability theory tells us about martingale strategy for the 100% winning probability. Therefore, our research is conducted to explain the gap between theoretical and practical sides of martingale strategy. Simulations will been run on Microsoft Excel using historical market data and self-generated data to provide

quantitative evidence for our study to determine the effectiveness of this strategy in both short run and long run.

1.1 Research Background

Originally, martingale referred to a class of betting strategies that was popularized in 18th century France and the strategy was presented by a mathematician in French named Paul Pierre Levy. The martingale strategy was a kind of gambling style based on the premise of 'doubling down' in the beginning. An American mathematician called Joseph Leo Doob had contributed a lot of work on martingales and best known for his work on probability theory, especially martingale theory.

The mechanism of the martingale system involves a beginning stake. The stake will be doubled after every losing bet and one winning bet would be able to recover all the previous losses plus a profit equal to beginning stake. The probability for gamblers to eventually get a winning bet is approximately to 1 if the gambler's capital and available time jointly approach infinity, which makes the martingale strategy, seems like a sure thing. With the presence of this strategy, casinos have no choice but to impose table limits to ensure their own survival. This is one of the reasons for the imposition of betting limits even though casinos are normatively enjoying a mathematical edge in the casino games offered to their patrons. However, the nature of the martingale strategy will require gamblers to double the bet after every loss. This will eventually increase the required bet amount exponentially which might lead to the gambler's bankruptcy. A martingale process known as Stopped Brownian motion can be used to model the trajectory of such events.

Martingale theory illustrates the history of mathematical probability: the basic definitions are inspired by crude notions of gambling, but the theory has become a sophisticated tool of modern abstract mathematics, drawing from and contributing to

other fields. Martingales have been studied systematically for about thirty years, and the newer probability texts usually devote some space to them, but the applications are so varied that there is no one place where a full account can be found (Doob, 2013).

To have a better understanding on the rationale behind the martingale strategy, let's look at the Table 1.1 below. Assume a gambler had a coin and betted in a betting game on heads with a starting stake of RM 1. A coin will be flipped and it will land on either heads or tails with a same probability, 50% and 50% where each flip is independent which means the previous flip will not impact the outcome of the next flip. As long as the gambler sticks with his bet on heads each time, the coin will eventually land on heads and regain all of his losses plus the initial stake, RM 1 given an infinite amount of capital. The strategy is based on the premise that only one winning trade is needed to turn gambler account around.

Table 1.1: Betting Game using Martingale Strategy

Round	**Your Bet**	**Stake**	**Flip Results**	**Profit/Loss**	**Account Equity**
0	-	-	-	-	RM10
1	Heads	RM1	Heads	RM1	RM11
2	Heads	RM1	Tails	RM (1)	RM10
3	Heads	RM2	Tails	RM (2)	RM8
4	Heads	RM4	Heads	RM 4	RM12

Source: Developed for the research

Assume that a gambler has RM10 in his account equity initially and he started with an initial stake of RM1. He bets on heads, the coin flips on the heads as well so that he wins RM1, pulling his account equity up to RM11. Each time he wins, he continues to bet the same amount, RM1 until he loses. The next flip is a tails, and he loses and it brings his account equity down to RM10. On the coming bet, he stakes RM2 wishing that the coin lands on heads, so that he can recoup his previous losses and bring the loss to zero. Unluckily, the coin lands on tails again and he loses extra RM2, bringing his total equity down to RM8. Therefore, the required bet amount for the next bet is RM4 using martingale strategy. Fortunately, he hits a winner and wins RM4, pulling his total account equity back up to RM12. Apparently, all he needed was one winning trade to recoup all of his previous losses and making a profit equal to the original stake.

Table 1.2: Betting Game using Martingale Strategy under Worst Case Scenario

Round	**Your Bet**	**Stake**	**Flip Results**	**Profit/Loss**	**Account Equity**
0	-	-	-	-	RM10
1	Heads	RM1	Tails	RM (1)	RM9
2	Heads	RM2	Tails	RM (2)	RM7
3	Heads	RM4	Tails	RM (4)	RM3
4	Heads	RM3	Tails	RM (3)	ZERO

Source: Developed for the research

Let's look at Table 1.2 above, another example using Martingale Strategy under Worst Case Scenario. Once again, a gambler has RM10 to stake, he starts with an initial stake of RM1. In the first round, he straight away loses on his first stake and brings his account equity down to RM9. He doubles his stake up to RM2, but he still

loses again and ends up with RM7. On the third round, his stake rises to $4 and he hits a string of losses continuously and making his account equity down to only RM3. He does not own enough capital to double his stake, so what he can do is just to bet his entire remaining stake, RM3. If he loses, he is down to zero and even if he wins, he is still far from his initial $10 starting capital.

Although the martingale strategy might look attractive to some gamblers, traders or investors this is because of its 100% winning probability under probability theory. However, there are some conditions such as i) unlimited capital and ii) no restriction on the number and amount of bets, that need to be fulfilled in order to successfully utilize this strategy. Since the martingale strategy is not without its flaws, practitioners should be aware of the limitations of the martingale strategy and the conditions under which the strategy can be successfully implemented so that it would not produce unfavorable consequences. Therefore, this paper will examine the effectiveness of martingale strategy in gambling and investing. A popular casino game called Sic Bo and two other financial markets which are stock market and foreign exchange market were selected to carry out the study. Simulations have been run on Microsoft Excel using historical market data and self-generated data to provide quantitative evidence for our study.

1.2 Problem Statement

Mathematically, the martingale strategy seems to be perfect with near to 100% success rate under probability theory. However, it had one crucial flaw: occasionally the required bets would increase beyond the size of the investor's capital. Although investors might make small profits in the short term, eventually solvency would get in the way of strategy. Despite its popularity, the martingale was a system that no one could afford to pull off successfully.

On the empirical study of martingale strategy, the literature reviews on martingale strategy mostly focus on the effectiveness of martingale strategy for gambling event. For instance, Turner (1998) examines the effectiveness of doubling and constant bets as strategies for gambling on the results of a computer simulation study of doubling strategy and compares the short term and long term results of doubling to gambling with a constant bet size. Flectcher (2008) investigates the effective of martingale strategy and its risk ratio reward ratio in Baccarat, a card game played at casinos. Davis (2011) determines the practical probability of martingale strategy and its relationship to casino odds and sucker bets.

Therefore, our research is conducted to provide a new dimension to various parties such as investors, traders and gamblers to look at the application of martingale strategy in financial markets specifically in Asia markets. More importantly, a concrete simulation will be run based on market historical data from different financial markets and self-generated data for Sic Bo to provide quantitative evidences regarding to the effectiveness of martingale strategy in different markets in both short term and long term, also to recognize both theoretical and practical sides of martingale strategy from more perspectives.

1.3 Research Objectives

Based on the problem statement that we had reviewed on the above, we derived some objectives for our research.

1.3.1 General Objective

1. To examine the effectiveness of martingale strategy in gambling and investment

1.3.2 Specific Objective

1. To determine the profitability of using martingale strategy as a gambling and investment strategy in the short run

2. To determine the profitability of using martingale strategy as a gambling and investment strategy in the long run

1.4 Research Questions

1. Is martingale strategy applicable in Sic Bo, a popular casino game in Asia and financial markets?

2. Is martingale strategy profitable in the short run?

3. Is martingale strategy profitable in the long run?

1.5 Hypotheses of Study

It is argued that the use of a martingale strategy is related to an incomplete conceptualization of random events sometimes known as the "law of averages" (Turner, 1998).

Based on law of averages, it is hypothesized that gamblers or investors who apply martingale strategy are more likely to win in the short term. In the long term, the losses suffered by doublers were much greater than losses suffered by constant bettors. Doublers also incur with a greater chance of losing the whole capital compared to the players who using martingale strategy in short term.

It is hypothesized that gamblers or investors with a huge capital who able to double up their bet up to more than 30 times, is very likely to win consistently with a probability approximately to 0 to lose all of their capitals under the circumstance where the probabilities of winning and losing are almost equivalent.

1.6 Significance of the Study

This study investigates the chances of winning in financial markets including stock market and foreign exchange market and Sic Bo, a casino game by using martingale strategy. Simulation will be run using both market historical data and self-generated data to provide quantitative evidences to support our findings.

This paper is significant to augment the understanding of investors, traders and gamblers in martingale strategy to the vital impact of their investment outcomes based on their risk preferences. The findings from this research are anticipated to have significant effect for investors, traders, gamblers, fund managers and bankers as they may consider the findings of this paper to formulate their investment decisions in different financial markets based on their risk preferences.

1.7 Chapter Layout

This study comprises of five chapters. Chapter 1 introduces the overview of background of research, problem statement, research objectives, hypotheses and also the significance of the study. Chapter 2 presents the literature review on the martingale strategy as a gambling and investment strategy and the behavior of investors and gamblers. Chapter 3 covers the methodology and simulation used in determining the effectiveness of martingale strategy in gambling and investing. Chapter 4 demonstrates the trends and the analysis of the data. Lastly, Chapter 5 discusses the major findings, policy implication, limitations, recommendations for future research and conclusion.

1.8 Conclusion

This study aims to examine effectiveness of the application of martingale strategy in Sic Bo and financial markets. Simulations will be run using on market historical data from different financial markets and self-generated data for Sic Bo to provide quantitative evidences in determining the effectiveness of martingale strategy in different markets in both short term and long term. This study is essential to provide more perspectives to look at the gap between theoretical and practical sides of martingale strategy.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This study focuses on the effectiveness of the Martingale strategy applied in the Financial Market by reviewing major contributions of existing literature which mainly focus on the Martingale strategy adopted as a gambling strategy. Based on the prior studies, it enlightens the investors on how reliable for the Martingale as a gambling strategy can be utilized as a powerful trading strategy. Martingale strategy will be an unbeatable and intelligent strategy after observing the behavioral aspects of an investor and a gambler. With this it gives a reason to study whether investors are the same as gamblers. Additionally, the winning probability of the Martingale strategy could be intensified by using the simulation generated from the Sic Bo which is a Chinese dice game instead of the Roulette.

2.1 Gambling Behaviour

Invariably, betting can be fun, notwithstanding gambling can be a thrill too. Any belief or unanticipated behavior can trigger a person's inclination to gamble without considerate on the potential losses generated from the game. Ironically, gambler's behavior is hard to be construed neither in ancient times nor in modern fast-paced technological era. Gambler behaves diversely or sometimes can be emotional. This betting behaviors are literally attributed to a number of underlying theories namely loss aversion, misconception and irrational thinking.

Occasionally, gambler's satisfaction is driven by the excitement while waiting for the betting result. Tversky and Kahneman (1974) proposed another behavioral aspect where the prospect theory explained the propensity of gamblers to continue betting in losses than in win, though the casino gambling offers zero and negative sum of game. Furthermore, utility of gambling is another driving factor that tempts gamblers to casino as well as obliquely drives the misperception on the casino odds whereby the perception is indicated from the prospect theory (Diecidue, Schmidt & Wakker, 2004). Tversky and Kahneman (1974) revealed that one of the gambler's behaviour is known as "Loss Aversion" which was defined as the relatively hypersensitive to losses compared to gains. This misconception was then being studied and was given a term to it.

Rogers (1998) unveiled the irrational thinking in the lottery gambling which consists of gambler's fallacy, in which most have a misconception about drawing odds. There is a belief of personal luck, representative bias, a belief on hot and cold number, delusion of control and the social factor effect on lottery play. On the other hand, Spence, Sugden, and Kale (2013) wrote in their research about "The Hot Hand Fallacy" that eventually build up the belief that the streaks of head will make the next flip to be a head instead of a tail. In other words, people are most likely to presume that the random sequences from the game are rather overly persistent than reversal. Intuitively, most people relied on the faulty assumption on the random probability. Spence, Sugden, and Kale (2013) provided an illustration on the gamblers who possess the representative bias will erroneously bet on black after they noticed the ball from the roulette wheel has landed on red for five times consecutively. This phenomenon is also literally denoted as representative heuristics which is also similar to the gambler's fallacy said Tversky and Kahneman (1974).

Due to the gambler who thinks that they will surely win the next round, this gives a place for the seed of addiction to grow. Narayanan and Manchanda (2012) had done a study on the gambler's addictive behaviour which ensue the irrational behaviour among the gamblers. The author supported the study of Spence, Sugden, and Kale

(2013) and Rogers (1998) stated that the irrational behaviour encompasses two beliefs which are gambler's fallacy and hot hand fallacy. Both are sharing the common characteristic which is the representative of small sample. The gambler fallacy shows the likelihood of gamblers escalating their bets after winning is zero while the hot hand fallacy suggests that the gamblers increase their bets from the previous gains.

2.1.1 Gambling

While gamblers are caught up with their behaviour, looking into the term of gamblers and knowing where they carry out their activities is important. Nasierowski (2012) mentioned that the meaning of "gambling" is ambiguous. The author describes the meaning as the potential loss resulting from the game is solely based on the basis of chance. As a matter of fact, the diversity of gambling activity is not only confined into casino gambling but also horse racing betting, sports betting as well as online gambling. Due to the gambling behaviour, there is a mindset that people have towards gambling due to the terror in its disadvantages. This has led past researchers to believe that gambling is a place where the money may be lost when it is being placed on the table (Cuff, Cover, Kumar & Zhao, 2011). As a matter of fact, casino gains profit literally by offering games with a house edge. The house edge is defined as the difference between the dollar that a gambler actually won and the money that casino pay the gambler after won (Cuff, Cover, Kumar & Zhao, 2011).

2.1.2 Table Limit

Due to the thought that even casino has to earn, since they can be considered business for those who opened them. Casinos will set the table limit as a form of control the flow of money. Study done by Spence, Sugden, and Kale (2013) has shown that the longer period of time the greater number of times the gambler played, it will reduce the chances of winning to 47% or less. This model is to help casino managers by setting bet limits that maximizes the total number of winnings by the casino. However, the casino management has to revise and consider the likelihood of the negative effect emanated from the bet limits. Furthermore, the table limits placed by each of the casinos vary among its competitors. Implicitly, the house's advantage will be driven from the high table differential and high table bet maximum. As a result of an increment in the allowable maximum bet limits, the bettor is harmed by the increasing of total amount of bets.

2.2 Martingale and Gambling

Due to the unfamiliarity towards gambling, many have been finding ways to penetrate the odds and seek for sure win condition. As mentioned in chapter 1 that the martingale strategy is implemented in the areas of Gambling and has brought profit. However, past literature revealed that the adoption of martingale strategy in the game of Roulette is only effective in Short Run, not on a Long Run (Turner, 1998). This can be shown in the table below:

Table 2.1: The Probability of Winning by Applying Martingale in Roulette

Type of Bet	**Probability of Winning**	**Payout Multiplier**
Straight Up (bet on one number)	1/38	35 to 1
Square Bet (bet on four numbers)	4/38	8 to 1
Dozen Bet (bet on twelve numbers)	12/38	2 to 1
Colour Bet (bet on eighteen numbers)	18/38	1 to 1

Source: Turner, N. E. (1998).

Since Roulette is not likely to be used, Turner (1998) replaced game originally from the Roulette to Sic Bo which was believed to be more applicable in obtaining a robust result on the effectiveness of Martingale strategy as it showed the effect of randomness and constant effect in betting, hence eliminating bias. This is further evidenced from Turner (1998) that the probability of a win by betting on a black or red slot in a game of Roulette is 18/38 which is 47.37%, as shown in the Table 2.1. Whereas in Sic Bo, the probability of a win by betting on “big” or “small” is 48.60% (Silverthorne, 2010).

Apart from that, the study of martingale strategy has brought this research yearning to understand martingale strategy applied in gambling which lead this study to Turner (1998) article in which he used computer simulation to generate the outcome from the study of Martingale strategy and compares the outcome for the short and long tenure of gambling using doubling strategy but with constant sized bet. Players that used doubling strategy tends to win more than lose in the short term. However, in the long term it will suffer losses more when doubler wagers up the bet size after the consecutive losses which is contrast to the losses suffer by the constant bettors.

On the other hand, the law of averages is related to Martingale Strategy because it is also the frequency of the possibilities of outcome which is expected to take place. The author mentioned this strategy has a connection to unfinished mindset of fortuitous

activities which is known a "law of averages". It is examined that the chance of doubling in the perfect world where the "law of averages" was applicable. To continue, Turner (1998) depicts the drawbacks of Martingale strategy. For short period of time, doublers have higher chances to win before losing, albeit players for long period of time endure double losses than those constant gamblers. Notwithstanding the shortcoming of the Martingale approach, it is more likely for the players that adopt Martingale strategy earn better than constant players in actual fact. It was then inferred that doublers are better than constant bettors in the ideal world.

In practice, it is advisable to look at the most rational situations that this research can relate to because how much can a person face loss as they double up in a long period of time. In reality, the strategy is not applicable when the bettors does not have unlimited funds to double their bets constantly after a string of losses and due to the bet limits set by the house (Davis, 2011). The author also disserted that the casino purportedly established the table limit too low could be unappealing to the bettors but setting too high will potentially cause financial losses to the casino. In the context of casino gambling, the house or the casino is denoted as the "sucker bet" as the wager which is ultimately favours the house. Davis (2011) described that the Martingale is not considered as the sucker betting grouping but it only make betting a little more interesting when it is a little bad. To sum up, Martingale is a betting strategy that makes everything looks better than they really are. In contemplation to the exposure caused by the Martingale strategy, the casino management imposed the table bet limits and the table differential (Spence, Sugden& Kale, 2013).

As mentioned earlier, casino management set table limit to control the amount of wining and losses. Furthermore, Spence, Sugden and Kale (2013) mentioned that the table limits placed by each of the casinos vary among its competitors. Implicitly, the house's advantage will be driven from the high table differential and high table bet maximum. Then again the bettor will be affected due to the boost in overall number of bets. For the sake of it, people persevere through in order to overcome the house by applying the Martingale strategy. Dorn and Sengmueller (2009) mentioned that

nevertheless, the player reacts differently towards the satisfaction on playing the game which depends on the resources available-on-hand and the imposition of bet limits.

There is a need to understand the unfavoured part of the games in making the best decision. Aloysius (2003) examined an individual's proneness in pursuing a series of unpromising gambles. The author contended that a when a player wants to be efficient at the game, players would rationally choose the Martingale strategy. Therefore, the maximum wagers set by the house or short of fund would not distort the decision to engage the Martingale strategy. In the long run, the house gains advantage when the bettor ceases to play after experienced continuous losses and infrequent wins from the games. "The long run is a misleading guide to current affairs. In the long run bettors will all be dead," said John Maynard Keynes.

However, all the gambling strategies have their pros and cons. For instances, flat betting will prone to lowest chances of winning but lowest risk exposure in keeping the capital in hand said Rogers (1998). In contrast, the martingale approach proves that the chance of winning is more appealing as compared to the former strategy. Not only that, escalating the wager after winning the stake is sometimes could be frustrating for most of the players as a single time of losses would cost a great disastrous for the gambler, who expects for the consecutive wins in every single increasing bets.

Based on the previous study on having the best strategy in gambling, researchers asserted that the martingale strategy could be an ideal strategy if the gamblers are allowed to consistently double up their wager until they won the bet (Rogers, 1998). The author continue by relating it to reality, this strategy is only workable when there is no any house limits imposed on the games or unlimited capital. As such, the author claimed that the investors receive low return but with higher exposure in losing the previous stake on the event of losses.

2.3 Is an Investor a Gambler?

From the common view of perceptions, majorities believe that investing is a good thing but gambling is a bad thing. Inevitably, the curiosity in distinguishing these two different words is undoubtedly high. Thus, there is an ample of disputes over whether an investor is a gambler.

In the past century, the market is more often related to gambling than investing. Particularly, the thrill of gambling is inherently diverse from the utility which arises from a secured return of investment. In tandem to this controversy, Stegemoller (2011) affirmed that investing varies against gambling in some vital aspects. In this regard, investor enjoyed the privilege to claim on the assets in proportional to the amount of their invested fund while the assets do not exist in the gambling world. Not only that, the author viewed that the changes of monetary gain from investment over time allowed the investor to exit from disadvantageous position while gambling activities composed immediate effect of win or loss.

Generally, gambling constitutes higher risk of exposure as compared to investing due to the knowledge possessed by the player is dubbed as inadequate. Pelletier and Ladouceur (2007) studied the effect of the knowledge of mathematics on the gambling decision. The result has shown that the gambler with a basic knowledge in mathematics would have better gambling skills as well as behave more responsible than their companions.

Conversely, there are many kinds of investment available in the financial market specifically in the foreign exchange market, capital market, and money market and so forth. Gambling and investing both have their own trading platforms whereby the player or investor can put their money to the dealer or the house as an capital invested or betting amount as well as seek for the capital appreciation or win the game.

In the context of financial market, it acts as a medium which used to facilitate the flow of capital from the investor to the business while gambling is deemed not to be a positive contributor in the form of country's productivity. However, the productivity attributed from the investing activities is unachievable when some of investors aim for profitable investment affiliated with the concept of "buying low and selling high".

By virtue of the investor's gambling behaviour, they will try to acquire undervalued stocks and sell when the stock prices start to drift higher. The investor's behavior implied that the use of word between investing and gambling are interchangeable. In this respect, gambling and investing both shares the common characteristics as they carry an equivalent risk of lavishing the whole capital.

Apart from that, invest in mutual fund assemble the gamble feature as an abundance of investor ignorant on how the fund manager allocates their funds in contingent on the stakeholder's interest. This renders the fund manager the unscrupulous sales commission by taking advantage on the investor oblivious towards the complexity of an investment (Stegemoller, 2011).

From the perspective of cost-effective, investing appeared to be virtually identical to gambling. This is due to the excessive transaction costs are typically similar to the gambler who bets more than they can afford to lose. Often, the frequencies of an aggressive trader in buying and selling securities are tremendously high until it diminishes the returns and ultimately, reduce the capital available to invest. Indeed, the transaction costs that are endured by an active trader encompass the broker's commission fees which are subject to the purchase volume, the volume of transaction and the account value (Pelletier and Ladouceur, 2007).

Kuhn (2008) described the difference between investing and gambling is that profit gains from investing is generated from the escalating economic condition while the wealth created from gambling activities are solely based on random luck. In fact, option market by its means is a pure gambling. Option market can be a useful

investment tool for investor when it can be deployed to reduce the risk exposure resulted from an adverse movement of the underlying commodities in an option contract. Notwithstanding, the gambling feature is defined on the probability that an option holder bets on the future option prices which are either above or below than the exercise price for a specified date.

Additionally, experiments on jackpot lotteries have been conducted in Taiwan and the result concluded that individual investors trade stocks as a method of gambling. Kumar (2009) studied on the individual gambling preference will be traced on their investment decision. As such, the behavior of a lottery player shows the resemblance with an individual investor that invests unwarrantedly in the stock with lottery features. Investors replaced lottery gambling with stock trading as they expressed strong interest in Jackpots and Lottery game (Jones, Dorn & Sengmueller, 2012). Similarly, the stock trading activities is comparable with other gambling activities specifically lottery, roulette, betting on house tracks and so forth. Moreover, Kumar (2009) observed that a surge of aggregate demand for the "lottery-type" stock during the economic downturn. Not only that, the socioeconomic characteristics influenced the propensity on the gambling-related trading as well as the stock market behavior.

The replacement between the gambling and investing is supported by Gao and Lin (2011) as investing is very akin to gambling (Jones, Dorn & Sengmueller, 2012). The apparent result from the previous study exhibited when jackpot over 500million Taiwan dollars, the number of shares that being traded falls by 7% among the low-capitalization stocks with relatively high individual investor's participation, high historical yield and high historical turnover rate. Not only that, individual trading decreases by 7% among the lottery-typed of stocks. Moreover, the magnitude of the decline rises in accordance with the fluctuation in jackpot and firm-level trading activity reacts negatively to the massive growth in jackpots. Lastly, the trading activity by individual investors decline by 5% of large jackpot.

Furthermore, the bankrupt firms' stock embodies unique lottery-like features. One stock that cost a few cents can involve in an investment strategy that provide with a low possibility of huge upcoming return and with a higher chance to obtain small loss. According to Kumar (as cited in Coelho & Taffler, 2009), this study suggested that this kind of stock offers striking benefits to huge numbers of less savvy individual investors.

This paper is also studied to determine the effect of market price of gambling-motivated trading. Over the year, the result showed that there were strong, negative and statistically significant post-bankruptcy decreases by at least 28%. From another point of views, the arbitrageurs will need to bear substantially high implementation costs and risk as their attempt to exploit the mispricing among all the bankruptcy firms is hardly to be identified (Coelho & Taffler, 2009).

The myth draws the definition of certainty as the reflection against the risk. Risk exists everywhere, everything and every time. This incorporates the exposure from the gambling activities as well as the uncertainty from the stock investment. If one investor gain advantage against another party is deemed to be investing and the reversal is true for gambling. As said by Warren Buffet recently in the year 2015, an uninformed investor who injects money in a risky investment is merely gambling. In a nutshell, the previous study proved that investing incorporates several gambling features has shed light on determining whether an investor is a gambler to an extent.

2.4 Martingale on Financial Markets

There are many people who used martingale strategy in the financial markets such as banks and companies. In a study by Brown and Steenbeek (2001), they show that a person named Nicholas Leeson, who was the former chief derivatives trader and who fraudulently caused the collapse of Barring Banks in the past. This person has come

out with a trading strategy based on his name which is known as Nicholas Leeson's trading strategy. This Nicholas Leeson's trading strategy is having the same concept with martingale strategy which is also known as doubling strategy. This showed that Nicholas Leeson has doubled his position in the market whenever the market price decreases.

Nicholas Leeson believed that his doubled trading position would ultimately pay off but it turns out to be a wrong assertion. This is shown in the theory of Kahneman and Tversky where people are more concerned on the loser than the winner (as cited in Agwuegbo, Adewole & Maduegbuna, 2010).

From another view of perspective, the investor bets on bank that the probability of a group of borrower default at the same time is notably implausible than one person defaulting on a loan payment. The fact of the statement has shown that the debtor's credibility on the debt obligation is built upon the lender's risk. Though, the assumption is rejected from Kucharski (2012) resulted from the eruptions of financial market and economic downturn in 2008.

Furthermore, martingale strategy does apply in different field such as trading world and real working environment. In the trading world, the rationale for an investor opts to hold their losers in exchange with the winners is due to the information is yet reflected in the price changes, acquired lower-priced stocks with potentially high trading costs and investor reference points (Odean, 1998). From an opposite point of view, the author demonstrated that investors tend to sell off their losing investments at the end of year in order to circumvent the tax imposed against the realized capital gain. Not only that, a handful of investors presumes that today's losers will soon outperform than today's winners.

On the other hand, in the real working environment, people are threatened to commit fraudulent activities in order to uphold their trust and reputation. In the aforementioned Leeson situation of unfavourable movement in prices, the manager

attempted to invest in the market in a way that his losing more than his investment (Agwuegbo, Adewole & Maduegbuna, 2010).

2.5 The Use of Martingale Strategy on Government Policy

The most recent research about the martingale strategy also applied in the central bank policy in the European Sovereign Debt Crisis. The author aims to provide a description on the developments by implementing dynamic stochastic general equilibrium model. This model is to provide the ideal debt rule for a country that being exposed to own settling movements on the financial markets. The study shows that being a third party that provides the countries in the EMU with the implementation of the martingale strategies. The impetus of lowering the risk premiums and reduce the punishments of the future non-payment encourage the government to take additional risks on pertinent to the country's development in order to take the edge off the indebtedness (Lane, 2012).

2.6 What Other Strategies is Compatible with Martingale Strategy?

There are various betting systems emerging in present day. The progression of the betting system are mostly placed under three broad descriptions namely flat, positive and negative. As a matter of fact, a flat wager bets constantly with an attempt to win the games while the positive thinker doubles the bets after wins (Fletcher, 2008).

The Baccarat Attack Strategy shares the similarities with the notion of "Hot Hand Fallacy". The investors are likely to benefit in escalating bets based on the past records typically on the winning streaks. Baccarat Attack Strategy allows one to gain advantage from the games without the risk of losing previous winning streaks.

In the trading world, risks are defined as the exposure of losing the trading capital. As such, the primary objective of trading is not only to protect the loss of capital but also to gain profitable return on investment. However, a trader will need to bear an equivalent risk in proportionate with the profit earned from the trading activities. Hence, a better solution to hinder the unnecessary risk is to double the position size once the trading system provides consistent profits. The notion of this betting strategy is known as Anti-Martingale Strategy. This approach encourages the trader sustains greater risks with their profits instead of the initial capital. Consequentially, this approach helps to maintain the primary goal which is to safeguard the initial trading capital (Leibfarth, 2006).

2.7 Conclusion

This chapter enriches public a better understanding of application of martingale strategy in games at casinos as well as in financial markets. The previous literature has convinced the investor and gambler to apply the Martingale strategy. This is due to the investor and gambler behaves similarly as they escalate their bet or investment randomly after endures losses in the game or investment. In this case, the Martingale strategy appeared to be an intelligent strategy for the better and investor when they double up their position from the previous losses provided that there is an unlimited capital. However, most of the study believed that the strategy can only be sustained in short term but not in long term. In a nutshell, the prior researches has shed light in our research which would be necessary to clear up the doubts from different parties like traders, investors and gamblers regarding to the martingale strategy today, in 21st century to ensure the traders, gamblers and investors can have a better grasp in the application martingale strategy in different financial markets from more aspects. Thus, the methodology that used to examine the effectiveness of the application of Martingale strategy used in this research paper will be presented in the next chapter.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter explains the method of data collection and other methodologies involved in conducting this study. This study attempts to evaluate the relevance and effectiveness of Martingale strategy in today's financial markets. Trade simulations and testing are carried out on various data sets to complete the research. The profitability and limitations of each strategy in the study are then analyzed to observe the findings of the study.

3.1 Research Design

In this study, the research is carried out by running tests and simulations on sets of data. Microsoft Excel software is used to run the tests such as betting and trading simulations and then to present the results in the form of graphical information.

3.2 Data Source

The data used in this research consists of both simulated data and secondary data. There are 3 sets of simulations run on 3 different types of data which are Dice (Sic Bo), Forex and Stock Index. The 3 types of data are selected so that they can each represent their own context of casino gambling, forex market and stock market respectively. This allows for the comparison of the application of the Martingale strategy in the 3 different contexts and observation of the differences if there are any.

Table 3.1: Sources of Data Used in Simulations and Sample Sizes

Data	Source	Sample Size
Sic Bo	Microsoft Excel	1000 plays
EUR/GBP	Fusion Media Limited	1000 days
EUR/USD	Fusion Media Limited	1000 days
USD/JPY	Fusion Media Limited	1000 days
S&P 500	Fusion Media Limited	1000 days
KLCI	Fusion Media Limited	1000 days
NGSEINDX	Fusion Media Limited	623 days

Note: Sample size subject to availability of data, Fusion Media Limited, http://www.investing.com/currencies/

Sic Bo is chosen for this study of Martingale strategy in casino gambling because it has a winning probability of almost 50% which is similar to that of Roulette. Turner (1998) mentioned in his work that the probability of a win by betting on a black or red slot in a game of Roulette is 18/38 which is 47.37%. Whereas in Sic Bo, the probability of a win by betting on "big" or "small" is 48.6% (Silverthorne, 2010).

Data for the Sic Bo simulation is generated by using the random numbers generator in Microsoft Excel. This is to ensure that the Sic Bo outcomes are completely random and to eliminate bias in the sample.

Data used for the Forex and Index simulations are secondary data. For the Forex market, three of the most traded currency pairs which are EUR/GBP, EUR/USD, and USD/JPY are chosen to conduct the study.

For the stock indices, the US S&P 500 index, the Kuala Lumpur Composite Index (KLCI) and the Nigerian Stock Exchange All Share Index (NGSEINDX) are selected to each represent their own context of developed economy, developing economy and

underdeveloped economy. This enables the observation of the differences these 3 economies would have on the Martingale strategy.

To determine whether the sample size would or would not affect the results, a sample of 100, 500 and lastly a maximum of 1000 are used in all the simulations. Another reason of using a large sample is to ensure the reliability of the test results and to show the different effects of short run and long run if any exists.

3.3 Random Number Generator for Sic Bo Outcomes

Table 3.2: Example of Sic Bo Simulation

A	B	C	D	E
1st Die	2nd Die	3rd Die	Total	Outcome
4	6	5	15	BIG
3	3	2	8	SMALL
1	1	1	3	N

Source: Developed for the research

FUNCTION (A,B,C)	=Randbetween(x,y) Where x,y is between 1 to 6

To simulate a Sic Bo play, it is required to generate Sic Bo dice rolls using a random number generator. In columns A, B and C, the function above is used in Microsoft Excel to generate numbers between1 to 6 randomly (1^{st} – 3^{rd} Die). Then, the total values of three dice are summed up in column D by using AutoSum function. The end outcome in column E is classified into Big, Small or N based on the total in D. If all numbers are equal (1,1,1 or 2,2,2 up to 6,6,6) the outcome will be "N", whereas total

of 4 to 10 = Small, 11 to 17= Big. This enables the generation of Sic Bo dice rolls of up to any amount of plays instantaneously using Microsoft Excel.

3.4 Simulation Using Different Strategies (Martingale, Anti-Martingale & Constant Bet)

For every set of simulation conducted in this study, there are three strategies used to manipulate the bet size, which are martingale, anti-martingale, and constant bet strategies. For Martingale strategy, the bet size is doubled after every loss. The rationale for this is that in a game such as Sic Bo which has a winning probability of close to 50%, it is not statistically possible to get the same outcome for an infinite amount of times. If the losing player continues to place the same bet, he will eventually be able to get a win. Therefore, as the bet size gets bigger and bigger with every loss, one win will enable him to regain all of his previous losses, plus the initial bet amount. The bet size is then reset to the initial amount after every win as shown below:

Function for Martingale (M)	=IF(H2=”Win”,1,+PRODUCT(2,G2))

For Anti-Martingale strategy, the bet size is doubled after every win and reset to the initial bet amount after every loss. This is opposite to the Martingale. The rationale of using this strategy is that the player believes there is a trend or winning streak. Therefore, he will win more and more with every win. However, once the winning streak is broken, the player will suffer a huge loss due to his much larger bet size at the end of the streak.

Function for Anti-Martingale (AM)	=IF(H2="Lose",1,+PRODUCT(2,G2))

For the purpose of comparison, the third strategy which is a constant bet strategy is included as a control variable in the study. The bet size remains the same throughout the whole sample. Thus, if the player bets on Big throughout the game, he will go home a winner if there are more "Big" outcomes than the total of "Small" and "N" outcomes. The same logic is applied to the simulations of Forex and Stock Index trades.

Generating random bet positions:

For every bet size strategy (M, AM & Constant), there are three bet positions (Small, Big & Random) or (Short, Long & Random). The Random bet is added as a control variable to determine whether the bet position is significant in affecting the results of the bet size strategies.

To generate the bet positions for Random strategy, the random number generator is used to generate numbers 1 and 2. These numbers then represent the bet positions of "Big or Small" in the Sic Bo play and "Short or Long" in the Forex and Stock Index trades.

Function	=CHOOSE(RANDBETWEEN(1,2),"Short","Long")

Imposition of Table Limit:

In real casino gambling, there are table limits imposed to control the losses of the casino. In contemplation to the exposure caused by the Martingale strategy, the casino management imposed the table bet limits and the table differential (Spence, Sugden & Kale, 2013). Thus, in order to simulate the real scenario, table limit is applied in the Sic Bo simulations. The table limit for a Sic Bo game with minimum bet of RM10 in Malaysia's Genting Casino is observed to be RM13, 000. Therefore due to a minimum bet of $1 in the Sic Bo simulations, a relatively equivalent $1,300 table limit is imposed.

3.5 Measurement of the Outcome/Balance in Graph and Averages

Table 3.3: Extracted from KLCI Trade Simulation of 1000 Samples

(Martingale Random)

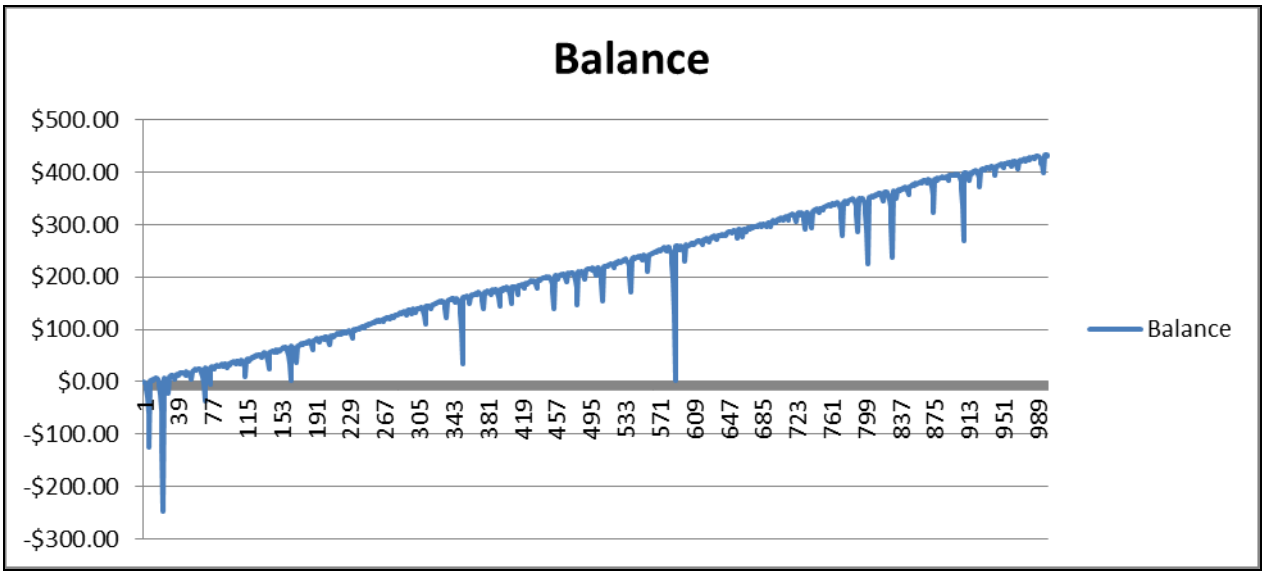
Date	Change %	Outcome	Bet	Win/Lose	Bet Size	Change	Balance
11-Feb-2011	-0.63%	Short	Long	Lose	$1.00	-$1.00	$64.00
14-Feb-2011	0.72%	Long	Short	Lose	$2.00	-$2.00	$62.00
16-Feb-2011	0.06%	Long	Short	Lose	$4.00	-$4.00	$58.00
17-Feb-2011	0.15%	Long	Short	Lose	$8.00	-$8.00	$50.00
18-Feb-2011	0.60%	Long	Short	Lose	$16.00	-$16.00	$34.00
21-Feb-2011	0.55%	Long	Long	Win	$32.00	$32.00	$66.00

Source: Developed for the research

The above table shows how the simulations are done. If the percentage change of the index is negative, it is classified as a Short. So by betting on Short, the trade is considered a winning trade and vice versa.

The Balance figures are then presented in a graph such as the one below to enable further analysis and comparison of the results.

Figure 3.1: Representation of Trader's Account Balance for Simulation of 1000 Trades on KLCI



Source: Developed for the research

Note: Strategy used is Martingale on Short position

Averages for all 4 samples of random strategies (Forex and Index)

In order to make sure the random strategies are not biased and to minimize the effect of outliers, the study generated a total of 4 samples for the random bet position. The balances from all the samples are then combined in a single spreadsheet to find the average value which is then used as the final result for the random strategies.

3.6 Conclusion

In the nutshell, simulated data and secondary data has been used in the study. The necessary variables were included to obtain the most reliable results. The Microsoft Excel software was used to carry out all the simulations and the results will be presented in graphical information. The results of the simulations will be further discussed in the next chapter.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

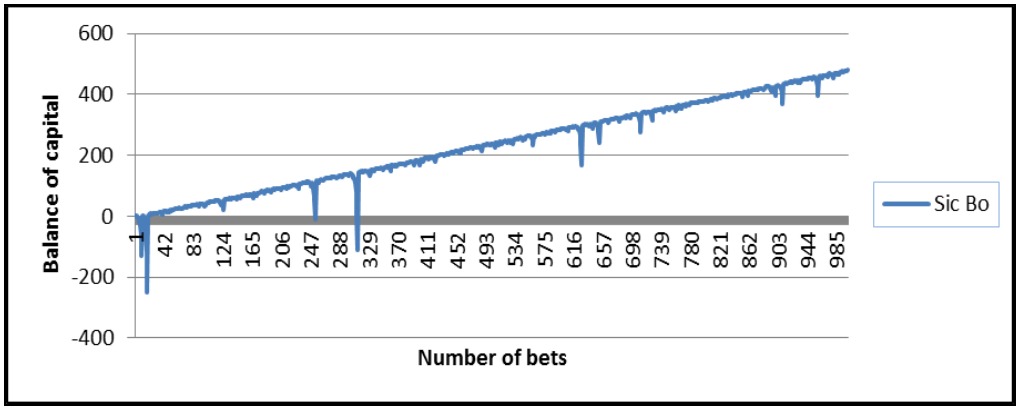
This chapter explains the result generated from the trade simulation with various data sets. The findings from this research paper will help to examine the relevance of Martingale strategy in the contemporary financial markets. The data are then presented in forms of table and graphs followed by a brief explanation.

4.1 Martingale Strategy

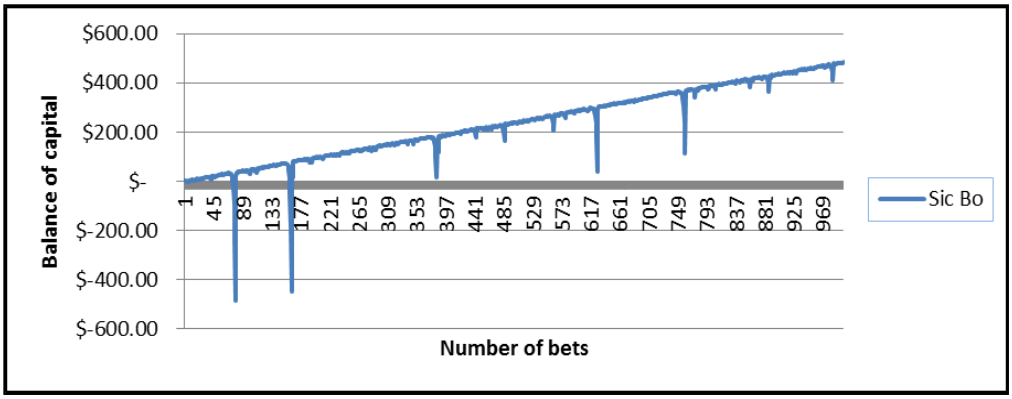
As mentioned in Chapter 3, in this game (Sic Bo) there is nearly 50-50 chances of winning, yet it is not mathematically demonstrated in the past. On the other hand, the martingale strategy proposed that the player who loses will double their bets. And as they double the bets, eventually the players will be able to win, consequently allowing players to recover its previous losses and initial amount, thus showing an upscale in the profit. By drawing the profits in graph, it will obtain an uphill trend along with some drastic decrease during the period of time.

4.1.1 Martingale Strategy on Gambling

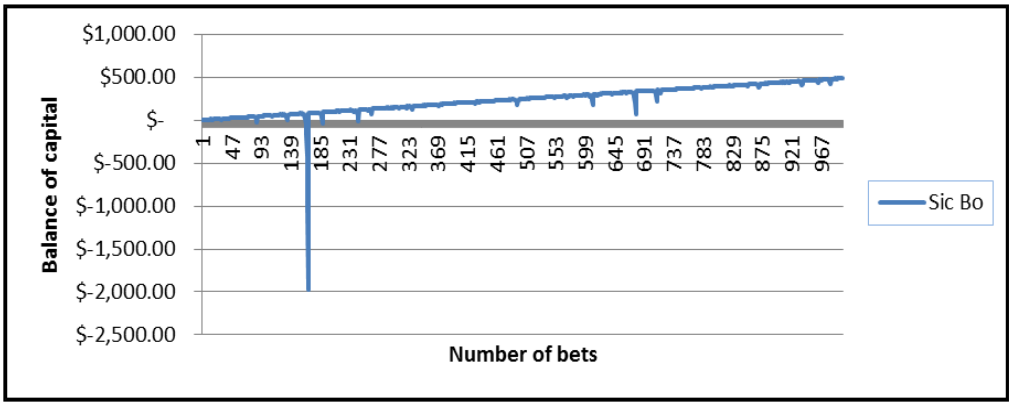
Figure 4.1 Martingale Strategy on Sic Bo



(a) Martingale Strategy for Sic Bo under Random Bet



(b) Martingale Strategy for Sic Bo on "Big"



(c) Martingale strategy for Sic Bo on "Small"

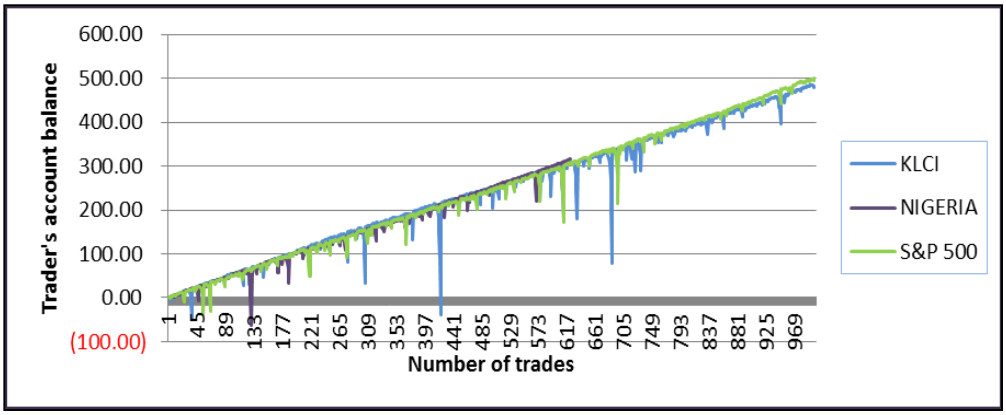
Source: Developed for the research

A random average graph of Sic Bo was used to avoid bias. The line graph above shows the total winning and losses of a player in a period of time. Figure 4.1 proves that this strategy works. Even as there will be a great loss, player's position will be able to bounce back by doubling their bets as they lose. From the panel (a), (b) and (c), regardless of different amount of bets (100 or 500) or different player betting, the trend of the graph is also alike.

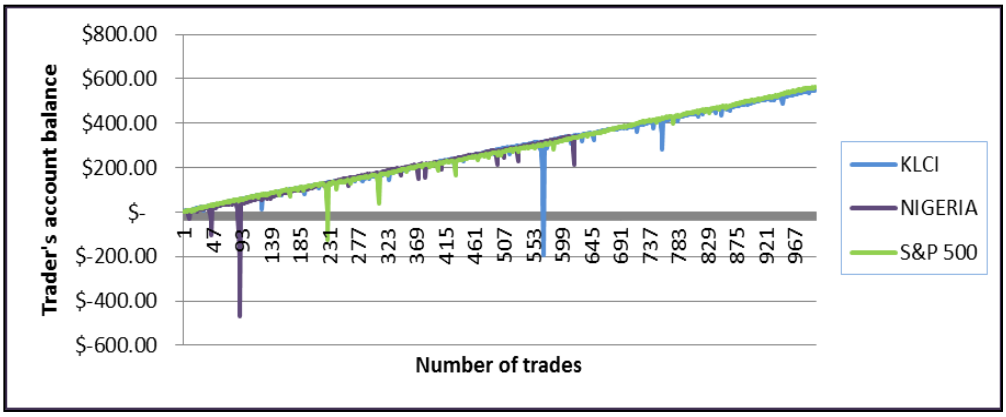
This graph also tells a story about the Short Run and the Long Run. Assuming Long Run is about 1000 bets and Short Run is less than 1000, 500 or 100. Nevertheless, according to Panel (a), at any point of bets as the player bet randomly, players will still be able to achieve profit. At the same time, for the betting on "Big" and "Small" as shown in panel (b) and (c) also shows the same outcome. Turner (1998) mentioned that in his study of Martingale strategy, the amount of losses in Long Run is more than Short Run due to the bet size. In Long Run, the probability of getting a losing streak will be greater compared to the Short Run. Even though the results obtained show a long losing streak towards the beginning, the player has a higher chance of losing all his capital in the Long Run.

4.1.2 Martingale Strategy on Financial Markets

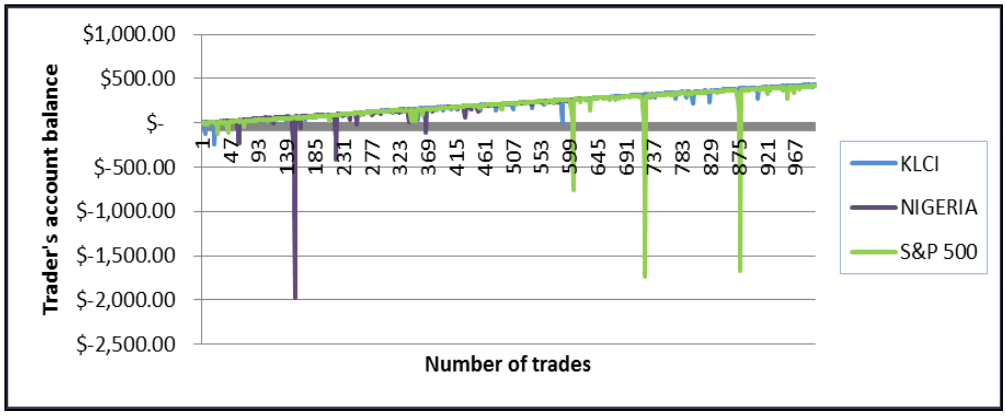
Figure 4.2 Martingale Strategy on Stock Index



(a) Martingale Strategy for Stock Index under Random Bet



(b) Martingale Strategy for Stock Index on "Long"

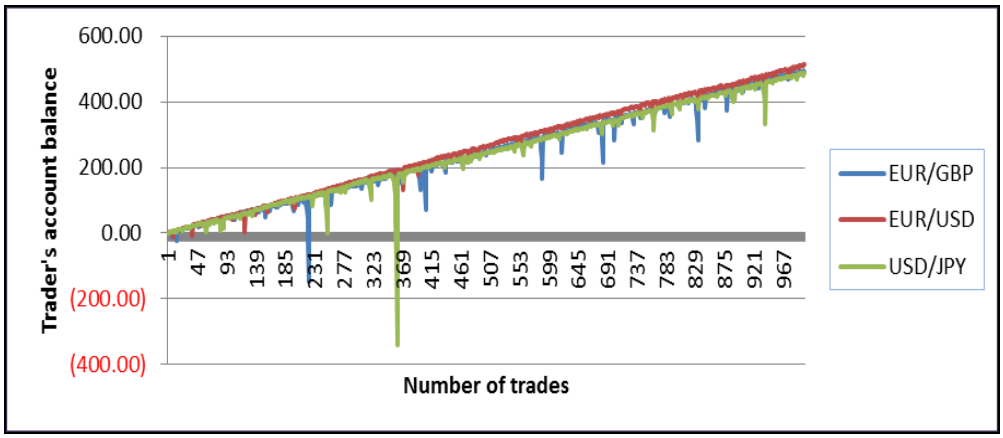


(c) Martingale Strategy for Stock Index on "Short"

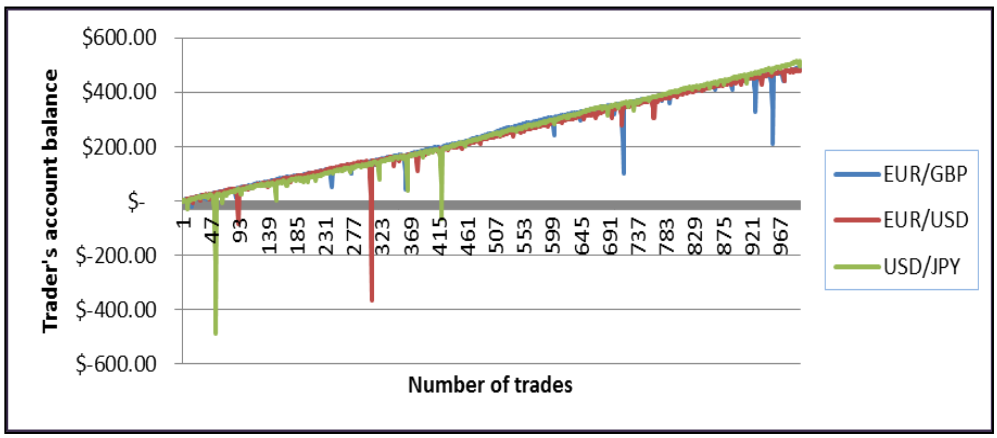
Source: Developed for the research

Again the graph above shows, there are sharp drops in the total equity or balance of trade of an investor due to streaks of continuous losses. As mentioned in Chapter 3 that under the Stock Index, this research uses three different types to show the country development status. Figure 4.2 shows that regardless of the country's well-being of the economy, Martingale Strategy is a sure win and profitable strategy. The Figure 4.2 also shows that the account balance that the investors have in trading will eventually meet a downturn and then rise back up again, which is significant to the Martingale Strategy. This strategy is not limited by the economy status of countries but allows them to be traded equally, even though investors were to make a random trade. Just like Forex Market, Figure 4.2 shows an uphill trend which shows a significant profit. From this investors from different country will be able to make a profit out of Martingale strategy. Referring to the panel (b) and (c), regardless of random bet as illustrated in panel (a), this chapter also shows that even if the investors bet on "Long" or "Short" respectively, it demonstrated the same outcome.

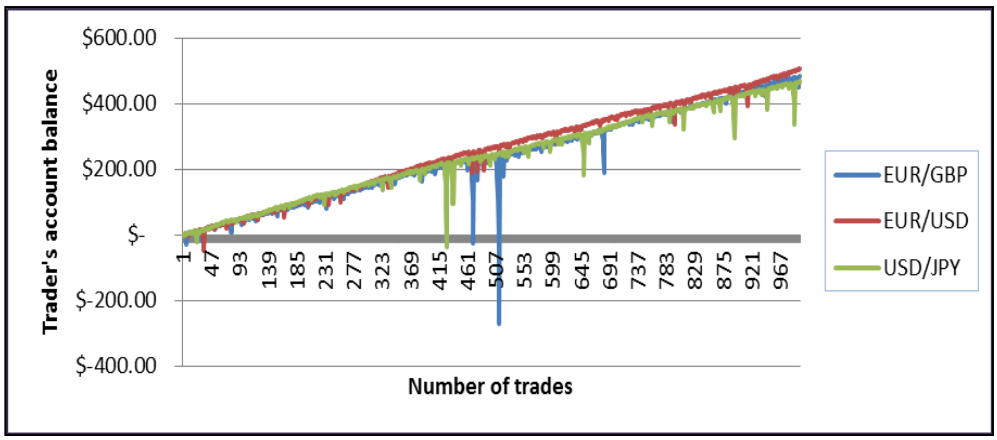
Figure 4.3 Martingale Strategy on Foreign Exchange Markets



(a) Martingale Strategy for Foreign Exchange Markets under Random Bet



(b) Martingale Strategy for Foreign Exchange Markets on "Long"



(c) Martingale Strategy for Foreign Exchange Markets on "Short"

Source: Developed for the research

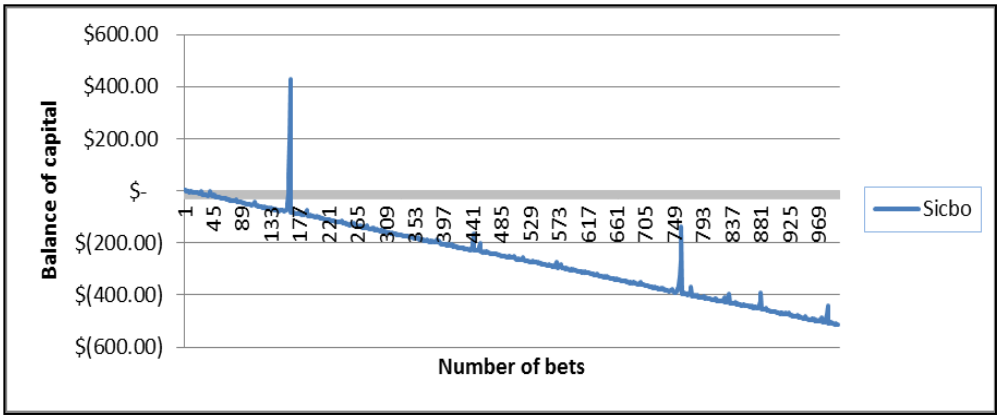
In the foreign exchange market this research chose three currencies to avoid bias and generated Figure 4.3 to represent the average total equity or total balance of trade of investors at the end of the day. All three currencies showed the same trend. By implementing Martingale Strategy in the Foreign exchange market, the overall trend in the three currencies shows an uphill trend. As in Figure 4.3, there is a constant outcome. As investor's total equity dropped as they trade, they would choose to double the stake to follow the martingale strategy (Turner, 1998), hence allowing them to recoup their losses. Although EUR/USD doesn't have a huge dip in the line chart, this research cannot assume that there will not be any steep decrease because EUR/GBP and USD/JPY has the drastic drop in investor's total equity. John Maynard Keynes quoted that in the Long Run, players will face a large number of losses and it's known to be deadly, which is shown in the USD/JPY and EUR/GBP but eventually, using the martingale strategy they are able to win back and cover their losses.

4.2 Anti-Martingale

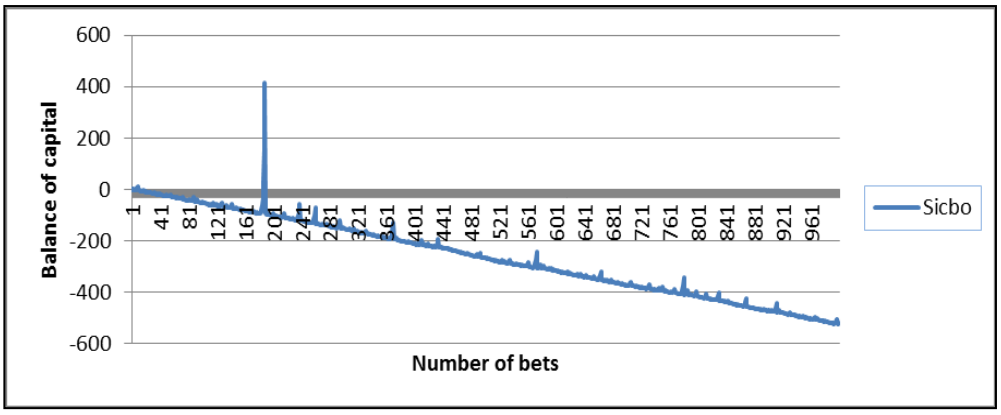
Anti-Martingale strategy is proposed that the player who wins will double their bet position. This strategy is applied when the player believes he is on a winning streak also known as the hot hand fallacy. By doing this, the bet size is doubled after every win and reset to initial bet amount after every loss. However, the player will lose tremendously when the player's assumption that there is a trend of winning streak is violated.

4.2.1 Anti-Martingale Strategy on Gambling

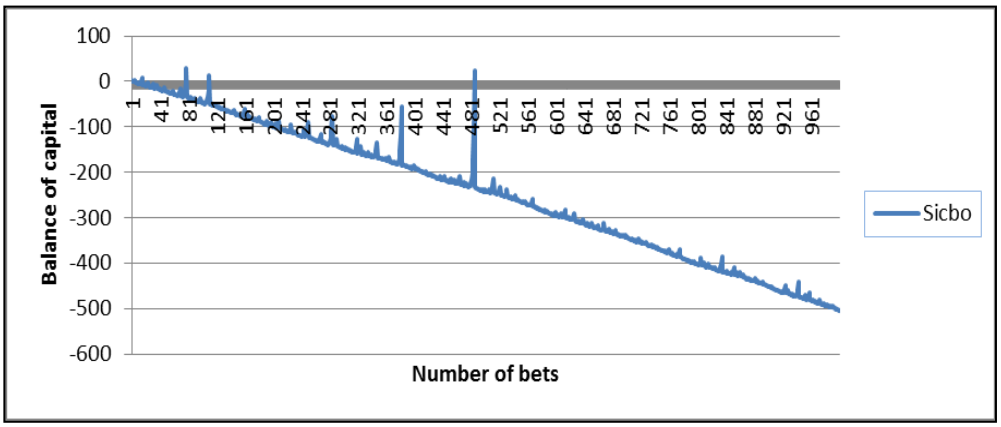
Figure 4.4 Anti-Martingale Strategy on Sic Bo



(a) Anti-Martingale Strategy for Sic Bo under Random Bet



(b) Anti- Martingale Strategy for Sic Bo on "Big"



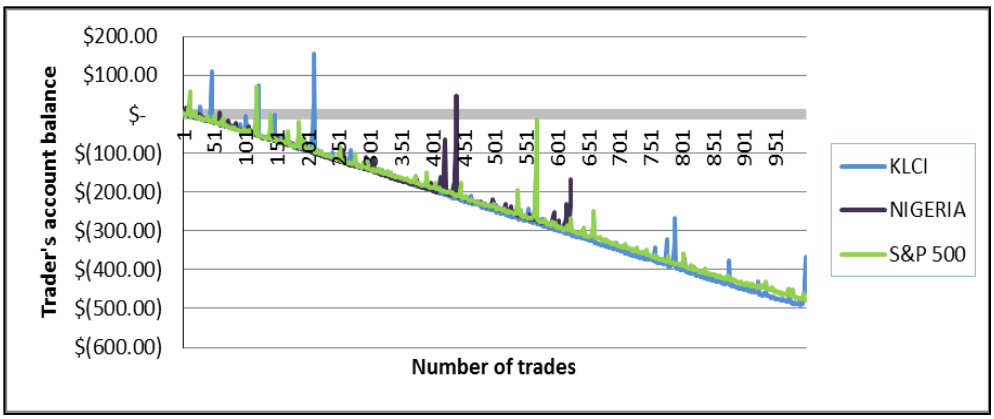
(c) Anti-Martingale Strategy for Sic Bo on "Small"

Source: Developed for the research

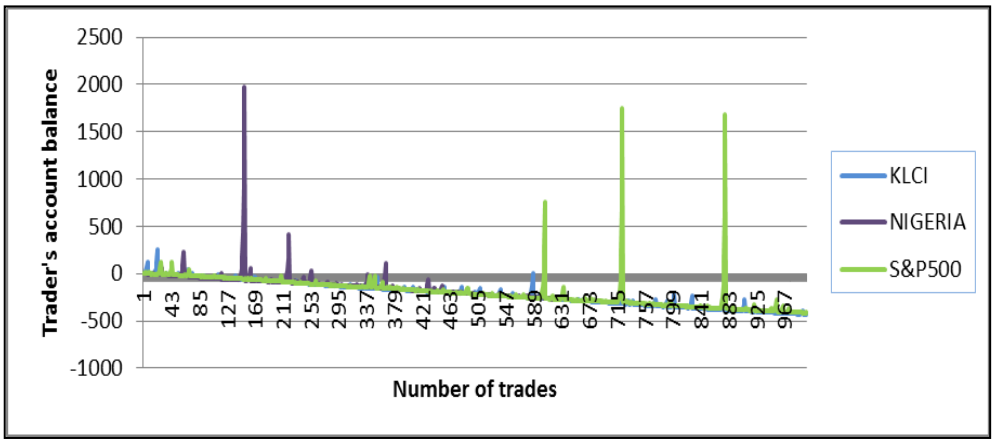
Panel (a) shows the average simulation result of the effect of the Anti-Martingale strategy in casino games namely Sic Bo by using random bet position. From this observation, there are 100 to 500 plays denoted as the Short Run data while 1000 plays as the Long Run data. Subsequently, the test with the simulation using another two different bet positions which are "Big" and "Small" are presented in panel (b) and (c). The Figure 4.4 clearly details a downward trend of the gambler's money balance as it yields higher negative return in the Long Run than in the Short Run. Most significantly, the trend in panel (a) dictated a boom in the gambler's profit which is peaked at $429 followed by a slump in winnings consecutively. The dramatic rise in the profit is spotted at 164^{th} of plays, which is within the range of 100 to 500 plays. This infers that the chance of winning in Short Run is relatively higher than in the Long Run. Likewise, the simulation using "Big" and "Small" also contributed the similar result as in the "Random" simulation. Based on the yielded result, Anti-Martingale strategy is not suitable to be applied in the casino gambling in the Long Run. In overall, the negative outcome signaled the limitation of the Anti-Martingale strategy on doubling the bet size after every win. In fact, the result generated from the Chinese Dice Game (Sic Bo) shown that there is a string of losses which is however, contradicts with the player's belief that there is a trend of winning streak.

4.2.2 Anti-Martingale Strategy on Financial Markets

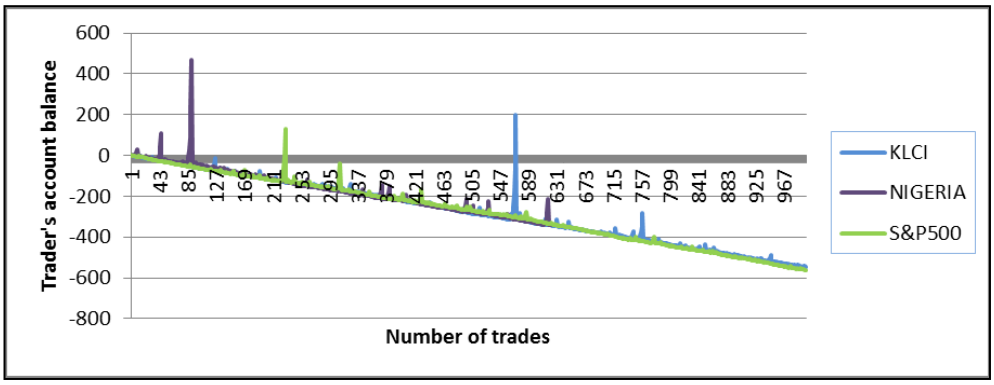
Figure 4.5 Anti-Martingale Strategy on Stock Index



(a) Anti-Martingale Strategy for Stock Index under Random Bet



(b) Anti-Martingale Strategy for Stock Index on "Long"



(c) Anti-Martingale Strategy for Stock Index on "Short"

Source: Developed for the research

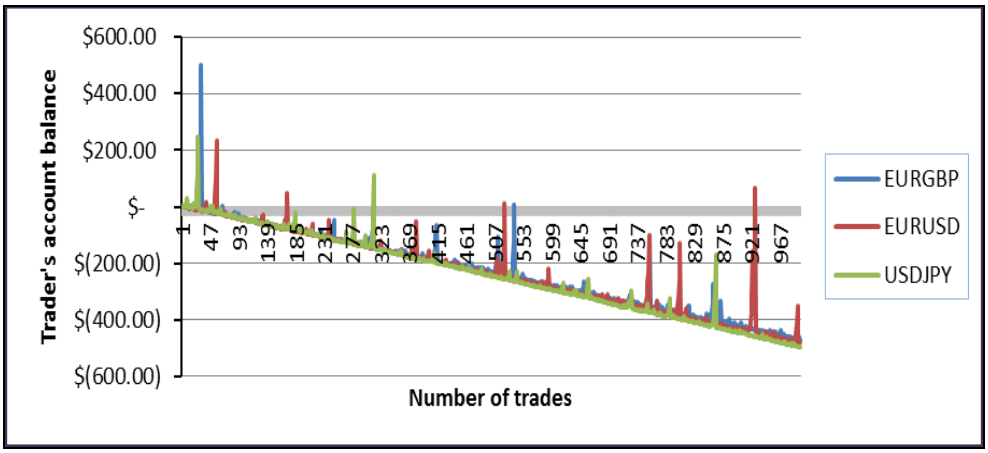
The panel (a) compares the average result of the simulation of Anti-Martingale Strategy using Random bet position applied in KLCI and S&P 500 with 1000 days as well as in Nigeria with 623 days, which comprises of the most current data. Also, the simulation by trading solely in "Long" and "Short" position is depicted in panel (b) and (c). From the above Figure 4.5, it does not reflect any seasonal pattern, but an obvious downward trend in a long series of data. It may be clearly seen that the trader's account balance reaches a peak at a point before falling tremendously with a small fluctuation in the account balance, presumably that the number of gains do not cover fully the total losses after the spike in trader's account balance.

Notably, the line graph in panel (a) for the KLCI stock market drops slightly by $94 and soars abruptly to $155.75 followed by a sharp decline in the trader's account balance by $100.50 shortly. In tandem to this, the fluctuation in Nigeria stock market gives a maximum return with $45.25. Conversely, the market condition in the S&P 500 allows the trader to gain a relatively stable and positive return within the first 120 days but not in the subsequent days.

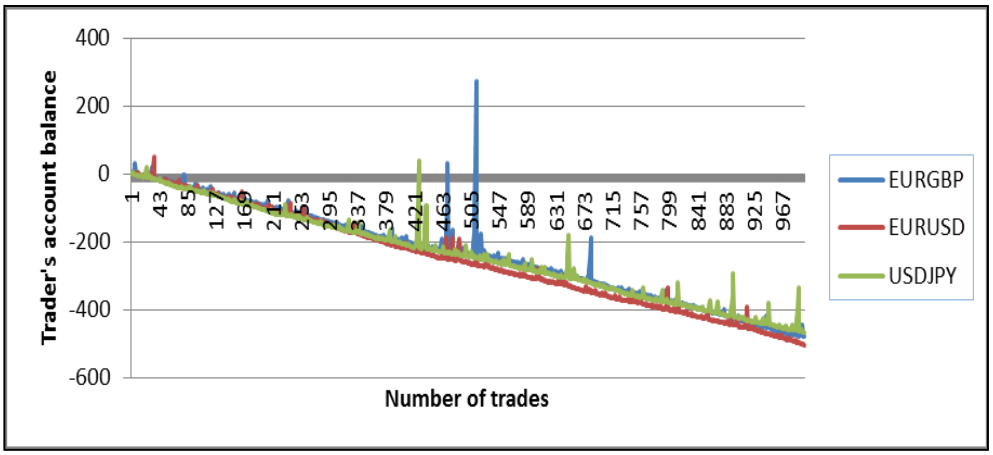
In comparison, the ascending order for the countries benefit the most from the return of the investment subjected to the length of time period will be KLCI, S&P 500 followed by Nigeria. As a matter of fact, the Figure 4.5 revealed in the extreme case that every deep rise in the investment gains is wholly or partially offset by enormous losses. This general trend indicates the profit gained from Anti-Martingale strategy did not sustain for a long period of time and the accumulated profit can be drawn down from the next unanticipated losses as the trader double the investment after win.

To summarize, it is unlikely for the trader to gain a massive return by applying Anti-Martingale strategy in three different economies either in the Short Run or Long Run unless there is a string of nearly infinite upside gain in the investment after a certain losses occur.

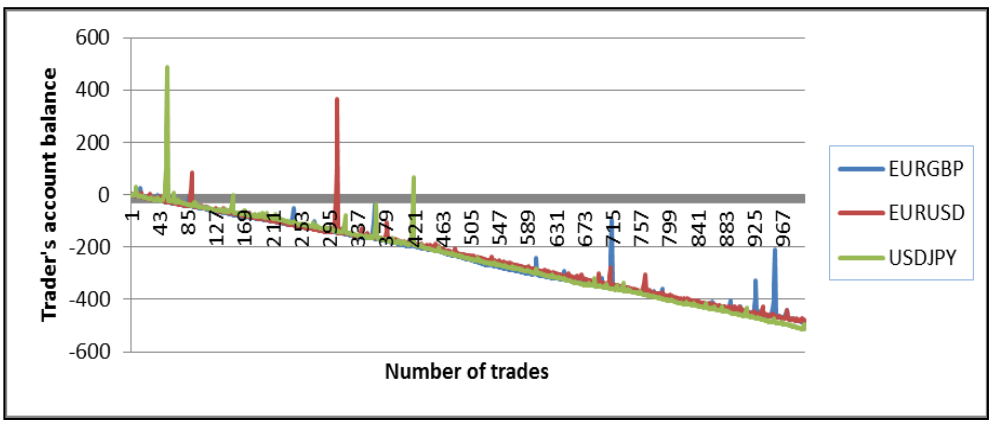
Figure 4.6 Anti- Martingale Strategy on Foreign Exchange Market



(a) Anti- Martingale Strategy for Foreign Exchange Market on Random Bet



(b) Anti- Martingale Strategy for Foreign Exchange Market on Long"



(c) Anti- Martingale Strategy for Foreign Exchange Market on "Short"

Source: Developed for the research

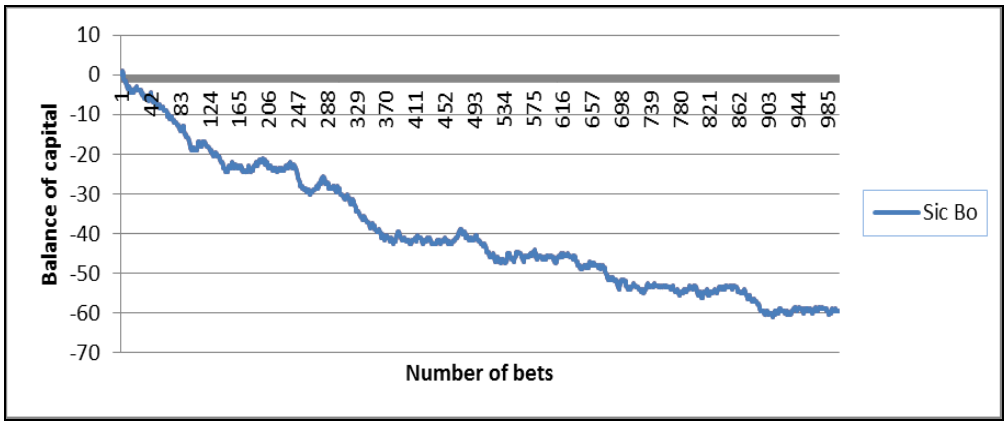
The panel (a) compares the average changes in the trader's account based on the simulation on the Foreign Exchange Market applying Anti-Martingale strategy with random bet position over 1000 days of sample size. The graph covers three different pairs of currencies namely EURGBP, EURUSD and USDJPY. Apart from that, the similar result of the application of Anti-Martingale strategy by focusing on one betting position specifically "Long" and "Short" is portrayed in panel (b) and (c). Apparently, the highest peak among the three actively traded currencies is EURGBP followed by the USDJPY and EURUSD. As in panel (a), it shows that the trader's account balance rises steadily and steeply during that period in the EURGBP exchange market, at just within 33 days to reach the maximum account balance at $501. Notwithstanding, the profit earned from trading USDJPY is slightly higher than EURUSD by $15.25 though the profit from both market is lower than the profit yielded from EURGBP. In spite of that, the next decrease from the trading position is hardly insignificant as it causes tremendous losses for the trader gradually as well as unexpectedly. To specify, the trader account's balance in EURUSD has soared by $67.50 after a series of losses in the investment occurs after 928 days. However, the overall outcome is similar for three currencies. In sum, the trend in panels (a), (b) and (c) indicates that Anti-Martingale strategy is not applicable practically because the trader will not possibly be able to make the right trade continuously for an infinite number of times.

4.3 Constant Bet

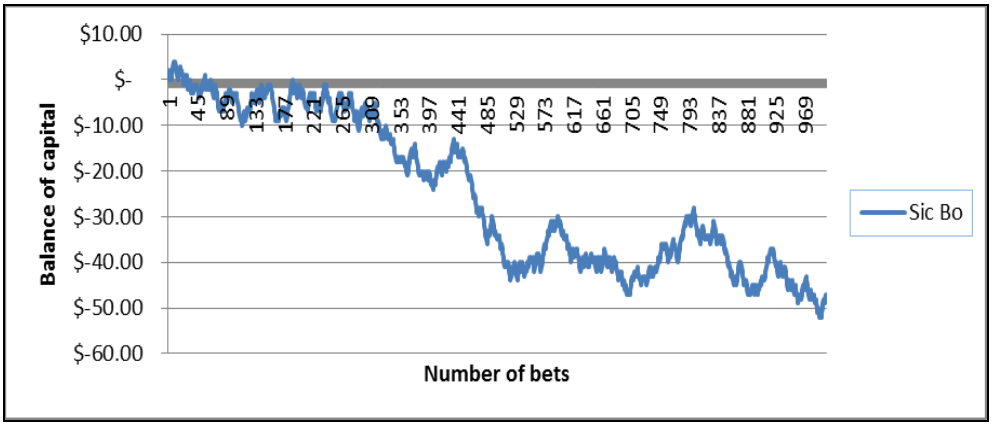
Constant bet is carried out where the players will continue their bet at a single amount, which is their initial amount, regardless whether it's a win or lose.

4.3.1 Constant Bet Strategy on Gambling

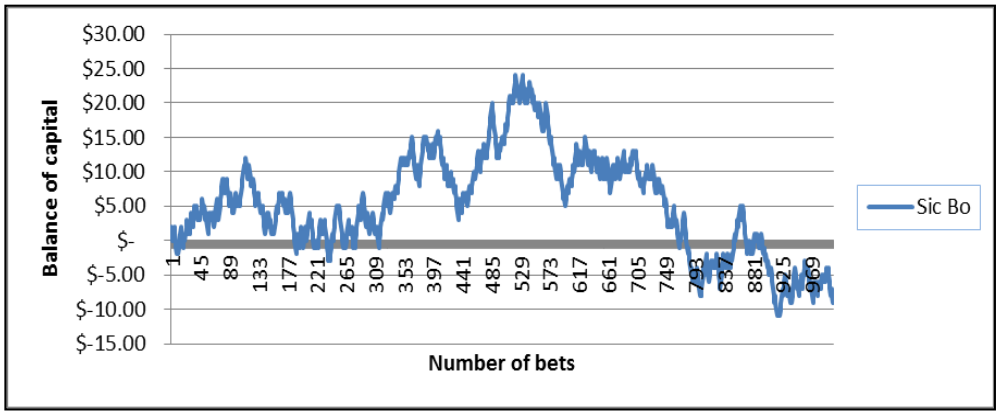
Figure 4.7 Constant Bet Strategy on Sic Bo



(a) Constant Bet Strategy for Sic Bo under Random Bet



(b) Constant Bet Strategy for Sic Bo on "Big"



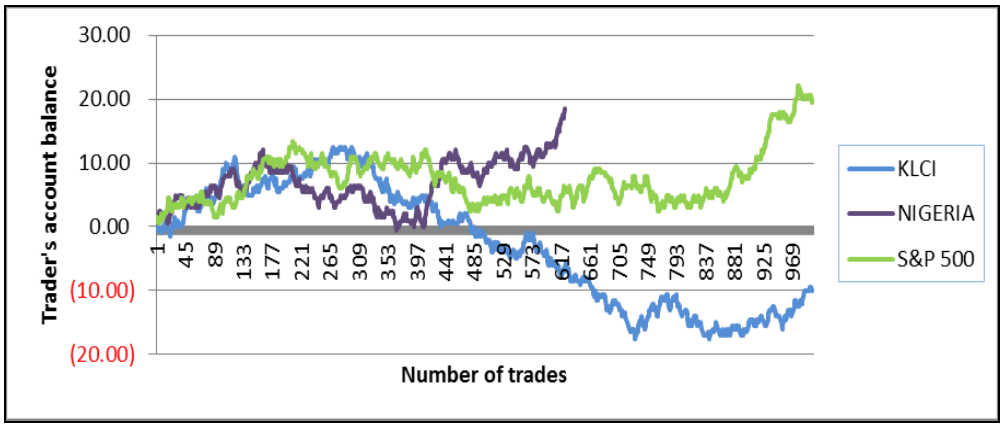
(c) Constant Bet Strategy for Sic Bo on "Small"

Source: Developed for the research

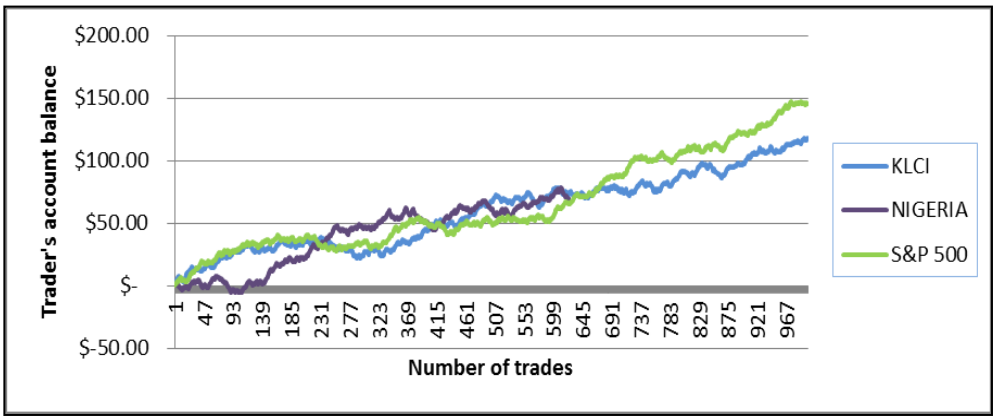
Figure 4.7 shows that without any strategy as the player bets randomly, the player will face a minor loss. As shown in the Figure 4.7, the player will still win as there is a slight raise but as a whole graph, its trend is a downhill trend. This is due to players bet constantly and even when there is a win, they bet back at the initial amount and hence couldn't cover back all its previous loss. The player starts losing at the 1st 45 bets, and it sums up to about -$9, but since the constant bet strategy promotes on betting the initial bet $1 on the next bet, which doesn't help the player to cover the $9 that they lost but instead, increasing their loss. Constant bet strategy on random bets yields a negative trend because of the possibility of the outcome to be "N" which occurs when the dice are triples. When this happens, the player is confirmed to lose regardless of their bet positions because it's the house advantage to the casino. In panel (b), when the entire 1000 plays contain a majority of "Small" dice outcomes the player will lose more when betting on "Big" and win more when betting on "Small" as seen in panel (c). Thus the constant bet strategy is not reliable because the player has no prior knowledge of the outcome of dice rolls.

4.3.2 Constant Bet Strategy on Financial Markets

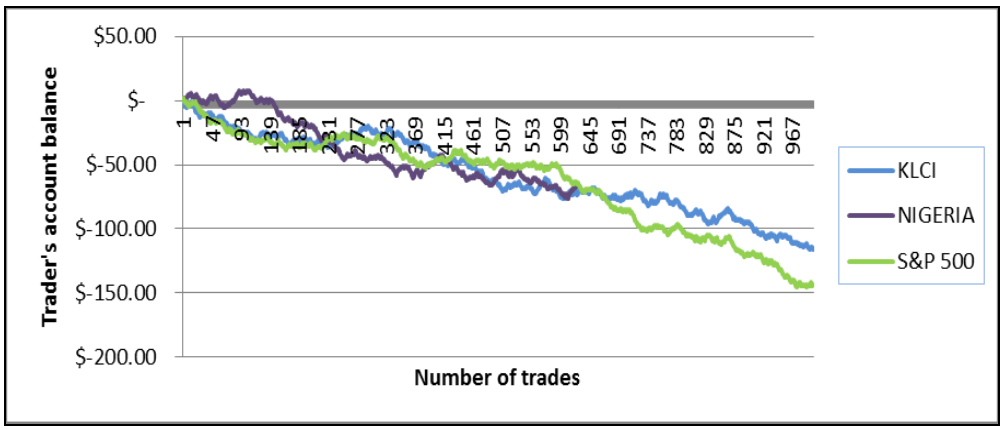
Figure 4.8 Constant Bet Strategy on Stock Index



(a) Constant Bet Strategy for Stock Index under Random Bet



(b) Constant Bet Strategy for Stock Index on "Long"

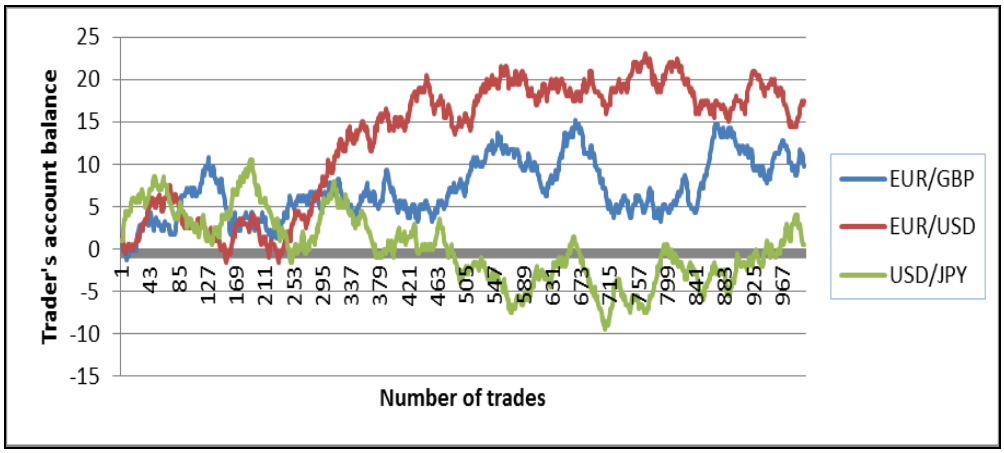


(c) Constant Bet Strategy for Stock Index on "Short"

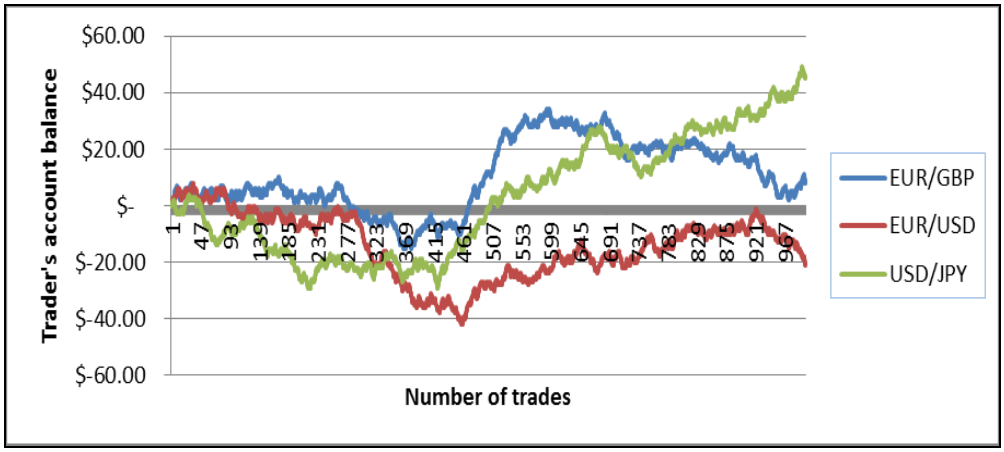
Source: Developed for the research

The Figure 4.8 above wavers around and does not show a complete profit. This graph shows that even if the country's economy is developed, developing, or undeveloped, they have uncertain outcome which is risky investment strategy due to them not producing the same trend. Referring to the panel (b), by using constant bet on "Long" position, the investor will be able to gain consistent profits because the three indices move in an uptrend direction. However, if the investor constantly bets on "Short" which is clearly portrayed on panel (c), the investor will tend to get consistent losses. Constant bet strategy is observed to work only when the direction of the market moves in favor of the trader's bet position. Thus, constant bet is a risky strategy to be implemented because the movement of the market is unpredictable.

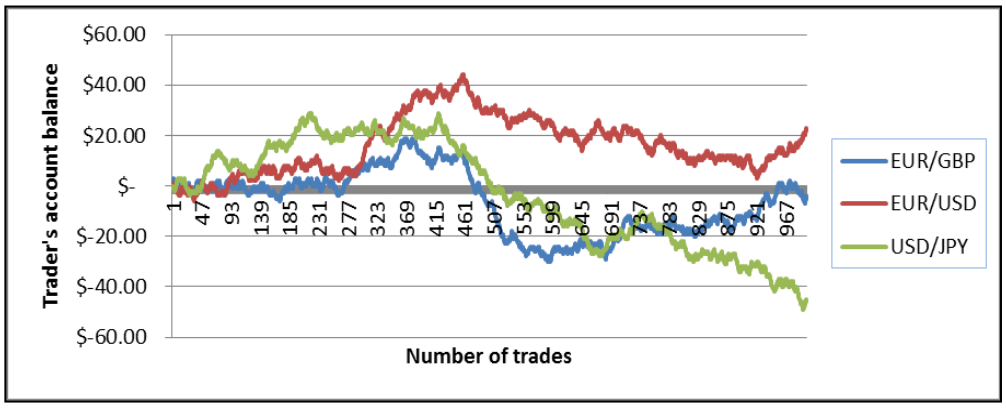
Figure 4.9 Constant Bet Strategy on Foreign Exchange Market



(a) Constant Bet Strategy for Foreign Exchange Market under Random Bet



(b) Constant Bet Strategy for Foreign Exchange Market on "Long"



(c) Constant Bet Strategy for Foreign Exchange Market on "Short"

Source: Developed for the research

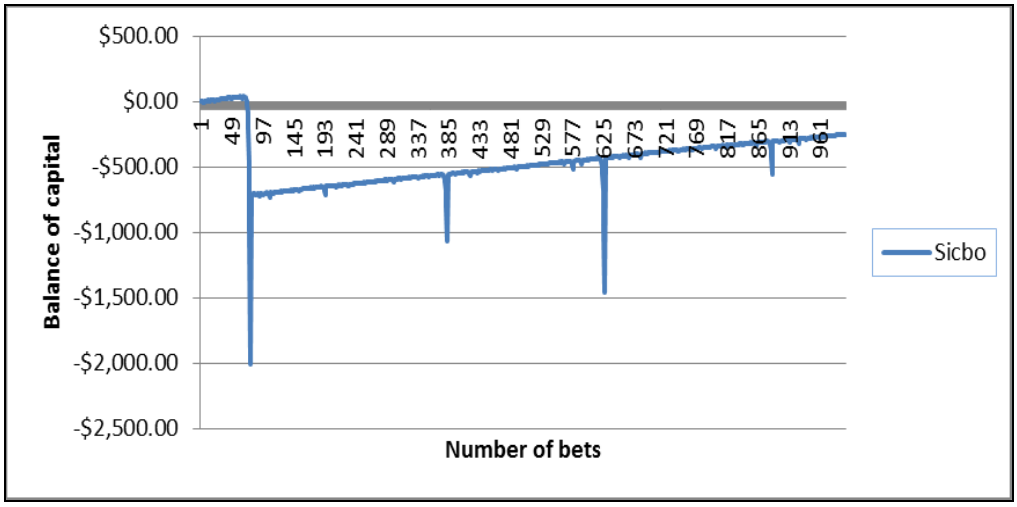
Due to the unpredictable situations in foreign exchange market, constant bet made it even riskier. The Figure 4.9 above also shows a wavered trend where there is no guaranteed profit is shown due to its inconsistent outcome as traders' betting position differs. From panel (a), EUR/USD and EUR/GBP shows that at the point 265th onwards the graph slowly escalates but USD/JPY starts to decline negatively but at 892nd bet there was a slight increase but eventually decline. Under panel (b), as trader continues to bet on "Long" position, the trader will face loss in the beginning but made profit generally as the figure showed an ascending trend allowing them to profit. Whereas for traders who bets on "Short" position, the figure shown in panel (c) reports that the traders will have a slight gain in the beginning but make losses in general as the graph show a descending order. This concludes that this strategy is only appealing to the traders when the bet position is equivalent to the market movement.

4.4 Table Limit

In the context of casino gambling, there are table limits imposed to manage the exposure caused by the Martingale strategy. In Malaysia's Genting Casino, the table limit imposed for the Sic Bo game with minimum bet of RM10 while the maximum bet is observed to be RM 13,000. Therefore, with a minimum bet of $1 in the Sic Bo simulations, a relatively equivalent $1,300 table limit is imposed.

4.4.1 The Imposition of Table Limit on Sic Bo

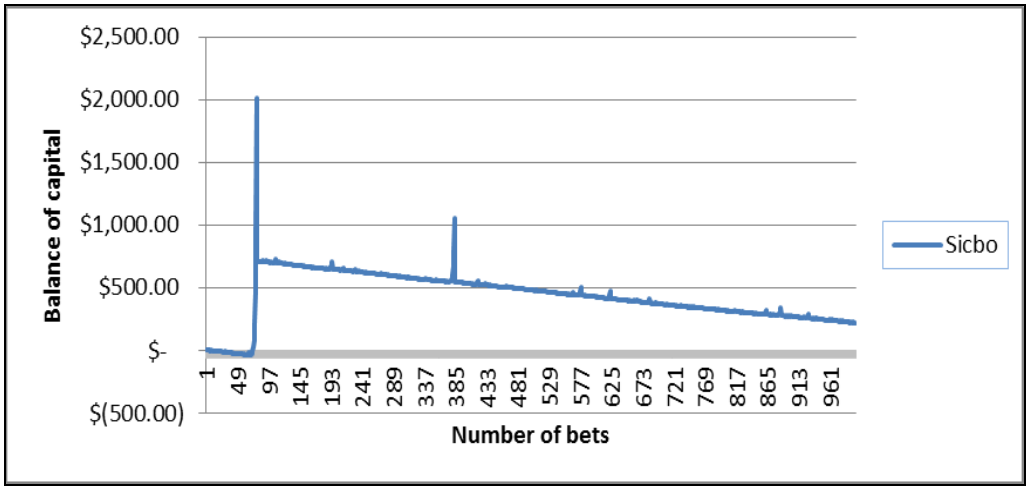
Figure 4.10 Martingale Strategy on Sic Bo under Random Bet with the Imposition of Table Limit



Source: Developed for the research

The Figure 4.10 outlines the effect of table limit on the effectiveness of Martingale strategy with 1000 plays of random bet position. It can be clearly seen that there has been a sharp decrease in the player's money balance by $2,010 after the player reaches the maximum bet limit, $1,300. In the 80th play, the player starts to gain a gradual return by using the Martingale strategy. In tandem to this, the player will only be able to double up the bet size to maximum bet limit of $1,300 when the previous bet size is $1,024. Thus, the player will only able to reduce their accumulated losses to $710 when the next play is in a winning position. This indicates that the minimum and maximum bet limit constraints the use of Martingale strategy in the casino. Based on this scenario analysis, the Martingale strategy appeared to be less effective at allowing the player to recoup his losses and the player was not able to get back into a positive balance even after 1000 plays. The above figure illustrates vividly that the Martingale strategy is greatly undermined and not very effective when there are table limits imposed.

Figure 4.11 Anti- Martingale Strategy on Sic Bo under Random Bet with the Imposition of Table Limit



Source: Developed for the research

The Figure 4.11 illustrates the impact of table limit on the adoption of Anti-Martingale strategy in the casino gambling namely Sic Bo including 1000 plays with random bet positions. Despite there are some minor fluctuation in the line graph, but in overall the Figure 4.11 shows a significant downward trend but having a better position (positive return) as compared to the return earned without the table limit imposed by the casino house edge. It may be clearly seen that the gambler's money balance hits a peak with $2,010 at 79th of the plays but drops dramatically after the table limit comes in and constraint the bet size to $1,300. Meanwhile, the money earned by the gambler encountered a slight fluctuation upward from a low of $546 to $1,057 before a consistent downward trend to the lowest, $217 on the last play. By using this strategy, the player may win a huge profit when he/she is on a winning streak but the player is limited by the table limit when increasing his bet size. However the player will face consistent and gradual losses if there are no strings of continuous wins. In general, the line graph explains that the effect of table limit undermines the application of Anti-Martingale strategy in the casino gambling, specifically in the game of Sic Bo.

4.5 Conclusion

This chapter provides graphs that represent stimulations done with three different type of strategy according to different scenario. This study can conclude that out of these three strategies, Martingale Strategy is better and does guarantee win. Results also show that under Martingale, Anti-Martingale and Constant bet that both gamblers and investors shows the same trend of graphs as they have an uphill trend, downhill and wavelike trend respectively, which demonstrated that these strategies is applicable to the Financial Market but only Martingale can bring investors profit. The outcome on constant bet also tells that regardless of economy status and ways of betting, as long as investors double every losses they will make profit. This is all applicable only if investors or gamblers have unlimited capital. As for table limit, it is bad for martingale strategy because it restricts the potential to recoup all the losses when the required bet size exceeds the table limit.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATION

5.0 Introduction

The last chapter highlights the overall findings of the research topic. The aim of the entire study is to determine the effectiveness of martingale strategy in gambling and investing. Simulations has been run using historical market data and self-generated data to provide quantitative evidence to the research. The study is mainly focused on the application of martingale strategy in Sic Bo, a casino game, stock market and foreign exchange market. This chapter includes the summary and discussion of the findings, significance of the study, the limitation and also the recommendation for future studies.

5.1 Summaries of Statistical Analyses

Strategy Used	Findings
Martingale Strategy	The simulations in Sic Bo, stock market and foreign exchange market showed that there's an overall uptrend with sharp dips and a positive total account balance after 1,000 plays using martingale strategy under random bet position.
Martingale Strategy with Table Limit	The simulations in Sic Bo with table limit showed that there's an overall uptrend with sharp dips but with a negative total account balance after 1,000 plays using martingale strategy under random bet position.
Anti-Martingale Strategy	The simulations in Sic Bo, stock market and foreign exchange market showed that there's an overall downtrend with sharp hikes and a negative total account balance after 1,000 plays using anti-martingale strategy under random bet position.
Anti-Martingale Strategy with Table Limit	The simulations in Sic Bo with table limit showed that there's an overall downtrend with sharp hikes but with a positive total account balance after 1,000 plays using anti-martingale strategy under random bet position.
Constant Bet	The simulation in Sic Bo showed that there's an overall downtrend with a negative total account balance whereas simulations in stock market and foreign exchange market showed that the trends are uncertain after 1,000 plays using constant bet strategy under random bet position.

5.2 Discussion of Major Findings

5.2.1 Martingale Strategy

The overall uptrends prove that martingale strategy is applicable in Sic Bo and financial markets. The total account balance is positive and increases consistently using martingale strategy. However, there are sharp decreases when there are strings of losses and this requires gamblers or investors to double up their bets indefinitely until there is a subsequent win that recoups all their previous losses. This implies that the martingale strategy is more reliable in the short run compared to the long run because the probability of getting a long string of losses is higher in the long run. Thus gamblers or investors are more likely to lose all their capital or face insolvency as they fail to double up to the required amount in the next bet. Therefore, martingale strategy is proven to favor the gamblers or investors with huge amounts of capital. The nature of martingale strategy is found to have a high probability to win a small amount of money in proportion to the total capital consistently but with a very low probability to lose all the capital.

5.2.2 Martingale Strategy with Betting Limit

The overall uptrends prove that martingale strategy is applicable in Sic Bo and financial markets. However, the total account balance is negative but increases consistently using anti-martingale strategy. This is because the table limit prohibits gamblers or investors to double up their bets indefinitely when there are long strings of losses. This makes the martingale strategy becomes less effective when there are table limits imposed. In contemplation to the

exposure caused by the Martingale strategy, the casino management imposed the table bet limits and the table differential (Spence, Sugden & Kale, 2013).

5.2.3 Anti-Martingale Strategy

The overall downtrends prove that anti-martingale strategy is less applicable in Sic Bo and financial markets. The total account balance is negative and decreases consistently using anti-martingale strategy. The high volatility of the markets and Sic Bo does not favor anti-martingale strategy because the winning streak does not last forever and eventually all the accumulated gains will be wiped out in a single loss. However, this strategy is very profitable if the market moves in a favorable direction forever. Hence, the gamblers or investors can employ anti-martingale strategy profitably if they walk away with their profits before their winning streak ends which may wipe out all their accumulated profits.

5.2.4 Anti-Martingale Strategy with Betting Limit

The overall downtrends prove that anti-martingale strategy is less applicable in Sic Bo and financial markets. The total account balance is positive but decreases consistently using anti-martingale strategy. The table limit prohibits gamblers or investors to double up their bets indefinitely when there are long strings of wins. It limits the potential gain of investors or gamblers when the markets tend to move in a favorable direction continuously for a long period of time. However, winning streak does not last forever and eventually all the accumulated gains will be wiped out in a single loss. Therefore, anti-martingale strategy is only profitable if the gamblers or investors are

disciplined enough to walk away with their profits before their winning streak ends.

5.2.5 Constant Bet

The overall downtrends prove that constant bet strategy is less applicable in Sic Bo but uncertain in financial markets. In the context of Sic Bo, the total account balance is negative and decreases consistently using constant bet strategy. This is because the casino has the house advantage in the event that the dice outcomes are triples. The gambler loses regardless of whether he bets on either big or small. Therefore, this is an ineffective strategy to apply in Sic Bo. In the context of financial markets, constant bet strategy works when markets move in favor of the bet position and vice versa. Therefore, based on the unpredictable nature of financial markets, it is uncertain whether constant bet strategy would be profitable.

5.3 Implications of the Study

This study investigates the effectiveness of martingale strategy in gambling and investing. From the results obtained, martingale strategy is shown to be applicable in certain conditions but ineffective when certain restrictions exist. The major findings may contribute to gamblers, traders, investors, fund managers and financial institutions around the world that are looking for a consistently profitable way to earn money.

As observed in the findings, martingale strategy is applicable when there are no betting limits and the practitioner has huge amounts of capital. Thus, this strategy may be effectively employed by high net worth individuals and financial institutions.

Besides, the simplicity of this strategy allows it to be implemented through electronic trading. This is further enhanced by the advancement and increased use of technology that allows automated trading in the financial world.

The study also showed that the martingale strategy is not as perfect as what the theory suggests. Under probability theory, the martingale strategy may achieve 100% winning probability when the capital of practitioners is infinitely big. In reality, there are a lot of restrictions such as the table betting limits, insufficient capital and investors' irrational behavior which undermines the effectiveness of martingale strategy in gambling and investing.

Last but not least, this study provides a deeper understanding towards the martingale strategy in both theoretical and practical sides. Since the martingale strategy is not without its flaws, practitioners should be aware of the limitations of the martingale strategy and the conditions under which the strategy can be successfully implemented so that it would not produce unfavorable consequences. The findings of the study are expected to help high net worth individuals and financial institutions in formulating their investment decisions based on their risk preferences.

Hence, this study attempts to encourage more future studies involving the application of martingale strategy which will provide more perspectives on the strategy that may have significant impacts to the gambling and investing community.

5.4 Limitations of the Study

There are some limitations for this study. Firstly, the availability of free data is limited. Most of the sources only provide up to 5 years of historical data for stock indices and currency pairs. All the findings can only show the effectiveness of martingale strategy in these markets in the most recent 5 years up to 2014. Thus, the long run effect of using this strategy for duration of beyond 5 years could not be determined in our study.

Secondly, this study does not capture the magnitude of change for stock indices and currency markets in the simulations which may significantly affect the application of martingale strategy in real life. Due to the time constraint and limited resources such as the absence of superior simulation software, the study can only take into consideration the direction of change for the fluctuations of the financial markets using Microsoft Excel to run the simulations manually.

Thirdly, only the historical data of stock market and foreign exchange market was being used. The study does not include other types of financial markets such as commodity market, bond market, option market and et cetera in the simulations due to availability of data. Although there are several limitations, it is not likely to affect the significance of the findings but only provide platforms for future research.

5.5 Recommendations of Future Research

There are several recommendations for future studies. Firstly, the sample size for daily data from 2010 to 2014 is relatively insufficient in this study. The future researchers are recommended to increase sample size which covers more than 5 years of historical data for the simulations. This enables future researchers to obtain a more detailed result as well as increase the reliability of the study.

Secondly, the study suggests that future researchers can take into account the magnitude of the price changes in financial markets to reflect the real world application of martingale strategy in financial markets. This can be achieved by utilizing superior simulation software in which the effects of many other constraints and scenarios can be captured and analyzed.

Last but not least, future researchers are recommended to include data of other types of financial markets such as commodity market, bond market, option market and et cetera in their studies. This will contribute to a deeper understanding of the application of martingale strategy in a wider perspective.

5.6 Conclusion

In this study, all the objectives of the study are achieved with qualitative and quantitative evidence. The evidence showed that martingale strategy is profitable in Sic Bo, stock indices and foreign exchange market in both short run and long run. However, this strategy requires two main conditions to be met which are unlimited capital and no restriction on the number and amount of bets. Therefore, martingale strategy is favorable to high net worth individuals and financial institutions that have large amounts of capital. Due to the limitations and conditions required for the application of martingale strategy, practitioners should be aware of the limitations of the martingale strategy and the conditions under which the strategy can be successfully implemented so that it would not produce unfavorable consequences.

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