MULTI FACTOR EQUITY MODEL FOR SHARIAH INVESTMENT

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ABSTRACT

The study is set out to discover a new multi factor model for *Shariah* investing in Malaysian stocks based on *musharakah* principle. It also wants to know the model explanatory power of stocks' risk decomposition and return attribution as well to forecast risk given the current volatile market.

Existing single factor model such as Capital Asset Pricing Model and multi factor model like Fama French Model are formulated on the basis of risk-free rate element in which rescind out with *Shariah* principle of *musharakah*. Moreover, the models do not explained their factors well in emerging markets that include Malaysia. Thus, exploring the alternative model is pertinent.

A fundamental factor model is carefully constructed from four key essential elements of *musharakah*: Business Sector, Management Quality, Profitability Growth and Capital Strength factors. It gives greater insight into the sources of stocks performance and leads to intuitive action items. The cross-sectional approach is used to build the model.

Key results show that the model has high explanatory power for contemporaneous returns, maintains high forecasting ability in high and low volatility environments and stays unbiased with no significant under-forecasting or over-forecasting of risk for a broad variety of portfolios.

Despite the existence of long established multi factor models, this study offers new empirical evidence suggesting the application of *musharakah* principle as a framework, although without risk-free rate element, is able to increase the explanatory power of *Shariah*-compliant stocks' risk and return. Moreover, it goes well with those who subscribe to principle based investing.

ABSTRAK

Kajian ini dibentangkan untuk membina model berbilang faktor yang baru bagi pelaburan saham Syariah di Malaysia berdasarkan prinsip musyarakah. Ia juga bertujuan untuk mengetahui kuasa penerangan model terhadap risiko dan pulangan saham serta ramalan risiko di pasaran yang turun naik sekarang.

Model faktor tunggal yang sedia ada seperti model Penentuan Harga Aset Modal dan model pelbagai faktor seperti model Fama French digubal atas dasar unsur kadar bebas risiko yang tidak sesuai dengan prinsip Syariah yakni musyarakah. Selain itu, model-model tersebut tidak menjelaskan faktor-faktor dengan baik bagi pasaran sedang membangun yang mana termasuk Malaysia. Oleh itu, meneroka model alternatif adalah penting.

Model tersirat dengan teliti ini dibina daripada empat unsur penting utama musyarakah: Sektor Perniagaan, Kualiti Pengurusan, Pertumbuhan Keuntungan dan Kekuatan Modal. Ia memberikan gambaran yang lebih besar ke dalam sumber prestasi saham dan membawa kepada perkara tindakan intuitif.

Penemuan utama adalah bahawa model ini mempunyai kuasa penjelasan yang tinggi untuk pulangan jangka masa tertentu, mengekalkan keupayaan ramalan yang tinggi dalam persekitaran perubahan yang naik dan turun dan tetap tidak berat sebelah dengan tidak di bawah-ramalan atau lebih-ramalan risiko yang ketara untuk pelbagai portfolio.

Walaupun kewujudan model berbilang faktor sudah lama dibangunkan, penyelidikan ini menawarkan bukti empirikal baru dengan mencadangkan penggunaan prinsip musyarakah, tanpa unsur kadar bebas risiko sebagai rangka kerja, dapat meningkatkan kuasa penerangan risiko and pulangan saham patuh Syariah. Selain itu, ia sesuai dengan pemodal yang melabur berdasarkan prinsip.

To Father, Mother, Mother In-law, Wife, Daughters and Son

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LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviation	**Meaning**
AST	Total Assets
AAOIFI	Accounting and Auditing Organization for Islamic Financial Institutions
BLR	Based Lending Rate
CAP	Market Capitalization
CAPM	Capital Assets Pricing Model
CEO	Chief Executive Officer
DBV	Debt to Book Value
DJ	Dow Jones Indexes
DMC	Debt to Market Value
EBITDA	Earnings before Minority Interest, Tax, Depreciation and Amortization
EBS	EBITDA to Sales
EVS	Enterprise Value to Sales
EVE	Enterprise Value to Earnings
EWMA	Exponential Weighted Moving Average
FFM	Fama French Model
FTSE	Financial Times Stock Exchange
GFC	Global Financial Crisis
GICS	Global Industrial Classification Standard
IPO	Initial Public Offerings
MFM	Multi Factor Model
MM	*Musharakah* Model
MSCI	Morgan Stanley Capital International
P&L	Profit and Loss
PBT	Profit before Tax
PBR	Price to Book Ratio
PER	Price to Earnings Ratio
PCF	Price to Cashflow
ROA	Return on Assets
ROC	Return on Capital
ROE	Return on Equity

S&P	Standard & Poor’s
SACSC	*Shariah* Advisory Council of Securities Commission
SPAC	Special Purpose Acquisition Companies
VCV	Vector Covariance

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CHAPTER 1: INTRODUCTION

This chapter first outlines the background of the study and the contemporary issues in multi factor model and *Shariah* investing particularly the *musharakah* principle. In addition, the research aim and objectives as well as its significance are stated for directing this research study. Furthermore, it sets out the scopes and limitations as well as research questions to be addressed.

1.1 Background of the Study

Multi factor models have become an indispensable tool for modern portfolio management as well as risk management in the last several years. They provide greater understanding of sources of portfolio risk, ability to forecast absolute risk as well as risk relative to a given benchmark, review of portfolio performance attribution and improvement for portfolio construction (Kresta and Tichy, 2012). The recent market volatility has highlighted the urgency of managing unnecessary factor exposures in stocks investment as mentioned by Bansal, Kiku, Shaliastovich and Yaron (2014). While the multi factor models have been in existence for at least two decades, the hedge fund crisis in mid 2000, capital market turbulence in the midst of the Lehman Brothers scandal and extreme volatility of various fundamental factors since then have attracted attention of traditional and quantitative portfolio managers alike and has dramatically increased investor interest in multi factor models.

Furthermore, the multi factor models are relied upon the basic principle that stock returns are determined by a set of common factors, thus stocks risk depend on how volatile and correlated these factors are and by the size of stock exposure to each factors. Additionally, there are risks not captured by the common factors, called non-factor risks and multi factor models help estimate these as well (Elton, Gruber, Brown and Goetzmann, 2007). In this study, the common factors will observe *Shariah* principle of *musharakah* which requires an analysis on the four main essential elements (*rukun*) as the foundation for multi factor model.

Musharakah is a structure similar to partnership in common law which is based on sharing of gain and loss as described by Wilson (2007). In older manuscripts of *Shariah* law, the phrase *musharakah* is also known as *shirkah* or partnership. Where, the current application of *musharakah* will include public listed stock or unlisted stock (private company) with an observation of the elements of *musharakah* principle such as business, management, profit sharing and capital. These four elements are therefore tabulated as fundamental factors of multi factor equity model as a new model for *Shariah* investing. Combining with the researcher's industry experience of more than a decade in Islamic finance and investment management opens a new perspective of multi factor modeling.

1.2 Problem Statement

The existing single factor model such as Capital Asset Pricing Model (CAPM) and multi factor model like Fama French Model (FFM) are formulated on the basis of risk-free rate element which contradict with *Shariah* principle of *musharakah*. It is important to note that as briefly explained earlier where *musharakah* principle is about common risk and profit sharing among investors, the guarantee of justice among investors and those trading is based on the *Shariah*-compliant stock (Sadique, 2013).

In addition, the CAPM and FFM models do not exclude stock that is not permissible by *Shariah* as prescribed by Hanif (2011) such as banking services based on *riba* (interest), gaming operator, producer or sale of non-*halal* goods or related goods and other businesses deemed non-permissible by the *Shariah*.

Furthermore, Cakici, Fabozzi and Tan (2013) found that the local factors performed much better as compared to size, value and momentum factors in all developing economies. It was further confirmed by Lischewskia and Voronkova (2012) that size, value and liquidity factors require detail investigation of specific market characteristic. In research study by Viszoki (2012), the model suggested that there is a significant element of the cross section which left unsolved by the FFM and the unexplained part is notably higher for emerging equity markets. As for the Malaysian stocks market, Rahim and Nor (2006) discovered that excess return and value factor were not significant to explain FFM. Therefore, segmenting the Malaysian stocks market into its specific characteristics is crucial in getting greater explanatory power of the factors.

1.3 Research Objectives

The primary objective of the study is to develop a new quantitative model for stocks investing that observes *Shariah* principle of *musharakah* in order to have greater explanatory power of the risk and return (*Musharakah* Model or MM).

At the same time, the second objectives of the study are to validate the statistical significant of *musharakah* factors with its financial descriptors and to examine the accuracy as well as stability of predictive elements for the MM given the current market dynamic.

1.4 Research Questions

The three research questions that will be addressed and articulated by this research study are as follows:

1. How to construct a new multi factor model in the current volatile market that is responsive and stable throughout the market cycles?
2. What are the common factors and its financial descriptors for a *musharakah* based multi factor model of *Shariah*-compliant stocks?

3. What will be the overall model performance and the explanatory power of each factor group as well as its significance?

1.5 Scope and Limitations

The research is primarily focused on Malaysian stocks listed on Bursa Malaysia Securities (Bursa Malaysia) for Main Market and ACE Market of primary shares during January 2009 to December 2013. Besides that, the stocks have to be *Shariah*-compliant throughout the period as sets-out by the *Shariah* Advisory Council of Securities Commission (SACSC) with no inclusion or exclusion of company.

1.6 Significance of the Study

Despite the growing interest in Islamic finance in general and *Shariah* investment specifically, there are limited empirical studies that examine the application of *musharakah* principle on analyzing the risk and return of stocks into a multi factor model. In particular, the studies of *Shariah*-compliant stocks in Malaysia have not yet been rigorously investigated. This is in spite of the importance of the Malaysia market as being the world's largest and developed Islamic capital market.

Thus, the study offers new empirical evidence, suggesting the application *Shariah* principle of *musharakah* is able to increase explanatory power of *Shariah*-compliant stocks' risk and return. At the end of the study, the use of MM will assist those investing based on *Shariah* principles to make an informed investment decisions as an alternative investment analysis tool. This is particularly helpful in determining portfolio performance attribution, forecasting risk, managing investment risk and tabulating optimal assets allocation. More important, *Shariah* principle used has the ability to address the 'what' and 'how' to invest in Islamic stocks market. The former question has been addressed by the SACSC with bi-annually *Shariah*-compliant securities list issued in at the end of May and

November every year. Nonetheless, the latter question is being addressed by existing techniques like CAPM and FFM that subscribe to risk-free rate framework which forbidden in Islamic Law.

Thus, by fulfilling the research objectives, the study fills the gap and extends the literature on the *Shariah* investment as well as multi factor modeling and thereby to contribute to the body of knowledge and development of Islamic finance as a whole.

CHAPTER 2: LITERATURE REVIEW

This chapter will elaborate and discuss the previous studies on the subjects of *musharakah*, risk and return and the multi factor models. In addition, the contemporary issues in regression and its assumptions are looked into.

2.1 Musharakah

Musharakah is a structure that is equivalent to partnership where the partners or investors share the gain or loss. In ancient Islamic reference, the concept of *musharakah* is similar to *shirkah* or partnership. It has been adapted earlier than the Prophet Muhammad's ﷺ initial disclosure and since then, the carry out of *musharakah* has been assumed as component of *Shariah* law by virtue of *Sunnah* of the Prophet Muhammad ﷺ. *Shirkah* mainly encompasses business partnership and co-right partnership. The former is normally used for partnership with business purpose, whereas, the latter uses to co-own in a specific investment (Ottoman Courts Manual, 2005).

2.1.1 Authenticity of Musharakah Contract

The authenticity of the *musharakah* contract follows the *Qur'an*, the *Sunnah* of the Prophet Muhammad ﷺ and the agreement amongst of Muslim scholars (Bank Negara Malaysia, 2013).

2.1.1.1 The Quran

The subsequent *Quranic* verses commonly show the legitimacy of *musharakah* that were used in business and Islamic finance transaction primarily in investment.

2.1.1.1(a) *"...but if more than two, they share in a third..." (Al-Nisa':12)*

The verse mentioned focusing on Islamic estate distributions. However, in a bigger perspective, Muslim scholars have regarded that the verse as permits multiple type of partnership (Rosly, 2010).

2.1.1.1(b) *"Verily many are the partners (in business) who wrong each other except those who believe and work deeds of righteousness and how few of them…." (Al-Sad: 24)*

2.1.1.2 The Sunnah of the Prophet Muhammad ﷺ

The following narrations generally indicated the supporting arguments of *musharakah* principle that applied in *fiqh muamalat* or Islamic finance transaction.

2.1.1.2(a) The Narration of Abu Hurayrah

"Abu Hurayrah said that: The Prophet, Sallallahu `Alaihi Wasallam, said: Allah says: I am the third [partner] of the two partners as long as they do not betray each other. When one of them betrays the other, I depart from them". (Sunan Abu Daud)

2.1.1.2(b) The Narration of Abu al-Minhal

"Abu al-Minhal narrated that Zayd Ibn Arqam and al-Barra' Ibn 'Azib were partners, and they bought silver in cash and credit. Their practices were brought to the Prophet Sallallahu `Alaihi Wasallam, and the Prophet Sallallahu `Alaihi Wasallam pronounced that what was bought on cash then they could benefit from it and what was bought on credit then they should reject it." (Musnad Ahmad)

The narration indicated that the Prophet Muhammad ﷺ consented the partnership created between Zayd Ibn Arqam and al-Barra' Ibn 'Azib but disconcerted their undertaking into commercial dealing of buying silver on credit.

2.1.1.3 The Consensus of the Muslim Scholars

Imam Ibn Al-Munzir states in his book al-Ijma': "*And they (Muslim jurists) agree on the validity of partnership where each of the two partners contributes capital in dinar or dirham, and co-mingles the two capitals to form a single property which is indistinguishable, and they would sell and buy what they see as (beneficial) for the business, and the surplus will be distributed between them whilst the deficit will be borne together by them, and when they really carry out [as prescribed], the partnership is valid.*". Moreover, it is well understood that the kind of partnership has been adapted all this while without objection from the scholars.

2.1.2 Stock Company

The present modern day of a company formation is generally conforming to the *Shariah* principle of *musharakah*. This will include stock company whether it is listed on the stock exchange or unlisted or private company. However, a stock company needs to observe the essential elements of the *musharakah* contract (Accounting and Auditing Organization for Islamic Financial Institutions, 2010) in order to have permissibility to invest in it.

Firstly, the company or business venture must be permissible by *Shariah* as stipulated by the SACSC. One needs to exclude company with income contribution of more than five percent form business activities such as *riba* based banks and insurance, gaming operator, alcoholic and alcoholic related activities, ham and ham related activities, non-*halal* foodstuffs and drinks, non-permissible entertainment, tobacco and tobacco related activities, interest earn from deposits and investments and other businesses that are non-permissible by the *Shariah*. Besides that the twenty percent income contribution rule applies to company with operating revenue from hospitality operations, stock trading, stock-broking activities, leasing earned from *Shariah* non-compliant business and other businesses that are non-permissible by the *Shariah*. These business activities can be easily tracked by classification standards such as Global Industry Classification Standard or Industrial Classification Benchmark formed in cooperation by Morgan Stanley Capital International (MSCI) and Standard & Poor's (S&P) and; Dow Jones Indexes (DJ) and the FTSE Group (FTSE) respectively.

Secondly, while the investment partners of shareholders are allowed to be involved in the management of the venture, they can opt to be excluded from the management to become a silent partner, such agreement is permissible. The shareholder is also allowed to appoint a third party to manage the business on behalf of the *musharakah* partnership. In the case of listed company, the shareholders will appoint the line-up for board of directors in which responsible to appoint the senior executive normally the chief executive officer (CEO) to run the company. Thereafter, the CEO will form his or her senior management team to assist in managing the firm. Generally, the CEO and its management team are appointed based on their management quality like past performance such as financial and business performances.

Thirdly, the percentage of income to be shared among the shareholders has to be consented earlier upon initiation of the *Shariah* agreement as stipulated in the memorandum of article of association of the company or in the shareholders agreement. Normally, the profit distributions in terms of dividends will be allocated proportionate to shareholders holding in the ordinary shares. Nonetheless, in the event of any financial failure shall be allocated among the shareholders based on their investment contribution ratio represented by their ordinary shares. Nevertheless, assuming the loss is as a result of the carelessness of the party running the business or senior executives, such losses will be a responsibility of the manager. Hence, the profitability growth is an important component in ensuring the partnership remains for a long period.

Lastly, shareholders pool of investments may not automatically be the same and it will be ranked *pari passu*. The investments could be in terms of money or properties with a qualified valuation. Later, it will be recorded as paid-up capital and will be stated in the financial statement like balance sheet of the company. This shows the capital strength of a company.

2.1.3 Business Sector

In order for a stock to qualify as permissible investment, the business venture or sector of a company has to be *Shariah*-compliant where the primary income may be derived from a range of sectors such as information technology, energy, healthcare and utilities (Hussin, Hussin and Abdul, 2014).

The listing of *Shariah*-compliant stocks by the Shariah Advisory Council of Securities Commission (2014) where gathered from the Securities Commission (SC). The SC collated all the information from the firms' audited financial statements as well as direct enquiries made to the firms. As governing authority, the SACSC will progressively monitor the *Shariah* status of companies traded on Bursa Malaysia yearly depending on the recent audited information of the firms.

The SACSC classifies the *Shariah*-compliant status of companies by using a two-tier quantitative approach. They will look into the business activity thresholds and the financial ratio thresholds in verifying the *Shariah*-compliant status of the companies. Thus, the companies will be recorded as *Shariah*-compliant if they are within the business activity thresholds and the financial ratio thresholds.

As for the business activity thresholds, the revenue from *Shariah* non-compliant incomes to the earnings and profit before taxation (PBT) of the firm will be calculated and measured alongside the applicable business activity thresholds as follows:

(i) The 5-percent threshold

The threshold is appropriate to the subsequent company operations like conventional financial services i.e. banks and insurance companies, gaming operators, alcoholic and alcoholic related activities, ham and ham related activities, non-*halal* foodstuffs and drinks, entertainment companies that are non-permissible, tobacco and tobacco linked businesses, *riba* earn from non-compliant deposits and financial products as well as other income that is not *Shariah*-compliant. Therefore, the income from non-permissible operations to the total income or total PBT of the listed stock should not be more than 5-percent.

(ii) The 20-percent threshold

The 20-percent threshold is related to the following businesses activities such as hospitality sectors (i.e. hotel and resort operations), stock trading, securities broking firm, leasing income from *Shariah* non-compliant businesses. Therefore, the input non-permissible income to the total earnings or total PBT of the business must not be more than 20-percent.

As for the financial ratio thresholds, the SACSC considers the following financial information:

(i) Cash over total assets

The cash component will comprise money deposited or financial products invested in conventional banks, whereas money allocated in *Shariah*-compliant products will not be taken into account.

(ii) Debt over total assets

This will cover the conventional debt whereas *Shariah*-compliant financing or Islamic bond (*sukuk*) is not calculated into the total debt. The two ratios mentioned above which is intended to measure interest (*riba*) elements must not be more than 33-percent.

Besides the two criteria above, the public perception of the company will be taken into consideration as well in line with the Islamic teaching. It is primarily based on the *ijtihad* or personal opinion of the scholars in deriving this decision.

In determining the business sector or industry classification of a company, there are several standards used in the marketplace. However, the Global Industry Classification Standard (GICS) is the most prominent within the institutional investors. It takes investment community input such as portfolio managers and investment analysts for an accurate and complete industry classification. In addition, the GICS methodology is continuously reviewed so that the universe is fully represented.

The GICS classification approach has four tiers or levels (see Table 2.1 for details). As at December 2014, there were 10 sectors, 24 industry group, 67 industries and 156 sub-industries as defined by Morgan Stanley Capital International (2012).

Table 2.1: Global Industry Classification Standard

Code	Sector	Sub-code	Industry Groups
10	Energy	1010	Energy
15	Materials	1510	Materials
20	Industrials	2010 2020 2030	Capital Goods Commercial & Professional Services Transportation
25	Consumer Discretionary	2510 2520 2530 2540 2550	Automobiles & Components Consumer Durables & Apparel Consumer Services Media Retailing
30	Consumer Staples	3010 3020 3030	Food & Staples Retailing Food, Beverage & Tobacco Household & Personal Products
35	Healthcare	3510 3520	Health Care Equipment & Services Pharmaceuticals, Biotechnology & Life Sciences
40	Financials	4010 4020 4030 4040	Banks Diversified Financials Insurance Real Estate
45	Information Technology	4510 4520 4530	Software & Services Technology Hardware & Equipment Semiconductors & Semiconductor Equipment
50	Telecommunication Services	5010	Telecommunication Services
55	Utilities	5510	Utilities

Every listed stock is allocated with GICS categorization coding at the sub-industry ranks by S&P and MSCI following its main classification business operations. A key element to classify the main operation of a company is source of income. Other elements, such as revenue breakdown and investors view will be taken into account. Stocks are reexamined every year and each time there is a key business amendment that modifies a company's main operation to make sure the appropriate coding.

With that, the study will observe the permissibility of a stock as stipulated by the SACSC and the industrial classification of a stock based on the GICS for grouping the stocks within the Business Sector factor.

2.1.4 Management Quality

Al-Zuhayli (2003) suggests that the *musharakah* venture may be managed by all capital contributors or investors in which primarily suitable for private company or by certain investors or single investor or by an outsider for which normally seen in the public listed company in the stocks exchange.

An appointed person(s) may be allowed to pre-agreed rewards for he/her skill-set as the administrator on top to their allocation in profit/loss sharing as an investor, if a person(s) is also an investor(s). On the other hand, the pre-agreed remuneration may more or less than its original share in the venture. Alternatively, investors of the *musharakah* venture may elect external person to handle the company using applicable structure such as *wakalah* (agency), *ujrah* (fee) or *mudarabah* (entrepreneur partnership). Non-participating investors may elect to give up their voting rights in regard to the management of *musharakah* and this has to be mentioned in the agreement. The manager(s) as a responsible party will be accountable for any losses resulted by his or her negligence or misconduct or contravene of management agreement.

Thus, a growing company requires a close attention to the quality of management to make sure that any decision made for the betterment of the company. Nonetheless, many executives discover that as their business expands they sense more distant from its daily operations. Therefore, having performance measurement systems in the company will be a crucial tool to monitor the growth of the business. It provides and critical information about current achievements and it also gives the preliminary tip for a performance measurement of the management team.

With those suggestions, the study will observe financial descriptors that best explained the Management Quality factor of a company as stated and used in the research design.

Furthermore, the factor is able to differentiate between performing and under-performing managers for a long-term period.

2.1.5 Profitability Growth

The profitability for a *musharakah* venture is considered when the income more than the capital contributed less all the expense and cost incurred in managing the business (Arshad and Ismail, 2010). It further explained that the profit may be divided proportionate to the capital contributed to the venture. Besides that, no pre-determined flat sum of proceeds should be declared which deprives the other investors. However, a pre-determined fixed amount of profit may be allowed if other investors not at disadvantage and gain from distribution the profit.

Translation of the profit sharing ratio could be in the form of fixed percentage depending on the capital invested once the venture turn to profit. As a matter of prudent the distribution of profit should derive from actual or realized profits (Jaffar, 2010). This can be viewed as measuring the profitability growth of a company under the *musharakah* venture where return on equity can be one of the indicators.

Assets sale may be another form of profit derived from the business operation. Such profit will only be allowed for realized gains where valuation is based on market valuation or external valuer for verification (Astrom, 2012). Looking into this asset sale, one can assess the profitability growth by taking the return on asset and return on capital employed for measuring its performance.

Other than measuring the asset and capital based performance, assessing the profit margin will be good profitability indicator. It can be related to the argument by requirement of a profit can be taken after deducting the cost and expense as articulated by Al-Suhaibani and Naifar (2014). Hence, a ratio of earnings before income tax and depreciation charges to sales will represent profit margin of a company.

In adverse event, loss on principal incurs when a real asset i.e. investment or property reduces in value. The loss has to be shared equally amongst the investors proportionate to the initial investments (Lewis, Ariff and Mohamad, 2014). No special treatment for any investor is permissible as the wisdom behind it is mutual risk sharing.

The better managed company will persistently deliver sustainability profitability growth over long term period normally over five years horizon. Thus, this study will instigate into the financial descriptors that better explained Profitability Growth factor as one of the factors and used in the method.

2.1.7 Capital Strength

According to Yousfi (2013), the primary requirements of a legitimate *musharakah* capital are it is willingly presented, it needs to be contributed by all investors in the venture and the capital may be structured as money or other resources that comprises tangible and intangible assets.

He then explained that the assets in foreign currency denomination shall be valued as agreed prior contract execution. Capital in the context of non-monetary assets is estimated based on the agreed value with a third party. This third party comprises of the government entities, specialists or valuers, or as decided upon by the agreeing investors at the time of concluding the agreement. In calculating the *musharakah* capital, all other forms of debts are not qualified to be as part of the calculation. This includes all types of account receivables and expense payable from other investor or other persons since they are deemed as obligation. Notwithstanding to the above statement, a non-cash investment with an essential obligation part to the capital may be considered in calculating the *musharakah* capital provided that its essential obligation is no more than 50-percent of the capital value. However, this shall exclude the debt generated through Islamic financing mode such as *sukuk* (Islamic bond).

Furthermore, the funds deposited to the Islamic financial institutions in the term of cash are allowed as capital in a *musharakah* structure. The capital sum placed by each party must be determined up front. Each party must also agree on the mode of capital payment whether in total or on spread over a period of time. Any extra investment may also be included upon consensus among all investors. At this point, the investors are approving on the changes on the proportional basis of the capital allocation, profit sharing ratio or replacement of investors. The investors however have a right to terminate or modify the contract based on the exact capital allocation. Failure to contribute capital as scheduled and agreed by the partners, shall constitute as breach of contract.

In addition, the monetary and non-monetary assets of the *musharakah* capital investment can be commingled in place of the combined privileges of each investor. Once contributed as capital, the partners shall undertake the rights, commitments and debts of total investments as stipulated under the *musharakah* contract. The assets contributed among the investors will not be guaranteed argues Al-Suwailem (1998). In the event that the partners insist to act as agents to each other, this will lead to partnership misconduct or negligence and therefore responsible to pay back the loss of investment to the other investors should he caused the loss of capital. This capital loss is called investment impairment. Once the contract terminated, investment impairment loss will be responsibility of the investors in proportion to their percentage of investment contributions.

Rahman (2014) explains that an allocation of a *musharakah* capital is allowed to be reassigned to current investors or external investors based on their current terms and conditions of the *musharakah* agreement. The *musharakah* contract can outline a provision that permits investors to tender redemption of the investor's share of investment to current investors according to the approved terms and conditions. Additional investors can join the *musharakah* partnership in the period of current venture depending on the agreement.

Clearly, the Capital Strength is the important factor in determining the company size and capital position. Therefore, this study will examine the financial descriptors to further explain the company size and capital positions.

2.2 Return and Risk

The notions of return and risk have been discussed significantly in investment community. Ross (1976) illustrates the main worry experienced by investors in substitute for higher returns, shareholders bear superior risks. In investment jargon, this is called the return and risk tradeoff and investors select a return and risk permutation depending by its risk appetite.

Larsen and Marx (2011) mention that in an unsure market cycle, investors consume risk where risk is the total spread or volatility of returns on stock prices. Moreover, risk associates to the uncertain prospect. Traditional concepts of risk perceived risks as negative, with non-desirable outcomes. However, within stock investors' community, risk is calculated not only as negative outcomes. It illustrates chances of outcome in dual manners, positive and negative, as well as the degree of volatility. Suitable risk heights and the best performing stocks are very subjective from the investor's perspective. The definition of risks varies, based on investor's uniqueness, particularly total affluence and risk appetites.

On the other hand, return is the incentive to hold a particular stock which comprise of payments gotten in dividends as well as paper gains or losses. In other words, return is the risk premium received by a stock in which the stock return minus the benchmark return plus the risk-free rate of which arguably from the *Shariah* context.

2.2.1 The Importance of Risk

A good investment portfolio performance is the result of vigilant concentration to four basics such as figuring estimated returns, managing investment risk, scheming costs and monitoring the investment program (Pedersen, 2013).

These four basics happen in all portfolio management issue, such as strategic asset allocation assessment, a dynamic portfolio management or a passive fund that applies conventional methods or mathematical modeling. Referring to an ancient saying, the substitution involving gain and loss is the substitution involving eating well and sleeping well.

Ignoring risk will create a problem to the investment portfolio. One way to ignore risk is by putting all investment in a single stock but no one will adopt this strategy. Thus, the risk concerns could compel each stock investment. Regrettably, it does not impact them enough in some cases. We can learn from the financial disasters that happen because of limited risk management. The debacle of Asian Financial Crisis in the late 1990s testifies to the risks of overlooking or badly accepting risk.

However, risk analysis could be an enhancement of investment opportunities rather than avoiding at all. Bernstein (1996) has pointed out that a limited knowledge of risk damper the financial market and economic development. The present economic growth involves a grasp of risk where a systematic risk assessment may improve investment opportunities. Therefore, the study discusses the risk primer as well as previous and recent practice of stock risk modeling.

2.2.2 Risk Computation

A classical approach to measure risk was the standard deviation of return (SD). Another measure of risk is variance (VAR), the standard deviation squared. Normally, the risk indicator used by investors was SD given that it was calculated in the identical units as return. Thus, if the SD was identified, the VAR will be simply calculated or the other way round.

$$StdDev\ [\tilde{r}] = \sqrt{Var\ [\tilde{r}]} \qquad \text{(EQ 2-1)}$$

$$Var\ [\tilde{r}] = E\ [\ (\tilde{r} - \bar{r}\ )^2\ ] \qquad \text{(EQ 2-2)}$$

where

$\tilde{r}$ is the return

$\bar{r}$ is the average return

$StdDev\ [x]$ is the SD of x

$Var\ [x]$ is the VAR of x

$E\ [x]$ is the estimated value of x

Figure 2-1 shows that the SD is symmetrical with positive and negative returns. Some reviewers argued that this symmetry was ambiguous as well as did not really consider the concern of negative returns volatility i.e. the loss investors wanted to avoid. Case in point, a distance range of positive returns was considered in the same way as a distance range of negative returns. Nevertheless, standard deviation was still the better one because it provided a relative calculation of risk exposure (Grinold and Kahn, 1995).

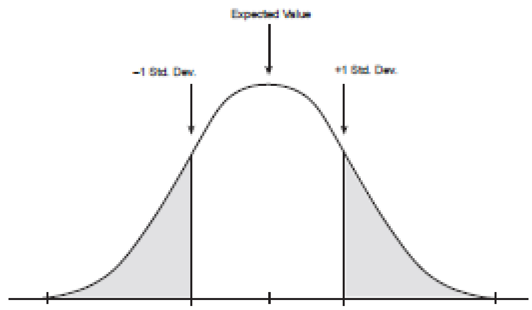


Figure 2.1: The Dispersion of Returns

2.2.3 Return Component

Each unit of risk reflects single unit of total return. The main elements of return as mentioned by Grinold and Kahn (1995) are risk-free rate return where particular return generated on a solely risk-free asset, typically the yield of a short term treasury issued bond like 3-Month Malaysian Treasury Bills or 3M T-bills are taken a riskless asset and excess return where the gain in excess of the risk-free rate or the total gain minus the 3M T-Bills.

While the T-bills are determined by collective investor conduct, each investment analysts had more power over the assumed excess return of stocks investment. Portfolio managers may modify their portfolio policy or asset allocation to change the risk appetite of stocks investment as well as the return.

The real challenge here is, from *Shariah* perceptive, the governing principle that oversees *Shariah* investing is common risk and profit sharing among investors. Hence, the concept of risk-free investment shall not work in this context (Laldin, 2011).

2.2.4 Portfolio Risk

When one thinks of investment risk, the most natural thing to do is to look at profit and loss (P&L) of a given investment. Let's define the investment as a portfolio of stocks that are bought at time *t*-1 and that are still holding at time *t*. For example, time, *t* is stock price at market close yesterday, while *t*-1 is the beginning of last week. This portfolio's P&L will be referred as portfolio return for the time period between *t*-1 and *t*.

$R_t = (P_t - P_{t-1})/P_{t-1} - 1$ (EQ 2-3)

where

R_t is the portfolio return from time t-1 to time t, expressed in percentage points

P_t is the portfolio value at time t which include dividends, coupon payments, etc. paid during the time period between t-1 and t

P_{t-1} is the portfolio value at time t-1

Note that sometimes one wants to see how portfolio performed relative to a given index or benchmark. In order to analyze that, one needs to look at alpha of the portfolio. Alpha (excess return over the index or benchmark) is derived as the subtraction between portfolio return and that of the index:

$R_{alpha} = R_{portfolio} - R_{index}$ (EQ 2-4)

The concept of portfolio risk is related to variability of portfolio return (Bhushan, Brown, and Mello, 1997). The riskier the portfolio, the more variability one would expect to see in portfolio returns. It is natural to think of portfolio returns as a distribution. One can define portfolio risk as a standard deviation of portfolio return distribution.

$\sigma = \sqrt{E[(R - E(R))^2]}$ (EQ 2-5)

where

σ is the portfolio risk, derived as SD of portfolio return

R is the portfolio return for a given time period, example one day

$E(R)$ is the expected return, i.e. sum of all returns divided by the number of these returns

Risk can be defined as either an absolute risk defined using formula EQ 2-5 above, or active risk (risk of underperforming a benchmark) as widely used in the industry. Portfolio active risk is also called tracking error. Active risk is defined as following:

$$\sigma_a = \sqrt{E[(R_a - E(R_a))^2]} \qquad \text{(EQ 2-6)}$$

where

σ_a is the SD of portfolio alpha

R_a is the portfolio alpha for a given time horizon, example daily portfolio return minus daily benchmark return.

$E(R_a)$ is the expected active return, i.e. sum of all active returns divided by the number of observations

Usually tracking error is calculated for daily, weekly, or monthly returns, but is quoted as an annual number. To convert tracking error to a different time horizon the following formula is used:

$$\sigma_{annual} = \sigma_{time\ horizon} * \sqrt{N} \qquad \text{(EQ 2-7)}$$

where

σ_{annual} is the annual tracking error

$\sigma_{time\ horizon}$ is the tracking error for a given time horizon

N is a number of time horizons in a year i.e. if time horizon is monthly, then $N = 12$

Based on the above definition of risk, we can calculate historical risk for a given portfolio. Historical portfolio risk is sometimes referred to as 'ex-post' risk as commonly used in the industry. Risk management process deals with forward looking risk. Forward looking risk refers to risks that a given portfolio might be facing in the future. Such risk is referred to as ‘ex-ante’ risk. Over the last 50 years a vast body of academic and industry research was produced that covered the issue of forward looking risk modeling. So this problem is now well understood. In order to estimate portfolio risk, one needs to be able to estimate risks of stocks that make up a given portfolio and then be able to aggregate individual stock risks to the portfolio level.

Let’s say we have two stocks in the portfolio, stock A and stock B. Then the ex-ante risk of that portfolio is defined as following:

$$\sigma_{portfolio}{}^2 = (w_A\sigma_A)^2 + (w_B\sigma_B)^2 + 2 * w_A * w_B * cov(A,B) \qquad \text{(EQ 2-8)}$$

where

$\sigma_{portfolio}{}^2$ is the portfolio variance, or portfolio standard deviation (ex-ante risk) squared

σ_A is the ex-ante risk of stock A

w_A is the weight of stock A in the portfolio

σ_B is the ex-ante risk of stock B

w_B is the weight of stock B in the portfolio

$cov(A,B)$ is a covariance between returns of stocks A and B where it is a statistical measure of how much the returns of two stocks move together

It can be seen that this approach works if one has a limited number of stocks in the portfolio, but it becomes more complicated as the number of stocks grows. For example if one has 500 stocks in the portfolio, it will need to estimate covariances for well over 100,000 unique stock pairs. Such process will produce spurious numbers that won’t be stable and explainable.

The standard way of getting around this problem is to use multifactor models. Let's assume that stock return is driven by some set of common factors. For equities some of these common factors might be stocks' industries, or equity market as a whole. For fixed income securities these factors might be the relevant yield curves. Now we can decompose stock return as follows:

$$r_{stock} = \sum_{i=1}^{n} Exp_i * Factor_i + r_{residual} \qquad \text{(EQ 2-9)}$$

where

r_{stock} is the stock return

n is the number of factors in the multifactor model

Exp_i is the exposure to factor (factor beta)

$Factor_i$ is the return of factor

$r_{residual}$ is the residual return i.e. portion of stock's return that is not explained by the factors

Stock ex-ante risk is defined as following:

$$\sigma_{stock}{}^2 = Exp_{stock} * VCV * Exp_{stock}{}^T + \sigma_{stock\ residual}{}^2 \qquad \text{(EQ 2-10)}$$

where

$\sigma_{stock}{}^2$ is the stock risk squared

Exp_{stock} is the vector of stock factor exposures (factor betas)

VCV is the factor variance-covariance matrix, if we have N factors in the model, then the size of this matrix is NxN

$Exp_{stock}{}^T$ is the vector of stock factor exposures transposed

$\sigma_{stock\ residual}{}^2$ is the stock residual risk squared, i.e. portion of stock's risk that is not explained by the factors

Moreover since portfolio return is just a weighted sum of stocks' returns.

$r_{portfolio} = \sum_{i=1}^{n} w_i * r_i$ (EQ 2-11)

and

$Exp_{portfolio} = \sum_{i=1}^{n} w_i * Exp_{stock_i}$ (EQ 2-12)

where

$r_{portfolio}$ is the portfolio return

$Exp_{portfolio}$ is the portfolio exposures

w_i is the weight of stock *i* in the portfolio

r_i is the return of stock *i*

Exp_{stock_i} is the exposure of stock *i*

Then portfolio risk is defined as following:

$\sigma_{portfolio}{}^2 = Exp_{portfolio} * VCV * Exp_{portfolio}{}^T + \sigma_{portfolio\ residual}{}^2$ (EQ 2-13)

If we substitute portfolio weights with portfolio active weights, then we get the formula for the portfolio ex-ante tracking error.

$\sigma_{active}{}^2 = Exp_{active} * VCV * Exp_{active}{}^T + \sigma_{active\ residual}{}^2$ (EQ 2-14)

In addition to portfolio tracking error (as defined in EQ 2-13 above), one can look at additional risk measures in order to better understand portfolio risk. Such measures include various tracking error decompositions. These decompositions help user understand not only the level of overall portfolio risk, but also where risks are concentrated. Basic risk decomposition measures include isolated risk, marginal risk, and contribution to risk (Lintner, 1965a). These risk measures can be defined for a particular portfolio holdings subgroup (for example a particular GICS Sector), or for a particular portfolio risk subset (for example portfolio risk explained by risk factors vs. residual risk).

To understand risk that is coming from a particular portfolio holdings subgroup, it is common to look at isolated risk of that subgroup. For a given subgroup, isolated risk is defined as a risk of the portfolio if risk of all stocks that do not belong to that subgroup is set to zero. For example, one can look at isolated risk of a given GICS sector for a stock portfolio.

Marginal risk of a given portfolio subgroup is the value by which portfolio tracking error changes for a 1% increase in weight of that subgroup.

Contribution to risk shows tracking error decomposition into components that sum up to portfolio overall tracking error. Sometimes they can be expressed in percentage points, and in that case they sum up to 100%. Contribution to risk takes interaction effect into account.

Beta is a risk measure that shows portfolio sensitivity to the market. If the benchmark is specified for a given portfolio, beta is calculated as portfolio sensitivity to that benchmark. For example if portfolio has a beta of .9 and benchmark goes up by 10%, we expect that portfolio to go up by 9% (10% times .9).

(Koijen, 2014) said the most common application of risk analysis is to look at portfolio risk level and various risk decompositions for the most recent data available. Sometimes one might want to look at risk for a particular historical date, or risk time-series to see how portfolio risk changed over time. For time-series view of risk there are two most commonly use cases: (1) Look at current portfolio risk exposures, and see the risk level that these exposures generated for a particular historical time period. (2) Look at historical portfolio holdings, and historical risk measures for these holdings to see how portfolio exposures and risk changed over time.

2.2.5 Concern of Straightforward Risk Calculations

The quantitative measurement of risk based on dispersion of returns is then simple as well as applicable for every stocks portfolio. Nonetheless, this process has a disadvantage as a result of numerous shortcomings in estimating covariance matrix and standard error terms (Froot, 1989).

A robust covariance matrix estimation of stock returns involves information data of longer period to analyze the stocks in the portfolio. For a relatively new Islamic capital markets like Bursa Malaysia, long historical fundamental data is obviously not accessible. Whereas, the modern history of Islamic finance in Malaysia can be dated back in 1983 where the first Islamic bank was established said Abdus (1999). It further explained that the estimation mistake may arise within horizon as a result of erroneous asset correlations that may not occur in orderly manner. Standard covariance matrix provides modest meaning in the manner of investment research. Putting in different views, it is basically a hidden content with modest perceptive foundation or forecast capability.

With all those rationale, investment analysts have explored for several decades to model investment risk in more explainable approach. Next, the discussion will address those efforts to model the risk by looking into Capital Asset Pricing Model and Fama French model.

2.3 Capital Asset Pricing Model

During early investment theory, the development of stock risk models has been unassuming and unscientific guesswork. Thereafter it becomes in-depth into quantitative research and technical complexity for sophisticated investment modules. Among new complex models for risk and return, it has turned toward replicating of rising sophistications of stock markets.

About 60 years ago, no model of systematic market return where existence and in those time gain is simply an increase of stock prices and risk is a fall of stock prices. Back then the research analysts' main research instruments are purely on the investment research of a company financial statements. Portfolio construction was mainly comprised of a combination of expected performing stocks.

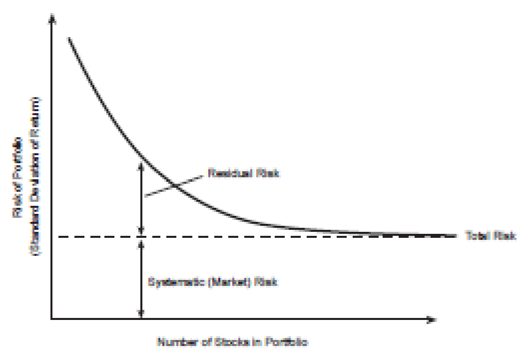


Figure 2.2: Diversification and Risk

Figure 2.2 shows that the diversification influences risk exposures where it summarizes factor related risk and extensively minimizes stock residual risk. Nevertheless, diversification does not remove all risk since the stock prices move in tandem with broad capital market. For that reason, broad stocks market risk cannot be removed by stocks diversification alone.

As portfolio managers and investment analysts became knowledgeable, there was a drive to discover the conceptual asset pricing for stock analysis. The CAPM is a technique to explain the regularity association of stock return and the risk (Sharpe, 1964).

Key discussion of CAPM is that, in general, portfolios are not rewarded for having on diversifiable or non-systematic risk. Moreover, CAPM states that the expected non-systematic return is '0', whereas the estimated residual return is more than '0' and linear equation as shown in Figure 2.3.

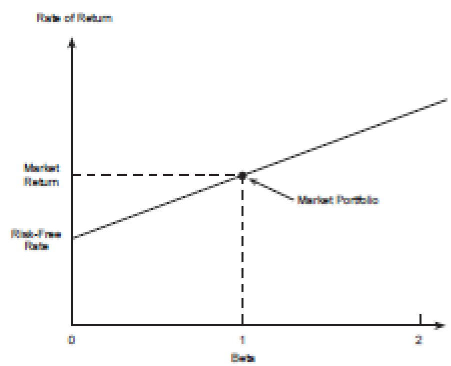


Figure 2.3: The Capital Asset Pricing Model

Computation of stock exposure to systematic risk is called beta (β) in which can be measured as the correlation of a stock given broad stocks exchange movement. Basically, beta is the numerical assessment of a stock's systematic risk. On the other hand, returns or also known as risk premium for every stock is equated toward β in which an impact of un-diversifiable systematic risk as illustrated in EQ (2-15).

$$\mathrm{E}[\tilde{r}_i] - r_F = \beta_i \mathrm{E}[\tilde{r}_M - r_F] \qquad \text{EQ (2-15)}$$

where

$\tilde{r}_i$ is the return on asset *i*

r_F is the risk-free rate of return

$\tilde{r}_M$ is the return on broad market

$\beta_i = \frac{Cov[\tilde{r}_i, \tilde{r}_M]}{Var[\tilde{r}_M]}$

CAPM is simple and uncomplicated to apply and starts to detach the elements of risk. Nevertheless, this abridged single factor model is unfinished as CAPM excludes the risk that derived by common factor exposures.

2.4 Fama French Model

The long established CAPM as discussed earlier identified solely a single factor to explain of a portfolio or stock returns as benchmark again the broad stock market. In the case of Fama and French (1992, 1993) model, it identified three factors to describe stock risk and return. FFM begins with the study that two factors attributed to stocks have a tendency to perform better as compared to broad stock as a whole i.e. small market capitalization stocks as well as stocks with a high book-to-market ratio or also known as value stocks and growth stocks if otherwise. The two professors subsequently adjusting the two factors into CAPM to replicate a stock's beta for these two classes:

$$E(R) = R_f + \beta_\varepsilon\left(K_m - R_f\right) + b_s\,.\,SMB + b_v\,.\,HML + \propto \qquad \text{(EQ 2-16)}$$

where

$E(R)$ is the expected return

R_f is the risk-free return rate

K_m is the return of the broad stock market

β is the exposure

SMB is representation for "Small market capitalization Minus Big" which calculates the different of small market capitalization stock over large market capitalization stock

HML is representation for "High book to market ratio Minus Low" which calculates the different high book value stock over low book value stock

b_s and b_v are the beta coefficient

$\propto$ is an alpha or an intercept

In contrast, the formulation on risk-free rate above does not fit well with *Shariah* principle where the basis of *musharakah* is profit and loss sharing or mutual risk sharing. Having said that, a few researches have accounted that when the model was tested to emerging markets the book to market factor maintains its explanatory ability but not in the case for the market capitalization of stock factor. Aguenaou, Abrache and El-Kadiri (2011) had found out that the three factor model did hold totally in the emerging markets such as Moroccan stock market. Furthermore, Connor and Sehgal (2001) discover that there is no dependable connection between the common risk factors in company's revenue with stock returns.

FFM has other limitation too. Although the model studies multi factor for risk analysis, it does not consider different factor weight or suggest a method for measuring the factor exposures. Given that, the stockholders must depend on robust and intuitively defined multi factor model.

Nonetheless, the FFM did explain the risk and return very well for some of the developed markets such as United States, United Kingdom and Japan stock markets as confirmed by Griffin (2012). Consequently, the model offers a highly reliable instrument for capturing portfolio performance, quantifying the impact of active management, portfolio construction and forecasting returns. It has replaced CAPM as the commonly used to explain the share prices in total and stock returns.

2.5 Multi Factor Model

The development of multiple-factor model (MFM) such as FFM has extended non-factor risk into residual and universal factor risks, allowing FFM to choose and guess variables that best explain the forecasted returns and estimated risks for particular stock. This model presents an outline to build up instrument for risk management, investment assets allocation and performance attribution (Connor and Korajczyk, 1993). This can be argued as extension of CAPM which can be defined as single factor model.

Connor and Korajczyk also mentioned that the multi factor model was official claims about the interactions between stock returns in an investment pool. Key principle of MFM will show that similar stocks will behave similar stock returns pattern. The "similarity" is described as stock attributions depended on broad market information like stock price, trading volatility or other financial data derived from a company's financial statements.

In addition, MFMs recognize the common factors and identified stock return movement to investors' outlooks on those factors. The total risk equation will then sum-up the common factor stock return as well as non-factor stock return. With that, the risk profile should react instantaneously to the changes of fundamental data.

MFMs are based on stocks trends monitored over a time horizon. The great challenge are investigating these trends and thereafter replicating it with stock attributions that any investors would be able to appreciate. Asset attribution is categorizations that are related to stocks price sensitivity like business sector category (Chan and Hameed, 2006).

Currently, the phase of model development for the residual and factor return are distinguished. Note that the models recognize the current attributes for stock's risk and return where they require eliminating transitory or idiosyncratic objects that lead bias of the study (Nardari and Scruggs, 2007).

Risk estimation is the last phase in developing a robust and reliable model where the variances and correlation coefficient between the variables being calculated as well as predicted. Those estimations will be able to explain forecast risk for a stock as discussed with lengthy in methodology section.

Stockholders depend with beta estimations for identifying investable investments and assets allocation as well as additional portfolio techniques. Their assessments are pretty much depending on the data extracted from the MFM analysis in addition to return assumptions they obtain from other investment analysis.

Connor (1995) has identified numerous advantages to use MFM for stock and investment analysis. First, MFM presents a detailed segregation of beta and, hence, a comprehensive understanding of beta exposure. Second, since basic investment reasoning applied to the model construction, MFM is not only depending on historical analysis or outdated data. Third, MFM is robust analysis techniques that able to handle outliers. Fourth, as the overall economy and companies' fundamental change, MFM adapts to replicate shifting in stock uniqueness. Fifth, MFM isolates the impact of each factor that projects categorical analysis for better informed research analysis. Sixth, in terms of it applications, MFM is sensible, tractable, and logical to research analysts and portfolio managers. Finally, MFM is dynamic models permitting for a variety type of investor likings and opinion.

As probably known by now, MFM has its own weakness. Even though the model forecasted a majority component of the risk; it does not explain everything in regard to the risk. Moreover, the MFM shall not suggest stock buying and selling but portfolio managers have to decide their individual investment practices and preferences.

2.5.1 Types of Multi Factor Model

There are three common types of factor models as described by Rudd and Classing (1998). They all differ in their approach to defining factors and stock factor exposures. They list these classes below and highlight their advantages and disadvantages.

Statistical factor models use methods similar to principal component analysis. Both factor returns and factor exposures are determined from asset returns. The benefit of such models is that they are simple to develop and involve little data: only stock returns are needed. Their primary concern is interpretability. Case in point, it is uncertain what a portfolio manager should do if she finds out that a lot of her risk is coming from the fourth principal component since there is no easy way to associate economic meaning with the principal components.

Explicit factor models start by specifying factor returns and then use techniques such as regression analysis to determine exposures to factors. In terms of data requirements such models require asset returns as well as factor returns. Sometimes the models referred as time series models since stock beta is defined on a stock-by-stock basis in calculating regression of time-series. Benefit of the models it permits for an inclusion of random factors, provided that the factor time-series information can be accessible. The main disadvantage is that stock-level exposures in these models tend to be non-intuitive. For example, a telecommunication company can be strongly exposed to a technology factor or a small market capitalization company may have a strongly positive size factor exposure. Additionally, since there are many exposures determined from historical time-series regressions, such models tend to have good fits in-sample and poor fits out of sample.

Implicit factor models describe stock betas to every factor. Thereafter, it reveals factor returns from regression of stock returns. These kinds of models are usually used data mainly. It involves stock returns as well as numerous factor betas of every stock. Sometimes the models often called as endogenous factor models, cross-sectional factor models or fundamental factor models. One advantage of these models is that they are more intuitive for a portfolio manager to understand. For example, if the model has size, value and momentum factors, then a large market capitalization company that has recently underperformed the market will have a large and positive exposure to the size factor and a negative exposure to the momentum factor. Buying more value stocks will increase contribution of the value factor to the portfolio risk. Another advantage is responsiveness of these models to changes in asset characteristics. Finally, these models perform well out of sample due to the fact that they impose a lot of structure compared to the other model classes. One disadvantage of these models is a much higher data requirement, which requires more complex techniques for dealing with the data. For example, additional care should be taken when only some data elements are available for a particular firm.

Table 2.2: Comparison of Factor Model Types

	Advantages	**Disadvantages**
Statistical	▪ Require little data (only returns) ▪ Easy to build	▪ Lack of interpretability
Explicit	▪ Can easily include arbitrary time series	▪ Non-intuitive stock exposures may result ▪ Poor predictive power
Implicit	▪ Easily Interpretable (can be traced to fundamental data for each stock) ▪ Clear actionable interpretation ▪ Good predictive power	▪ Data intensive

Given the three common types of factor models in Table 2.2, the implicit factor model type will be explored to develop a new multi factor equity model based on *Shariah* principle of *musharakah* in this study.

2.5.2 Model Equations

MFMs are based upon a single factor models such as CAPM by adding and restating the interrelationships between factors. For a single factor models, the mathematical formula that explains the excess rate of return is:

$$\tilde{r}_i = X_i \tilde{f} + \tilde{u}_i \qquad \text{(EQ 2-17)}$$

where

$\tilde{r}_i$ is the total excess return over the risk-free rate

X_i is the exposure of security *i* given the factor[X]

$\tilde{f}$ is the return on the factor[X]

$\tilde{u}_i$ is the non-factor or residual return on security *i*

The model is able to be constructed to incorporate J_factors where mathematical formula for $\tilde{r}_i$ of MFM develops into:

$$\tilde{r}_i = \sum_{j=1}^{J} X_{ij} \tilde{f}_j + \tilde{u}_i \qquad \text{(EQ 2-18)}$$

where

X_{ij} is the beta of stock *i* to factor *j*

$\tilde{f}_j$ is the return on factor *j*

When the J = 1, the model mathematical formula shrinks similar to previous single factor formula such as the CAPM where only market factor determines the stock return.

If the investment has only a stock, EQ 2-17 illustrates the stock's excess return. However, the majority of investments have numerous stocks and every stock has a share of the overall investment. While loadings of w_{P1}, w_{P2}, ... , w_{PS} indicate the share of S stocks in portfolio P, the excess return can be articulated in the subsequent formula:

$$\tilde{r}_P = \sum_{k=1}^{K} X_{Pk} \tilde{f}_k + \sum_{j=1}^{S} w_{Pj} \tilde{u}_j \qquad \text{(EQ 2-19)}$$

where

$$X_{Pk} = \sum_{j=1}^{S} w_{Pj} X_{jk}$$

This formula consists of the risk from various bases and sets the foundation for further MFM research study as this paper has explored.

2.5.3 Risk Prediction with Multi Factor Models

Portfolio managers and research analysts seem to treat the portfolio variance as to analyze holistic risk evaluations. In measuring the risk of an investment, the covariances of various variable requires to be measured. With no structural form of a multi factor model, calculating the covariance of a stock with each other stock is mathematically onerous and possibly lead to considerable estimation errors. To illustrate, with a portfolio of 500 stocks, it will calculate 100,000 variances and covariances.

An MFM reduces these estimations to a great extent where the results from substituting each company profiles with classes derived by same factors where the non-factor risk is uncorrelated. Therefore, it will leave with the variances and covariances to be measured by the model. Additionally, in view of the fact that there are lesser constraints to find out, the MFM can be estimated with greater accuracy.

The challenge is how to estimate covariance matrix? Ledoit and Wolf (2003) have improved the estimation of covariance matrix for stock returns by using shrinkage method. It begins with shrinking the sample covariance matrix into the identity matrix of the same dimensions which is the target matrix. They further suggest an approach to identify the optimal shrinkage concentration by finding the common factor weighting that provides the lowest expected value of the sum of squared deviations (Ledoit and Wolf, 2004).

Thus, it can simply obtain the matrix algebra computations that hold and relate the above point of view by using an MFM.

$$\tilde{r}_j = \beta\tilde{f} + \varepsilon \qquad \text{(EQ 2-20)}$$

where

$\tilde{r}_j$ is the return on stock *j*

β is the beta of factor_*f*

$\tilde{f}$ is the factor return

ε is the non-factor return

By replacing this relation in the mathematical equation the risk defines as follows:

$$Risk = Var(\tilde{r}_j) = Var(\beta\tilde{f} + \varepsilon) \qquad \text{(EQ 2-21)}$$

As a result of the matrix algebra procedure for variance, the risk computation illustrates as follows:

$$Risk = XFX^T + \Delta \qquad \text{(EQ 2-22)}$$

where

X is the exposure matrix of stocks against factors

F is the covariance matrix of factors

X^T is the transpose of X matrix

Δ is the diagonal matrix of non-factor risk variances

This is the basic mathematical equation that describes the matrix calculations applied in investment risk analysis for the MM.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter describes overview of the *musharakah* model and its universe as well as factors' descriptors in cross-sectional approach. It establishes the factor model and tests the model for its fitting. The model development process is summarized in Figure 3.3.

3.1 Model Overview

The approach to constructing the model is based on the implicit model type mentioned in the second chapter. While this type of models has several advantages over the alternatives, this approach is chosen primarily due to its better interpretability by the user. It gives greater insight into the portfolio risk sources and leads to intuitive action items. In addition, the MM incorporates the four basic tenets of *musharakah* in tabulating the factors.

It starts by noting that *Shariah*-compliant stocks with similar characteristics should have similar returns and risks as discussed in the previous chapter. This similarity between *Shariah*-compliant stocks is defined by the similarity of their factor attributes such as Business Sector, Management Quality, Profitability Growth and Capital Strength. These attributes define factor exposures (or betas) to factors. Next, the model estimates (or implies) factor returns by running the following cross sectional regression for each return period:

$$R_{nt} = \sum_{k=1}^{K} X_{nkt} * F_{kt} + \varepsilon_{nt} \qquad \text{(EQ 3-1)}$$

where

R_{nt} is the stock *n* return for time period *t*

X_{nkt} is the pre-defined factor exposure of stock *n* to a factor *k*, at time *t* with *K* factors in total

F_{kt} is the factor return to a factor *k* at time *t* to be derived from regression above

ε_{nt} is the non-factor return of stock *n* at time *t* that is not explained by the above regression

Regression (EQ 3-1) utilizes monthly returns on the left hand side and is run on a monthly basis for a set of stocks that it calls the Estimation Universe. Silvennoinen and Teräsvirta (2009) mentioned that higher frequency observations such as weekly tend to be nosier. Hence, monthly data is chosen. Not all stocks in the Estimation Universe enter the above regression with the same weight. Intuitively, larger stocks should have more influence. Mathematically, the best weighting scheme is the one that down-weights stocks with large expected non-factor return volatilities. The inverse square root of the stock market capitalization is a good proxy for non-factor volatility and captures in a simple way the empirical fact that large firms tend to have lower non-factor volatilities than small firms (Ang, Hodrick, Xing and Zhang, 2009). Therefore, the study uses inverse square root of the stock market capitalization as the weighting scheme in (EQ 3-1).

Factor returns F_{kt} are an output of the above regression. This regression is run every month over the last several years to get a time series of factor returns for each factor. Next, it uses these factor returns for estimating a covariance matrix. This study would like to make the model more responsive to recent market events while maintaining a robust correlation structure. Therefore, it applies an exponential decay to factor returns to estimate the covariance matrix, so that more distant factor returns are assigned smaller weight relative to the more recent ones (Bell and Pak-Ho, 2014).

As mentioned in the literature review, one advantage of the cross-sectional approach to building a factor model is that as companies change, the model can capture some of these changes almost instantly. For example, if two companies merge, factor exposures will be based on the characteristics of the merged entity as soon as the transaction has taken place. Similarly, we can incorporate IPOs[1] and spin-offs as soon as they are completed.

[1] Initial Public Offerings or newly listed companies.

Hence, the equations for MM can be written as:

$$R(n) = \sum_{b=1}^{24} \beta_b(n,b) r_b(b) + \sum_{m=1}^{5} \beta_m(n,m) r_m(m) + \sum_{p=1}^{4} \beta_p(n,p) r_p(p) + \sum_{c=1}^{4} \beta_c(n,c) r_c(c) + \varepsilon(n)$$

(EQ 3-2)

where

$R(n)$ is the return to asset *n*

$\beta_b(n,b)$ is the stock *n*'s factor beta to Business Sector factor *b*

$\beta_m(n,m)$ is the stock *n*'s factor beta to Management Quality factor *m*

$\beta_p(n,p)$ is the stock *n*'s factor beta to Profitability Growth factor *p*

$\beta_c(n,c)$ is the stock *n*'s factor beta to Capital Strength factor *c*

$r_b(b)$ is the return to Business Sector factor *b*

$r_m(m)$ is the return to Management Quality factor *m*

$r_p(p)$ is the return to Profitability Growth factor *p*

$r_c(c)$ is the return to Capital Strength factor *c*

$\varepsilon(n)$ is the Non-factor return to stock *n*.

$$\sigma_n = \beta_n * VCV * \beta_n{}^T + \sigma_\varepsilon$$ (EQ 3-3)

where

σ_n is the risk measure for stock *n*

β_n is the vector of stock factor exposures

VCV is the factor variance covariance matrix of 4 x 4 given the four factors

$\beta_n{}^T$ is the vector of stock factor exposures transposed

σ_ε is the non-factor risk in which not explained by the factors.

3.2 Coverage Universe

Coverage for the model extends to all *Shariah*-compliant stocks listed on the Bursa Malaysia as defined by the *Shariah* Advisory Council of Securities Commission (2014) that satisfies minimum data availability requirements:

- Stock price and market capitalization data are available,
- Price is larger than 5 *sen*, and
- Industry membership information is available

The 5 cent rule helps exclude penny stocks that trade infrequently and have little data available. For industry membership his model currently uses Global Industry Classification Standard industry groups. However, if GICS information is not available, the model infer GICS industry group from Bursa Malaysia industry classification. Currently, the model covers over 600 *Shariah*-compliant stocks.

3.3 Estimation Universe

The study starts from the coverage universe defined above, excludes companies incorporated outside of Malaysia, sorts what is left by market capitalization, and focuses on companies that cumulatively account for 95% of the total market capitalization. This universe is rebalanced annually (see Figure 3.1). MM takes additional steps to minimize the turnover of the estimation universe by making it harder to enter and leave the universe in case if market capitalization drops and then recovers later relative to other firms.

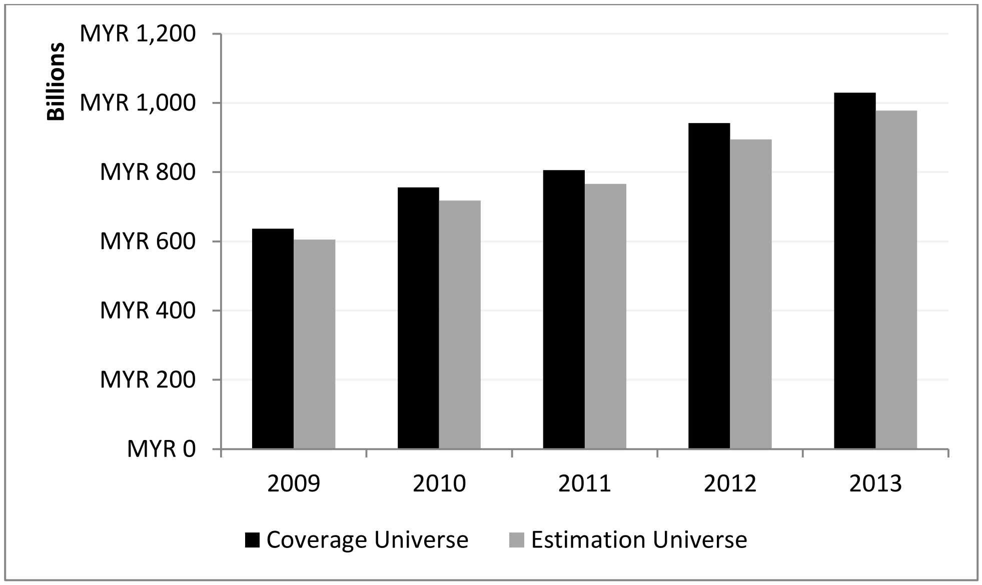


Figure 3.1: Market Capitalization of the Stocks Universe

3.4 Model Factors

The factors used in this model are split into four groups: Business Sector, Management Quality, Profitability Growth and Capital Strength factors. This is based on the basic tenets of *musharakah* principle as discussed in the earlier chapter.

3.4.1 Business Sector Factors

Business Sector or industry factors are based on the 24 GICS Level 2, GICS Industry Group (Morgan Stanley Capital International, 2012) memberships. If a stock belongs to a given industry, it is assigned the exposure value of 1 to this industry and 0 for all other industries. Those stocks that are not *Shariah*-compliant will be excluded in the on-set. In cases when GICS data is not available, the model infers the GICS industry group on the basis of the Bursa Malaysia's industrial classification. In addition to industries, MM has a market factor to which each stock has a unit exposure. It can be thought of as an intercept in (EQ 3-1). However, the 24 industry factors are not independent: the model can always infer the 24^{th} industry exposure from knowing the other 23. To avoid multi-collinearity, regression (EQ 3-1) is run with an additional restriction that weighted industry factor returns sum to zero.

3.4.2 Management Quality Factors

A composite value metric that identifies management capabilities in creating attractiveness of stock valuation are based on management performance data (Fama and French, 1996 and 2008). Management Quality factors use several dimensions of management factor definition to cover it from different perspectives. These are Book-to-Price Ratio (Chen, Roll and Ross, 1986), Price Earnings Ratio (Sorensen, Hua, and Qian, 2005), Cash flow-to-Price Ratio (Asness and Frazzini, 2013), Sales-to-Enterprise Value (Lintner, 1965b) and Earnings before Income Tax and Depreciation Charges-to-Enterprise Value Ratio (Miller, 2006).

3.4.3 Profitability Growth Factors

Profitability Growth factors distinguish between highly profitable companies and money losers by measuring Return of Equity (Wilcox and Philips, 2005), Return on Capital Employed (Damodaran, 2007), Earnings before Income Tax and Depreciation Charges-to-Sales (Huang, 2004) and Return on Assets (Rosenberg and Marathe, 1976).

3.4.4 Capital Strength Factors

Capital Strength factors consist of the firm size and its capital position like Market Capitalization (Carhart, 1997), Total Assets (Chen and Jindra, 2010), Debt-to-Book Value (Bhandari, 1988) and Debt-to-Market Capitalization (Banz, 1981).

Each factor consists of several atomic descriptors. Factor descriptor refers to a particular stock characteristic that is part of the factor definition. The model detects outliers in the descriptor data by applying rigorous checks to the underlying data and addressing data errors. To make the process more robust to outliers that may still slip through, this study applies descriptor-specific sanity bounds to each descriptor as suggested by Tsay (1988). For example, stock price movement is allowed to vary $\pm$30% per trading day as per Bursa Malaysia (2014) rules for limit up and limit down of existing stock.

A weighted combination of standardized atomic descriptors forms stock exposure to factor. For example, the Capital Strength factor uses four descriptors: Market Capitalization, Total Assets, Debt-to-Book Value and Debt-to-Market Capitalization. The advantage of using multiple descriptors is that it helps better capture stock factor exposure and gives it more explanatory power. Also, a factor based on a single descriptor may be noisy (Black, 1986) and more susceptible to data errors as well as more intuitive.

In order to combine several different atomic descriptors into one Capital Strength factor, it needs to standardize them first. The model simply subtracts a Market Capitalization weighted mean and divides by the standard deviation, so that the standardized descriptor has a zero market capitalization-weighted mean and a unit standard deviation. Then extreme standardized values that are outside of -3.0/+3.0 interval are set to -3.0 or +3.0 in line with Gumbel (2012) suggestion. The market capitalization weighting of the mean in this standardization process guarantees that if an investor holds a market portfolio, then that portfolio has zero exposure to the capital strength factors.

3.4.5 Rank Auto-Correlation of Exposures

Data used to construct exposures should be sufficiently processed so that they are stable enough to warrant inclusion as a defining stock characteristic, yet flexible enough to change in accordance with evolving risk characteristics of the individual name. Figure 3.2 plots the auto-correlation function of each factor exposure. All factors are relatively stable over time. Although the profitability growth factor is not in line with the other factors, it can be accepted with relatively stable as the auto-correlation has been above 80% since the beginning.

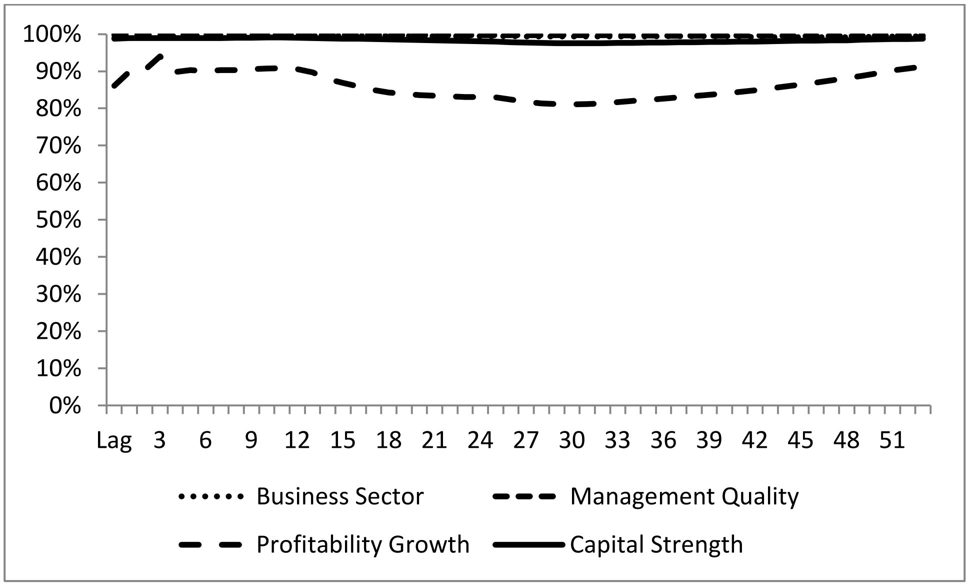


Figure 3.2: Rank Auto-correlation of the Factors

3.5 Factor Weighting

To combine atomic descriptors into Management Quality, Profitability Growth and Capital Strength factors, MM has developed a descriptor weighting algorithm by using principal component analysis (PCA). The main idea is to find a common dimension among atomic descriptors within a given factor. For example, the Management Quality factor has five atomic descriptors. They are based on the enterprise and equity values; near-term and long-term going concerns; and liquidation or restructuring. How should we combine them? Equal weighting would be the simplest solution, but the model came up with a method that is robust, intuitive and captures the most common information contained in descriptors. First, it calculates a cross-sectional Spearman (1904) rank correlation matrix of descriptors as shown in Table 3.1 for details[2]. Then the model runs a principal component analysis of this matrix and extracts the first principal component which explains the most descriptor variability. The loadings of the first principal component on the atomic descriptors are

[2] Compared to the usual Pearson correlation, Spearman correlation is less sensitive to outliers.

normalized to sum up to 100% and these are the final atomic descriptor weights as shown Table 3.2.

Table 3.1(a): Correlation Matrix of Management Quality Factor Descriptors

	PBR	PER	PCF	EVS	EVE
PBR	100%				
PER	90%	100%			
PCF	87%	87%	100%		
EVS	93%	79%	64%	100%	
EVE	98%	92%	87%	92%	100%

Note: PBR: Price-to-Book Ratio, PER: Price-to-Earnings Ratio, PCF: Price-to-Cashflow, EVS: Enterprise Value-to-Sales and EVE: Enterprise Value-to-Earnings.

Table 3.1(b): Correlation Matrix of Profitability Growth Factor Descriptors

	ROE	ROC	EBS	ROA
ROE	100%			
ROC	96%	100%		
EBS	22%	73%	100%	
ROA	99%	96%	26%	100%

Note: ROE: Return-on-Equity, ROC: Return-on-Capital, EBS: Earnings before Interest, Taxes, Depreciation and Amortization-to-Sales and ROA: Return-on-Asset.

Table 3.1(c): Correlation Matrix of Capital Strength Factor Descriptors

	CAP	AST	DBV	DMC
CAP	100%			
AST	81%	100%		
DBV	77%	76%	100%	
DMC	89%	64%	85%	100%

Note: CAP: Market Capitalization, AST: Total Assets, DBV: Debt-to-Book Value and DMC: Debt-to-Market Capitalization.

Table 3.2(a): PCA-based Weighting Method for Management Quality Descriptors

Name	1st PC loading	Weight
PBR	0.26	38%
PER	0.13	18%
PCF	0.07	10%
EVS	0.13	19%
EVE	0.10	15%

Table 3.2(b): PCA-based Weighting Method for Profitability Growth Descriptors

Name	1st PC loading	Weight
ROE	0.31	25%
ROC	0.21	17%
EBS	0.37	31%
ROA	0.32	26%

Table 3.2(c): PCA-based Weighting Method for Capital Strength Descriptors

Name	1st PC loading	Weight
CAP	0.31	46%
AST	0.27	41%
DBV	0.03	4%
DMC	0.06	9%

3.6 Missing Data

Despite most excellent data compilation hard work, occasionally there is no fundamental data for a particular factor. Instead of eliminating that stock from its coverage universe, the study populates the missing data using method called ordinary least squares (OLS). It infers the descriptor value based on other available information, such as the stock's business sector membership, company size, and other available factors. For example, if a capital strength factor is missing due to temporary suspension, the model infers that stock's size from size of stocks in the same industry and with similar size.

3.7 Factor Covariance Matrix

After the factor returns from the factor regression (EQ 3-1) are calculated, the model builds a factor covariance matrix. This study decomposes the factor covariance matrix into a correlation matrix and a diagonal factor volatility matrix and applies different exponential decay, half-life weighting to the two parts as recommended by Litterman and Winkelmann (1998).

Assuming data that appeared 12 months ago must be given semi weighted of the present data. Refer M as present time and m as any time historically, $m = 1, 2, 3, \ldots, M\text{-}1, M$, therefore, $\delta = 0.5^{1/12}$ (see EQ3-4). Let allocates a weight of δ^{M-1} to data m, then data that appeared 12 months ago will have 50-percent-weight of the present data and one that occurred 24 months ago will have 25-percent-weight of the present data. Hence, the model weighting approach will have exponentially reducing weights to data as δ withdraw from historical data. Selection of 12 months for the above is merely an example.

Let the following:

$$\delta = (0.5)^{\frac{1}{Half-life}} \qquad \text{(EQ 3-4)}$$

and assign a weight of:

$$w(t) = \delta^{M-1} \qquad \text{(EQ 3-5)}$$

Thus, half-life periods will determine on how fast the factor covariance matrix reflects to current market adjustments among the factors. Another scenario, same data weighting will result to half-life = ∞. Nonetheless, a very little a half-life will definitely eliminates data in the early sequence.

Correlation matrix is further refined by a procedure called shrinkage, which improves out-of-sample performance of covariance estimators. The shrinkage procedure starts with the sample correlation matrix C_D and then mixes it with (or shrinks it towards) a well-behaved target correlation matrix C_T which in already known and therefore does not have errors (Kwan, 2011). The model thus form the final correlation matrix C as

$$C = wC_T + (1 - w)C_D \qquad \text{(EQ 3-6)}$$

The only remaining challenge is to find a suitable target C_T. MM has determined that one of the best target matrices is simply an identity matrix. This is due to the special structure of these factors where most of them are not correlated. In fact, the average pair-wise correlation between these factors in C_D is close to zero. The optimal shrinkage intensity, w, provides the lowest expected value of the squared deviation. To determine w requires the variance and standard deviation of the factors to be estimated.

3.8 Non-factor Risk

Non-factor risk is driven by returns that are not explained by the four factors. The non-factor risk forecast is based on a structural factor model (Forni, Lippi, Giannone and Rechlin, 2009). This study uses Business Sector, Management Quality, Profitability Growth and Capital Strength factors exposures and also adds variables that are specific to the non-factor risk model. First, the model collects non-factor returns from running regression (EQ 3-1).

These are inputs to the model for the absolute magnitude of non-factor returns. This model is constructed by pooling several years of data on non-factor returns and it decomposes the model into the market-wide forecast part (which is common to all stocks but varies with time) and the stock relative part (relative to the market, which varies stock by stock as well as over time). In other words, the model does the following:

Run the factor regression (EQ 3-1). Calculate the absolute non-factor return$|\epsilon_{nt}|$. Then decompose it into the market-wide mean and stock-relative parts as follows:

$$|\epsilon_{nt}| = M_t(1 + SR_{nt}) \quad \text{(EQ 3-7)}$$

where M_t is simply a weighted average of $|\epsilon_{nt}|$ for all stocks and SR_{nt} is the stock relative part of $|\epsilon_{nt}|$.

This decomposition allows it to model the two pieces of the puzzle separately. First, it forecasts M_t on the basis of EWMA (exponentially weighed moving average with 6 months half-life) of its historical realized values. Second, the model builds a forecast of stock-relative part SR_{nt} by pooling two years of realized SR_{nt} monthly data and running the following regression:

$$SR_{nt} = \sum_{l=1}^{L} Y_{nlt} * G_l + \varphi_{nt} \quad \text{(EQ 3-8)}$$

where Y_{nlt} is a slightly expanded set of common factors, with most of Y_{nlt} being the same as X_{nlt}. However, the model also adds an important term to Y_{nlt} which is an EWMA of historical realized SR_{nt} with a 6 months half-life. G_l is coefficient determined by the regression (EQ 3-8) and φ_{nt} are residuals that the model does not attempt to model since his focus is on the forecast for $SRnt$. Notice that G_l coefficients no longer contain *t* subscript since data is pooled over time. However, it refits the model in equation (EQ 3-8) every week, so G_l slowly evolve over time.

It is important to emphasize the difference between regressions (EQ 3-1) and (EQ 3-8): the former is run on returns, whereas the latter is run on return magnitudes. Another important distinction is that the model runs regression (EQ 3-1) every period, using only one period of data to reveal the factor returns, whereas in (EQ 3-8) it pools several years of data together. The power of pooling allows MM to make the non-factor forecast more stable, ensuring that the relationships it uncovers between stock characteristics and non-factor returns magnitude are robust. To make the model responsive to changing market conditions, the model weighs old data in the pooled regression less than recent data, with a one year half-life.

Then, the model put the two forecasts for M_t and SR_{nt} together and obtains the forecast for the absolute magnitude of non-factor return $|\epsilon_{nt}|$. Finally, it converts the forecast from absolute magnitude to standard deviation by multiplying by a conversion factor to produce σ_{nt} the forecast of non-factor return volatility. The study applies numerous data quality checks in running regression (EQ 3-8) and on the outputs of the regression by trimming outliers.

3.9 Bias Test Bounds

Bias test measures how closely forecast risk follows realized risk. Let r_{it} denotes the return of some portfolio *i* at time *t*. In order to carry out the bias test (Lo and MacKinlay, 1990), it needs to construct forecast standardized returns ($\hat{\vartheta}_{it}$) by dividing the portfolio returns with their forecast standard deviation ($\hat{\sigma}_{it}$) obtained from the factor model.

$$\hat{\vartheta}_{it} = \frac{r_{it}}{\sigma_{it}}$$

If the true risk is forecast correctly (that is, if the forecast risk $\hat{\sigma}_{it}$ is an accurate characterization of the realized risk, $\hat{\vartheta}_{it}$ should have unit standard deviation. In this sense, we define bias statistic as the sample standard deviation of $\hat{\vartheta}_{it}$ as follows:

$$Bias_{it} = \sqrt{\frac{1}{T}\sum_{t=1}^{T} (\hat{\vartheta}_{it} - E[\hat{\vartheta}_{it}])^2} \qquad \text{(EQ 3-9)}$$

Bias values above or below 1 indicate under-forecast or over-forecast of risk respectively. On the other hand, sampling error causes this statistic to be away from 1 by an expected amount. To this end, the study construct confidence bands that account for the amount of sampling error expected from a small sample size. It calculates the bias statistic over time and measure the percentage of time it remains within the bands.

If we assume r_{it} comes from an independent and identical (i.i.d.) normal distribution, then forecast standardized returns follow an i.i.d. standard normal distribution. Under this setting, it can be shown that

$$□x_{iT} = \sum_{t=1}^{T} (\hat{\vartheta}_{it} - E[\hat{\vartheta}_{it}])^2 = \sum_{t=1}^{T} \hat{\vartheta}_{it}^2 \qquad \text{(EQ 3-10)}$$

follows a chi-squared distribution with T degrees of freedom. By the above expression, it the bias statistic can be rewritten as

$$Bias_{iT} = \sqrt{\frac{x_{iT}}{T}} \qquad \text{(EQ 3-11)}$$

which converges to a normal distribution (by a property of chi-squared random variables) with mean and variance 1 and 1/2T, respectively. Therefore, in practice it can use the following approximation

$$Bias_{iT} \sim N\left(1, \frac{1}{2T}\right) \qquad \text{(EQ 3-12)}$$

Using the approximation above, a 95% (2 standard deviation) confidence region for bias statistics is given by $CR_{95\%} = 1 \pm 2\sqrt{1/2T}$ which is equivalent to $CR_{95\%} = 1 \pm \sqrt{2/T}$

For T=12, this confidence region becomes (0.6, 1.4).

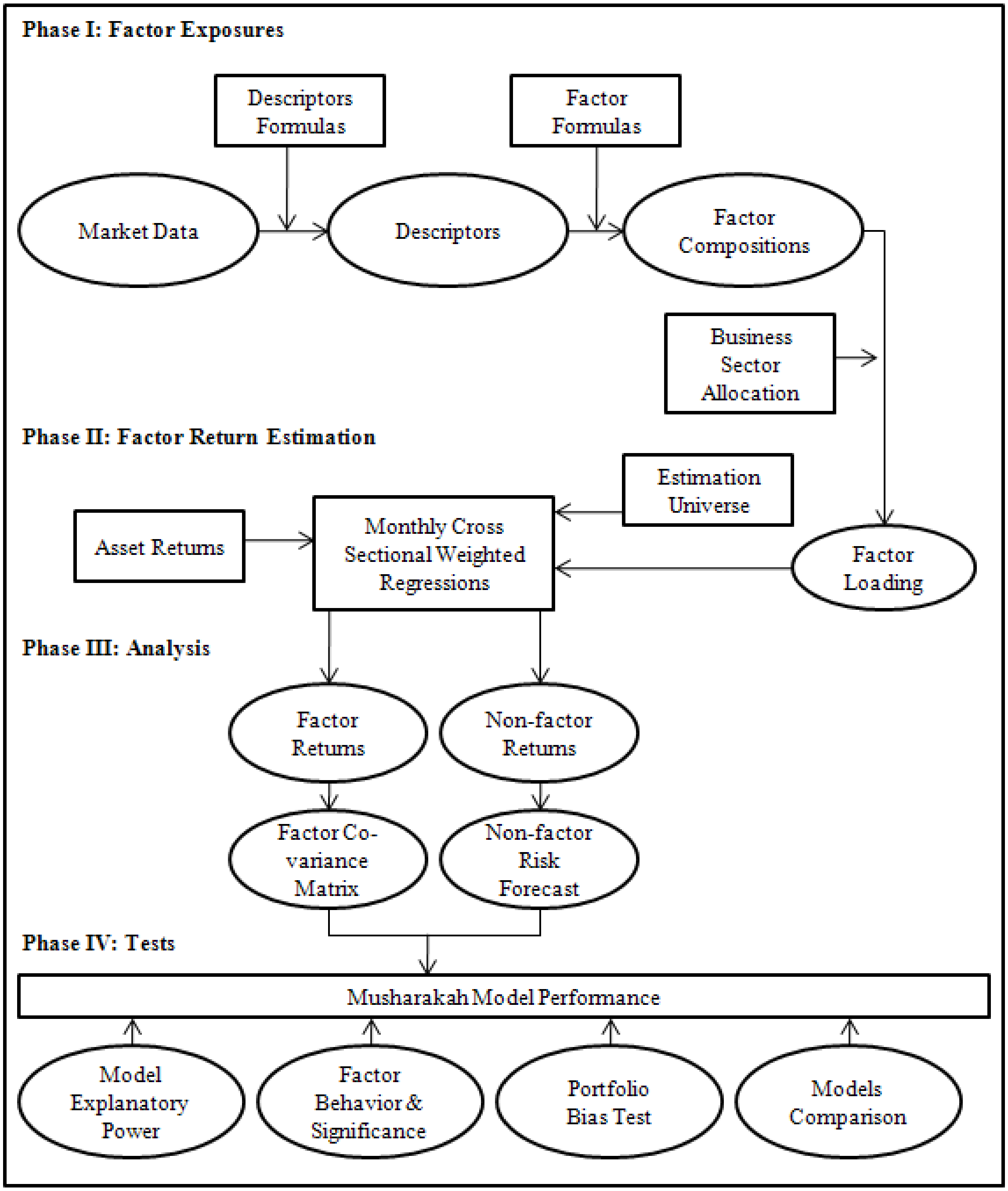


Figure 3.3: Model Estimation Process

CHAPTER 4: RESULTS AND DISCUSSION

This chapter provides a high-level summary of results in meeting the research aim and objectives as well as addressing those research questions for the development *Musharakah* based factor model.

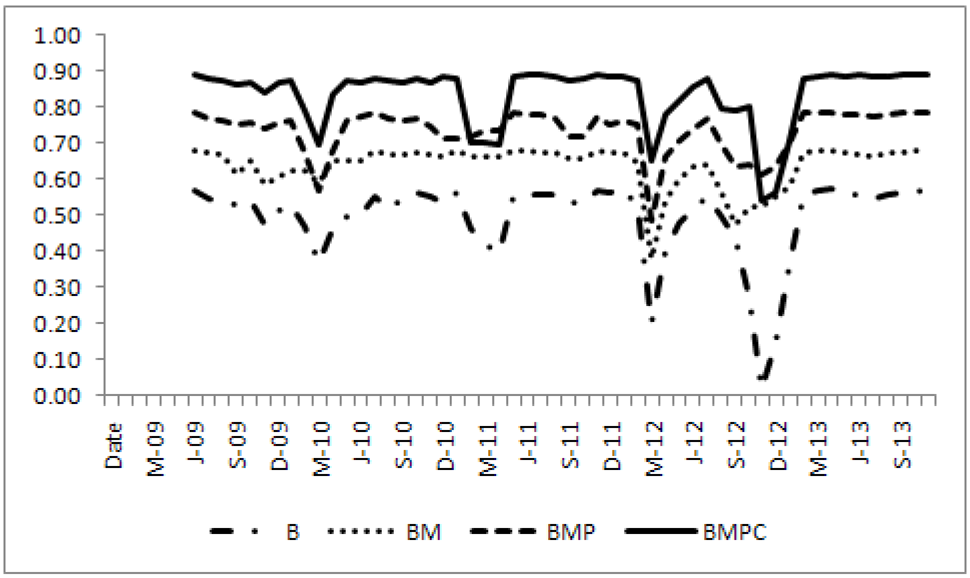
The main takeaways are that common factors chosen are able explain stock returns well in the cross-section, are significant in different market environments or cycles, has high forecasting ability that stays high during the recoveries and are unbiased for a broad variety of portfolios during high and low volatility environments.

4.1 Overall Performance

Contribution of the factors to R-squared in the Figure 4.1(a) below shows the contribution to explanatory power of each factor group (Business Sectors, Management Quality, Profitability Growth and Capital Strength). It displays a rolling 6-month and 12-month average of the adjusted R-squared for three different specifications: Business Sectors factor alone; Business Sectors and Management Quality; Business Sectors, Management Quality and Profitability Growth and Business Sectors, Management Quality, Profitability Growth and Capital Strength. The Management Quality factor seems to be responsible for the general dynamics of the explanatory power based on R-squared results in Figure 4.1(a) and Figure 4.1(b). Explanatory power of the overall factors increased markedly during the market recovery (February 2009 till March 2011) post global financial crisis (GFC) in October 2008. This is consistent with a market-wide recovery. Generally, the MM explanatory power increases during more volatile periods and improves tremendously by using longer estimation data as shown in Figure 4.1(b).

Aside to Management Quality factor, Business Sector contributes the lion's share of explanatory power, while Profitability Growth factor seems to contribute a small share on top of that. The contributions of Management Quality, Profitability Growth and Capital Strength factors varies over time and seems to have increased from an average of 26 percent, 13 percent and 15 percent respectively over the period January 2009 to December 2013.

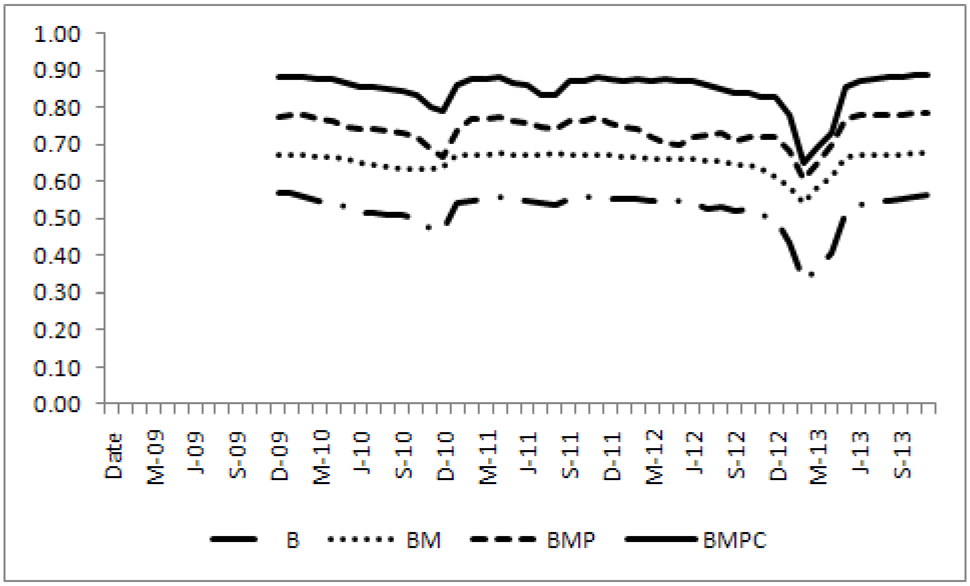
As mentioned earlier, the R-squared improved tremendously with longer estimation period i.e. from 6-month into 12-month period. The improvements are about 100, 300 and 100 basis points[3] by adding Management Quality, Profitability Growth and Capital Strength respectively into the Business Sector on cumulative basis.



Note: The B, M, P and C represent Business Sector, Management Quality, Profitability Growth and Capital Strength respectively.

Figure 4.1(a): Rolling Six Months R-squared

[3] One basis point is equal to 1/100 or 0.01%.



Note: The B, M, P and C represent Business Sector, Management Quality, Profitability Growth and Capital Strength respectively.

Figure 4.1(b): Rolling Twelve Months R-squared

Comparison of forecast and realized risk can also be judged by sorting ability of the predicted risk. That is, does the model's ranking of assets by total risk agree with the realized risk? To address this question, the model calculates realized volatility using a 12-month period. We calculate the Spearman correlation (rank correlation) of this statistic with the risk forecast on the week before the 12-month period. The Figure 4.2 below demonstrates that the rank correlation is high (around 80% in most cases). Notably, the MM does not lose predictive ability in market recovery and market side-line (stagnant movement of the stock returns) like that of post GFC episode.

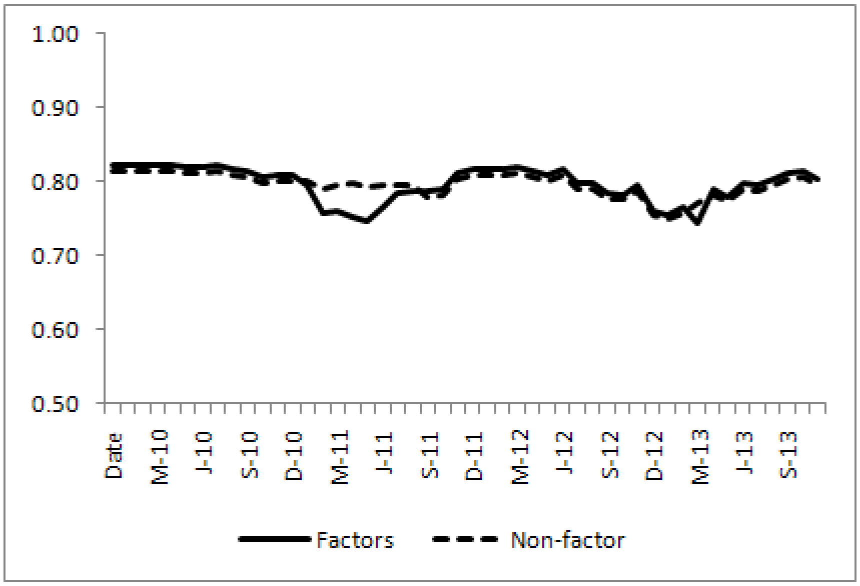


Figure 4.2: Spearman Correlation of Forecast and Realized Risk

4.2 Factor Behavior and Significance

A desirable property of the estimated factor returns is their ability to convey both the magnitude and directional effects of the market. Figure 4.3(a) and 4.3(b) plots the cumulative style factor returns beginning with a unit investment in each factor at the beginning of January 2009. The events of the recovery can be clearly seen in the behavior of Management Quality's descriptors and especially the price-to-book ratio and price-earnings ratio, when both descriptors experienced very large returns.

In addition, over the period of five years ended December 2013, putting the money on Consumer Durables sector will give the best returns as illustrated in see Figure 4.3(c). On the other side, the Technology sector experience the worst as this consistent with stock market recovery experience as shown in Griffin, Harris, Shu and Topaloglu (2011) study.

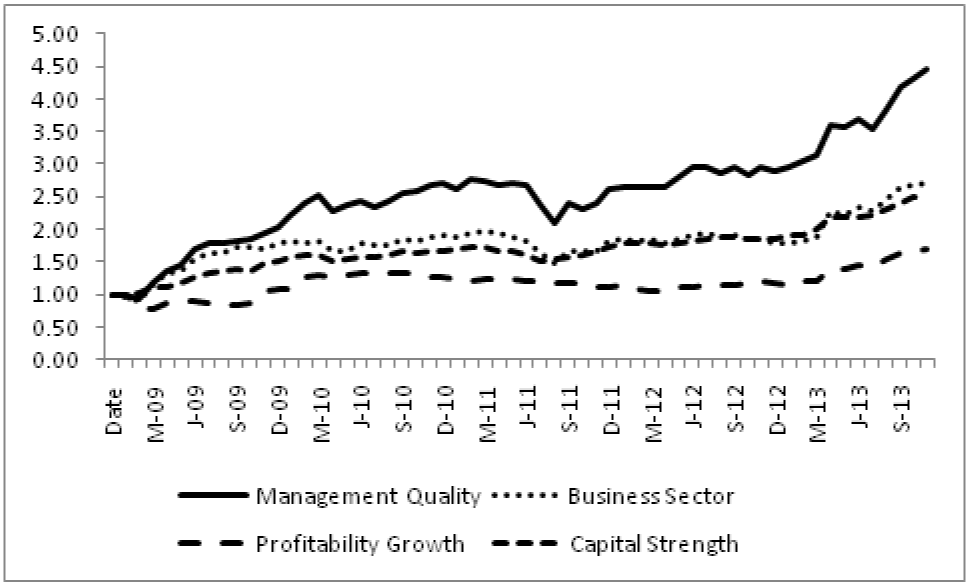
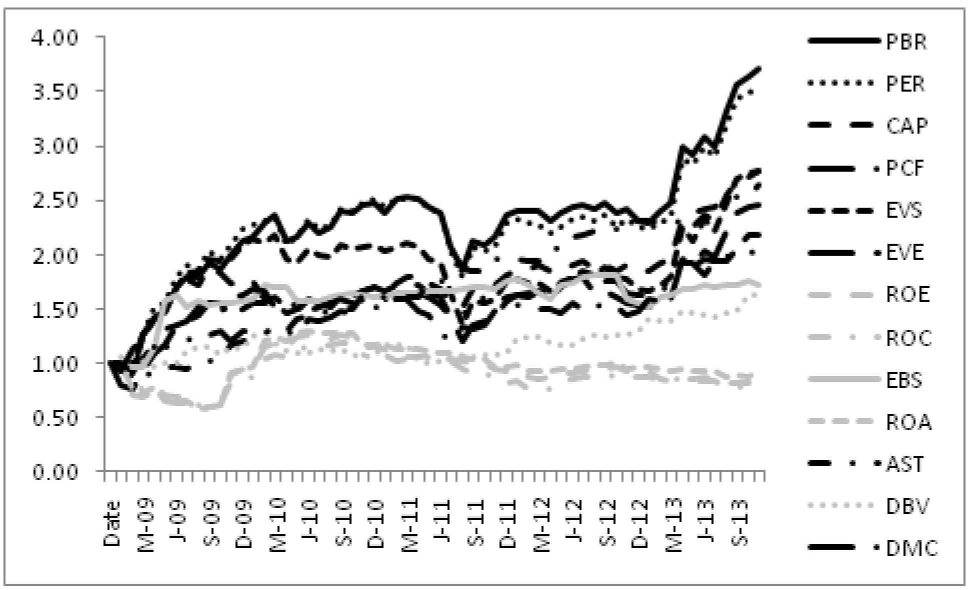
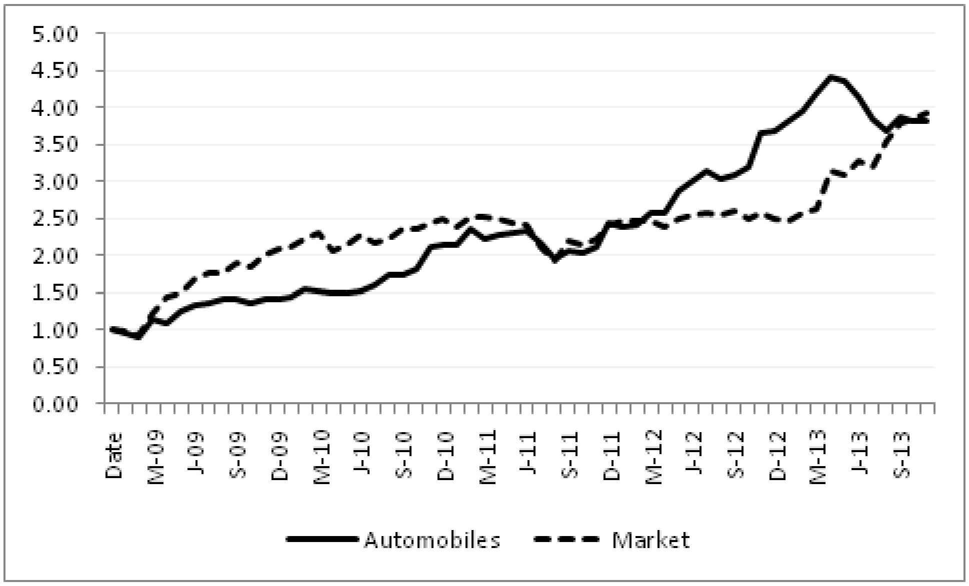


Figure 4.3(a): Cumulative Returns of Musharakah Factors



Note: PBR: Price-to-Book Ratio, PER: Price-to-Earnings Ratio, CAP: Market Capitalization, PCF: Price-to-Cashflow, EVS: Enterprise Value-to-Sales, EVE: Enterprise Value-to-Earnings, ROE: Return-on-Equity, ROC: Return-on-Capital, EBS: Earnings before Interest, Taxes, Depreciation and Amortization-to-Sales, ROA: Return-on-Asset, AST: Total Assets, DBV: Debt-to-Book Value and DMC: Debt-to-Market Capitalization.

Figure 4.3(b): Cumulative Returns of Descriptors



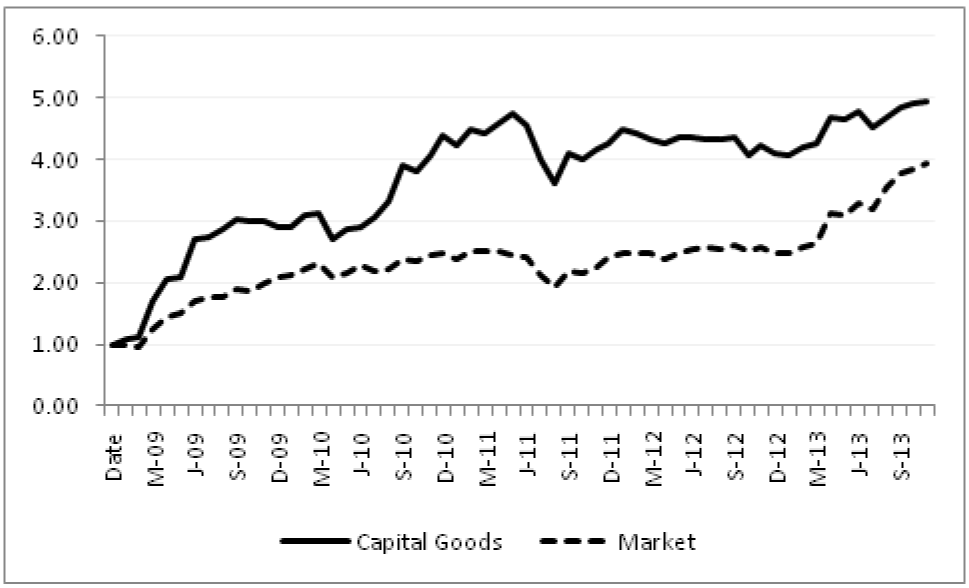
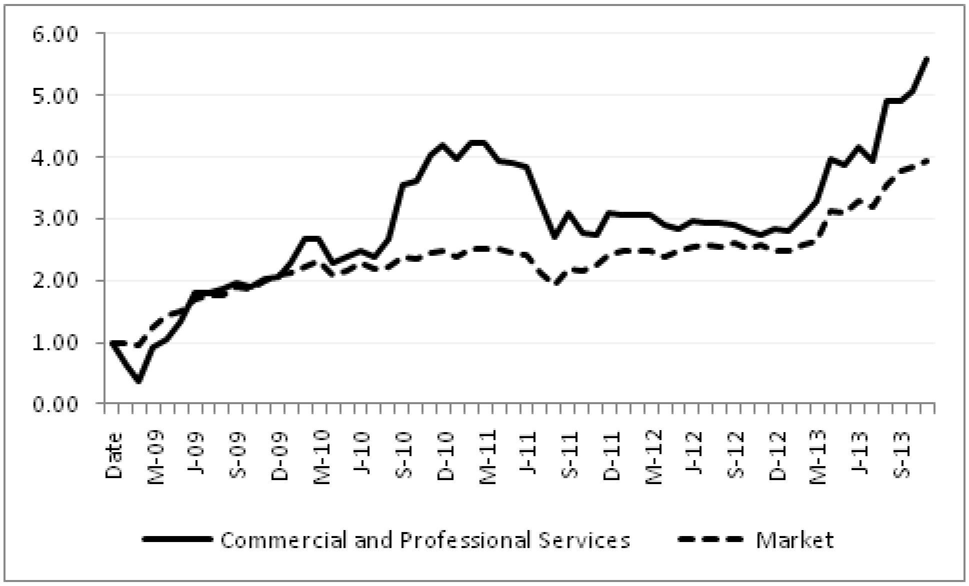


Figure 4.3(c): Cumulative Returns of Business Sector Factors



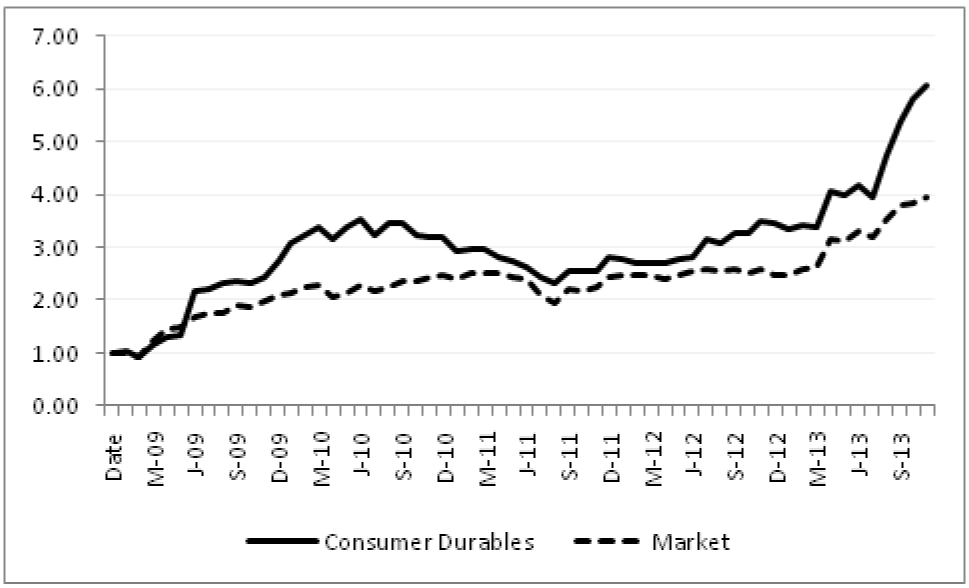
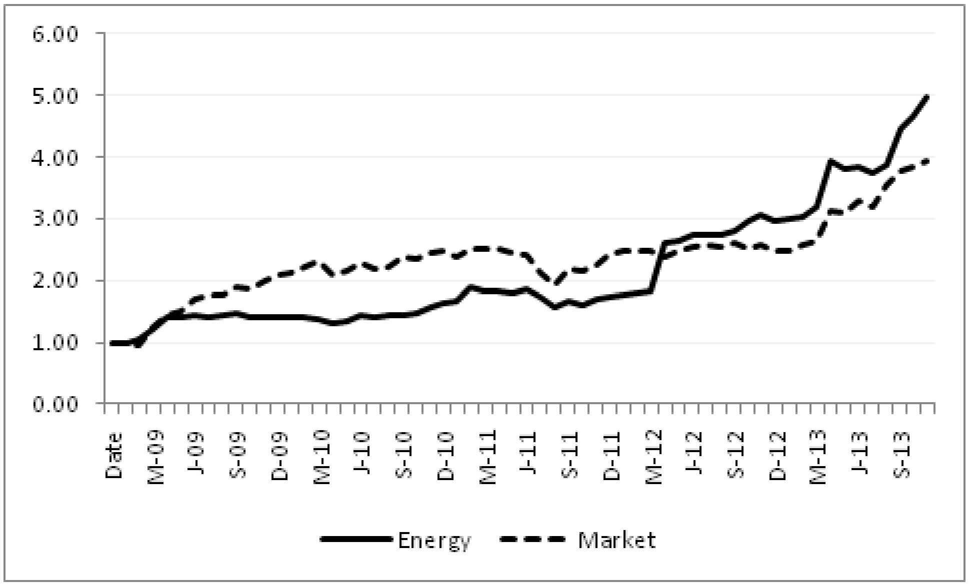


Figure 4.3(c), continued



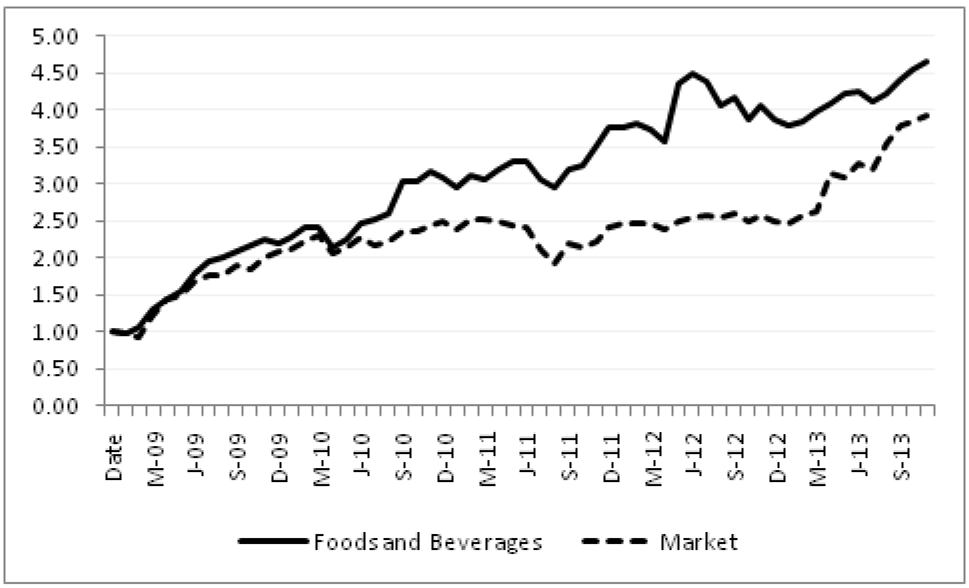
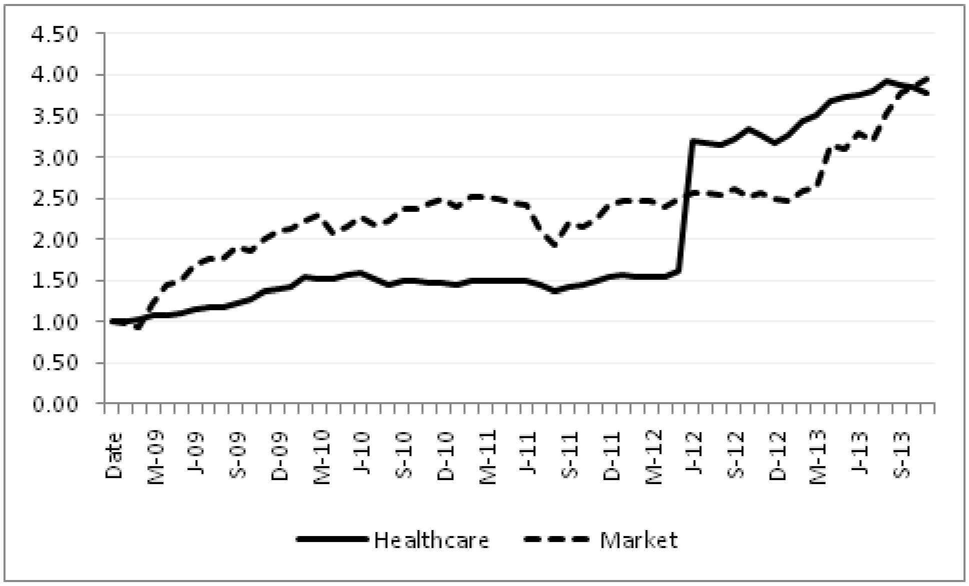
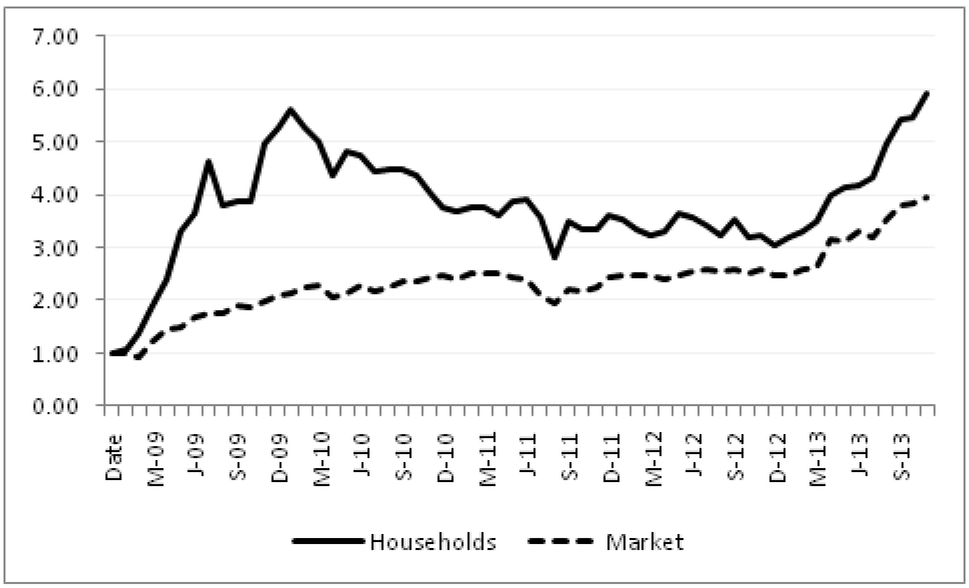


Figure 4.3(c), continued





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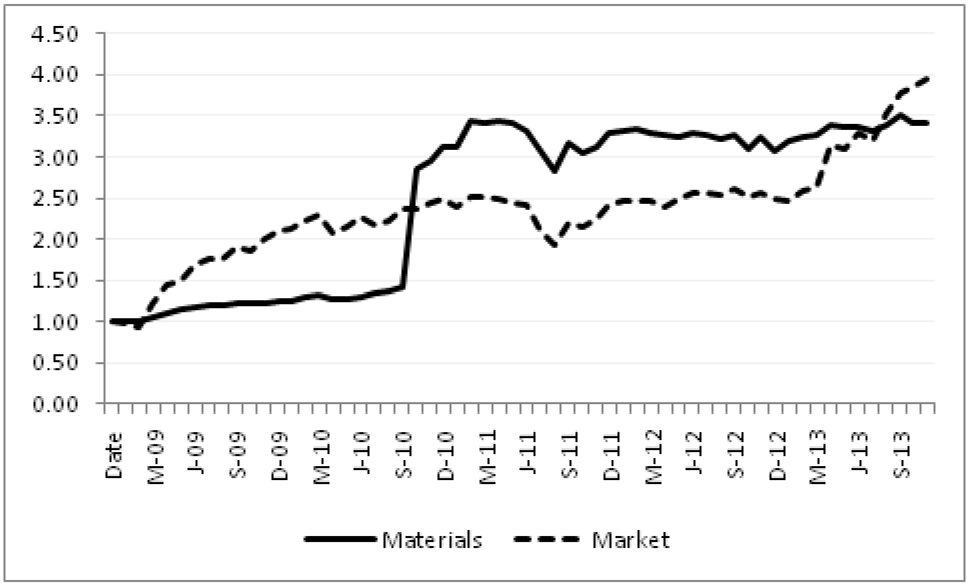

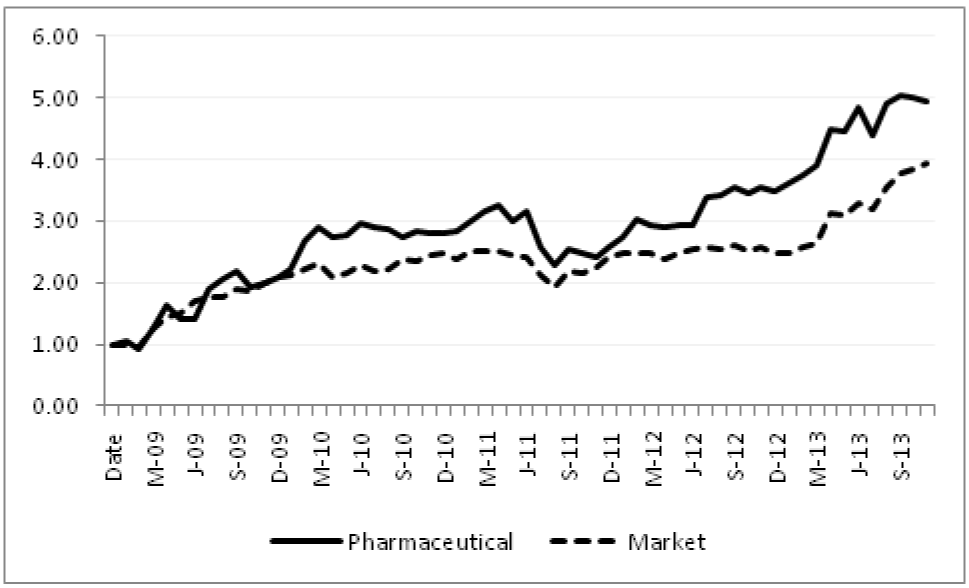

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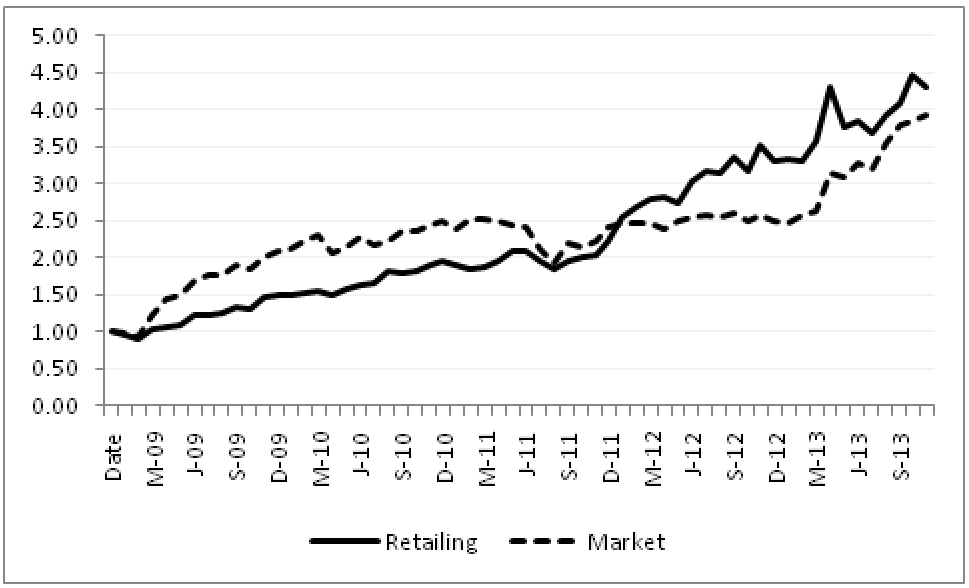

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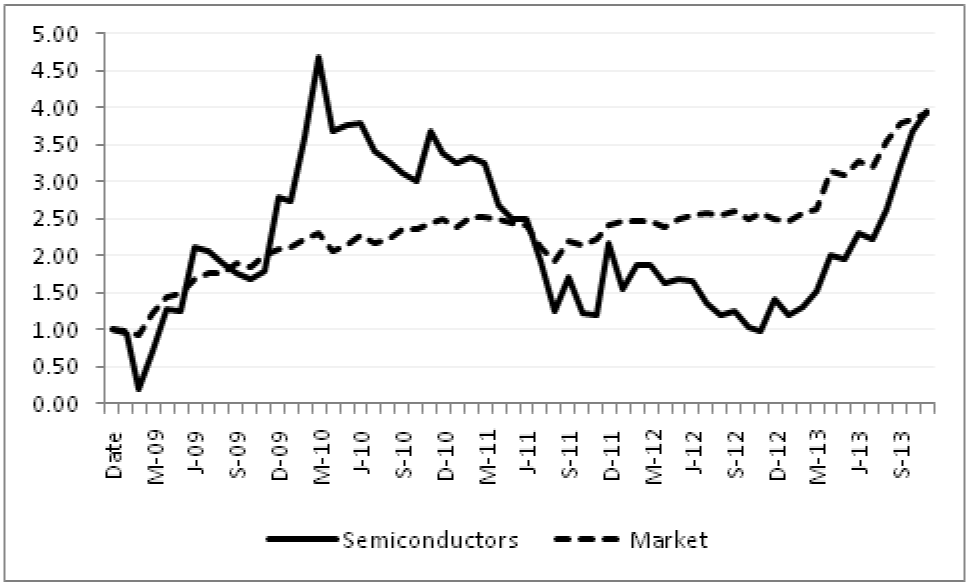

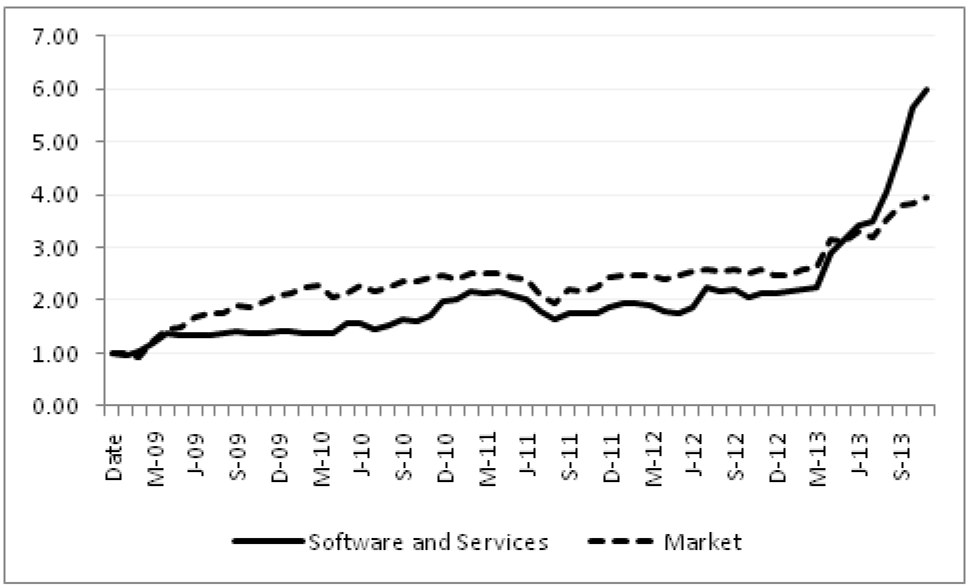

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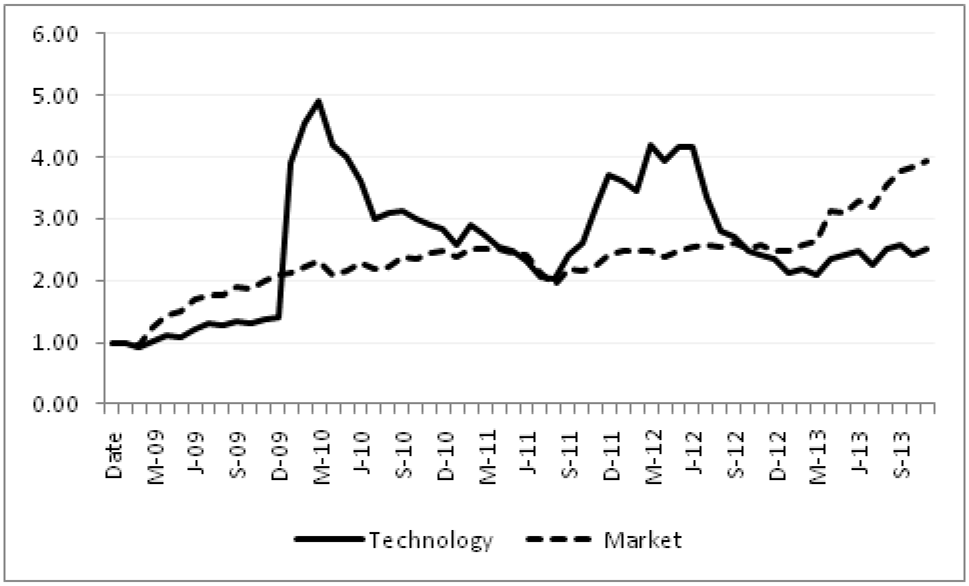

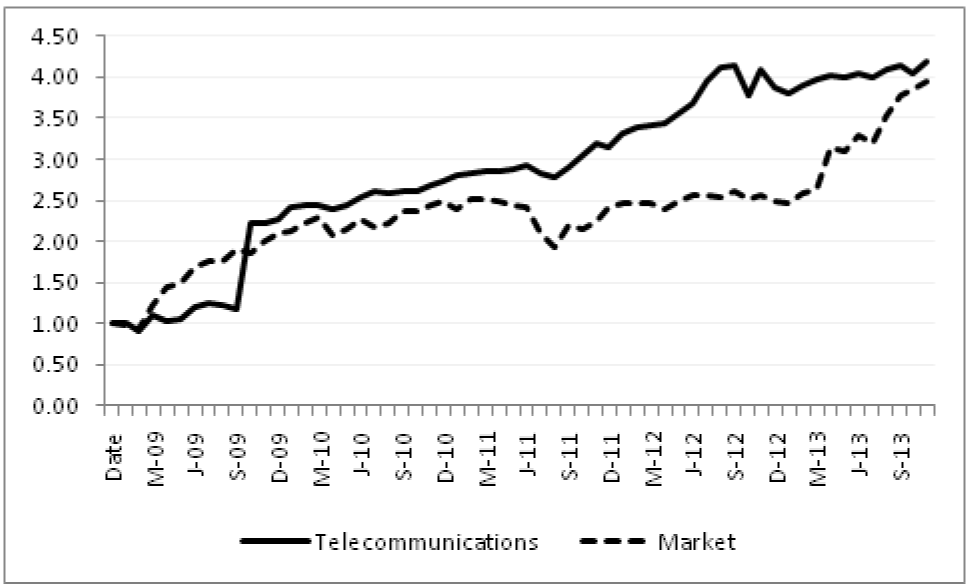

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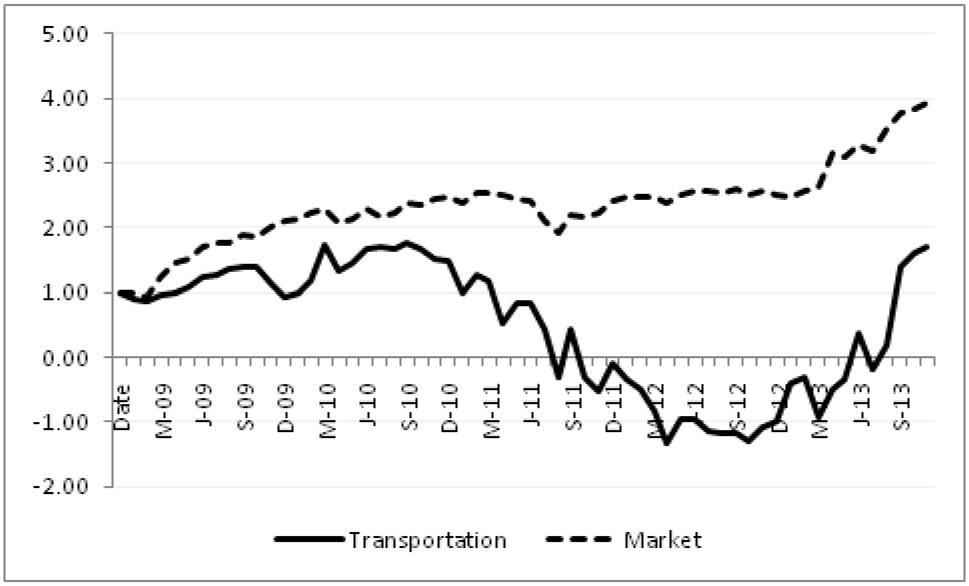

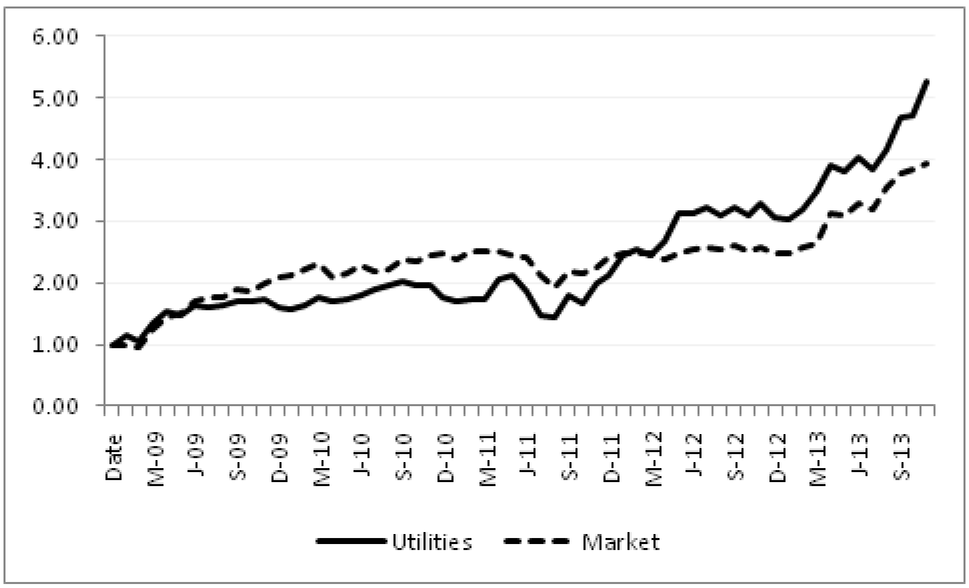

Figure 4.3(c), continued

The factor returns volatility in Table 4.1 presents the estimated factors volatilities on half-two dates (June 2011 and December 2013). As expected, nearly all factor volatilities increased in the second date as it includes a more volatile period in its calculation. Nevertheless, some sectors that are related to heavy industrial such as Capital Goods, Material and Semiconductors show less volatility as they benefited from the global economic recovery particularly demand from developed countries like North America and selected Europe countries.

Table 4.1: Factor Returns Volatility

	June 2011	December 2013
Business Sector	58%	61%
Automobiles	42%	78%
Capital Goods	103%	31%
Commercial	115%	80%
Consumer Durables	83%	99%
Energy	22%	99%
Food and Beverages	69%	45%
Healthcare	19%	103%
Household	120%	76%
Materials	92%	14%
Pharmaceuticals	72%	87%
Real Estate	57%	73%
Retailing	34%	78%
Semiconductors	111%	74%
Software and Services	34%	117%
Technology	122%	69%
Telecommunication	73%	46%
Transportation	32%	84%
Utilities	27%	98%
Management Quality	30%	33%
Profitability Growth	20%	19%
Capital Strength	23%	28%

To gauge the suitability of the variance covariance (VCV) as estimated to the factor return in Figure 4.4 the model plot all the factors and the +/- 1 estimated standard deviation. As shown, the estimated volatility is smooth and responsive, although sometimes breached by the factor movement.

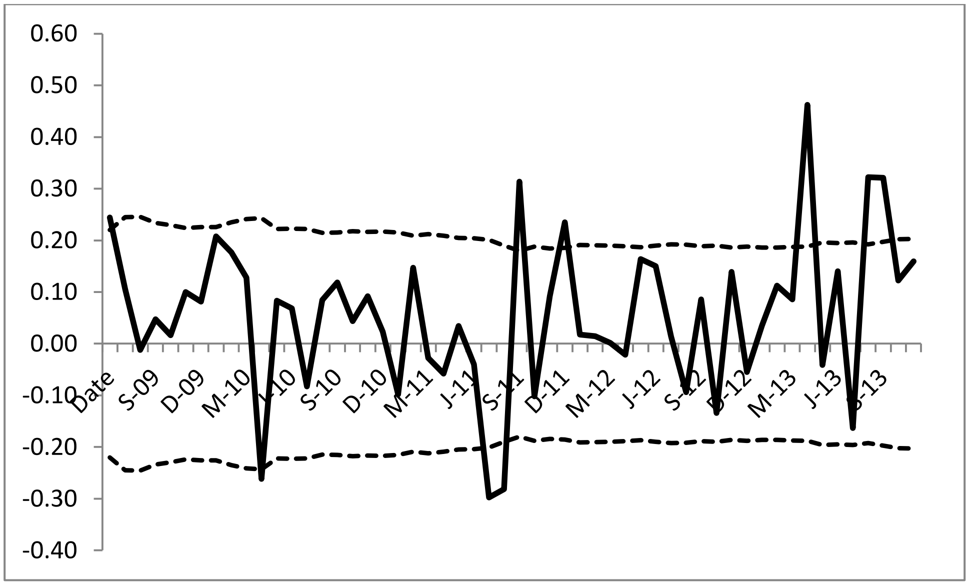

Figure 4.4(a): Stability of Estimated Business Sector Factor

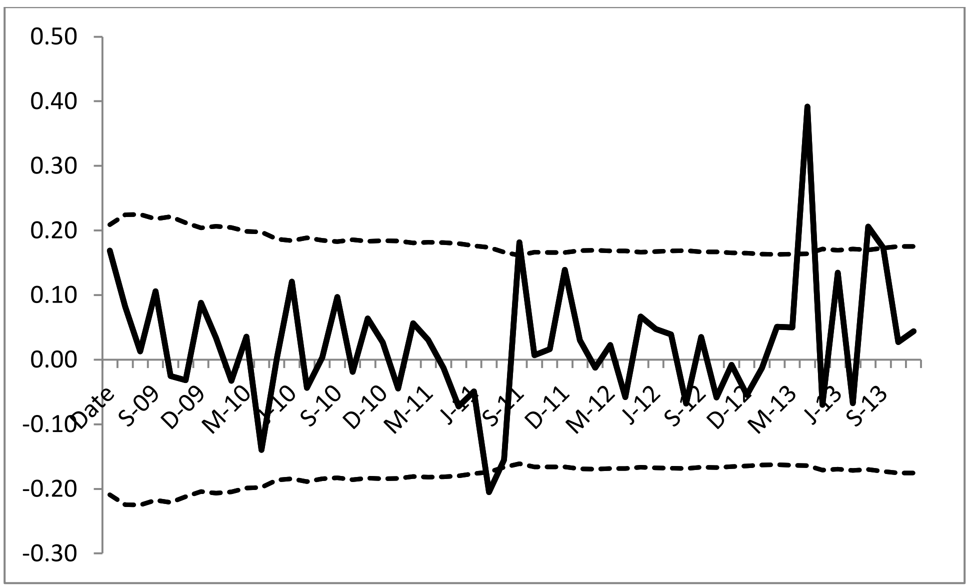

Figure 4.4(b): Stability of Estimated Management Quality Factor

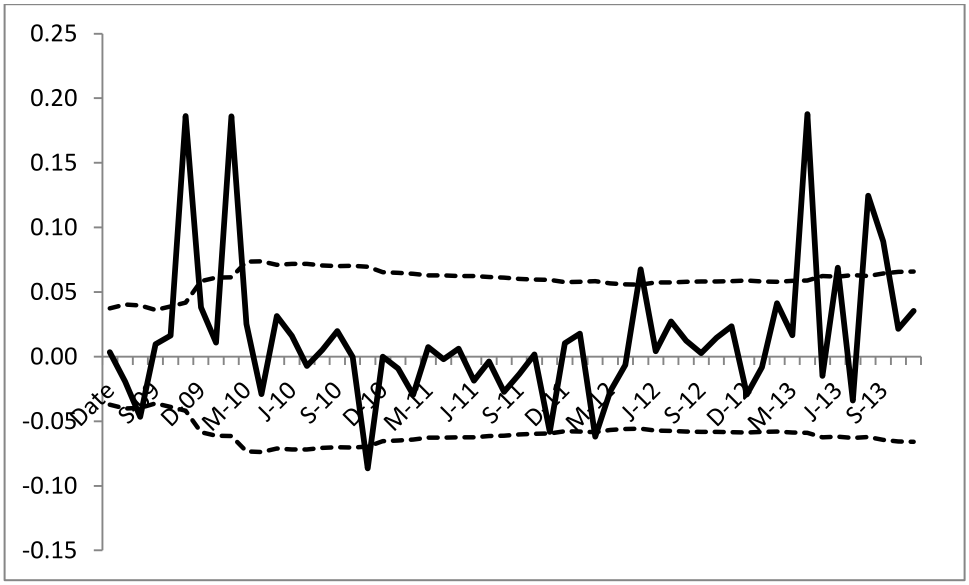

Figure 4.4(c): Stability of Estimated Profitability Growth Factor

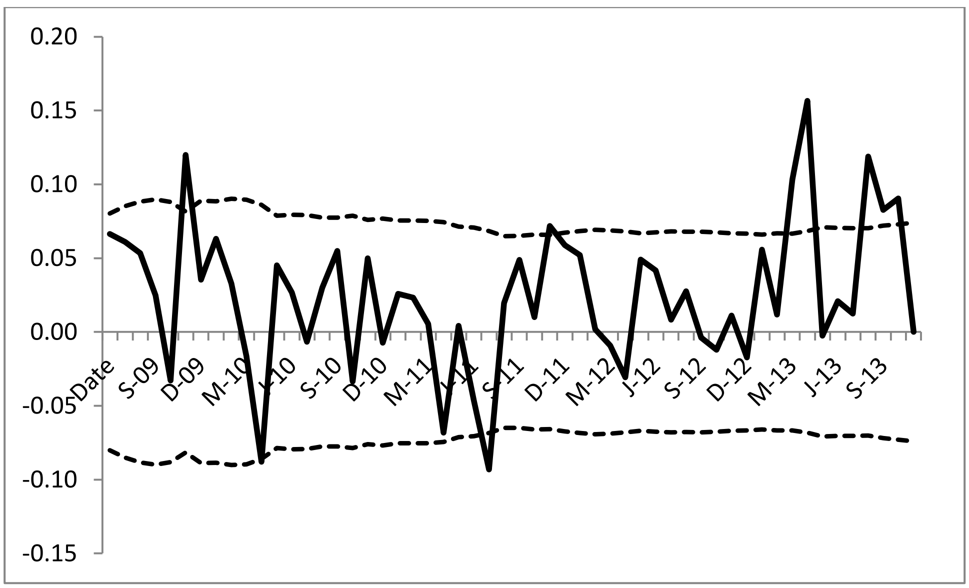

Figure 4.4(d): Stability of Estimated Capital Strength Factor

The common factors based on the *musharakah* principle chosen explain stock returns well in the cross-section and it is significant in dynamic market environments. Examining the statistical significance of factors can help one to judge whether the relevant factors have been chosen. To gauge whether a given factor is significant in explaining the volatility of returns, it performs statistical tests on factor coefficients. The *t*-statistic is constructed as F_k/Standard Error (F_k), where F_k is a factor return to a factor *k*. Under the ordinary least squares assumptions and the null hypothesis that the coefficient should be zero, this statistic should have a student-*t* distribution. If the calculated *t*-statistic is far enough from zero, the model can reject the null hypothesis that the coefficient is zero.

To summarize the results, the model might therefore look for *t*-statistics with absolute values greater than 2, which correspond to a 95% confidence interval. Table 4.2 below presents the mean absolute *t*-statistic for the entire sample, January 2009 to December 2013 for 48-months rolling period. Another summary statistic of factor significance is to look at the percent of the time when the factor's absolute *t*-statistic was deemed significant. The table also presents the percentage of time for which the coefficient was judged significant at the 95% level. To reject that the relationship is purely random we look for values well above 5%. Hence, the Management Quality factors seemed to be responsible for the general dynamics of the explanatory power followed by Business Sector, Capital Strength and Profitability Growth factors respectively.

Table 4.2: Statistical Significant of Musharakah Factors

Factor	Mean Absolute t-stat	Percent of Significant values
Business Sector	6.146	64%
Automobiles	11.448	83%
Capital Goods	13.359	86%
Commercial	16.994	91%
Consumer Durables	21.736	94%
Energy	13.026	86%
Food and Beverages	13.912	87%
Healthcare	9.874	79%
Household	6.001	61%
Materials	8.052	72%
Pharmaceuticals	27.932	96%
Real Estate	15.633	89%
Retailing	13.984	87%
Semiconductors	3.462	41%
Software and Services	14.390	88%
Technology	3.167	38%
Telecommunication	12.957	86%
Transportation	1.483	19%
Utilities	15.454	88%
Management Quality	16.322	91%
Profitability Growth	3.002	38%
Capital Strength	3.760	45%

4.3 Non-factor Risk

Two desirable properties of the non-factor risk estimate are that it be sufficiently stable to yield stable portfolio analytics while, at the same time, remaining sufficiently responsive to capture market changes. The forecast measure above works toward achieving this goal by creating forecasts component using an exponentially-weighted moving average of previous values with a 12-month half-life.

The realized absolute non-factor forecast (the size-weighted average of $|\epsilon_{nt}|$ over all assets) and the forecast value is demonstrated in Figure 4.5. Notably, it does so in a stable fashion throughout the five year period with a different of 41 basis points only.

As demonstrated earlier in Figure 4.2, the sorting ability of non-factor risk through time, which is remarkably high, with correlation between realized and forecast non-factor risk staying above 80% at all times. In a portfolio of a disciplined stock picker who is neutral to the benchmark with respect to all factors, the only active risk remaining is non-factor. This means that a portfolio manager using this model is more likely to allocate risk budget appropriately, helping him or her size his bets.

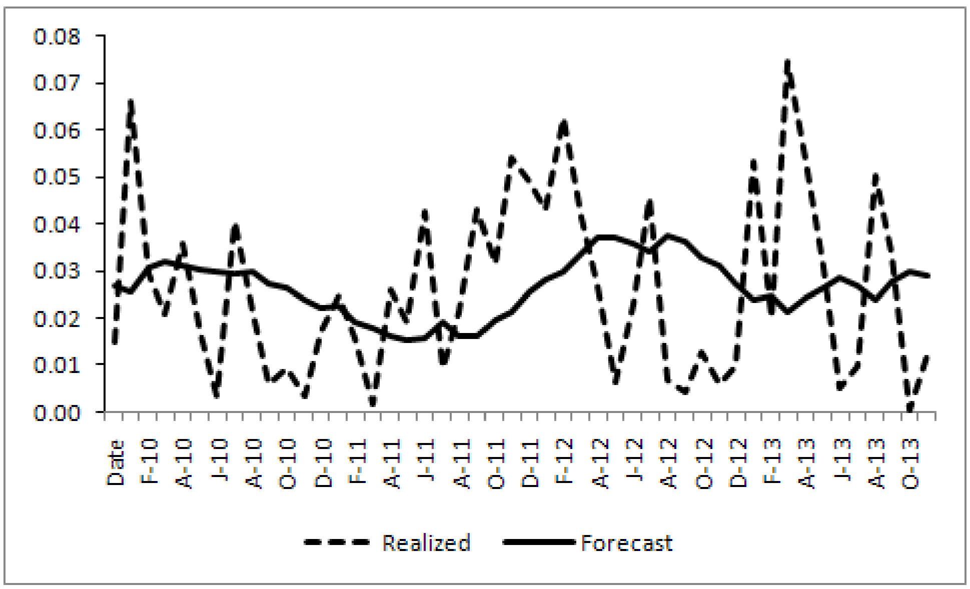

Figure 4.5: Market Average Non-factor Risk Forecast

4.4 Portfolio Bias Tests

Another desirable feature of a risk model is that the bias (defined as standard deviation of return normalized by forecast risk) is roughly equal to one.

$$Bias = \sigma(\frac{Return}{Forecast\ Risk}) \quad \text{(EQ 4-1)}$$

If the bias is close to one, in particular within a band of 1 +/- 0.14, the forecast is considered unbiased (Engle and Ng, 1993). If the bias is far less than one, the forecast risk is considered too high. Conversely, if the bias is far higher than one, the forecast risk is considered too low.

Illustration in Table 4.3(a) below presents the bias statistic for several portfolios (by factor tilt and business sector tilt) during a period of low volatility (January 2009 to June 2011) and a period of high volatility (July 2011 to December 2013). In general, during both low and high volatility periods, the MM risk forecasts are unbiased. During the low volatility period, the model tends to slightly over-estimate risk for the Return-on-Capital portfolio and slightly under-estimate the risk of the Price-to-Book Ratio portfolio. On the other hand, during high volatility period, the model tends to slightly over-estimate risk for the Total Assets portfolio and slightly under-estimate the risk of the Enterprise Value-to-Sales portfolio.

Table 4.3(a): Bias Tests for Descriptors

Type	**Name**	**Jan-2009 to Jun-2011**	**Jul-2011 to Dec-2013**
		Low volatility	High volatility
Management Quality	Price-to-Book Ratio	1.04	0.91
Management Quality	Price-to-Earnings Ratio	1.01	1.01
Management Quality	Price-to-Cashflow	0.98	0.98
Management Quality	Enterprise Value-to-Sales	1.00	1.08
Management Quality	Enterprise Value-to-Earnings	0.98	1.01
Profitability Growth	Return-on-Equity	0.99	0.99
Profitability Growth	Return-on-Capital	0.95	1.02
Profitability Growth	EBITDA-to-Sales	0.98	0.95
Profitability Growth	Return-on-Assets	1.00	1.07
Capital Strength	Market Capitalization	1.01	1.07
Capital Strength	Total Assets	0.98	0.90
Capital Strength	Debt-to-Book Value	1.01	1.01
Capital Strength	Debt-to-Market Capitalization	1.02	1.07

Looking in the industry sectors, during the low volatility period, the model tends to slightly over-estimate risk for the Food and Beverages portfolio and slightly under-estimate the risk of the Household portfolio. In contrast, it tends to slightly over-estimate risk for the Pharmaceuticals portfolio and slightly under-estimate the risk of the Materials portfolio. Nevertheless, the industries such as Capital Goods, Materials and Semiconductors portfolios experience similar level volatility due to impact of the global economic recovery. This is consistent with the discussion earlier where economic recovery will result improvement in capital market. Hence, long term stock market rally may take several years like 3 to 5 years in this case.

Table 4.3(b): Bias Tests for Business Sectors

Sector	**Jan-2009 to Jun-2011**	**Jul-2011 to Dec-2013**
	Low volatility	High volatility
Automobiles	1.06	0.95
Capital Goods	1.01	0.97
Commercial	0.98	0.88
Consumer Durables	1.00	0.98
Energy	1.00	0.98
Food and Beverages	0.85	0.93
Healthcare	1.02	0.94
Household	1.20	1.02
Materials	1.01	1.03
Pharmaceuticals	0.98	0.79
Real Estate	1.08	0.96
Retailing	1.00	0.92
Semiconductors	0.92	0.95
Software and Services	0.94	0.97
Technology	0.94	1.01
Telecommunication	0.95	1.02
Transportation	1.04	0.96
Utilities	1.14	0.98

4.5 Models Comparison

It is clear, as shown in the Table 4.4, that MM is large both from investment returns (Business Sector: 6.8%, Management Quality: 0.8%, Profitability Growth: 6.2% and Capital Strength: 4.2% per month, respectively) and statistical (p-value $\leq$ 0.05) perspectives. Although, the CAPM is statistically significant but the market return is too small. As for the FFM, all the factors i.e. Firm Size and Book Value are not significant and the market return is small negative as well as small positive for the firm size factor.

Table 4.4: Descriptive Statistics of the Models

Panel A. Explanatory Factors in Capital Asset Pricing Model			
	Mean	Std. Dev.	*t*-statistic
Return less risk-free rate	-0.5582	0.6873	-7.8074
Market	-9.3E-17	0.6156	6.8585*
Panel B. Explanatory Factors in Fama French Model			
	Mean	Std. Dev.	*t*-statistic
Return less risk-free rate	-0.5582	0.6837	-0.8334
Market	-9.3E-17	0.6156	1.3244
Firm size	1.1E-16	0.5577	-0.5923
Book value	-7.1E-05	0.5177	-0.9306
Panel C. Explanatory Factors in Musharakah Model			
	Mean	Std. Dev.	*t*-statistic
Return	-0.0544	0.6156	-2.0071
Business sector	0.0676	0.7565	6.1426*
Management quality	0.0088	0.3502	16.3215*
Profitability growth	0.0618	0.2014	3.0014*
Capital strength	0.0042	0.3412	3.7596*

Note: * denotes significant at 5% level.

In addition to the descriptive statistics above, comparison between the three models will be more meaningful by looking into the sorting ability. It started with taking the first half of the period i.e. January 2009 to June 2011 as the estimation universe. Thereafter, it forecast the total return for the period July 2011 to December 2013. As a result, the correlation of forecast with realized return is better for the MM as illustrated in Table 4.5.

Table 4.5: Correlation of Forecast with Realized Return

Model	Correlation
Capital Asset Pricing Model	0.55
Fama French Model	0.69
Musharakah Model	0.85

Further to the correlation investigations, the studies map-out the forecast and realized return for all the models. The CAPM and FFM have shown in the forecast period with a substantial spreads during market side-line. Moreover, the risk-free rate factor contributes to the widen gap between forecast and realized risk. On the other hand, the MM is fitted nicely into the realized returns since the beginning of the forecast period.

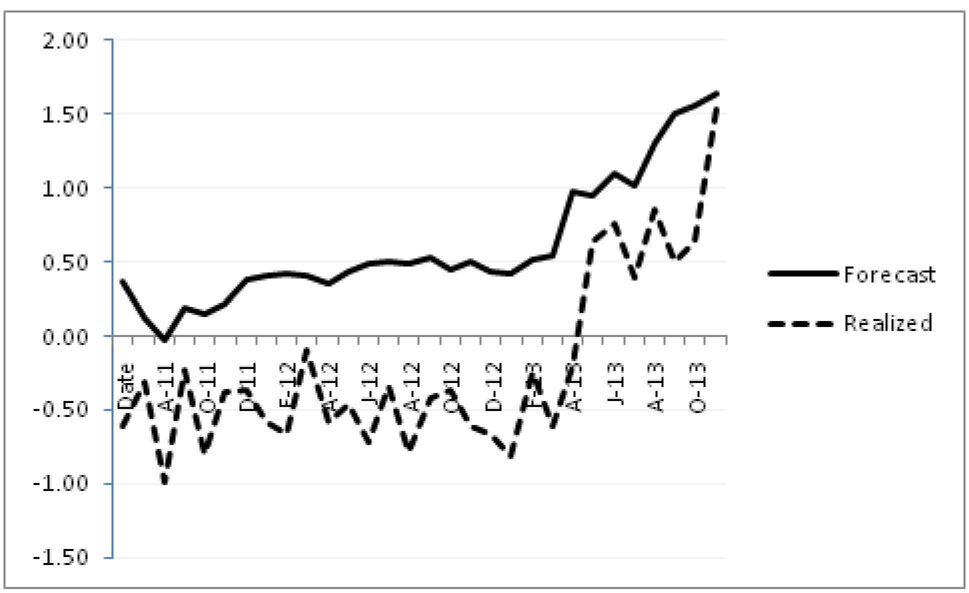

Figure 4.6(a): Forecast and Realized Return for Capital Asset Pricing Model

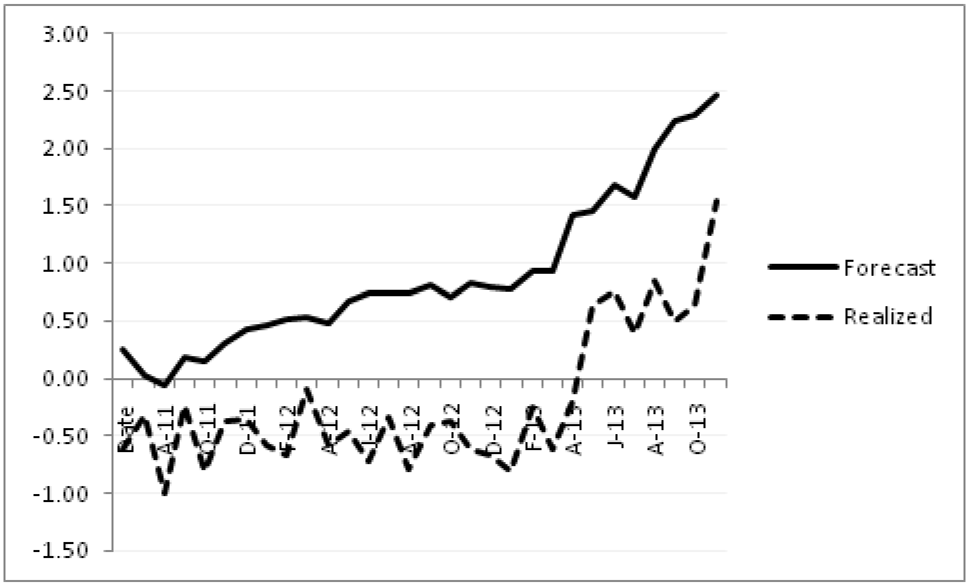

Figure 4.6(b): Forecast and Realized Return for Fama French Model

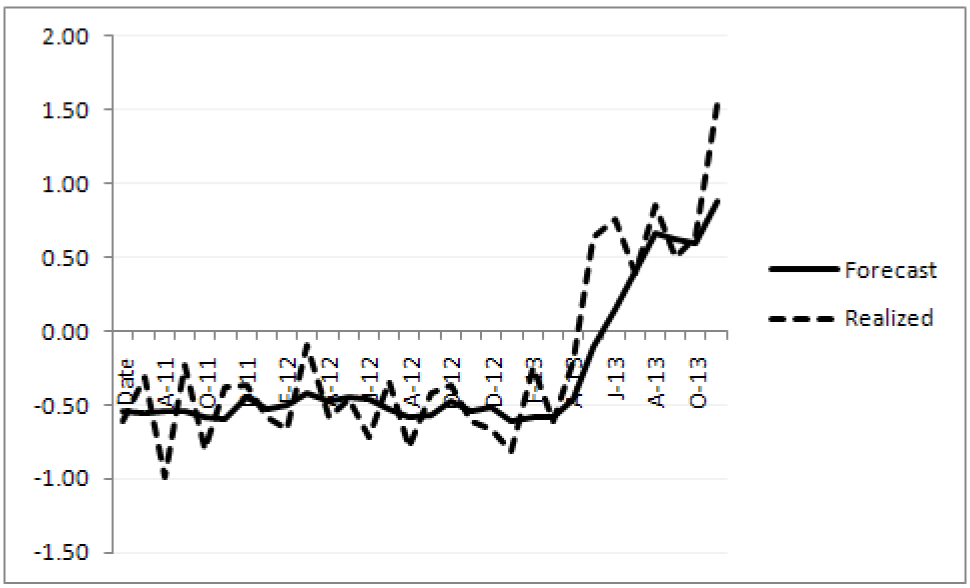

Figure 4.6(c): Forecast and Realized Return for Musharakah Model

4.6 Model Applications

There are various ways for the MM applications that can be used by the investors in managing stocks portfolio. However, this study focuses on application to the performance attribution and analysis as well as to the factor investing.

4.6.1 Performance Attribution and Analysis

Main functions of the MM are for risk decomposition, return attribution and risk forecast. These are delivered by providing the analysis of risk exposures and by explaining the return based on Business Sector, Management Capability, Profitability Growth and Capital Strength factors. More important, investors need to be compensated for every unit of risk consumed with measuring risk adjusted return.

To understand on how investors can apply the model, let's take the stock universe since January 2009 to December 2013. The results suggest that common factor explains the bulk of the sources of risk and return of which Management Capability factor contribute the most. With annualized risk and return of each contribute the largest share; there is consistency with the earlier finding that Management Capability factor contributes the most explanatory power for performance attribution of *Shariah*-compliant stocks. At the same time, investors are getting better return (positive return) for a unit of risk taken during the investment holding period as shown in Table 4.6.

Table 4.6: Portfolio Performance Attribution

Factor	Risk, %	Return, %	Risk Adj. Return
Total	4.55	13.64	3.00
Common Factor	4.53	13.54	2.98
Business Sector Factor	0.13	2.90	0.64
Management Capability Factor	1.99	6.22	1.37
Profitability Growth Factor	1.13	1.18	0.26
Capital Strength Factor	1.27	3.25	0.71
Non-factor	0.02	0.10	0.02

Although the Business Sector factor contributes second least return within the common factor, investors can identify which industry contribute the most. In rebalancing the portfolio, investors can overweight performing industries and underweight the less performing industries as Figure 4.7 illustrate the Business Sector return. Case in point, taking risk in transportation industry does not pay-off since it generates negative return during the investment period. On the other hand, investors get better payoff by investing in Healthcare industry followed by Software and Services as well as Energy industries.

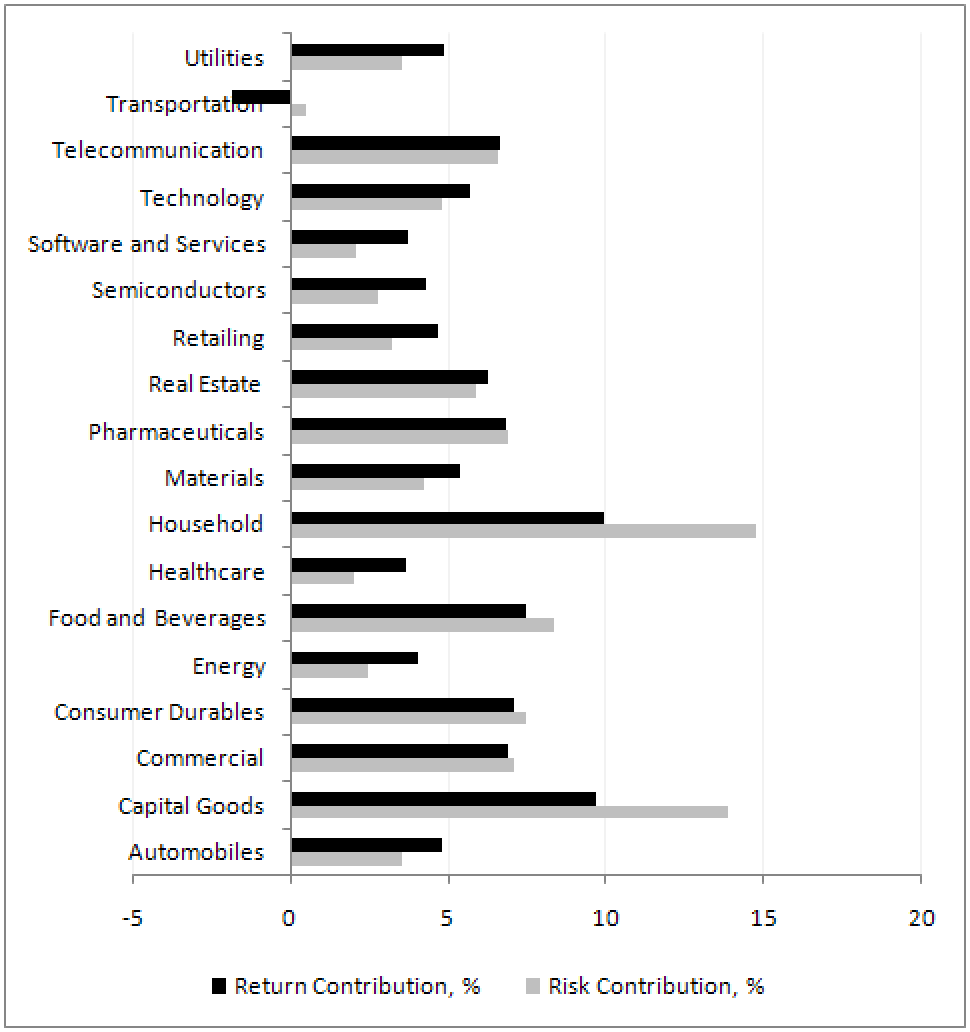

Figure 4.7: Portfolio Performance Attribution of Business Sector Factor

Among the Management Capability factor, Price-to-Book Ratio contributes the largest explanation of the risk and return (see Figure 4.8). The output is similar to Table 3.2(a) shown earlier where the Price-to-Book Ratio has the largest weight in principal component analysis of Management Capability factor.

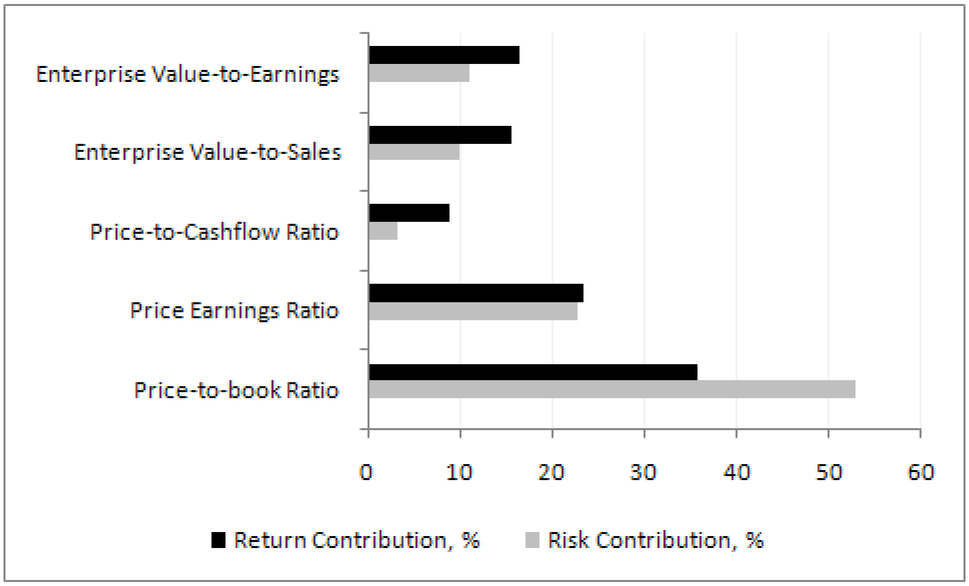

Figure 4.8: Portfolio Performance Attribution of Management Capability Factor

The same results for Figure 4.9 where EBITDA-to-Sales contributes the most for risk and return attributions. Again, the output is consistent with principal component analysis of Profitability Growth factor in which EBITDA-to-Sales weighing the most.

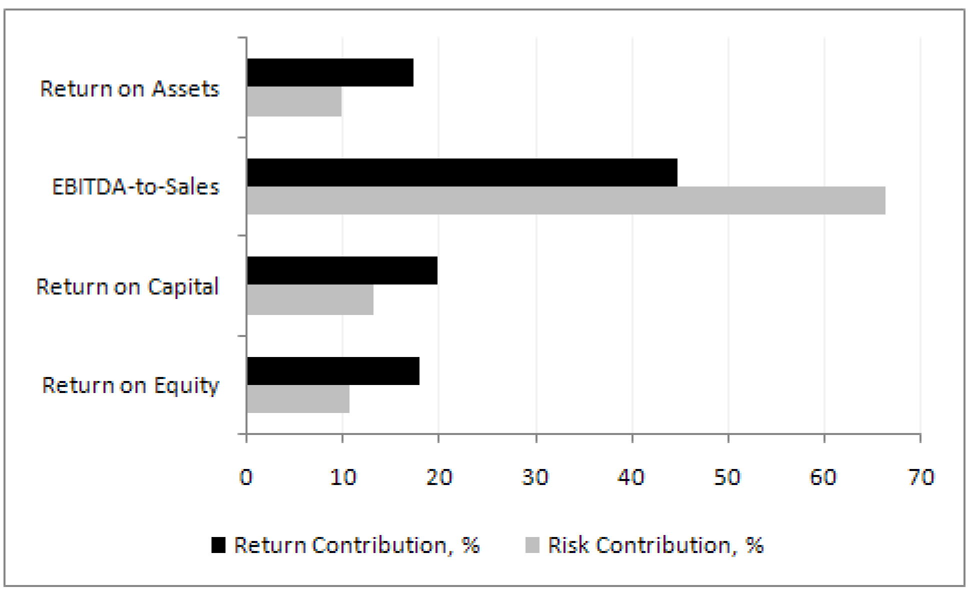

Figure 4.9: Portfolio Performance Attribution of Profitability Growth Factor

As for the Capital Strength factor, the result shows that Market Capitalization contributes the most explanation for the risk and return. Investors could have better performance by overweighting the portfolio in with higher Market Capitalization factor. Nevertheless, this will lead to concentrated risk as Market Capitalization is not always contribute the most or it may not provide higher return for a risk taken.

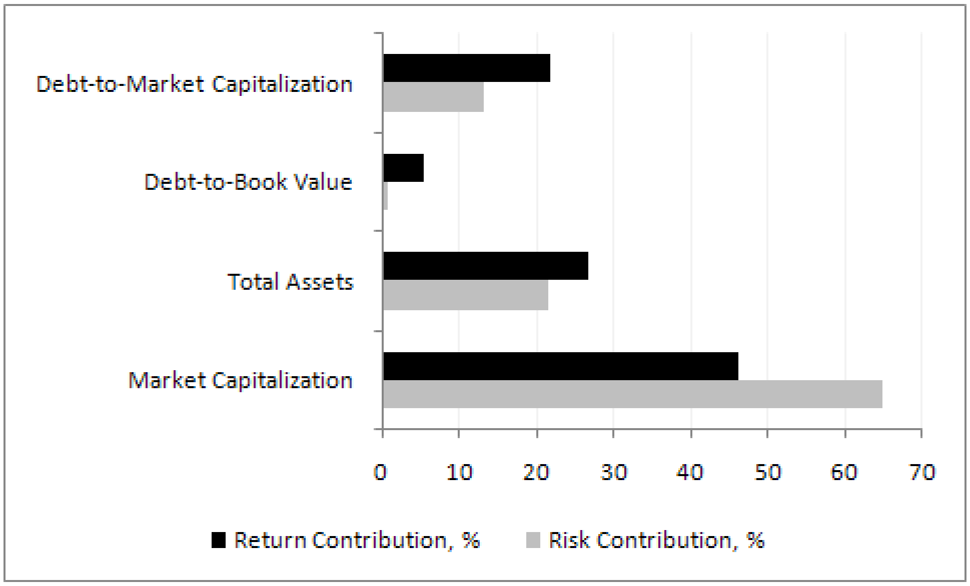

Figure 4.10: Portfolio Performance Attribution of Capital Strength Factor

To recap, the advantage of using multiple descriptors is that it helps to better capture stock factor exposure and gives it more explanatory power. Also, a factor based on a single descriptor may be noisy.

Forecasting the risk requires the matrix algebra formula in determining the variance as shown in EQ 2-22. Using the 12-month rolling as the estimation period, investors can forecast the factor risk and non-factor risk and the results are not far off from the actual results as tabulated in Figure 4.2. Given the accuracy of the risk forecast, investors can control the risk by reducing the unintended risk and at the same time optimizing the returns. Figure 4.11 below shows that automotive sector portfolio of Equal Risk Weighted Portfolio performs better than Market Capitalization Weighted Portfolio by an average of 3.09% per annum.

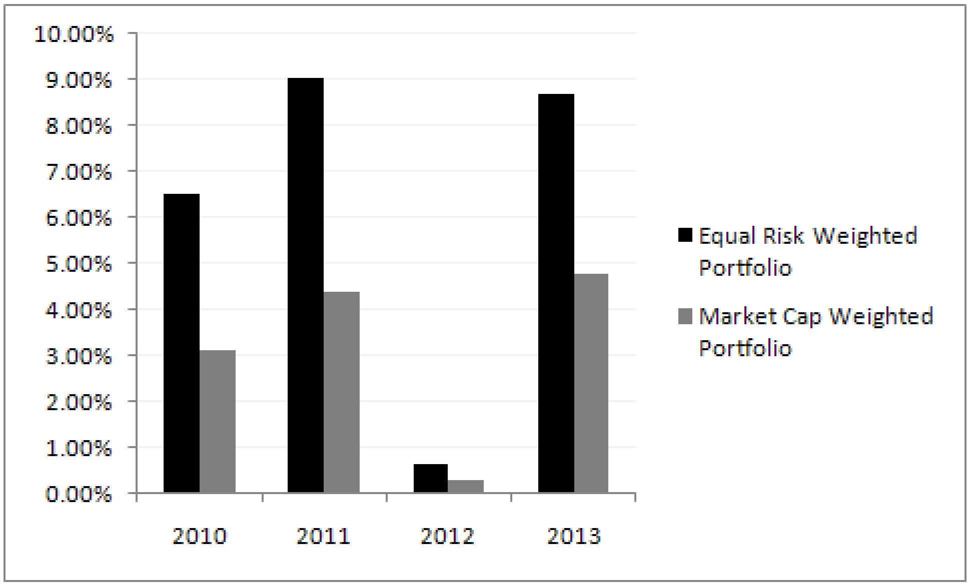

Figure 4.11: Risk Adjusted Return of Different Portfolios

4.6.2 Factor Investing

In the MM, for instance, all four factors are able to give explanations to the stock returns although some factor does not provide investment returns over and above the market benchmark or index over longer term period. For example, as tabulated in Figure 4.12, factors such as Profitability Growth, which distinguishes between highly profitable companies and money losers, has not perform better than the market benchmark over longer term horizons. Hence, the exposure to this type of factor should be reduced although factors can be cyclical similar to market capitalization based investing similar to Arnott findings (2011).

Several authors like Arnott, Hsu, & Moore (2005) disputed that stock market capitalization investing essentially imperfect and should be replaced with factor allocations for better investment returns. This study views it differently. First, a stock's market capitalization strategy provides opportunity set of stocks portfolio and reflects aggregate investments of the entire investors. Stocks investor would like to know the performance of stocks market, the market capitalization index will be a good indicator for that. Second, market capitalization strategy that mimicking the market capitalization index is macro-consistent where investors need to have for broad market exposure.

Although factor based strategy cannot provide the entire stocks opportunity set and do not reflect macro-consistent, it embodies a strategic stocks portfolio allocation that diverse against stocks market capitalization index. Figure 4.12 below gives the investors another perspective to consider factor investing as compared to market capitalization based investing. Management Quality Factor Index and Capital Strength Factor Index have higher annual returns (118% and 92% respectively) and higher volatility (26.37 and 22.60 respectively) while Profitability Factor Index has lower returns (33%) and lower volatility (8.04). Thus, the factor investing strategy generates outperformance market capitalization investing strategy with return of 59% and volatility of 22.31.

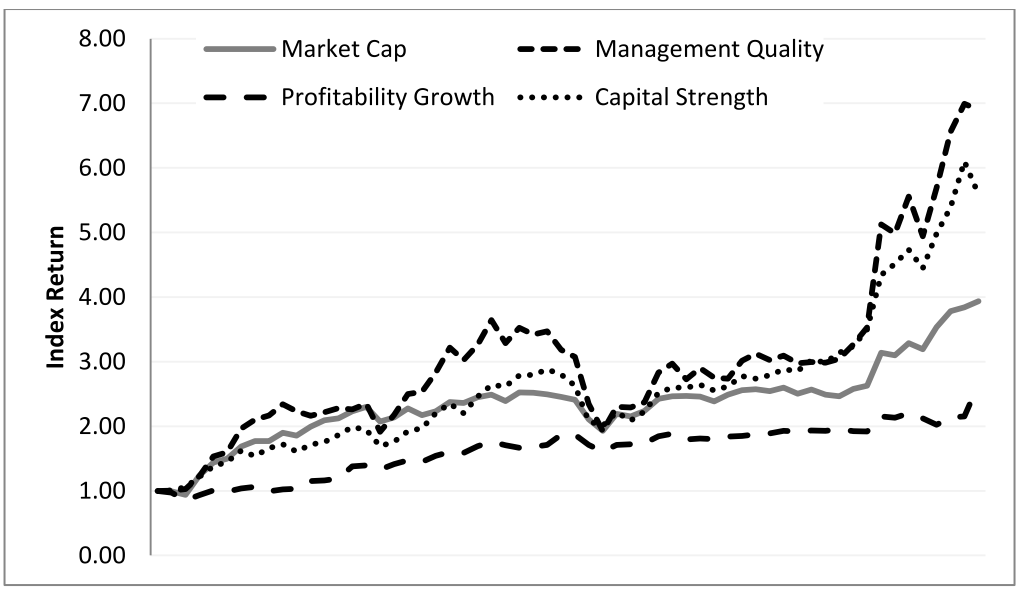

Figure 4.12: Factor Indexes and Market Capitalization Index Returns, January 2009 to December 2013.

An important observation is the factor cyclicality over the period of study. Although the factor indexes generate better investment returns in longer term horizons generally, over shorter term periods those factors show a considerable cyclicality with lower investment returns in some cases. As show in Figure 4.12, it observes that Capital Strength factor has registered lower investment returns in the earlier periods as compared to stocks market capitalization index. On the other hand, Profitability Growth factor has underperformed the other factors as well as the market capitalization index throughout 2009 till 2013.

CHAPTER 5: CONCLUSION

This chapter illustrates the main findings with regard to the research questions and describes the empirical findings based on the rigorous research approach. Moreover, it considers strengths and limitations of this study and offers recommendations for future research work.

5.1 Empirical Findings

This study set-out that a *musharakah* based multi factor equity model, when applied to *Shariah*-compliant stocks in Malaysia, can increase the model explanatory power of risk and return. Although this study does not intent to suggest stock buying and selling recommendation, the results compellingly demonstrate that investors can use the *musharakah* factors to decompose risk and return as well as to predict risk of a stock.

Current volatile market requires a new multi factor model that is responsive and stable throughout market cycles. Hence, how do we develop the model? In addressing that concern, this study develops a *musharakah* based multi factor equity model where it is carefully constructed from four key essential elements: Business Sector, Management Quality, Profitability Growth and Capital Strength. This structure is chosen to be intuitive and with fully transparent methodology. It starts by noting that stocks with similar characteristics should have similar returns and risks. This similarity between stocks is defined by similarity of their attributes in *musharakah* factors. Thereafter, the model estimates or implies factor returns by running the cross sectional regression for each returns period.

Shariah-compliant stocks share common factors and these are represented by the respective financial descriptors for multi factor model. So, what are the common factors and its financial descriptors? To answer these, four factors tabulated from *musharakah* principle show that each time a factor been added the multiple determination coefficient increases persistently throughout the period. Nevertheless, this need to be treated carefully as additional variable in most cases may contribute to increase in R-squared. In this study, contribution of the factors seems to be consistent over the rolling periods. Moreover, the multiple determination coefficients improved tremendously with longer estimation period as it average down the noise. Another suitability measure such as variance covariance suggests that the estimated volatility is smooth and responsive, although sometimes breached by the factor movement. With that the common factors chosen explain stocks returns well in the cross-section and it is significant in dynamic market environments. On the other hand, the non-factor risk estimate is sufficiently stable to yield stable portfolio analytics and at the same time remain sufficiently responsive to capture market changes.

Musharakah based multi factor equity model opened a new approach to risk attribution and return decomposition. What will be the overall model performance? The model has high explanatory power for contemporaneous returns, maintains high forecasting ability in high and low volatility environments and stays unbiased with no significant under-forecasting or over-forecasting of risk for a broad variety of portfolios. As compared to CAPM and FFM, correlation study shows that the forecast and realized return is better for MM and fitted nicely into the realized returns since the beginning of forecast period.

This model has shown its high explanatory power and forecasting ability. However, how investors can make use of it? There are various ways for the model applications. Nonetheless, this study focuses on performance analysis and factor investing. First, main functions of the MM are for risk decomposition, return attribution and risk forecast. These are delivered by providing the analysis of risk exposures and by explaining the return based on the *Musharakah* factors. More important, investors need to be compensated for every unit of risk consumed with measuring risk adjusted return. Second, the study transforms these factors into indexation for better analysis and performance measurement. It suggests that these factor indexes have historically earned excess returns over market capitalization weighted indexes and experienced higher Sharpe Ratios.

Thus, by fulfilling the research objectives and questions, the study has filled the gap and extended the literature on the *Shariah* investing, and thereby contributed to the body of knowledge and development of Islamic finance as a whole.

5.2 Limitations of the Study

One of the methods used is to require that a stock must be *Shariah*-compliant throughout the estimation period. As a direct consequence of this methodology, it will limit the newly listed company from being part of the modeling. Hence, same technique as treating missing data could be used. It can be done by inferring the descriptor value based on another company with similar information, such as the stock's business sector membership, company size, and other available factors. Other limitation is the period under study i.e. January 2009 to December 2013 where the stock market cycle had not experiencing a severe market downturn as well as market rally. However, it suffices to see that there was a market correction during the period of second quarter to fourth quarter of 2011.

5.3 Recommendations

Although, the model performance of MM has shown remarkable results it is however centered to Malaysian stocks market only. Therefore, a study on other markets is vital to conclude that the multi factor equity model based on *musharakah* principle or the MM itself works in any given stock market. Perhaps a study on other markets or regions like Kingdom of Saudi Arabia or Southeast Asia region where Islamic finance is more prominent will be a good start. To some extent, the research could be applicable to *sukuk* (Islamic bond) that based on *musharakah* principle.

5.4 Concluding Remarks

Despite the existence of long established multi factor models, the MM has shown that it has greater explanatory power although with the absence of risk-free rate framework particularly in Malaysian stocks market. Moreover, it goes well with those who subscribe to principle based investing.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Paper A: The Asset Pricing Model of Musharakah Factors

Simon, S., Omar, M., & Lazam, N. M. (2015) The Asset Pricing Model of Musharakah Factors. In: AIP Conference Proceedings Vol. 1643. (2015) *The 2nd ISM International Statistical Conference (ISM-II)*. MS Garden Hotel, Kuantan, Pahang, Malaysia, 12-14 August 2014, New York: AIP Publishing LLC, pp. 594-601.

Paper B: Factor Investing Based on Musharakah Principle

Simon, S., Omar, M., Lazam, N. M., & Mohd, M. N. A. (2015) Factor Investing Based on Musharakah Principle. In: AIP Conference Proceedings Vol. 1682. (2015) *The 22nd National Symposium on Mathematical Sciences (SKSM-22)*. Grand BlueWave Hotel, Shah Alam, Selangor, Malaysia, 24-26 November 2014, New York: AIP Publishing LLC, pp. 30005-30009.

APPENDIX

Appendix A: Descriptive Statistics

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Return	60	100.0%	0	0.0%	60	100.0%
Business_Sector	60	100.0%	0	0.0%	60	100.0%
Management_Quality	60	100.0%	0	0.0%	60	100.0%
Profitability_Growth	60	100.0%	0	0.0%	60	100.0%
Capital_Strength	60	100.0%	0	0.0%	60	100.0%

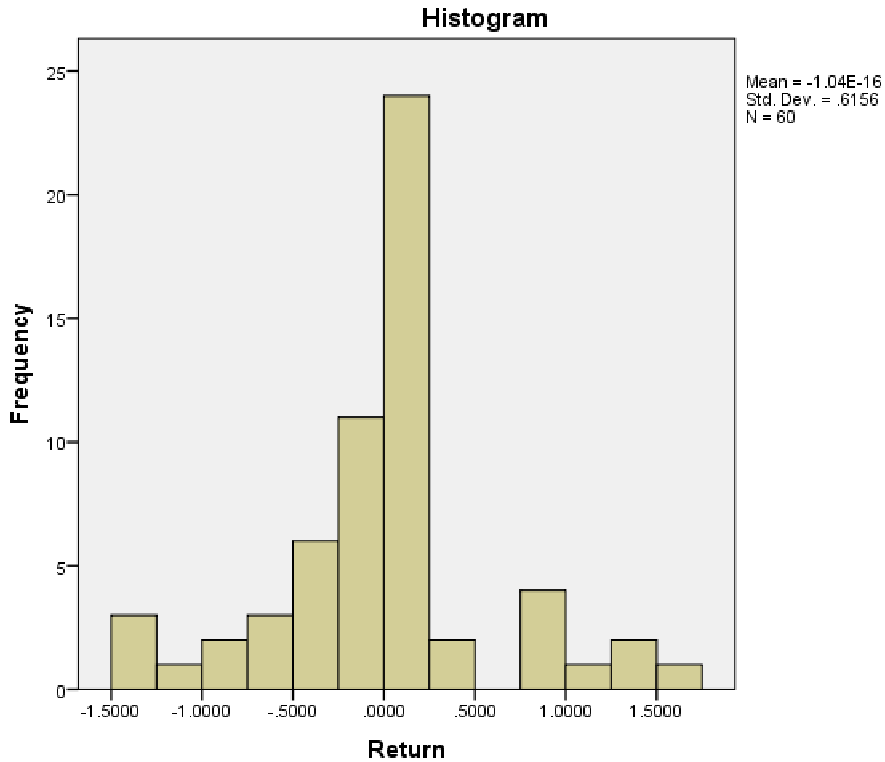
Tests of Normality

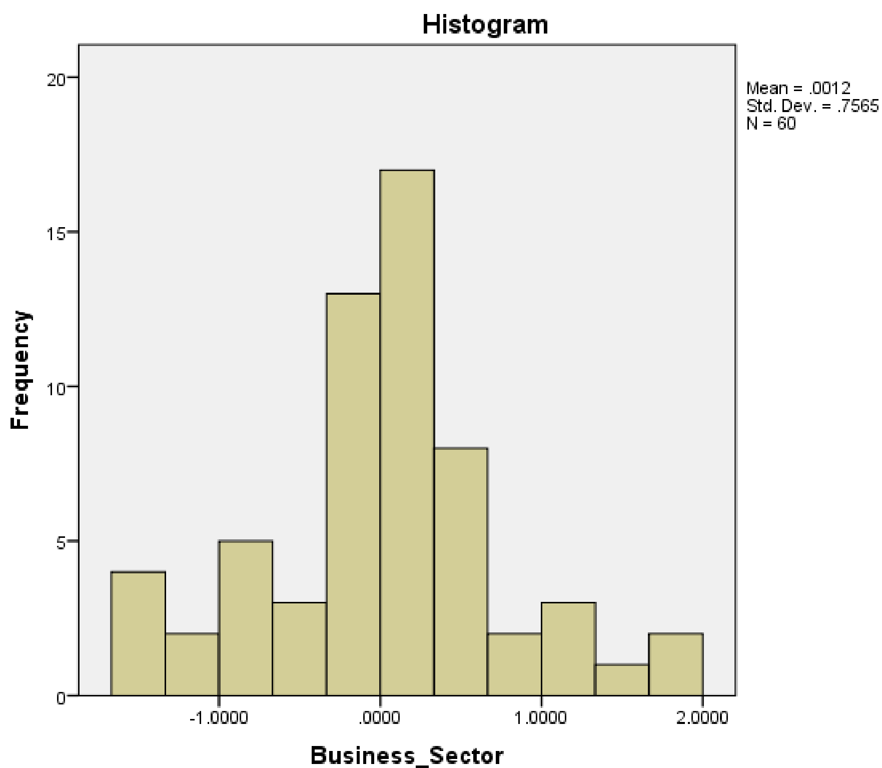
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Return	.192	60	.000	.928	60	.002
Business_Sector	.131	60	.012	.962	60	.058
Management_Quality	.199	60	.000	.895	60	.000
Profitability_Growth	.079	60	.200*	.967	60	.105
Capital_Strength	.113	60	.053	.961	60	.051

*. This is a lower bound of the true significance.

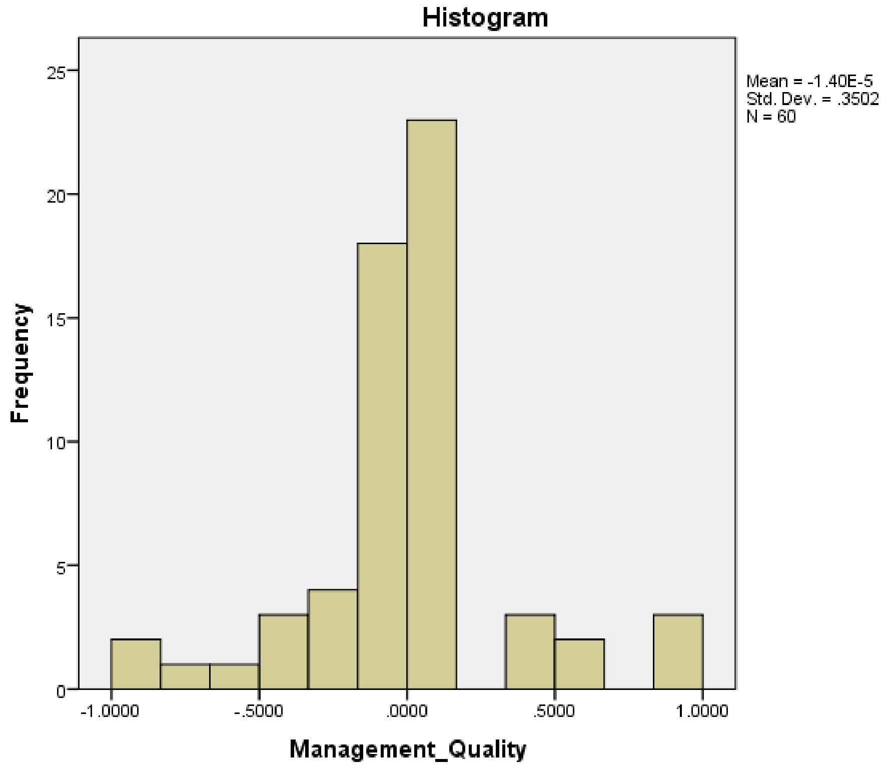
a. Lilliefors Significance Correction

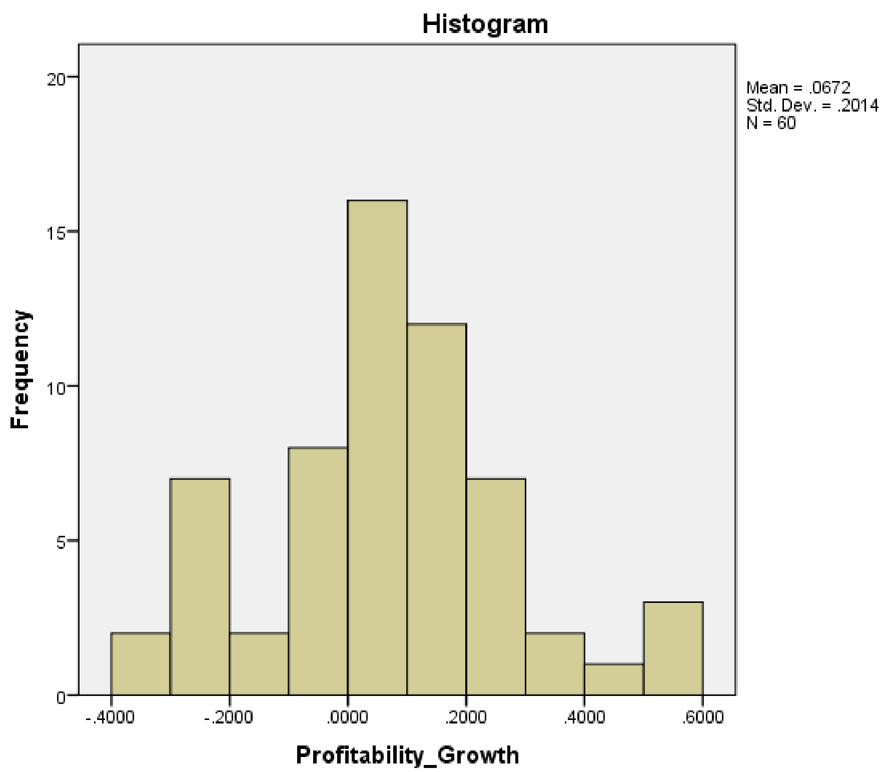
Appendix A, continued





Appendix A, continued





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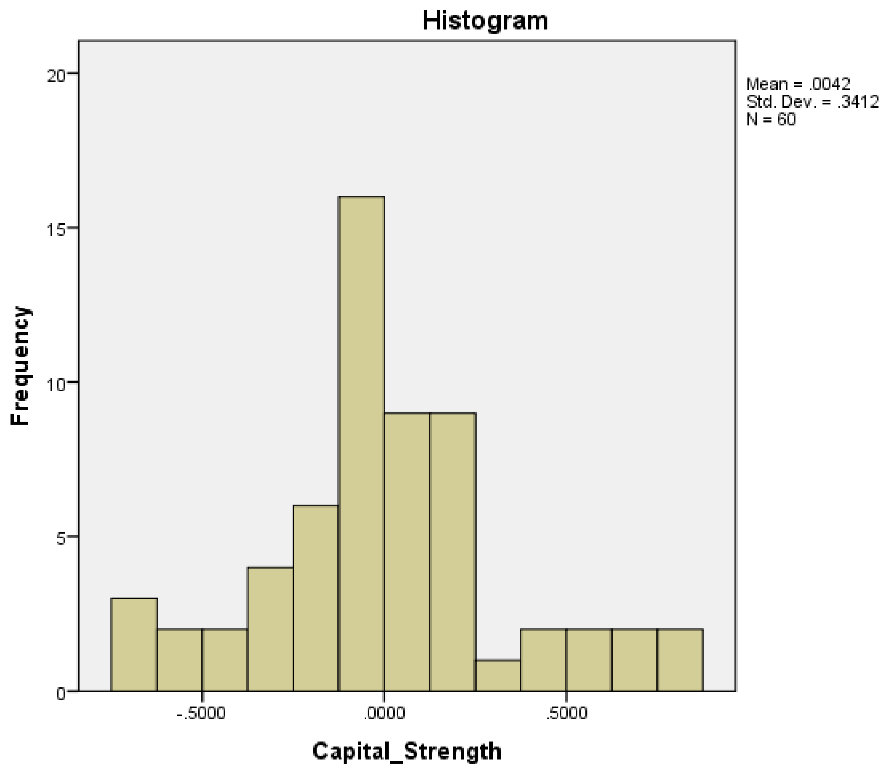


Appendix A, continued

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
PBR	60	100.0%	0	0.0%	60	100.0%
PER	60	100.0%	0	0.0%	60	100.0%
PCF	60	100.0%	0	0.0%	60	100.0%
EVS	60	100.0%	0	0.0%	60	100.0%
EVE	60	100.0%	0	0.0%	60	100.0%
ROE	60	100.0%	0	0.0%	60	100.0%
ROC	60	100.0%	0	0.0%	60	100.0%
EBS	60	100.0%	0	0.0%	60	100.0%
ROA	60	100.0%	0	0.0%	60	100.0%
CAP	60	100.0%	0	0.0%	60	100.0%
AST	60	100.0%	0	0.0%	60	100.0%
DBV	60	100.0%	0	0.0%	60	100.0%
DMC	60	100.0%	0	0.0%	60	100.0%

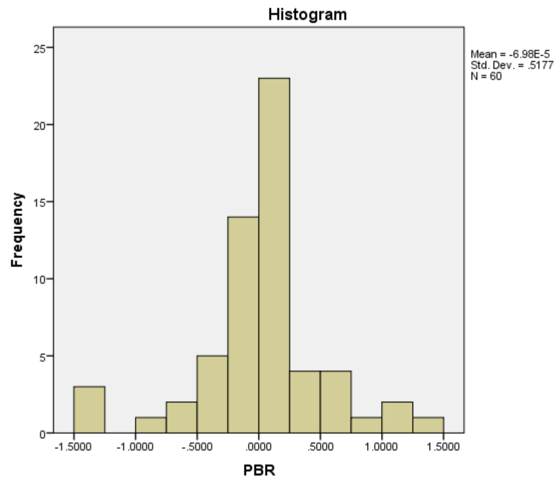
Tests of Normality

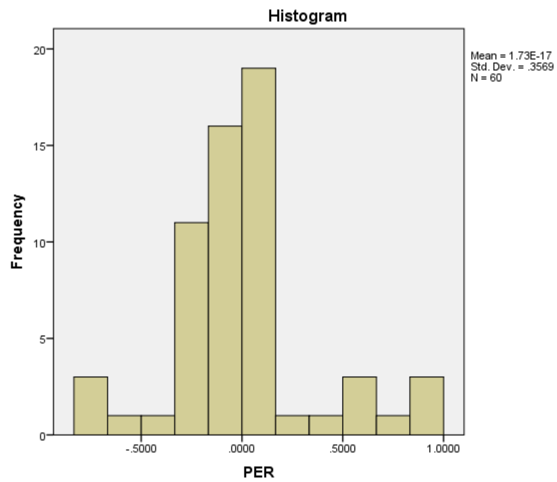
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PBR	.175	60	.000	.910	60	.000
PER	.189	60	.000	.906	60	.000
PCF	.123	60	.025	.974	60	.223
EVS	.107	60	.084	.954	60	.023
EVE	.167	60	.000	.915	60	.000
ROE	.079	60	.200*	.966	60	.093
ROC	.159	60	.001	.958	60	.039
EBS	.260	60	.000	.685	60	.000
ROA	.140	60	.005	.945	60	.009
CAP	.200	60	.000	.917	60	.001
AST	.097	60	.200*	.944	60	.008
DBV	.144	60	.003	.898	60	.000
DMC	.181	60	.000	.924	60	.001

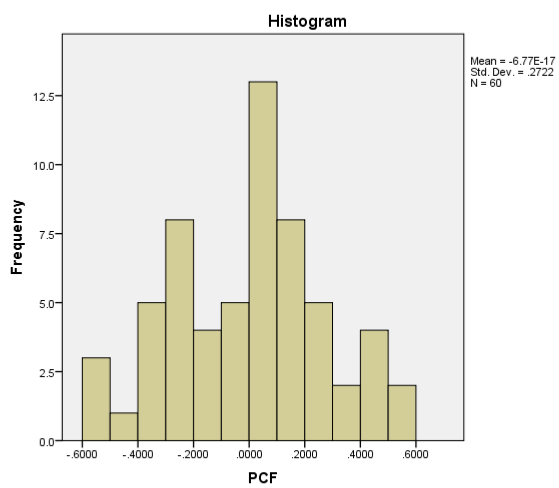
*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Appendix A, continued







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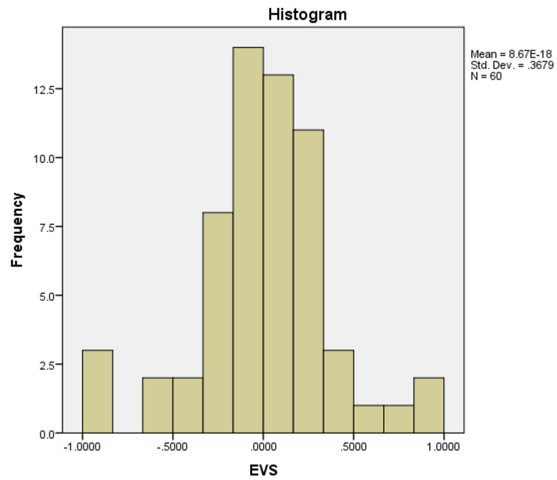

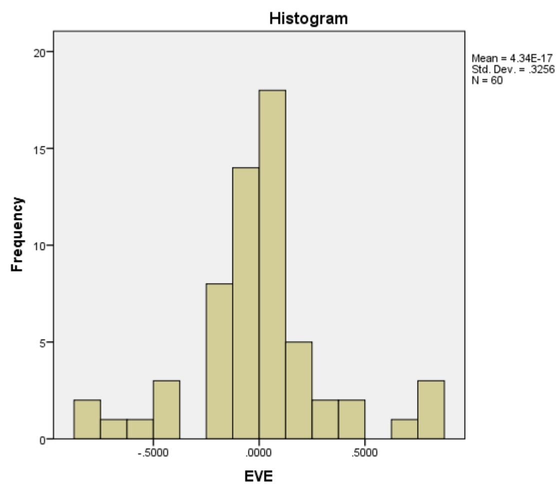

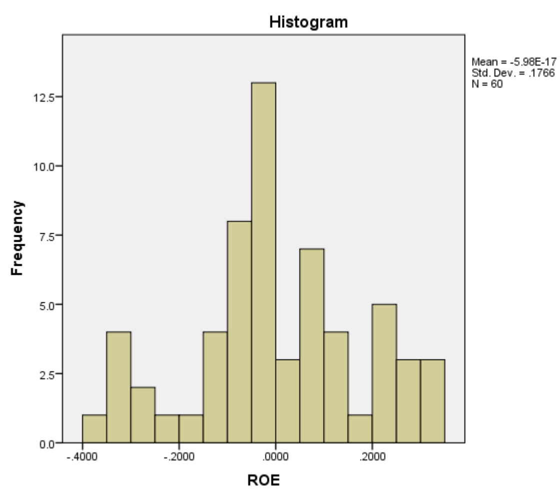

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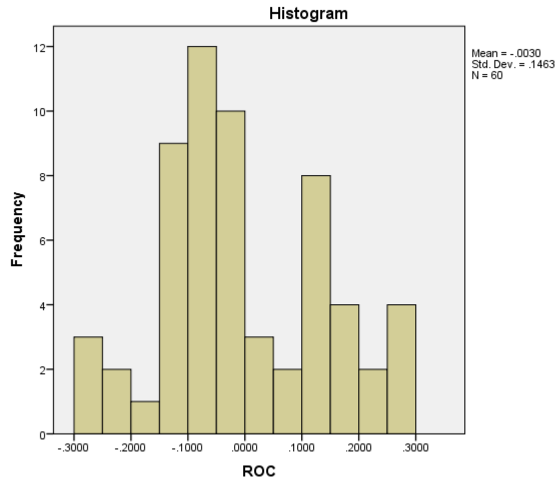
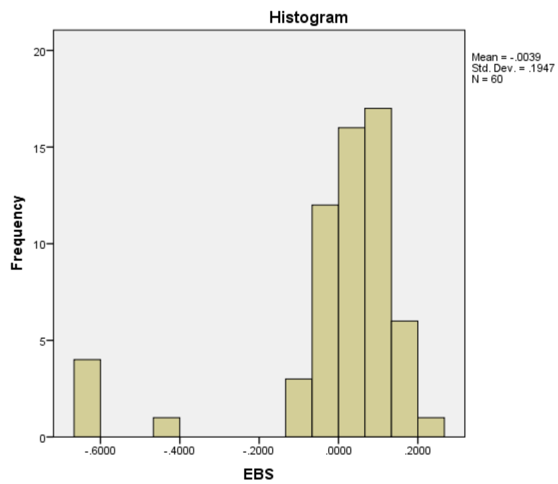
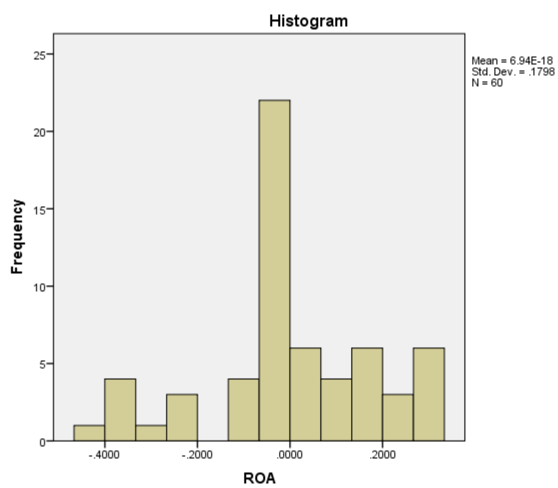
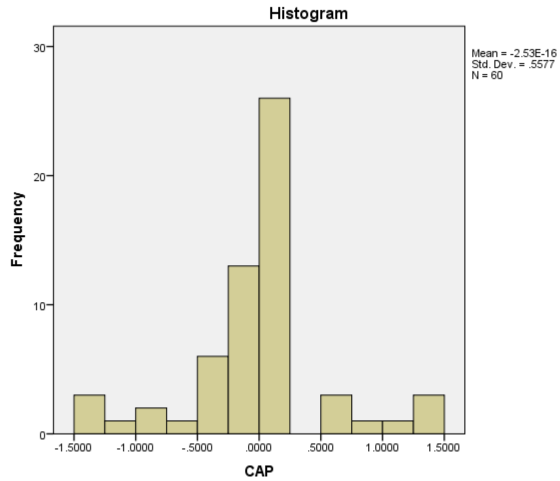
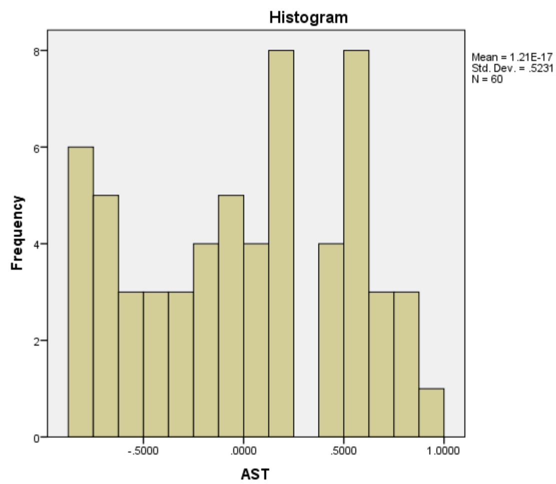


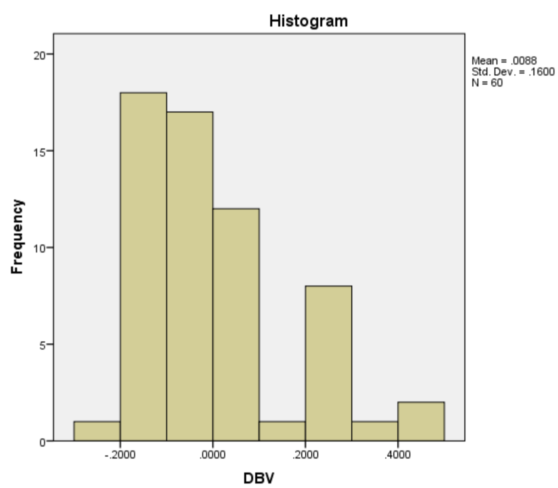




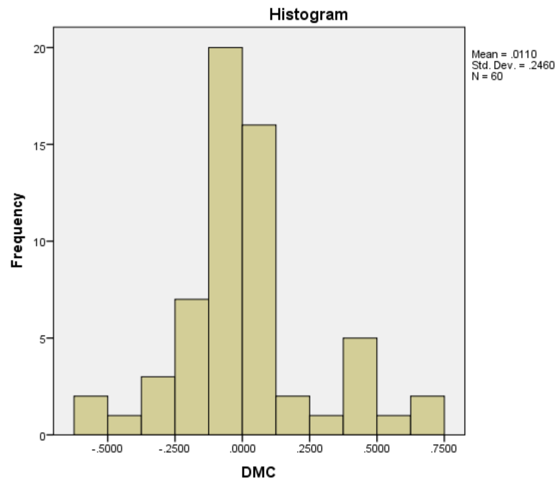
Appendix A, continued







Appendix A, continued



Appendix B: Structure of Global Industry Classification Standard

Sector		Industry Group		Industry		Sub-Industry	
10	Energy	1010	Energy	101010	Energy Equipment & Services	10101010	Oil & Gas Drilling
						10101020	Oil & Gas Equipment & Services
				101020	Oil, Gas & Consumable Fuels	10102010	Integrated Oil & Gas
						10102020	Oil & Gas Exploration & Production
						10102030	Oil & Gas Refining & Marketing
						10102040	Oil & Gas Storage & Transportation
						10102050	Coal & Consumable Fuels
15	Materials	1510	Materials	151010	Chemicals	15101010	Commodity Chemicals
						15101020	Diversified Chemicals
						15101030	Fertilizers & Agricultural Chemicals
						15101040	Industrial Gases
						15101050	Specialty Chemicals
				151020	Construction Materials	15102010	Construction Materials
				151030	Containers & Packaging	15103010	Metal & Glass Containers
						15103020	Paper Packaging
				151040	Metals & Mining	15104010	Aluminum
						15104020	Diversified Metals & Mining

Appendix B, continued

Sector		Industry Group		Industry		Sub-Industry	
15	Materials	1510	Materials	151040	Metals & Mining	15104030	Gold
						15104040	Precious Metals & Minerals
						15104050	Steel
				151050	Paper & Forest Products	15105010	Forest Products
						15105020	Paper Products
20	Industrials	2010	Capital Goods	201010	Aerospace & Defense	20101010	Aerospace & Defense
				201020	Building Products	20102010	Building Products
				201030	Construction & Engineering	20103010	Construction & Engineering
				201040	Electrical Equipment	20104010	Electrical Components & Equipment
						20104020	Heavy Electrical Equipment
				201050	Industrial Conglomerates	20105010	Industrial Conglomerates
				201060	Machinery	20106010	Construction & Farm Machinery & Heavy Trucks
						20106020	Industrial Machinery
				201070	Trading Companies & Distributors	20107010	Trading Companies & Distributors
		2020	Commercial & Professional Services	202010	Commercial Services & Supplies	20201010	Commercial Printing
						20201020	Data Processing Services - discontinued effective 04/30/2003.
						20201030	Diversified Commercial & Professional Services - discontinued effective 08/31/2008
						20201040	Human Resource & Employment Services - discontinued effective 08/31/2008
						20201050	Environmental & Facilities Services
						20201060	Office Services & Supplies
						20201070	Diversified Support Services
						20201080	Security & Alarm Services

Appendix B, continued

Sector		Industry Group		Industry		Sub-Industry	
20	Industrials	2020	Commercial & Professional Services	202020	Professional Services	20202010	Human Resource & Employment Services
						20202020	Research & Consulting Services
		2030	Transportation	203010	Air Freight & Logistics	20301010	Air Freight & Logistics
				203020	Airlines	20302010	Airlines
				203030	Marine	20303010	Marine
				203040	Road & Rail	20304010	Railroads
						20304020	Trucking
				203050	Transportation Infrastructure	20305010	Airport Services
						20305020	Highways & Railtracks
						20305030	Marine Ports & Services
25	Consumer Discretionary	2510	Automobiles & Components	251010	Auto Components	25101010	Auto Parts & Equipment
						25101020	Tires & Rubber
				251020	Automobiles	25102010	Automobile Manufacturers
						25102020	Motorcycle Manufacturers
		2520	Consumer Durables & Apparel	252010	Household Durables	25201010	Consumer Electronics
						25201020	Home Furnishings
						25201030	Homebuilding
						25201040	Household Appliances
						25201050	Housewares & Specialties
				252020	Leisure Equipment & Products	25202010	Leisure Products
						25202020	Photographic Products
				252030	Textiles, Apparel & Luxury Goods	25203010	Apparel, Accessories & Luxury Goods
						25203020	Footwear
						25203030	Textiles

Appendix B, continued

Sector		Industry Group		Industry		Sub-Industry	
25	Consumer Discretionary	2530	Consumer Services	253010	Hotels, Restaurants & Leisure	25301010	Casinos & Gaming
						25301020	Hotels, Resorts & Cruise Lines
						25301030	Leisure Facilities
						25301040	Restaurants
				253020	Diversified Consumer Services	25302010	Education Services
						25302020	Specialized Consumer Services
		2540	Media	254010	Media	25401010	Advertising
						25401020	Broadcasting
						25401025	Cable & Satellite
						25401030	Movies & Entertainment
						25401040	Publishing
		2550	Retailing	255010	Distributors	25501010	Distributors
				255020	Internet & Catalog Retail	25502010	Catalog Retail
						25502020	Internet Retail
				255030	Multiline Retail	25503010	Department Stores
						25503020	General Merchandise Stores
				255040	Specialty Retail	25504010	Apparel Retail
						25504020	Computer & Electronics Retail
						25504030	Home Improvement Retail
						25504040	Specialty Stores
						25504050	Automotive Retail
						25504060	Homefurnishing Retail
30	Consumer Staples	3010	Food & Staples Retailing	301010	Food & Staples Retailing	30101010	Drug Retail
						30101020	Food Distributors
						30101030	Food Retail
						30101040	Hypermarkets & Super Centers
		3020	Food, Beverage & Tobacco	302010	Beverages	30201010	Brewers
						30201020	Distillers & Vintners
						30201030	Soft Drinks

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Sector		Industry Group		Industry		Sub-Industry	
30	Consumer Staples	3020	Food, Beverage & Tobacco	302020	Food Products	30202010	Agricultural Products
						30202020	Meat, Poultry & Fish - discontinued, effective March 28 2002
						30202030	Packaged Foods & Meats
				302030	Tobacco	30203010	Tobacco
		3030	Household & Personal Products	303010	Household Products	30301010	Household Products
				303020	Personal Products	30302010	Personal Products
35	Health Care	3510	Health Care Equipment & Services	351010	Health Care Equipment & Supplies	35101010	Health Care Equipment
						35101020	Health Care Supplies
				351020	Health Care Providers & Services	35102010	Health Care Distributors
						35102015	Health Care Services
						35102020	Health Care Facilities
						35102030	Managed Health Care
				351030	Health Care Technology	35103010	Health Care Technology
		3520	Pharma-ceuticals, Biotechnology & Life Sciences	352010	Biotechnology	35201010	Biotechnology
				352020	Pharma-ceuticals	35202010	Pharmaceuticals
				352030	Life Sciences Tools & Services	35203010	Life Sciences Tools & Services
40	Financials	4010	Banks	401010	Commercial Banks	40101010	Diversified Banks
						40101015	Regional Banks
				401020	Thrifts & Mortgage Finance	40102010	Thrifts & Mortgage Finance

Appendix B, continued

Sector		Industry Group		Industry		Sub-Industry	
40	Financials	4020	Diversified Financials	402010	Diversified Financial Services	40201010	Consumer Finance – discontinued effective 04/30/2003.
						40201020	Other Diversified Financial Services
						40201030	Multi-Sector Holdings
						40201040	Specialized Finance
				402020	Consumer Finance	40202010	Consumer Finance
				402030	Capital Markets	40203010	Asset Management & Custody Banks
						40203020	Investment Banking & Brokerage
						40203030	Diversified Capital Markets
		4030	Insurance	403010	Insurance	40301010	Insurance Brokers
						40301020	Life & Health Insurance
						40301030	Multi-line Insurance
						40301040	Property & Casualty Insurance
						40301050	Reinsurance
		4040	Real Estate	404010	Real Estate - discontinued effective 04/30/2006	40401010	Real Estate Investment Trusts - - discontinued effective 04/30/2006
						40401020	Real Estate Management & Development - discontinued effective 04/30/2006
				404020	Real Estate Investment Trusts (REITs)	40402010	Diversified REITs
						40402020	Industrial REITs
						40402030	Mortgage REITs
						40402040	Office REITs
						40402050	Residential REITs
						40402060	Retail REITs
						40402070	Specialized REITs

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Sector		Industry Group		Industry		Sub-Industry	
40	Financials	4040	Real Estate	404030	Real Estate Management & Development	40403010	Diversified Real Estate Activities
						40403020	Real Estate Operating Companies
						40403030	Real Estate Development
						40403040	Real Estate Services
45	Information Technology	4510	Software & Services	451010	Internet Software & Services	45101010	Internet Software & Services
				451020	IT Services	45102010	IT Consulting & Other Services
						45102020	Data Processing & Outsourced Services
				451030	Software	45103010	Application Software
						45103020	Systems Software
						45103030	Home Entertainment Software
		4520	Technology Hardware & Equipment	452010	Communications Equipment	45201020	Communications Equipment
						45201010	Networking Equipment - discontinued effective 04/30/2003.
						45201020	Telecommunications Equipment - discontinued effective 04/30/2003.
				452020	Computers & Peripherals	45202010	Computer Hardware
						45202020	Computer Storage & Peripherals

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Sector		Industry Group		Industry		Sub-Industry	
45	Information Technology	4520	Technology Hardware & Equipment	452030	Electronic Equipment & Components	45203010	Electronic Equipment & Instruments
						45203015	Electronic Components
						45203020	Electronic Manufacturing Services
						45203030	Technology Distributors
				452040	Office Electronics	45204010	Office Electronics
				452050	Semiconductor Equipment & Products - discontinued effective 04/30/2003.	45205010	Semiconductor Equipment - discontinued effective 04/30/2003.
						45205020	Semiconductors - discontinued effective 04/30/2003.
		4530	Semi-conductors & Semiconductor Equipment	453010	Semiconductors & Semiconductor Equipment	45301010	Semiconductor Equipment
						45301020	Semiconductors
50	Telecom-munication Services	5010	Telecom-munication Services	501010	Diversified Telecom-munication Services	50101010	Alternative Carriers
						50101020	Integrated Telecommunication Services
				501020	Wireless Telecom-munication Services	50102010	Wireless Telecommunication Services
55	Utilities	5510	Utilities	551010	Electric Utilities	55101010	Electric Utilities
				551020	Gas Utilities	55102010	Gas Utilities
				551030	Multi-Utilities	55103010	Multi-Utilities
				551040	Water Utilities	55104010	Water Utilities
				551050	Independent Power Producers & Energy Traders	55105010	Independent Power Producers & Energy Traders