ABSTRACT

Understanding the effect of the Islamic finance restrictions and constraints on its financial performance as compared to a conventional portfolio is the aim of this dissertation. Therefore, I review the Islamic principles and characteristics as compared to socially responsible investment (SRI) first, concluding that Islamic finance is a special case of the SRI. Then, I examine and adjust the mean-variance model to reflect the restrictions and constraints requirement for the Islamic finance strategy. Finally, I compare the two strategies: Islamic finance and conventional strategy. Restrictions on the Islamic finance strategy include the forbiddance of the short selling and restrictions on the opportunity set. Using the Sharpe ratio (SR), I compare the performance of the two strategies; results show that the more restrictions and constraints I impose on the optimization model, the more the investment opportunity set shrinks and the less diversification benefits are realized. In addition, results show that short selling restriction plays a key role in the low performance of the Islamic finance strategy. However, investors are still attracted to the Islamic finance investments leading us to believe that investors might be attracted more to the ethical and socially responsible aspect of these investment rather than merely the financial benefits.

RESTRICTED PORTFOLIO MANAGEMENT
The Case of Islamic Finance

by

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AAOIFI	Accounting and Auditing Organization for Islamic Financial Institutions
CAL	Capital allocation line
CAPM	Capital Asset Pricing Model
CDO	Collateral debt obligations
CDS	Credit default swaps
CML	Capital market line
DJ	Dow Jones
DJIAI	Dow Jones Industrial Average Index
DJII	Dow Jones Islamic Market Index
DJIM	Dow Jones Islamic Market
FCNA	Fiqh Council of North America
FTSE	Financial Times Stock Exchange
GPFG	Government Pension Fund Global [Norwegian]
IMI ESG	Environmental, Social and Governance
KLD	Kinder, Lydenberg, Domini and Co., Inc.
MSCI	Morgan Stanley Capital International
MVP	Minimum Variance Portfolio
NAIT	North American Islamic Trust
NASDAQ	National Association of Securities Dealers Automated Quotations
NYSE	New York Stock Exchange
OIC	Organization of Islamic Countries
S&P	Standard & Poor
SR	Sharpe Ratio
SRI	Socially Responsible Investments

Introduction

Ernst and Young (2015) expected the global Islamic banking assets to reach US$1 trillion in 2015 and its profit to reach US$30.3 billion by 2020. S&P Islamic finance outlook (S&P Global Ratings 2018) reported that the Islamic finance industry reached $2 trillion at year end 2016. Modern Islamic finance originated in Islamic countries but nowadays, many European countries welcome the Islamic finance booming (e.g. England, France, etc.). In fact, David Cameron (2013) stated, "When Islamic finance is growing 50 percent faster than traditional banking and when global Islamic investments are set to grow to £1.3 trillion by 2014 we want to make sure a big proportion of that new investment is made here in Britain."

The E&Y report also indicates that the Islamic finance industry is positioning itself as socially responsible. Unlike other socially responsible investment strategies, the social responsibility and financial requirements of Islamic finance is derived from the Qur'an[1] and Sunnah[2]. However, a quick comparison of the characteristics of each of them reveals that the similarities between the socially responsible investment (SRI) and Islamic finance outnumber their differences. Using El-Galfy and Khiyar's (2012) nine characteristics of Islamic finance, agreed upon by most scholars, and the socially responsible principals as listed by two SRI authorities: GPFG[3] and MSCI KLD 400 (MSCI 2012) [4], we find that the similarities are clear and the differences are few.

[1] Quran is the divine book of Muslims

[2] Sunnah is the word of Prophet Mohammed (Peace Be Upon Him)

[3] GPFG follows the Norwegian ministry of finance guidelines for observation and exclusion from its Government Pension Fund (GPFG), a leader in Socially Responsible investing

The first three characteristics listed by El-Galfy and Khiyar (2012) are as follows: (1) the prohibition of unethical investments such as alcohol, gambling, etc.; (2) the fulfillment of socio-economic objectives and the creation of just society through specific tools (e.g. a mandatory tax on wealth or *Zakah*[5] and the introduction of interest free loans or Al Qard Al Hassan[6]); and (3) the ban of excessive uncertainty. Compared to the GPFG - one of the largest funds in the world and leader in SRI as reported by Andrew Ang (2012) - and the MSCI KLD index principals, the Islamic finance requirements match the socially responsible requirements.

In addition, other characteristics of Islamic finance can arguably be linked to SRI principles such as: (4) the ban of harmful contracts to any party; (5) preventing investors from making mistakes that are harmful to their own benefits (i.e. free from impulsion); (6) emphasizing equitable contracts; and finally (7) the desire of profit sharing. In general, these characteristics show the commitment of Islamic finance to just contracts and transactions, which is the moral behind the SRI principles.

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4 MSCI KLD 400 social index (MSCI 2012) is a free float adjusted market capitalization index designed to provide listing of U.S. companies that follows its guidelines.

[5] Zakah is defined as an obligatory periodic levy on all Muslims who have wealth or income above a certain minimum, to be directed to specific categories of poor and needy people. *Zakah* is the fourth pillar of Islam, every Muslim who meet a *Nissab* (certain wealth) have to pay a fix portion of his wealth to the poor at the end of the year if kept in cash or equivalent of cash. Although the literal meaning of *Zakah* in the Islamic literature is "more" referring to the blessing a Muslim will get as a reward for paying *Zakah* and the fact that Allah SWT will compensate him much more for that amount he gave to the poor, the immediate effect of *Zakah* is the application of a fix rate (generally 2.5%) to the investor's stagnant wealth after the end of period one. It is worth mentioning that Zakah also plays another role of providing income cleansing mechanism from "polluted" investments by deemed "impure" income in Islamic finance through the purification process. Impure income is usually all income from interest or other deemed unethical activities such as alcohol, tobacco, etc. For more details please refer to Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) rule number 35.

[6] Al-Qard Al-Hassan is simply defined as interest-free loan.

However, two characteristics of Islamic finance are somewhat unique to this type of investment. The first one is the linkage of finance to productivity and the second one is the prohibition of all sorts of interest dealings (borrowing and lending transactions). In today's world, one can argue that only Islamic finance requires these restrictions; although, Abdul-Rahman Yahya (2010) argues that the prohibition of interest is a well-established tradition among the Judeo-Christian era when usury (or interest[7]) was prohibited. Still, such unique requirements do not prevent Islamic finance from being labeled socially responsible. In fact, one can argue that it only makes Islamic finance a stricter form of socially responsible investments.

Given the growth of these types of investments and the special restrictions and constraints imposed on the Islamic finance investments, one would wonder about the reasons behind the growth of these investments: Is it because of the performance of this type of investment or the fact that it is a form of SRI? And what is the effect of these restrictions on the performance of the investment strategy as compared to a Conventional portfolio with no restriction?

The capital market is an area where the Islamic finance restrictions and constraints are manifested visibly since there are restrictions on the asset selection as well as the type of transactions (such as the prohibition of short selling). There are strict rules on the selection process of the assets, which have to be in accordance with the Islamic guidelines. As a result, certain assets are excluded by the nature of their business while others are permissible assets so long as their engagement in prohibited activities does not exceed a certain percentage (discussed in more detail in Chapter 1).

[7] Qur'an: Chapter 2 verses 275, 276, 278 and chapter 3 verse 130. 2:275: "That is because they say "trade is like usury" but God had permitted trade and forbidden usury."

In the U.S., as an example, there are three main investment funds that offer Islamic finance investment options to Muslims and non-Muslim investors. These are the Amana fund, the Azzad fund and the Iman fund. While all of them declare that they abide by Islamic finance principles, in practice they follow different sets of standards. For instance, Amana fund management follows the standards of the Fiqh Council of North America (FCNA), a U.S. entity that governs the Islamic investment requirements; while the Azzad and the Iman funds are known to follow the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI[8]) standards, and as such their implementation of the guiding principles differs from that of Amana.

Agreeing on the governing body that declares the constraints while having different practical guidelines is not unique to the Islamic finance; SRI encounters the same phenomenon. For example, although in principal the Norwegian Government Pension Fund (GPFG) and the KLD follow the same guiding principles, in practice the two have different practical criteria. The GPFG provides a set of well-defined requirements for SRI while the KLD which researches and analyzes socially responsible indices, such as KLD 400 social index, use a different methodology. In general, the regulatory bodies or criteria may be different and may have different guiding principles, but they share the same underlying principles (further discussion of these standards is provided in Chapter 1).

Once the restrictions are well defined, we will tackle the theoretical framework that is well-suited to answer our question: how restrictions affect the performance of a restricted Islamic finance strategy as compared to a conventional non-restricted strategy.

[8] AAOIFI is responsible for developing and issuing standards for international Islamic finance industry, providing guidance on Islamic permissibility and rules for specific Islamic finance products and mechanisms as well as other accounting, auditing, governance and code of ethics standards.

The constrained mean-variance model, also called the Markowitz or the Capital Asset Pricing Model (CAPM), will be used to compare two portfolios: one following Conventional investment and one following Islamic finance. The Sharpe ratio (SR), in this theoretical framework, is the key performance indicator of the investment strategies, which also includes explicitly the investors' preference of risk and return.

The CAPM is an economic model frequently used by conventional finance for valuing stocks, securities, derivatives and/or assets by relating risk and expected return. The powerful and intuitive prediction about the risk measurement and the relationship between risk and return is one of the main reasons of the model attractiveness (Fama & French, 2004). The CAPM is the result of the collective work of Markowitz (1952) who initiated the model, Sharpe (1964) and Lintner (1965) who added two key assumptions and Tobin's "separation theorem" (Tobin 1958), which allowed for the final conclusion of the tangency portfolio using a risk-free and risky tangency portfolio.

The mean-variance model is based on the idea that investors demand additional expected return (called, "risk premium") if they are asked to accept additional risk. The model decomposes the risk of a portfolio into systematic and specific risk. Systematic risk is the risk of holding the market portfolio. As the market moves, each individual asset is affected to varying degrees. To the extent that any asset participates in such general market movements, that asset has systematic risk. Specific risk is the risk unique to an additional asset. It represents the component of return of an asset that is uncorrelated with general market movements.

According to the mean-variance model, the market place compensates investors for taking systematic risk but not for taking specific risk because specific risk can be

diversified away. When an investor holds a market portfolio, each individual asset in that portfolio has specific risk but, through diversification, the investor's net exposure is just the systematic risk of the market portfolio.

Therefore, we present and evaluate two static mean-variance models in theory as well as in practice by using actual data to draw conclusions on the effect of Islamic finance restrictions on the portfolio optimization problem. The mean-variance model is used to develop two optimal portfolios: conventional and Islamic finance. The conventional portfolio will have no additional constraints, while restrictions are imposed on the Islamic finance portfolio to abide by the Islamic finance requirements. The aim of this exercise is to show whether additional constraints negatively impact the performance of the Islamic finance strategy. Imposing an upper-bound limit on the weights of the optimal solution will be another way to test the impact of even more constraints on both strategies, especially in balancing the weights.

Then we will conduct the same test but with different set of data to test the robustness of the initial conclusion. Here, we will use a different data set, a different time period, and a different risk free rate. In addition, we will conduct an experience by shifting the constraint of short selling from the Islamic finance strategy to the conventional one to understand the impact of this specific restriction on the performance of the two strategies. Overall results of all these cases lead us to question whether investors are attracted to the SRI nature of these investments rather than the actual performance of the strategy as compared to conventional strategy.

The rest of this dissertation is constructed as follows: Chapter 1 compares the Islamic finance and SRI requirements and then reviews the details of Islamic finance

restrictions such as the interest and short selling prohibition. Chapter 2 presents the mean-variance model and the special case constrained minimum-variance model. It discusses how the latter model is the best fit to answer our research question and then describes the adaptation of the model to meet all the Islamic finance requirements as well as additional constraints such as upper-bound (maximum allocation) and *Zakah* introduction. Chapter 3 presents the empirical results of the comparative study and all the special cases.

Chapter 1 – Socially Responsible Investments: Islamic Finance as a Special Case

In this chapter, we compare the characteristics and principals of Islamic finance to those of socially responsible investing principles (SRI) to identify the similarities and differences, if any, between the two investment principals. Then, a review of the Islamic finance restrictions and constraints is completed. Finally, a brief discussion about the difference between the theoretical principals and the practice of Islamic finance concludes.

1.1 Socially Responsible Investments Versus Islamic Finance

In this section, we discuss the similarities and differences of SRI and Islamic finance principals. To compare SRI and Islamic investment strategies, we will begin by reviewing the criteria and requirements of the SRI and compare them to the characteristics of the Islamic finance. Next, we will zoom into the specific restrictions of the Islamic finance for portfolio management and discuss the difference between the theory and practice of the Islamic finance in the U.S.

Conventional investment is traditionally concerned with the financial outcome of the investment in terms of return, risk, liquidity and diversification while SRI adds another layer of social impact. Created in the early 1990s, SRI includes investors' concern with the ethical, moral, social or environmental consequences in their investment decisions, in addition to focusing on financial returns (Basso & Funari, 2003; Boutin-Dufresne & Savaria, 2004).

Further, socially conscious, green, sustainable or SRI is defined by Cowton (1994) as the use of ethical and social criteria when selecting and managing an investment

portfolio. These socially responsible considerations could be either a screening process or a variable in the selection process (Knoll, 2002). The screening can be either negative (exclusionary) or positive (inclusionary).

Thus, SRI manifest itself in the choice of assets selected in the portfolio based on socially responsible considerations such as morals, religious affiliations, beliefs and values: SRI refers to the exclusion of stocks from funds mainly for ethical or religious reasons. Investment screening involves the selection of investment opportunities that are based on faith or religious belief (Entine, 2003). Faith-based investing is a response to the attempts of institutions to promote religious, ethical and social criteria in the selection and management of investment portfolios. Hence, the construction of faith-based SRI portfolios includes investments that have been screened on the basis of religious beliefs.

Islamic finance is a good example of faith-based investing. It began as a relatively modest endeavor in some Arab countries during the late 1970s. Islamic investing distinguishes itself from conventional investing in its apparent compliance with the principles of Islamic law, or shari'a.[9] It has experienced growth that has accelerated in recent years since in terms of the number of countries in which it operates, as well as the areas of finance in which it has ventured (El-Gamal, 2006). Needless to say, this fact has caught the attention of investment firms around the world that are interested in capturing this market.

Professionally managed assets following SRI strategies stood at $3.07 trillion as of 2010, a rise of more than 380% since 1995. In the same time period, a larger universe of conventional assets under professional management increased by only 260%, from $7

[9] Shari`a literally means "the way" and is the Arabic term for Islamic law as a way of life, comparable to the Hebrew *Halachah*.

trillion to $25.2 trillion. Correspondingly, between 2007 and 2010, as the overall universe of conventional professionally managed assets remained flat, SRI-based assets grew "considerably" (Social Investment Forum, 2010).

Research on SRI as an investment strategy can be broadly classified into areas of investment screening, shareholder advocacy, community investing and social venture investing (Harrington, 2003). In this dissertation, we will concentrate mainly on investment screening. Therefore, we will examine two examples of SRI measurement methodologies. We will consider first the case of the Norwegian ministry of finance selection and exclusion process for its Government Pension Fund (GPFG), a leader in socially responsible investing and one of the largest funds in the world. Then we will review the MSCI KLD 400 social index (MSCI, 2012), a free float adjusted market capitalization index designed to provide listing of U.S. companies that follows its guidelines for socially responsible investments.

GPFG follows the ministry of finance guidelines, which cover investments in the fund's equity and fixed income portfolios, as well as instruments in the fund's portfolio. The two major underlining principals are (1) the long term performance and (2) the limited risk taking (GPFG, n.d.). Therefore, the management of the fund has to ensure a long term vision when selecting assets that should be targeted to sustain development in the three major areas: economic, environmental and social. The second principal emphasizes the importance of limiting risk taking so that it does not go beyond acceptable norms.

These principals play a big role is in the negative screening or selection process. As part of this process, many assets or companies are excluded because of their involvement

in unethical acts. At the same time, the SRI selection process involves the positive selection of any company or asset that follows socially responsible principles. With that in mind, the ministry of finance prescribed two selection criteria for the GPFG mentioned above.

Therefore, the fund is prohibited from investing in companies which themselves or through entities they control produce weapons, tobacco or sell weapons or military material to states that are subject to restrictions. In addition, the fund is prohibited from investing in companies if there is an unacceptable risk that these companies contribute to or is responsible for such as human right violation, environmental damage or gross corruption.

Similarly, the methodology to construct the MSCI KLD 400 Social Index limits the selection universe of securities and assets by imposing constraints based on the value and the representation of each within the index. The universe of allowable securities and assets is limited to the MSCI USA IMI ESG index, which excludes companies that are involved in certain activities that are deemed unethical. For example, companies would be excluded if their main business objective is to sell, manufacture or produce product such as alcohol, tobacco, military weapons and adult entertainment.

In addition, the index uses certain financial ratios to limit the revenue generated from engaging in such activities (as a secondary source of revenue). These ratios are dependent on the category and the nature of the business of each company and how much revenue is generated from each excluded category or activity. For instance, the revenue generated from companies that produce alcohol, operate and support gambling and produce adult entertainment cannot exceed 5% of their revenues or more than $500

million total. The financial ratio increases to up to 15% of revenue generated from distributors, retailers and suppliers of tobacco while companies that are classified as producers of tobacco are excluded completely. In addition, KLD imposes a limit on the sector's weight by targeting a relative sector weight of plus or minus 25% and a minimum requirement of 200 standard size-segments ("large cap" and "mid cap").

Although the Islamic finance requirement and restrictions are derived from Qur'an and Sunnah we notice that they share similar criteria and restrictions as SRI. El-Galfy (2012) consolidates the principals of the Islamic finance to nine main characteristics that most scholars agree on. Out of those nine characteristics, four align perfectly with the SRI principles as listed by two authorities on social responsibility (GPFG and MSCI KLD 400) described above.

As an example, El-Galfy (2012) listed the following as part of the nine characteristics: the prohibition of unethical investments, the fulfillment of socio-economic objectives and the creation of just society and the ban of excessive uncertainty. Here all these characteristics match perfectly the SRI requirements. In addition, as part of the Islamic finance characteristic, El-Galfy listed the following criteria: the ban of harmful contracts to any party, the freedom from impulsion, the emphasis on equitable contracts and the desire of profit sharing (ibid.). All of these characteristics are discussed further down in detail, but for now, we can safely argue that they share the same goals as any SRI would expect to achieve. For these reasons, the Islamic finance industry is positioning itself as a socially responsible one.

The second characteristic of Islamic finance listed by El-Galfy (ibid.) is the prohibition of all unethical investment. Hence all investment in activities/assets deemed

unethical such as alcohol, gambling and tobacco are forbidden. This restriction is similar to the GPFG and the MSCI requirement described above and the shared objective of all SRI. These requirements translate to imposing strict rules for screening assets before making the investment decisions such as prohibition of investment in certain industries and activities which we will detail in the next sections.

The third characteristic is the avoidance of excessive uncertainty or *gharar* due to information asymmetry. The Arabic word *gharar* means risk, uncertainty and hazard. Al-Suwailem (1999) shows that a *gharar* transaction is a zero-sum game with uncertain payoffs. Zero-sum games, by definition, are games in which the interests of the two parties are in direct opposition. The set of Islamic rules and regulations, such as the prohibition of *gharar*, seek to ensure that exchange is undertaken for achieving win-win outcomes rather than transactions that lead to win-lose or lose-lose outcomes.

A legitimate question arises concerning the difference between buying a lottery ticket and buying a share in the stock market. A clear difference is that a lottery is a zero-sum game. The winner of a lottery only wins at the expense of the others. In a stock market, all participants might win when economic conditions are favorable. In addition, investing in the stock market is a long-term strategy for the Islamic finance investor who should establish ownership of the assets and play an active role in its management through proxy vote. Therefore, since collective winning is possible in a stock market, it certainly does not involve *gharar* and is therefore permissible (Al-Suwailem, 1999).

It should also be noted that some degree of *gharar* is acceptable in Islamic finance though excessive *gharar* need be avoided. There are several types of *gharar*: (1) settlement risk (when the seller has no control over the subject matter, i.e., a sale without

taking possession), (2) inadequacy and inaccuracy of information (*gharar* or uncertainty caused by lack of adequate value-relevant information), (3) complexity in contracting (*gharar* also refers to undue complexity in contracts; *sharia* does not permit interdependent contracts, for instance, combining two sales in one is not permitted according to Sunnah) and (4) games of chance (the Qur'an prohibits contracts based on uncertainty or pure games of chance) (Hassan, 2002). One of the consequences of this characteristic is the requirement that the terms of contracts and transactions such as the subject matter, the price and the time of delivery should be clear and free from excessive uncertainty. Another implication is the prohibition of investing in collateralized debt obligations (CDO) and credit default swaps (CDS).

However, this principal should not be understood as a way of avoiding risk all together because one of the Islamic finance principle and its nine characteristics as listed by El-Galfy (2012) is profit and loss sharing where all parties share the risk and the reward. Chapra (2008) stated that "no risk, no gain". Therefore, to gain return on investment or financial gains, one must take a certain level of risk. However, the risk taken should not be an excessive risk that encompasses deceptive ambiguity, asymmetric information, and risk shifting strategies.

The fourth, fifth and seventh characteristics also suggest that contracts between parties should be equitable, free from impulse and not harmful to any party. These principals imply that investors are free to enter or exit the contract or the transaction and are prevented from making mistakes that are destructive to their own interest. In addition, investors should have equal access to the information and get equal power in

negotiation. By consequence the investor with privileged access to "insider information" should not use it in their transactions.

The last and ninth characteristic is the notion of "duty" or "tax" or *Zakah* and *Al-Qard Al-Hassan* which are additional ways to promote socio-economic objectives and the creation of a just society. El-Galfy and Khiyar (2012) define *Zakah* as "an obligatory periodic levy on all Muslims who have wealth or income above a certain minimum, to be directed to specific categories of poor and needy people." On the other hand, *Al-Qard Al-Hassan* is simply an interest-free loan which aligns with the first characteristic of Islamic finance discussed later, the prohibition of interest. Islamic finance investors are allowed to enter partnerships (profit sharing contracts which involve risk taking) as well as other form of contracts but they are not allowed to borrow or lend money with a guaranteed interest rate.

The notion of *Zakah* in Islamic finance could play a role in inciting investors who abide by its restrictions to invest in the capital market. As an example, an Islamic finance investor is required - in theory - to pay a percentage of his wealth on a yearly basis when it is kept idle for the whole period. The percentage of *Zakah* as it related to the cash (or cash equivalent, e.g. gold, silver, etc.) held idle of one lunar year is generally set at 2.5% of the wealth. This money is distributed to the most underprivileged population of society by the end of one period (one year). This requirement might push Islamic investors to invest their funds in the equity market, as an example, to avoid the payment of *Zakah* if the funds are kept idle.

Only two of Islamic finance characteristics listed by El-Galfy (2012) can be viewed as an exception where the Islamic finance might not directly align with the SRI criteria;

however, looking closely at these two characteristics we find they are still linked to the overarching principals of SRI. These two characteristics of Islamic finance are the prohibition of interest and the linkage of finance to productivity (sustaining development in the economics and social area). Islamic finance regards money as a mean of exchange without intrinsic value. Therefore, money cannot be used to generate money. As a direct consequence, the prohibition of interest[10], also called usury or riba – whereby the prohibition of guaranteed interest on a loan (payment or receipt) – is the first characteristic. This prohibition is unique to the Islamic finance although we could argue that SRI is not in contradiction of it.

In fact, Abdul-Rahman Yahia (2010) argues that the prohibition of interest (borrowing or lending) is a well-established tradition among the Judeo-Christian era when usury[11] (or interest) was prohibited:

> …It is socially responsible because it applies the values of social responsibility of all those associated with it according to the same Judeo- Christian-Islamic values. For example, it looks at money not as a ''thing'' that can be rented at a price (the interest rate), but as a measuring tool to measure the success or failure of investing. It is also concerned with the type of investment in which it invests its money… and does not finance speculative activities that are focused on making money out of money, based on speculations in the different financial, commodities, and real estate markets. (P: 197)
>
> …As was stressed throughout this book, the Judeo-Christian-Islamic value system prohibits us from participating in the culture of renting money. Perhaps one of the most important prohibitions in the Jewish Bible (Exodus: Chapter 22, verses 24–26), and the Christian Bible (Exodus 22:25, Leviticus 25:35–37, Deuteronomy 23:19–20, Nehemiah 5:1–13, Psalm 15, Proverbs 28:8, Ezekiel 18:5–18,

[10] The prohibition of interest includes all forms whether nominal, excessive, simple, or compound, fixed or floating – regardless of size and the purpose of it (consumption of production activities).

[11] Qur'an: Chapter 2 verses 275, 276, 278 and chapter 3 verse 130. 2:275: "That is because they say "trade is like usury" but God had permitted trade and forbidden usury."

> Habakkuk 2:6–7, Luke 6:27–36) … is the prohibition of Ribit (Old Testament) or Riba (the Qur'aan).
>
> …we know from the original Jewish teachings that a person of the Jewish faith who participates in ribit cannot stand as a witness in a Jewish court; the old Catholic teachings (before 1100 C.E.) hold that a person who deals in ribit is denied a Catholic burial… (P: 376)

On the other hand, El-Gamal (2006) argues that the prohibition of interest is mainly driven by the need to protect individuals from accruing extensive debt or receiving undue profit for the extension of credit. With this intention, the Islamic investment methodology can be viewed not only as an SRI but as a stricter form of SRI.

The second characteristic listed by El-Galfy (2012), is that finance has to be linked to productivity. This linkage is an ordinary outcome of the nature of money in Islamic finance discussed above (i.e. no intrinsic value). Money must be used to generate productive activities that are beneficial to society, hence increasing production, improving quality, and/or involving physical transaction of goods and services. Therefore, wealth is accumulated from appropriate trades that aim to sustain development in the economic area.

Accordingly, one can undoubtedly say that these two characteristic exceptions of Islamic finance do not make Islamic finance less socially responsible. In fact, the only natural conclusion is that these restrictions and characteristics will make Islamic finance a stricter form of SRI. Indeed, the Vatican's official newspaper *Observatore Romano* said in an article in its March 3, 2009, issue that "the ethical principles on which Islamic finance is based may bring banks closer to their clients and to the true spirit which should mark every financial service".

Comparing the above nine characteristics and principals of Islamic finance to the SRI rules and restrictions, using the two examples, GPFG and the KLD, we can clearly draw conclusion that both investment strategies share very similar principals. Specifically, they all target the long-term investment horizon, aim to promote sustainable development and aim to avoid speculation. In addition, they set guidelines to avoid contributions to activities deemed unethical and unacceptable risk taking (*gharar*).

The main differences between SRI and Islamic finance are the prohibition of interest and the linkage of finance to production principals in the latter. We will see in later sections that, in practice, the requirement to prohibit interest was relaxed to a certain extent by Islamic jurists who decided to invoke the "rule of necessity" in order to expand the opportunity set of an Islamic investment. Therefore, we can conclude that Islamic investing is clearly a special case (stricter form) of the SRI.

In summary, this section briefly reviewed both the SRI and the Islamic finance principles and characteristics, finding that, in total; they are well aligned and aim to serve similar purposes although the Islamic finance requirement might seem stricter. Next we will review the screening and selection process required to construct an Islamic finance investment portfolio.

1.2 Islamic Finance Restrictions and Constraints

As described in prior section, the Islamic finance and SRI share similar principals to the point that we can consider Islamic finance as a special case (or a stricter form) of SRI. In this section, we will dig deeper to understand how an Islamic finance investor can construct an investment portfolio that abides by the Islamic finance restrictions. Comparing to the SRI restrictions and guidelines, we find that overall they are under the same umbrella.

As we have seen earlier, in principle, the major difference between Islamic finance and SRI is that the Islamic finance investment strategy imposes restrictions on "interest" and aims to link finance to production. On the technical side though, the prohibition of short selling is added to the Islamic Finance strategy when managing investments. The first two restrictions are part of the characteristics of Islamic finance while the short sale restriction is specific to the practice of buying and selling assets in the financial market. This fact makes studying Islamic finance an interesting endeavor. As such, in this section, we focus on the Islamic finance restrictions and attempt to discuss in some level of detail the restrictions imposed and how they differ based on the governing or legislating body.

In the case of SRI, we identified two different funds: the GPFG, which provides a set of well-defined requirement for SRI, and the KLD research and analytics socially responsible indices such as KLD 400, which use a different methodology from the GPFG and has a set of defined criteria that are well established. Although there might have been some difference, the restriction and criteria required by the SRI governing bodies still

follow the same overarching spirit to promote social responsible behavior in the capital market.

By the same token, establishing and agreeing on Islamic investment requirements and constraints was not an easy task. Rather, it was more complicated especially because of the prohibition of "interest". El Gamal (2006) stated that the prohibition of interest was much more difficult to comply with than the other restrictions as most companies either have excess liquidity – in which case they earn interest—or use leverage–in which case they pay interest. In today's international market, finding an asset free of "interest" dealings or transactions is rare. As a result, investing in the capital market is limited for Islamic investment portfolios due to interest prohibition.

While Shahnaz and Tony Naughton (2000) reported that James Robertson (1933) traces the origin of stocks to medieval Muslim traders, the Islamic investment industry was limited then because the notion of common stocks was viewed as possibly not permissible. One of the major moments for the Islamic capital market was the issuance of a ruling by the Organization of Islamic Countries (OIC) in 1992 that approved trading common stocks of companies that do not engage in activities that violate Islamic principles. In this ruling, the council of the International Islamic Fiqh Academy of OIC agreed that the subject of sale when a common stock is traded is an unspecified share in the assets of the issuing company which implies that the stock certificate is a documentation of the legal right to partial ownership of the company and its assets as a silent partner (El-Gamal, 2006).

Therefore, investing in the capital market become clearly permissible. However, there were no clear rules or indication related to the interest issues. Excluding all interest

bearing securities and assets that generate interest income and expenses would limit the universe of permissible equity investments and could possibly lead to an inefficient portfolio compared to the conventional investor (El-Gamal, 2006). This is particularly true in western economies such as the U.S. in which debt financing is encouraged by providing tax-deductible benefits to investors who use debt to finance their capital need. Thus, the exclusion of interest-bearing issues created complexity with respect to portfolio construction as most firms either have cash reserves that are invested, in which case they earn interest, or use leverage, in which case they pay interest.

On the other hand, Islamic finance is based on a principle of shared risk and return in an asset-based system that is unlike the conventional interest-based system. This principle rejects the notion that fiat money has a time value and, consequently, that money (interest) may be earned from it. In such a financial system, all transactions are to be based on the exchange of commodities, goods or services.

To overcome this strict guideline, the Islamic finance industry relies heavily on Islamic jurists (*fuqha* or experts on classical juris-prudence developed mainly between the 8th and 14th centuries), who help Islamic financial providers find precedent financial procedures in classical writings, upon which contemporary analogues of conventional financial products can be built. Consequently, Islamic jurists decided to invoke the *rule of necessity* since the universe of equity securities to choose from would be too small if they exclude all companies that either pay or receive interest (El Gamal, 2006).

Under the *rule of necessity* parameters, Islamic finance developed qualitative and quantitative screening processes that aim at the exclusion of certain categories of companies that clearly contradict the Islamic Finance requirements. The qualitative

screening is specific to the nature of the business while the quantitative screening uses financial ratios to exclude assets that do not adhere to the Islamic finance requirements. As an example, companies for which accounts receivables constituted a major share of their assets, companies that had too much debt, and companies that received too much interest are excluded (El Gamal, 2006).

The open question was around the quantification of the tolerable amount of interest dealings while still be considered "compliant" to Islamic finance principles. The answer finally came from the Dow Jones (DJ) Islamic Board who attained an agreement (*Fatwa*[12]) allowing the investment in assets that deals with interest but within certain limits, thereby creating a new way to accept certain assets with the condition to meet certain financial ratios and purification of impure income requirements.[13] The new set of rules introduced by Dow Jones Islamic Market (DJIM, created in 1999) opened the door to the Islamic investor to invest in the equity market.

Following the DJIM footsteps, AAOIFI approved the DJIM selection criteria but by incorporating some adjustments. Foremost, the AAOIFI clearly emphasized that dealing with interest is strictly prohibited. Nevertheless, within the limits and general guidelines of the *rule of necessity*, it allowed it when the corporation's primary activity is lawful. At

[12] Fatwa is the process by which a law is derived from the main sources (Qur'an & Sunnah) allowing or disapproving an act which is completed by a number of Muslim scholars (knowledgeable of the Islamic Law) on a specific matter. The five DJ Islamic board members (scholars) who took the tough decision to allow some interest and impure income are the following: (1) Sheikh Muhammad Taqi Usmani, (2) Sheikh Dr Mhamed A. Elgari (3) Sheikh Dr Abdul Sattar Abu Ghudah (4) Sheikh Nizam Yaquby and (5) Sheikh Yusuf Tala Delorenzo.

[13] After experimentation with different cutoff marks for financial ratios, the Dow Jones Islamic Market Index is now an accepted standard, excluding companies whose accounts receivable are more than 45% of assets and companies whose debt to moving average of market capitalization exceeds 33%. Generally a third rule related to the first excludes companies whose interest income exceeds 5% (or, for some, 10%) of total income.

the same time, the deposit and borrowed amount on the basis of interest as well as the amount of debt/interest in each asset shall not exceed some tolerable amount.

In sum, the AAOIFI prescribed the tolerable interest dealing in the following requirement: the debt ratio should be below 30% percent, the account receivables ratio should be below 45% percent, and interest income should be below 5% percent. More details are provided in the published AAOIFI's standards number 21 and 35 that govern the screening, purification, vote proxy and annual mandatory *Zakah* requirements for Islamic equity-market investments' requirements. The AAOIFI standards gained a wide spread popularity amongst interested investors because they were clear, had well defined constraints and were approved by highly regarded scholars.

The standards provided fund managers and Islamic investors clear direction on how to invest in the equity market. It included the nature of the assets and firms allowed, the financial ratios limitations and the short selling restriction. It is worth it to note that AAOIFI does not select stock, but it sets standards that are used as a guideline for investors. Many countries adopted the new guidelines for this reason as they viewed the guidelines as coming from a neutral party.

The combined efforts of the AAIOFI and DJIM to provide clear direction on avoiding the complete prohibition of interest, led to the development of many other equity indices that track the Islamic compliant assets in the equity market. For instance, DJ has created a family of equity indices for people who wish to invest according to Islamic investment guidelines. The DJIM indexes track *shari'a*-compliant stocks from around the world, providing Islamic investors with comprehensive tools based on a global investing perspective. The DJIM indexes currently include the DJ Islamic Market Index

(DJII), the DJIM U.S. Index (IMUS), the DJIM Technology Index (IMTEC), the DJIM Extra Liquid Index (IMXL), the DJIM Canadian Index (IMCAN), the DJIM UK Index (IMUK), the DJIM Europe Index (IMEU), and the DJIM Asia/Pacific Index (IMAP) (Hassan, 2002).

Presently, there are more than 70 different Islamic indices from DJIM alone, which provide access to more than 2,700 stocks from around the world, about 60% of which is from the U.S. (especially health care and technology securities). The DJII follow multiple screenings/exclusion criteria, which are designed to exclude companies with financial ratios, industries, sectors and business lines that are viewed as "incompatible" with Islamic investment guidelines.

In addition to the DJIM and AAOIFI selection criteria, there are other entities that develop indexes, provide guidance and rank assets based on their abidance to the Islamic finance requirements. These include (1) Standard and Poor (S&P) *shari'a* indexes which were introduced in 2006, (2) The Russell-Ideal Rating Islamic Index which was based on the Russell Global Index, (3) The Morgan Stanley Capital International (MSCI) Islamic Index series which is based on an MSCI Equity Index, and (4) The Financial Times Stock Exchange (FTSE) Shariah Global Equity Index series which is based on the large and mid-cap stocks in the FTSE Global Equity Index Series universe. Each of these organizations set rules that slightly differ from the others although they all source their rules from the Qur'an and Sunnah as well.

In general, all these organizations follow a two-step screening in order to assess the compatibility of an assets or company to the Islamic Investment requirements. The first step is what is generally called the qualitative screening, which is based on the nature of the business. Many industries and activities are excluded due to this first step, such as

conventional banking and insurance industries. The second step is what is generally referred to as the quantitative screening, which is based on a set of financial ratios. Therefore, to construct an Islamic financial portfolio, all of the components of the assets must pass these strict requirements.

The qualitative screening has multiple general implications such as the prohibition of investment in the conventional financial sector as mentioned above. In addition, since the excessive risk taking, speculations, and gambling are not allowed in Islamic finance, all assets in which the main activity is speculation or gambling are excluded. Furthermore, all assets whose main activity involves alcohol are excluded since alcohol business dealing is forbidden as well.

To illustrate the number of industries and assets that are excluded from an Islamic finance investment we take the example of the DJII which considers all income from the following sources as "non-permissible income": (1) interest income from operating or non-operating activities, (2) adult entertainment, (3) alcohol (and intoxicants in general), (4) cinema, (5) conventional banking activities (banking, mortgage, conventional financial services, conventional insurance), (6) gambling and casinos, (7) defense and weapons, (8) hotels, (9) pork, (10) tobacco etc. In fact, the DJII requires that the total "non-permissible" income cannot exceed five percent (5%) of total income generated by the company in order to be considered as Islamic finance asset.

Overall, there is a consensus among these organizations on the qualitative screening methodology with some exceptions that are noted for industries such as defense, weapons and media. Some organizations consider industries such as defense, weapons and media as permissible while others opt to exclude them altogether. Some

organizations allow minor violation of this restriction when the nature of the business is permissible even though the company also engages in other activities that are not permissible. As an example, DJIM and S&P exclude companies which have any involvement in prohibited activities while the FTSE and MSCI allow minor violations if the nature of the business is permissible.

These restrictions limit the opportunity set for an Islamic finance strategy. Therefore, the quantitative screening was specifically designed to solve for the total prohibition of interest and allow some interest-dealings in the business. Knowing that it is hard to find companies that deal with no interest at all, the DJII permitted financial leverage ratios that do not exceed 33%. This concept allowed Islamic finance entry to the equity market. AAOIFI then limited this ratio to 30% with the indication that these ratios cannot exceed a third of the market capitalization.

As such, the quantitative restrictions differ from one organization to another, especially the permissible financial ratio. The ranges of acceptable ratios vary from 30 to 33 percent for debt and interest–based investment, while permissible liquidity ratios range from 33 to 49 percent. In addition, there is a difference in how these ratios are calculated especially in the denominator. At the center of the debate was whether to use the total assets or the market capitalization. Even among those who agree on the market capitalization as a denominator, the historical data requirement varies from 12-month, to 24-month, to 36-month average total market capitalization.

In essence the qualitative rule include two main financial ratios that are used as follows: (1) the collective amount raised as loan on interest of any length does not exceed

a specific percentage of the market capitalization of the corporation[14], (2) the total amount of interest-taking deposits of any length shall not exceed a specific percentage of the market capitalization of total equity. Moreover, it is required to observe these rules throughout the period of participation or trading. If the rules cannot be applied, it is obligatory to give up such investment no matter how profitable it is. Accordingly, given the nature of the equity market, the financial ratios can change very frequently requiring an active management of an Islamic finance portfolio. This becomes the new impediment since it is, in essence, a requirement to change the optimal position based on the new information as soon as new information is available.

Before we will review how fund managers approach this requirement in practice by illustrating the case of three U.S. investment funds, we need to highlight another requirement that is unique to Islamic finance: the prohibition of short selling. The prohibition of short selling is a unique condition of the Islamic finance since we do not notice similar restriction on the SRI. El-Galfy & Khiyar (2012) argue that the theoretical Islamic principles are incompatible and inapplicable to the purely monetary activities of conventional banking. By consequence, the debt rescheduling, debt swaps, financing speculative cash balances, collateral debt obligations (CDOs), interbank liquidity speculative transfers, currency speculation, hedge funds and short selling are not allowed in Islamic finance (El-Galfy & Khiyar 2012). In this context, one can argue that this requirement is not too far from SRI which was developed to help investor to weigh social and environment factors in their investment choices and not only purely monetary.

[14] Market capitalization is calculated by multiplying the number of a company's shares outstanding by its price per share.

The AAOIFI standard number 21 clearly states, "It is not permitted to sell shares that the seller does not own and the promise of a broker to lend these at the time of delivery is of no consequence." Explaining how this constraint is relevant to today's markets given the 2008 financial crisis, Rehman (2010) pointed out that U.S. market regulator temporarily banned short selling stocks in the financial sector during the financial crisis. The difference here is that in the case of Islamic finance it is a permanent ban.

In summary, this section reviewed the general requirement for selecting an asset in order to construct an Islamic portfolio. As in the case of an SRI, the requirements differ slightly depending on the organization that sets those requirements. However, the principals are the same. These requirements manifest themselves in the number of constraints imposed on the portfolio optimization problem. On top of limiting the opportunity set by using negative screening (qualitative and quantitative), we also need to restrict short selling to fit the Islamic requirements. These restrictions might have implication on the portfolio strategy selected due to the performance of the Islamic finance strategy specifically.

In the next section, we will discuss how the Islamic finance requirements and principals are being used in practice. We will take the case of three U.S. Islamic investment funds and compare how they implement these rules. We will also review the role of some concepts such as *Zakah* and the role of money on the overall preference and investment decision of an adherent to the Islamic finance investment.

1.3. Islamic Finance: Theory & Practice

Islamic finance sets guidelines for ensuring justice across all of society, not just the financial sector. In this dissertation, we focus mainly on the investment piece of Islamic finance but to be able to understand the interest and short selling prohibitions mentioned earlier, we need to review the fundamental principles of Islamic finance, which normalize these prohibitions. At the same time, the practice of these principals diverges with respect to location and the institutions or entities that claim to follow the Islamic finance principals. Therefore, we will review briefly the concept of interest and inflation in theory and practice. Then we will focus on the implementation of the restrictions in the U.S. in the case of three Islamic investment funds.

One common argument that supports the necessity of interest in the conventional capital market is the presence of inflation, in which case interest is viewed as a possible compensation for the lost value. Islamic scholars realized many centuries ago that the movement in the price level is caused by demand and supply (Chapra, 2008). However, Siddigi (1996) argued that there are four major stabilizers in Islamic finance that guarantee zero inflation or, at least, minimize inflation's impact.

The first major stabilizer in Islamic finance is the requirement that debt financing is not allowed which is the main determinant of inflation. Since interest is prohibited, debt financing is nonexistent in the Islamic finance theory. Instead, the debt financing is replaced with equity and profit sharing financing in the form of partnership and other allowed contracts. Thus, no guaranteed interest rate is allowed and the golden rule is that no risk no gain (Chapra, 2008).

Other stabilizers are the *Zakah* and inheritance laws, call for moderation in consumption, and the government role. The *Zakah* and the inheritance laws affect the distribution of income in favor of the less privileged population which, in turn, influences aggregate demand. The third stabilizer is imbedded in the fact that Islamic finance encourages moderation in consumption and strictly discourages waste. By consequence, it is expected that we would see a decrease in aggregate demand. Lastly, the fact that Islamic governments, in principal, should consider public money as trust which requires them to keep public expenditure within bounds set by available means and any financing should be attached to the growth of the economy in theory.

In addition, the monetary system used by early Islamic finance was mostly based on the gold and silver standard. Abdul-Rahman (2014) compared the difference in inflation levels between using the gold and silver standards and the conventional system. Abdul-Rahman shows the gold and silver based system leads to lower inflation rate. Correspondingly, Kia (2017) claims that the early Islamic history witnessed a very low but not equal to zero inflation rate, this is different than the theoretical assertion that inflation should be zero if there is no imported inflation.

Indeed, the comparative study revealed that the purchasing power of gold and silver has remained extremely stable over not just the past century but over most of history. For example, it is reported that the price of 100 barrels of oil measured in ounces of gold has remained fairly stable between 5 and 10 ounces of gold for the last 100 years. From just 1973 to 2008, the price of a barrel of oil in U.S. Dollars increased by 3,300%. Over the same period the number of ounces of gold required to buy 100 barrels of oil rose by only 18%.

Nowadays, none of the Muslim countries use the gold and silver standards, leading them to experience high levels of inflation with just a few exceptions. Now, the argument against using the gold and silver standards is that having a metallic standard would handcuff governments as they can only print money relative to the amount of metal they can get hold of. In contrast, by arbitrarily printing money, the conventional system has caused inflation leading to a need for interest rate collected to compensate, in part, for the high levels of inflation.

In addition, although *Zakah* is a mandatory requirement in Islam, most Islamic countries are not imposing its collection. In general, it ends up being a personal choice of the individual Islamic finance investors. Therefore, Islamic finance investors make their own judgment based on their personal convictions. Hence, the determination of the *Zakah* rate could be different and paid on many different timelines or even not paid at all since certain individuals would consider paying taxes to the government as if it was the mandatory *Zakah*. Therefore, the presumed impact of *Zakah* in alleviating the inflation by the re-distribution of income is minimized.

Similarly, the total prohibition of interest has been relaxed by organizations with authority in the Muslim world. As an example, AAOIFI deemed a certain level of interest dealings as acceptable even though the same organization stated clearly that all interest dealings are prohibited. This is a very sensitive subject since the prohibition of interest is clearly stated in the Qur'an, where it prohibits the giving or charging of interest in loan or sales transaction.

Similarly, Islamic finance investors may find themselves confronted with interest transactions, despite purchasing a product in compliance with Islamic finance. As an

example, Islamic finance mortgage companies in the U.S. such as Lariba[15] and Guidance[16] are deemed Islamic finance institutions offering Islamic finance mortgages among other financial products. The terminology used while advertising their mortgage products include words such as financial "fees" and "leasing language" such as rent to own contracts. When commercializing their mortgage product, the Islamic finance institutions proclaim that they do not deal with interest but to be compliant with local regulations, the institution has to translate this agreement into a regular mortgage (with an agreement about interest). When reviewing the final contract with their clients they have to state clearly and sign the "interest rate" agreement required, for instance, in the U.S. Seeing interest rate calculations in the actual mortgage contract, which can be very surprising for an Islamic finance investor.

Such practical issue leaves the door open to many doubts around the authenticity of the Islamic finance offerings today including the equity market investments. The leap between the theory and practice widen to the point that it might hold many new investors from investing in these assets. This also opens the door for a lack of trust between the financial institutions that are labeled Islamic and their potential clients, something that we will discuss late in chapter 3.

Indeed, we reflected in previous section on how organizations such as AAOIFI and DJIM set the restrictions for Islamic finance but have different interpretation of compatible industries and different restrictions on the financial ratios. Individual Muslim

[15] Lariba is an American finance house providing Islamic products such as home financing, car financing and commercial business. More details available at: https://www.lariba.com/sitephp/index.php

[16] Guidance is provider of Islamic finance products in the US. More details available at: https://www.guidanceresidential.com/

investors are no different. In fact, there are more than 1.5 billion Muslims in the world who believe in the Qur'an and Sunnah as the main sources of Islamic finance but vary in how they will follow its detailed instructions in practice. That is why we see many investment funds thrive although they might adhere to different set of restrictions. Accordingly, each investor would invest in the Islamic investment fund that would fit their beliefs the most.

In the U.S., as an example, there are three main investment funds that offer Islamic finance investment options. These are the Amana funds, the Azzad fund and the Iman fund. Although all of them claim to follow the Islamic finance investment principals, in practice they choose different set of standards to follow. Amana Fund Management follows the standards the Fiqh Council of North America (FCNA). The Azzad and the Iman funds are known to follow the AAOIFI standards.

The Amana fund was initiated on June 23th, 1986 by a mainstream investment firm called Saturna Capital, where the majority of its investors are non-Muslim socially responsible investors. Their investors are usually attracted to this Islamic finance fund due to its interesting combination of performance and socially responsible options. Saturna now has expanded its operations to offer four additional Islamic funds with different strategies that focus on: income, growth, developing world and participation funds, thereby managing billions of dollars worth of assets.

Although both of the relatively new Islamic funds Azzad (developed in 1997) and Iman (launched in 2000) follow the AAOIFI requirements, in practice their implementation of AAOIFI rules varies. Each fund uses a different technique to keep the portfolio compliant at all times and throughout the period of investment. As an example,

the interpretation of the limited percentage of lending and borrowing that involves interest is capped to 30%, however, each fund internalizes that differently.

For instance, to avoid reaching the capped ratio, the Iman fund introduced another cap that is lower than the required 30% cap from AAOIFI so that there is room for them to sell assets before it reaches the cap. On the other hand, Azzad keeps the asset in the portfolio even when the financial ratios reach the 30% cap. They would keep it until they find the right time to sell the asset even if by the time of sale the ratios might have been slightly higher than 30%. Therefore, we could consider the Iman fund a more conservative fund since it thrives to strictly apply the professed constraints while the others allow for certain variation which they believe is not harmful.

In fact, the Iman Mutual Fund proposed to limit the selection of an asset based on a financial ratio that is lower than the standard 30% requirement. This methodology allows the fund some stability and provides some buffer for the fund to act and plan an exit strategy before the financial ratio of a certain asset reaches 30%. With this in mind, the investor's interest is not harmed by selling the asset when it exceeds the 30% even if it is at a loss. Other funds in the U.S. allow for a variance above the 30% with no penalty or requirement for immediate sale.

In chapter 2, we will use the Iman fund as reference for selecting securities that meet the Islamic finance restrictions assuming that an investor abiding by Islamic finance requirements will invest in a fund that aims to follow the most conservative restrictions possible. We will review the mean-variance model as the theoretical framework to compare the performance of two investment strategies: Islamic finance and conventional investment. In this case, we will impose restrictions on the Islamic finance portfolio to

meet the Islamic finance requirements while no need for any restriction on the conventional portfolio. Given the nature of this problem, which requires imposing constraints, the constrained mean-variance model will be utilized to solve the optimization problem.

Chapter 2 – Theoretical Framework for Restricted Portfolio Management

In this chapter, we will review the theoretical framework of the mean-variance model and its special case: the constrained mean-variance model. Then, we adjust the model to fit the Islamic finance restrictions requiring specific restrictions and constraints. The aim is to find the solution to the portfolio optimization problem for an Islamic finance portfolio. The need for optimization with constraints is not unique to the Islamic finance. In fact, due to the growth of defined contribution pension plans (which shifted the asset allocation challenge to the individuals), investments are often restricted to certain classes or assets as imposed by investors or some institutions that follow certain guidelines. These restrictions can also be due to the desire to avoid large risks such as the one related to the financial crisis in 2008 or simply to limit exposure to some risky assets or balancing the portfolio so that it is not heavily invested in few assets.

In the case of the Islamic finance, the constraints and restrictions are placed on the opportunity set as well as the optimization problem. However, the impact of these restrictions on the performance of the portfolio is not well known. From the theory of mean-variance model, imposing restrictions on the opportunity set might lead to a lower benefit due to the lack of diversification. Therefore, to understand better the difference between an investment that is restricted and another one that does not require additional constraints, we will compare the theoretical framework of two investment strategies: Islamic finance and conventional finance using the mean-variance model. We will complete the comparative study using actual data in Chapter 3.

First, we review the mean-variance model principals and assumptions that lead us to believe that the constrained mean-variance model is the best model for this paper. Knowing that we need to impose constraints on one of the portfolios, we will adapter the constrained mean-variance model instead to two investments strategies: (1) conventional, which does not require any restriction on the asset classes or short selling and (2) Islamic finance, which imposes many restrictions on asset classes and short selling.

In addition, we will review the case of *Zakah* and how we can incorporate this concept within the constrained mean-variance framework. As described in the previous chapter, an Islamic finance investor is faced with a choice between investing his wealth in an Islamic compliant investment vehicle or paying *Zakah* at the end of the period (one lunar year) if the money is kept as cash or cash equivalent. Therefore, we will adjust the model to care for this particular requirement.

Lastly, we will sketch the model to add more restrictions on the weights of each asset as doing so is well-known for balancing the portfolio weights and improving the performance of the model. Jagannathan and Ma (2003) show that imposing constraints help stabilize the mean-variance weights. These additional constraints are known for bringing back the unconstrained weights to economically reasonable values.

2.1. The General Mean-Variance Model

Finding the optimal portfolio choice is thriving given the methodological advances and the growing practical importance of this problem especially with the increase emphasis on defined contribution pension plans that shifted the asset allocation burden onto individuals (e.g. 401K account, Individual Retirement Account, etc.). The capital asset pricing model (CAPM) emerged as a practical and intuitive model to evaluate the performance of managed portfolios although many criticized its poor empirical record, (Fama & French, 2004).

The mean-variance model is widely used in many applications one of which is the selection of optimal portfolio strategies. The simplicity of the model and the intuitive linear trade-off between risk and return—demonstrating the benefit of diversification in portfolio management—allows it to be widely used to track portfolios' performance. The trade-off between risk and return starts from the concept that risk or volatility is bad while return is good and assumes that the markets are efficient. Therefore, it attempts to relate the returns on an individual stock or individual asset to the returns on the market.

In spite of many criticisms of the model's unrealistic assumptions and static nature, it is still widely used by professionals and researchers. The model uses historical data to estimate the risk and return parameters. Researchers either searched for obtaining explicit solutions to the optimization problem such as Merton (1970; 1990) or analyzed calibrated versions of simple methods to avoid practical challenges such as Campbell and Viceira (1999; 2002) among others.

2.1.1 The General Mean-Variance Model Framework

The Modern Portfolio Theory (MPT) models such as CAPM are utilized to define optimal strategies for investing in the capital market. The CAPM is an economic model for valuing stocks, securities, derivatives, and/or assets by relating risk and expected return (Sharpe, 1964; Treynor, 1961; Lintner, 1965). The model presumes that an investor aims to maximize the return of his portfolio while minimizing its risk, leading to a decision based on the trade-off between risk and return. Therefore, the only two important moments of the probability distribution of the expected returns and variance are the mean and the variance.

Harry Markowitz (1952), who initially developed the model, was the pioneer of the mean-variance portfolio framework and showed how the variance—which is used as a proxy for risk—can be reduced through the impact of diversification. Awarded the Nobel Prize in 1990, Markowitz emphasized that the variance of a portfolio can be reduced through the impact of diversification by selecting portfolios based on their overall risk-reward characteristics. So, no additional expected return can be gained without an increase in risk. Likewise, no additional diversification can lower portfolio's risk for a given expected return.

The Markowitz model measures the risk as the variance (or standard deviation) of the total return showing that as you add assets, the total risk of that portfolio declines continuously without sacrificing return. The risk is measured by the variability around the expected value of the probability distribution of returns. Return is computed based on the expected value of the distribution using the probability distribution of expected

return for a portfolio. If we assume that the assets prices will clear the market of all assets then we can identify an efficient portfolio.

According to the Markowitz model, investors are risk averse; they want high return, aspire to avoid risk and have one time horizon during which they maximize their utility functions within the framework of diminishing marginal utility of wealth. Therefore, it is a static portfolio choice that only considers the first two moments of the distribution of the asset's return. During this one period, the investors, who are risk averse, only consider the mean and variance of the returns of their portfolios. In addition, there are perfect markets, the investments are infinitely divisible, and there are no transaction costs and taxes.

These investors choose a mean-variance efficient portfolio by minimizing risk and maximizing expected return for a given a level of risk. Therefore, they are looking to identify a portfolio that must be efficient if asset prices are to clear the market for all assets. The efficient frontier, which leads to the efficient portfolios, is the intersection of the set of portfolios with minimum variance and the set of portfolios with maximum returns. Therefore, the efficient frontier is the set of all portfolios of which expected returns reach the maximum given a certain level of risk. Finding an optimal portfolio will thus depend on the degree of risk aversion, which is the willingness to trade off risk against expected return.

Sharpe (1964) and Lintner (1965) added two assumptions to the mean-variance model: (1) the joint distribution of assets' return during the period of analysis and (2) the unlimited borrowing and lending at a risk-free rate for all investors. These assumptions presume the existence of an alternative investment in a risk less asset with no variance.

Although an unrealistic assumption, adding risk-free borrowing and lending turned the efficient frontier into a straight line combining a risk-free lending/borrowing portfolio with some risky portfolio using the Tobin's two fund theorem (1958). So for a given variance, the investor can get higher expected return.

The two-fund theorem developed by Tobin (1958) won the Nobel Prize in 1981. The theorem states that when a risk-free asset exists, investors can use two steps to get to the optimal solution. Given the fact that this is a one period model, when we introduce the risk-free asset to the problem, it gives us an asset with zero variance since its rate of return is known. Therefore, using Tobin's two-fund separation theorem, we can first find the minimum variance efficient portfolio which is also called the tangency portfolio. Next, we create a combination of a risky asset portfolio and the risk-free asset which provides a wider efficient frontier and investment strategies. The efficient portfolios become a capital market line (CML) or called also capital allocation line (CAL).

The combination of a risk-free asset and a risky portfolio using a weighted approach will dictate the CAL. The position of the investor in this line will be based on the investor risk tolerance. Risk-averse investors will prefer holding more of the risk-free assets, which have a known return and no variance. Risk takers on the other hand, will borrow money to buy more risky assets. The tangency portfolio is the market portfolio assuming imperfect correlation between risky assets. Since the tangency portfolio is well diversified and eliminates systematic risk, all investors should invest in this portfolio in theory.

Fischer Black (1972) relaxed the assumption related to the unrestricted risk-free borrowing and instead introduced the assumption of unrestricted short sales of risky

assets. The same results could be obtained without the assumption of risk free rate borrowing and lending. Since the portfolios that are a combination of efficient portfolios are efficient themselves, the market portfolio is efficient. The problem becomes a quadratic programming issue except that the optimal portfolio may fall in an unfeasible region. All portfolios below minimum-variance portfolio are rejected as inefficient.

To find an optimal portfolio using the mean-variance model, we need to calculate the efficient frontier, choose a risky portfolio based on investor's CAL and then allocate funds between risky and risk-free assets that will be optimal for the investor. The main assumption is that the return of the financial asset is described by a random variable. This random variable has an expected variance and a mean which is derived from the historical data. The variance describes the risk of the financial instrument while the expected mean describe the return or the reward of such asset.

Therefore, the model assumes that investors are price takers who choose the portfolio that has the lower variance. At the same time, investors are risk-averse investors who are trying to avoid risk while trying to get the best possible return. Thus, given two assets that offer the same expected return, the investor will prefer the less risky one. This implies that the investor will expect to be paid extra (receive higher returns) for taking more risk.

If we assume a utility function that characterizes the investor's preferences and define the investor's indifference curve, the standard mean-variance utility portfolio model maximizes the investor's return by choosing the highest possible indifference curve. The optimal portfolio along the efficient frontier is not unique with this model and

depends upon the risk/return trade-off utility function of each investor. The optimal portfolio would be the point that is at tangent of a utility curve and the efficient frontier.

Researchers usually utilize a quadratic utility function to characterize an investor's preference although Markowitz (2014) argues that it is not a necessary condition for mean-variance analysis to maximize expected utility. Here, we will use the following quadratic utility function which been used by Chiarella et al. (2016)[17]:

$$U(X_{t+1}) = aX_{t+1} - bX_{t+1}^2$$

Where $U(X)$ is the utility function of the investor at time *(t+1)* and a and b are coefficients. Therefore, an investor's utility maximization problem between time t and $t+1$, subject to some constraints related to the investor's wealth, X_t, and the portfolio return, $R_{p,t+1}$, can be written mathematically as follows:

$$max\ E[U(X_{t+1})]$$

$$s.t.\ X_{t+1} = \left(1 + R_{p,t+1}\right)X_t,$$

Where $E[U(X_t)]$ is the expected utility function of the wealth at time t. Following the same method and using the Taylor series approximation, we can rewrite the problem as follows:

$$\max_{\sigma_t}[E(R_{p,t+1}) - \frac{\gamma}{2}\sigma_{pt}^2]$$

[17] Chiarella et al. (2016) p.49-50

Where $E(R_{p,t+1})$ is the expected return of the portfolio at time t, and σ_{pt}^2 is the conditional variance of the portfolio while Υ is the parameter of risk aversion, which capture the investor's risk preference. Therefore, we have an optimization problem that maximizes an objective function, which represents a linear combination of the first and the second moments of an asset return distribution.

With the introduction of the n risky assets and a risk-free asset with a rate of return R_f which has a zero variance over one time period, the solution to the optimization problem is as follows; where w_t represents the weights allocated to the risky assets in the portfolio:

$$w_t = \frac{1}{\gamma}\frac{(E(R_{t+1}) - R_f)}{\sigma_t^2}$$

Clearly, the risk aversion factor, γ, will determine the amount invested in risky and risk-free assets. The optimal weight allocation depends on the investor's risk aversion. However, researchers such as Cambell and Viciera (2002) showed that investors differ only in the overall scale of their risky asset position, measured by the risk aversion. The position of the risky assets remains the same across all investors which align with Tobin's (1958) initial mutual fund theorem. Investors with high risk aversion, γ, hold more of riskless asset (with a known expected return and zero variance) but they don't change the relative proportions of the risky assets since it determined by the following ratio: $(\frac{(E(R_{t+1}) - R_f)}{\sigma_t^2})$.

The Sharpe Ratio (SR) is commonly used as the key performance indicator to compare performance of different portfolios in this framework. The SR is defined as the

mean excess return divided by the standard deviation and represents the slope of the CAL. The SR implicitly accounts for the preference of the investors when we use the mean-variance model. Therefore, the SR includes investors risk preference, which is generally identified at three levels: risk taking, neutral or risk-averse investors. The CAL depicts all feasible risk-return combinations available from different asset allocation choices to determine the optimal risky portfolio. The objective is to maximize its slope for any possible portfolio.

The SR is expressed as follows:

$$SR_t = \frac{E(R_{t+1}) - R_{f,t+1}}{\sigma_t}$$

Here, SR_t denotes the portfolio SR at time t, $E(R_t)$ represents the portfolio expected return at time t, R_f is the risk-free rate and σ_t is the portfolio standard deviation.

Another key element is the market beta which is defined as the covariance of the risky asset return with the market return divided by the variance of the market return which measures the sensitivity of the asset's return to variation in the market return. Fama and French (2004) offer another interpretation of beta as the risk of market portfolio weighted by the covariance or simply the variance of the market return. The question that arises is what the definition of the market portfolio is? And which proxies should be used for the market portfolio? These questions as well as others raise the question around the validity of the model and its practical usages which we will tackle next.

In this section, we reviewed the unconstrained mean-variance model assuming that funds are given and only asset allocations have to be made. The model is based on the Markowitz's initial mean-variance portfolio model and requires many simplifying assumptions in order to get simple and intuitive results. In addition, given the nature of the optimization problem treated in this paper and the many and well-defined constraints introduced, the unconstrained mean-variance is not the best suited model. Therefore, we suggest using the constrained mean-variance model instead. In the next section, we will explains why and present some of the alternative model.

2.1.2 Which Model Is Best for This Research

The CAPM model, which is used to evaluate the performance of managed portfolios, among other uses, offers a powerful and intuitive prediction for measuring risk and expresses the relationship of risk with the expected return. However, many researchers argue that CAPM's empirical records are poor reflecting either its theoretical weakness or the difficulties in implementing valid test for the model.

Considerable debate among academics was triggered about the standard mean-variance model. One of the concerns is related to the notion that risk can be measured by the variance since it weights the upside and downside the same while investors might be more sensitive to loss than to gains. Another concern is related to the expected return and how we are only taking into account the first two moments. Other questions were raised related to the unrealistic model assumptions, being so restrictive as to invalidate its conclusions (e.g. rational investors, efficient markets), while others touch on the fact that it is a one factor model (Ang, 2012).

To illustrate further, the following questions fueled the debate in the literature: Are the market efficient? Is the CAPM model flawed as description of the risk-return relationship? Are there other measures acting as proxies for risk? Are the empirical tests flawed due to measurement errors? Which utility function to use? And what are the implications of using a specific utility function (such as quadratic utility function) leading to specific assumption associated with assets return as an example? These are questions that up-to-date prove the weakness and impact the validity of the model.

In fact, Fama and French (1992; 1998; 2004) concluded that, contrary to the relationship predicted by the CAPM, the market sensitivity or the variance of the market return was not related to average returns on stocks. In their recent paper they even declared that the problems are serious enough to invalidate most applications of the CAPM. Specifically, advanced tests of the CAPM shows that broad stock market indices are not good proxies for the market portfolio. Other assets such as real estate, land and human capital were cited by other researchers as possible assets that need to be included in the measure of wealth. Fama and French (2004) declare that weakness in the theory or in its empirical implementation make most application of the model invalid.

Another fundamental criticism of CAPM was undertaken by Cambell and Viciera (2002). They argued that if the CAPM logic is followed, all investors will end up investing in the same mutual fund, calling it the "single mutual fund of risky assets." Assuming imperfect correlation between risky assets, all investors would invest in the tangency portfolio (or the market portfolio) since it is well diversified and eliminates the unsystematic risk. Consequently, the static mean-variance model with riskless one period logic leads to a single optimal mutual fund of risky assets that will be attractive to all

investors. Therefore, all investors will have to invest in one single mutual fund of risky assets.

In addition, Cambell and Viciera (2002) also discuss two issues associated with the use of the utility functions. The first one is related to the nature of the utility function that been used. Although Markowitz (2010) asserts that he did not declare the quadratic utility function as the only utility function that must be used, it was the most widely used. Using the quadratic utility function has implication on the distribution of the assets returns which is the second challenge. When using the quadratic utility function, you are implicitly assuming that the returns of the assets are normally distributed. Markowitz (2014) argues that using the quadratic utility function and assuming a normal distribution of return is a sufficient condition in the mean variance model but not a necessary one.

With all the criticisms and the fact that the CAPM was firmly rejected by the data, the simplicity and intuition of the CAPM attract finance professionals. Ang (2014) cited that 75% of finance professors advocate using it and 75% of CFOs employ it in actual capital budgeting decisions. The concept of diversification and the benefits of diversification are so simple and powerful which drove wide adoption of the model to solve real life business challenges.

In the investment arena thought, the standard static portfolio model with no constraints does not reflect intuitions of the real world. Therefore, many researchers argue that the constrained minimum variance model delivers better results and leads to more balanced asset allocation while aligning with the reality of the investor's needs. With the recent financial crisis of 2008 as an example, the aim of the 401K and retirement

accounts is to avoid large loses and limit exposure to risky assets while ensuring that the portfolio is well diversified. Hence, the constrained model will be the best suited to incorporate restrictions and constraints such as the one imposed by Islamic finance.

Brandimarte (2006) contends that the need for constraints is realistic because, as an example, managers use lower and upper bounds on the allocation of single assets or groups of assets, limiting their exposure to certain risky stocks or to market sectors. In fact, with the recent financial crisis when reputable companies experienced bankruptcy without any early warning, it is clear that restrictions are warranted especially on the weights of the assets within the overall portfolio.

Jagannathan and Ma (2003) maintained that portfolio managers often use constraints to reduce the instability of the standard mean-variance weights recommending the use of constraints all the time. In addition, they show that imposing a short sale constraint when minimizing the portfolio variance is equivalent to shrinking the extreme elements of the covariance matrix. This is a very interesting results, especially that the Islamic finance strategy will include a short selling constraint. In addition, to check the impact of the short selling requirement on the strategy performance we will conduct an experiment in chapter 3 to test how the conventional portfolio performance will change if a short selling restriction is imposed. At the same time, we will relax this restriction for the Islamic finance strategy to detect impact of this important requirement.

The other argument is that adding constraints to the mean-variance model minimizes the variance based on a set target of portfolio returns, which allows the investor to minimize the variance by choosing an expected return. Thus, it lowers the risk

of estimating the expected returns since the return is a given so that one may only focus on the variance estimation. Since there are good models to estimate the variance, the results are usually better. Ang (2012) argued that when we remove all the errors associated with estimation of the means, estimation of the volatility is much more predictable.

Specifically, the minimum variance optimization problem solves for the combination of the weights that minimize portfolio variance subject to two constraints. The first constraint is the expected return equal to target return that the portfolio manager imposes and the second is that the portfolio is valid or all the weights equals one. Ang (2012) performed what he called a "horserace" between different strategies including the standard mean-variance and the minimum variance models and found the same conclusions still hold. He also showed that the minimum variance model outperformed the market because the lower volatility assets usually have higher returns than high volatility assets.

Chiarella et al. (2016) show the superiority of the constrained optimization model by constructing a risky portfolio including, in addition to the equity markets, the U.S. government, treasury and corporate bonds and finding the optimal portfolio using the two methods. Results show that when you compare unconstrained model using the utility function and a constrained model using the constrained mean-variance model the performance of the portfolio using the constrained model is better.

In our case, the need to use the constrained model is clear since we have to abide by the restrictions on short selling as described in previous chapter as well as other restrictions on the opportunity set. The Islamic finance strategy requires restrictions on

the universe of assets or the opportunity set in addition to the restrictions on short selling since it is prohibited. We will also introduce restrictions on the weights to test the impact of additional constraints on the performance of the portfolio. Comparing a conventional portfolio to an Islamic finance portfolio strategy will require imposing constraints on the assets and on short selling for the Islamic portfolio. Therefore, using the constrained mean-variance model to test our hypothesis is the best choice.

Next, we will review how we can adapt the constrained mean-variance model to fit the Islamic finance requirements.

2.2 The Conventional Portfolio Strategy

2.2.1 Constrained Mean-Variance Model

The constrained mean-variance model starts from the initial problem of maximizing the return with respect to a known variance or minimizing the variance subject to a known return with no explicit utility function. We can describe the optimization problem as finding the optimal weight of each asset from an opportunity set which contain a set of financial assets that is characterized by their expected means and covariance. The solution is an optimal portfolio that has the smallest risk for a given level of return or the highest return given a level of risk.

Therefore, the optimization model can be either expressed as maximizing the expected return with respect to a given variance or minimizing the risk with respect to a given rate of return. However, since the estimation of the returns is harder than estimation of the variance the latter is what been used to solve this problem. Hence, we use the quadratic optimization mathematical framework to find, for a level of return, a unique portfolio offering the lowest variance by holding the rate of return constraint and solving for the weights that minimize the variance.

Thus, for a conventional portfolio that incorporates no restrictions on long buying or short selling, the minimum variance model is computed for a given level of expected portfolio return subject to portfolio validity constraint. Therefore, the mathematical equation of a constrained mean-variance optimization problem for a conventional strategy can be written as follows, for n risky assets:

$$\min \omega^T \Omega \omega$$

$$\text{s.t.} \qquad \omega^T E(R_p) = \bar{r} \qquad (2.1)$$

$$\omega^T I = 1 \qquad (2.2)$$

Where ω is the weight vector of n risky assets and ω^T is its transpose. Ω is a variance covariance matrix of expected real returns of the risky assets. $E(R_p)$ is a vector of expected returns, I is the unit vector and $\bar{r}$ is a given expected portfolio's real return that the portfolio manager would like to get at the end of the period (it will depend on the investor's preferences). Equation (2.2) is the constraint that the sum of the weights of all risky assets is equal to one. It is also called the admissibility condition of the portfolio weights (Ang, 2012). The equation (2.1) is the constraint imposed based on the knowledge of the amount of return preferred.

This problem explicitly addresses the trade-off between expected rate of return and variance of the rate of return in a portfolio. The existence of a risk-free asset greatly simplifies the nature of the feasible set and also simplifies the analytic solution. To find a solution to the problem we can use the method of the Lagrange multipliers.

The Lagrange is defined as follow where λ and μ are the two Lagrange multipliers:

$$L = \tfrac{1}{2} \sum W_i W_j \sigma_{ij} + \lambda \left(\sum W_i E(r_i) - \bar{r}\right) + \mu \left(\sum W_i - 1\right)$$

To solve the above equation, we need to find the critical point and solve the system of differential equations. First, differentiate the Lagrangian with respect to each variable (W_i) and set it to equal to zero, which will provide n equations. In addition, we have two equations of the constraints bringing the total number of the system of equations to ($n+2$)

equations. With that, we can get an analytical solution to the system of the equation, solving for ($n+2$) unknowns: n, W_i's, λ and μ.

The portfolio that solves the optimization problem and minimizes the variance for a given expected return is called a frontier portfolio. Solving the Lagrangian will produce the weights for an efficient portfolio with the mean $\bar{r}$. A frontier portfolio is a linear combination of two frontier portfolios. The efficient frontier is the representation of all frontier portfolios and it is shaped as a hyperbola. The minimum variance portfolio (MVP) is the linear combination of two frontier portfolios that also represent the minimum variance possible.

However, according to this framework, the preferred frontier portfolio for an investor is the one that have maximum SR since it gives the highest expected return per unit of risk. The SR represents the expected return per unit of risk and it is used to compare the performance of portfolios. It is also called the tangency portfolio since the portfolio with maximum SR is the point where a line through the origin become tangent on the efficient frontier. Within this framework, the higher the SR, the better and more risk-efficient is the performance of the portfolio.

Adding a risk-free asset that has a low return that is deterministic, known with certainty, is expected to have no risk. Therefore, the variance of the risk-free asset is equal to zero. In addition, a risk-free asset has no correlation with the rest of the risky assets. In other words, a risk-free asset is a pure interest-bearing instrument; its inclusion in a portfolio corresponds to lending or borrowing cash at the rate of the risk-free asset. The lending means a positive amount is invested in the risk-free asset while borrowing means

that negative amount is invested in the risk-free asset. Therefore, lending has a positive weight, whereas borrowing corresponds to a negative weight.

When risk-free borrowing and lending are available, the efficient set consists of a single straight line or the CML, which is the top of the triangular feasible region. This line is a tangent to the original feasible set of risky assets. There is a point, M, in the original feasible set that is on the line segment defining the overall efficient set. The portfolio represented by the tangent point can be thought of as a fund made of assets and sold as a unit: there is a single fund, M, of risky assets such that any efficient portfolio can be constructed as a combination of the fund, M, and the risk-free asset.

From this model we derive the capital market line as follows:

$$E(r) = R_f + \big(E(r_m) - R_f\big)\beta_m\,, \qquad where\ \beta_m = \frac{Cov[r, r_m]}{Var[r_m]}$$

Assuming the existence of a risk-free rate asset with a rate of return R_f the SR in this case is as follows:

$$S_R = \frac{E\big(R_p\big) - R_f}{\sigma_p}$$

Where σ_p is the portfolio standard deviation. When the risk-free rate is equal to zero, the SR is a simple division between the expected portfolio return and the portfolio standard deviation.

The above-sketched mean-variance model will be used to identify the optimal solution for the conventional portfolio while allowing for short sale. Next, we will restrict

the weights of the assets to be able to test the impact of the additional constraints on the performance of the conventional portfolio in chapter 3.

2.2.2 Upper Bound Constraint for a Conventional Strategy

Adding more constraints to the mean-variance model is expected to reduce the sampling error, which will allow the model to perform better than the unconstrained portfolios. Chiarella et al. (2016) found that imposing constraints balances the portfolio weights and reduces portfolio risk as compared to unconstrained mean-variance utility models. In addition, they deduced that the constrained model is more appealing to practitioners because of its realistic constraints even though it does not explicitly characterize the investor's risk preference[18].

The hypothesis is that the additional constraints will help the portfolio weights to have economically reasonable positions. To demonstrate the point, Ang (2012) ran a horse race between several portfolio strategies building a diversified portfolio in different ways--mean-variance weights, equal weights, minimum variance, etc.--starting from the full mean-variance case to various special cases by adding restrictions. Results show that adding restrictions improve the performance of the portfolio.

In practice, the need to limit the risk of each asset to a certain level is real. This is in order to avoid complete wealth losses as some investors may have experienced during the last financial crisis. In fact, many pension funds and government retirement funds set their exposure to a certain sector, industry or even asset to a limit nowadays.

[18] Chiarella et al. (2016) p.49-50

The mathematical equation of a constrained mean-variance optimization problem using an upper bound limit is as follows for n risky assets:

$$\min \omega^T \Omega \omega$$

s.t.:

$$\omega^T E(R_p) = \bar{r} \qquad (2.1)$$

$$\omega^T \mathrm{I} = 1 \qquad (2.2)$$

$$\omega_i \leq a\,, i = 1,2, \dots, n \qquad (2.3)$$

Where ω is the weight vector of n risky assets and ω^{T} is its transpose. Ω is a variance covariance matrix of expected real returns of the risky assets. $\mathrm{E}(\mathrm{R_p})$ is a vector of expected returns, I is the unit vector and $\bar{r}$ is a given expected portfolio real return that the portfolio manager would like to get at the end of the period (which will depend on the investor's preferences). Equations (2.1) and (2.2) are as above in section 2.2.1 where (2.2) is the constraint that the sum of the weights of all risky assets is equal to one and (2.1) is the constraint imposed based on the knowledge of the amount of return preferred.

Equation (2.3) addresses the limit that we will impose on the weights of all assets so that it does not exceed a specific limit or the maximum allocation. With this additional constraint, we limit the optimal weights to a specific constant, a, called the upper bound limit or maximum allocation. When we solve for the optimization problem the weights of each asset have to be less or equal than "a". In our case, we will solve for the optimization problem four times, each time we will use a different values for, a. The first time, we will set the constant "a" to equal 40%, meaning that all the weights in the optimal portfolio cannot exceed a 40%. This optimal portfolio will be labeled portfolio A. Similarly we will use different values for the maximum allocation (upper-bound constraint), a, equal to

30%, 20%, and 10%; solving these different optimization problems will yield three different portfolios: B, C, & D respectively.

In the next section we will review the constraints imposed on the Islamic finance strategy and how we can model the optimization problem using the mean-variance model to fit the Islamic finance requirements.

2.3 The Islamic Finance Portfolio Strategy

In the case of Islamic finance investments a specific set of constraints must be observed which are specific to the asset selection (negative screening) in addition to the short selling restriction. In this section, we will review the specific selection and screening criteria we intend to use in constructing an Islamic finance strategy and review the model with the added short selling constraint as well as any additional constraints such as upper and lower bound restrictions on the weights.

2.3.1 Restrictions on the Assets Selection

Before we get into the constrained mean-variance model and how we will adjust it to fit the Islamic restrictions, we need to review the restrictions on the opportunity set for an Islamic finance strategy. As we have seen in Chapter 1, Islamic finance is a special case of socially responsible investments (SRI) where a similar practice of screening is observed to exclude one or more assets from the portfolio due to nonfinancial reasons. The main reason for the Islamic finance screening is religious and ethical concerns. One of the principals that are unique to Islamic finance is the forbiddance of interest dealings. Therefore, all fixed income instruments such as corporate bonds, treasury bills and certificates of deposits (CDs) are categorically excluded from an Islamic portfolio.

In addition, all conventional banks and conventional financial institutions that explicitly deal with interest as their main activities are excluded from the permissible universe. Therefore, the whole conventional financial sector is excluded due to the nature of their business, which is mainly based on the revenues from the interest dealings.

Furthermore, even preferred stocks are excluded because of the promise to get a fixed rate of return with no voting rights is not the ideal Islamic finance investment strategy. In addition, the assets must reflect ownership and the investor must intend for a long term investment. Therefore, investors and fund managers are not just concerned with the higher return and speculations, but rather, they exercise an active role in the management of the corporation by constantly monitoring the corporation's activities, reporting any deviation from the Islamic finance restrictions in a timely manner and rebalancing the portfolio based on this information.

It is also worth mentioning here that bonds are strictly forbidden in the Islamic finance, which explains why the assets selected as part of the opportunity set is limited to stocks. The AAOIFI standard number 21, which is specific to financial paper, aims to expand on the rules of shares and explain the rules of interest-bearing bonds. The rule number 4, which deals with the issuance of bonds, states clearly that:

> The issuance of bonds is prohibited when these bonds include stipulations for the return of the amount of loan and excess in any form, whether such excess is paid at the time of satisfaction of the principal amount of loan, is paid in monthly or yearly installments or in another manner and whether this excess represents a percentage of the value of the bond, as in the case with most types of bonds, or a part of it, as is the case with zero-coupon bonds. Likewise, prize bonds are also prohibited. This applies irrespective of the bonds being private, public or governmental."

AAOIFI also added in rule number 5 that: "trading in bonds, both sale and purchase, is prohibited and so is their pledging and endorsement and so on."[19]

[19] AAOIFI Standard number 21 was issues on 30 Rabii I 1425H corresponding to 20 May 2004.

As mentioned in chapter 1 and the previous sections, in our case, we will not engage in a screening effort but rather rely on an Islamic finance fund in the U.S. that actively manages a portfolio to select the assets in accordance with the Islamic strategy. In the U.S. there are three main Islamic funds that we considered but ended up selecting one (Iman fund) because we believe it provides the most restrictive rules thus more relative to our case in point. We will limit the opportunity set for Islamic finance as compared to conventional strategy because of the strict requirement of Islamic finance that excludes many industries, asset classes, and assets, leading to a limited opportunity set in general. Hence, the universe of assets will be smaller for the Islamic finance than the conventional strategy.

Therefore, for the Islamic finance strategy, we will select assets from opportunity set based on the risky assets listed by the Iman fund and assume that the fund manager conducted the two fold screening necessary to make these assets suitable for the Islamic finance strategy. Hence, we assume that the Iman fund managers conducted the qualitative and quantitative research, thus all the assets listed in their portfolio fund are permissible for an Islamic finance portfolio. Next, we adapt the mean-variance model to meet the Islamic finance requirements and restriction. With the introduction of the additional constraint, the model will help us define the efficient frontier and the optimum portfolio for the Islamic finance strategy.

2.3.2 Constrained Mean-Variance Model

To meet the Islamic finance requirement, we need to adjust the constrained mean-variance model as described in section 2.2.2 for the conventional portfolio strategy by

adding key additional restrictions. The first restriction will be on short selling since it is prohibited for the Islamic finance strategy. The AAOIFI standard number 21 clearly states that, "it is not permitted to sell shares that the seller does not own and the promise of a broker to lend these at the time of delivery is of no consequence." Therefore, short selling is not allowed.

Rehman (2010) explains how this constraint is relevant to today's markets given the 2008 financial crisis. Rehman points out that U.S. market regulator temporarily banned short selling stocks in the financial sector during the financial crisis. In the case of Islamic finance, the ban is not only during the financial crisis but it is a permanent ban. Therefore, we will be adding a constraint on short selling, which translates to the requirement that all the weights have to be positive.

Consequently, the mathematical equations that describe the optimization problem of an Islamic finance strategy thus far is as follows: knowing that the assets are pre-screened as described in the previous section to abide by the Islamic finance requirements on the interest:

$$\min \omega^T \Omega \omega$$

$$\text{s.t.} \quad \omega^T E(R_p) = \bar{r} \qquad (2.3)$$

$$\omega^T \mathrm{I} = 1 \qquad (2.4)$$

$$\omega_i \geq 0, i = 1,2, \dots, n \qquad (2.5)$$

Equation (2.5), added here, is called the non-negative constraint. Hence we only allow positive weight (i.e. short selling is not allowed) meaning that all the weight of all the assets has to be higher or equal to zero. None of the assets can be short sold since the AAOIFI rule 4/1/2/2 states that "It is not permitted for someone to sell shares that he

does not own and the promise of a broker to lend the shares to him [investor] at the date of delivery does not constitute ownership or possession of the shares"[20] op cit.

Assuming the existence of a risk-free rate asset with a rate of return (R_f) the calculation of the SR remains the same as the one for the conventional strategy case:

$$S_R = \frac{E(R_p) - R_f}{\sigma_p}$$

Where σ_p is the portfolio standard deviation and R_f is the rate of return of the risk-free asset with zero variance.

We should note here that the interest dealings are forbidden for an Islamic finance strategy although the scholars agreed to certain ratios when selecting the assets to be able to efficiently construct a portfolio strategy. Therefore, the constrained mean-variance model for the Islamic finance strategy uses the interest rate as well. However, the risk-free rate I will use will be equal to zero for two reasons. The first one is to be as compliant as possible with the Islamic principles. The second reason relates to the current environment after the 2008 crash of the financial market where interest rates are at a record low, practically zero.

Therefore, when we construct the optimal Islamic and conventional portfolios, we will use a risk free rate equal to zero ($R_f = 0$), which will correspond to a zero variance. We will also introduce another case where the risk-free rate is higher than zero to test the results for robustness.

[20] AAOIFI (2012) p.212

2.3.3 The Case of *Zakah*

Zakah is a financial obligation that Muslims have to fulfill by making a donation on a yearly basis based on their capital. The role of *Zakah* in Islamic finance law is very important in two instances. First, when the investor makes the choice between investing in the capital market versus keeping his wealth in the form of cash or cash equivalents. Second, when the investor realizes capital gains on speculative instruments versus shares held for non-speculative purposes.

In the first case, the rules of *Zakah* are very clear; the investor is required to pay a *Zakah* rate of 2.5% on his wealth when it reaches or exceeds a minimum amount called *Nissab* every lunar year when his monetary wealth is held idle. *Zakah* is payable to very specific people which are generally the unprivileged members of society. It is a form of purification in the form of paying charity on the personal wealth. On the other hand, one can consider this as a mechanism by which investors are encouraged to invest their capital in more productive sectors and avoid depriving the market from cash it need since that entails paying money on cash that sits idle. Thus the Muslim investor is encouraged to invest his wealth through this incentive.

In the second case, once invested, shares are divided into two categories for the purpose of *Zakah*. The first category is when the shares are held for speculative purposes, where the investor is buying and selling shares throughout the period. In this case, the investor pays *Zakah* on the principal as valued at the end of the period along with the profits realized for that period at a rate of 2.5%. The second category is when shares are held for non-speculative purpose and where the investor is holding these shares as a

long-term investment and aiming to collect the profit at the end of each period. In this case, which is more in line with the Islamic finance and SRI principles, *Zakah* is due on the profits realized at the end of each period only. Therefore, the investor does not pay *Zakah* on the principal invested.

Taking in consideration the *Zakah* concept for an Islamic investor and the fact that interest is prohibited in Islam, the idea of a risk-free asset might not be relevant unless the risk-free rate is equal to zero. Looking at the investment question for an Islamic finance investor from a different angle, we find that the fact that a Muslim investor has to pay different *Zakah* based on whether she invests in the capital market or keeps the wealth in cash might impact her investment decision instead of only comparing the risk-free rate to the investment return. In the case of investing in the capital market, the Islamic finance investor might realize some capital gain or losses. However, in the case of investing in cash equivalent product, it is guaranteed that the Islamic finance investor will end up paying 2.5% of his wealth at the end of the period (one lunar year) in the form of charity.

Therefore, following this logic, an Islamic finance investor would consider that any return rate that is higher than -2.5% is performing better than keeping the monetary wealth in cash, which would require paying *Zakah*. With that in mind, instead of taking an asset with a risk-free rate that equals to zero, we will consider the case of an asset that has a "risk-free" rate of *Zakah* rate, -2.5%. This asset has a known rate of return. Therefore, the variance must be equal to zero.

2.3.4 Upper-Bound Constraint for an Islamic Finance Strategy

For an Islamic portfolio manager, the requirement is to manage the risk and not necessary avoid the risk. To be effective at this task, one would argue that there is a need to limit exposure to risky assets to some degree to avoid implication of financial crisis. As an example, following the 2008 crash of financial market, some very known companies declared bankruptcy unexpectedly, which led to sever losses of pensions and investment worth for many investors. In addition, we discussed earlier in this chapter how adding additional constraints and restrictions help improve the model performance, especially in balancing the weights of the portfolio. Therefore, in this section, we will review how we can adjust the constrained mean-variance model to limit exposure of risky assets to a certain level.

The Islamic finance portfolio requires restrictions on the assets as well as prohibiting the short selling as we have seen in previous chapter. In this section, we will add another constraint of maximum allocation. In the case of the Islamic finance strategy, we do not need to add a lower bound restriction since we already have a lower bound restriction from the short selling restriction. Hence, the weights have a lower bound equal to zero in the case of the Islamic finance strategy since they cannot be negative (no short selling). We are only going to add the upper bound restriction or maximum allocation.

Therefore, the model used to find the optimal strategy with the added restrictions is as follows:

$$\min \omega^T \Omega \omega$$

s.t. $\omega^T E(R_p) = \bar{r}$ (2.4)

$\omega^T \mathrm{I} = 1$ (2.5)

$\omega_i \geq 0, i = 1,2, \dots, n$ (2.6)

$\omega_i \leq a\,, i = 1,2, \dots, n$ (2.7)

You notice here that equation (2.7) was added which will limit the optimal weights to a specific constant, *a*, called the upper-bound limit (or maximum allocation). With this additional constraint, the weights that solves this optimization problem is required to be less or equal than "a". Similarly to the constraints we imposed on the conventional strategy with upper-bound constraint, "a" will take four different values (40%, 30%, 20%, and 10%). The first time, we will set the constant "a" to equal 40%, meaning that all the weights in the optimal portfolio cannot exceed a 40% and optimal portfolio will be labeled portfolio E. Similarly we will use different values for the maximum allocation (upper-bound constraint), a, equal to 30%, 20%, and 10%; solving these different optimization problems will yield three different portfolios: F, G, & H respectively.

Assuming the existence of a risk-free rate asset with a rate of return R_f, the SR is as follows: where σ_p is the portfolio standard deviation and R_f is the rate of return of the risk-free asset:

$$S_R = \frac{E(R_p) - R_f}{\sigma_p}$$

2.4 Conclusion

In this chapter, we reviewed the theoretical framework that we will be using to assess the performance of conventional and Islamic finance strategies. We noticed that the constraint imposed by the Islamic finance strategy is well suited for the constrained mean-variance model. We adjusted the model by adding the short sell condition to meet the Islamic finance requirement. We also deduced that the Islamic finance strategy is no different that the SRI especially if the investor is looking for an interest-free environment, believing that the latter is the cause of many financial crises.

In addition, we reviewed the case of the upper-bound constraints which imposes a maximum limit on the weights of the assets when solving for the optimal solution. This restriction is well known for balancing the weights of the portfolio, a hypothesis that we will test in the next chapter with real data in the next chapter on both strategies: conventional and Islamic finance.

Chapter 3 – Strategy Performance: Conventional Versus Islamic Strategy

3.1 Universal Recital of the Methodology

In recent years, the growing practical importance of finding the optimal portfolio choice increased due to the methodological advances and increased emphasis on defined contribution pension plans which put the burden of portfolio choice and decisions onto individuals (e.g. 401K account, Individual Retirement Accounts, etc.). In today's financial markets, investors are often looking to restrict their investments to certain class of assets while certain constraints are imposed to meet requirements of or some institutions that follow certain guidelines or to avoid excessive losses due to financial crisis or other circumstances.

Similarly, the Islamic finance investment strategy requires portfolio managers to impose certain restrictions and constraints. However, these restrictions might impact the performance of these types of portfolios; limiting the opportunity set by negatively screening some assets and prohibiting short selling to meet the Islamic finance requirement might lead to lower diversification benefit, hence lowering the financial performance of the portfolio. Hence, the optimal solution for an optimization problem for an Islamic finance portfolio might have different technical outcome as compared to a conventional portfolio due to the imposed restrictions. In this chapter, we will test this hypothesis.

The constrained mean-variance model is used in many applications, one of which is the selection of optimal investment strategy. The fact that this model is simple and displays an intuitive trade-off between risk and return, hence demonstrating the benefit

of diversification in portfolio management, allows it to be widely used to track portfolios' performance. It is also the best model that can help us test the aforementioned hypotheses.

Within this framework, the investors choose a mean-variance efficient portfolio by minimizing risk (variance) and maximizing return (mean). Therefore, they are looking to identify a portfolio that must be efficient if asset prices are to clear the market for all assets. The efficient frontier, which leads to the efficient portfolios, is the intersection of the set of portfolios with minimum variance and the set of portfolios with maximum returns. Therefore, the efficient frontier is the set of all portfolios of which expected returns reach the maximum given a certain level of risk. So finding an optimal risky portfolio will depend on the degree of risk aversion, which is the willingness to trade off risk against expected return.

To compare performance of different portfolios, the Sharpe ratio (SR) is the one factor commonly used within this framework to indicate the portfolio performance. The SR is defined as the mean excess return divided by the standard deviation and represents the slope of the capital allocation line (CAL); it includes indirectly the investor's preferences. The CAL depicts all feasible risk-return combinations available from different asset allocation choices, to determine the optimal risky portfolio. The objective is to maximize its slope for any possible portfolio. Higher SR reflects superior portfolio performance.

Therefore, to understand the effect of the additional restrictions and constraints required by the Islamic finance strategy on its performance, we will use a data set that is comprised of U.S. based risky assets (stocks in particular) to find the optimal solution for

the two strategies and compare their performance: (1) conventional, which does not require restrictions on the asset classes or short selling and (2) Islamic finance, which imposes many restrictions on the asset classes and on the short selling. We will use the constrained mean-variance model to construct two set of portfolio based from the universe of available U.S. based risky assets. Then we will compare the portfolio's SRs, the main indicator of portfolio performance, to compare the performance of the two portfolios.

In addition, we will add a few cases to test how the performance changes based on three different scenarios: (1) upper-bound constraints (i.e. imposing a maximum allocation or limit on the optimal weights). The added constraints will also provide us with empirical information regarding the hypothesis that the additional constraints can improve the portfolio strategy, especially the economically reasonable weights per asset hypothesis described in the previous chapter, (2) a test of robustness with an interest rate that is higher than zero using a different set of data, and (3) the impact of the short selling condition on the performance of the strategies.

The introduction of an upper bound is a realistic assumption that will potentially limit the risk of each asset in the portfolio to avoid wealth losses especially if the assets included in the portfolio are correlated. Actually, this is a real challenge that many investors experienced during the latest financial crisis. Also, it is a good practice that many pension funds and government retirement funds use besides limiting their exposure to a certain sector, industry or even assets. Since the Islamic finance strategy imposes lower bound restrictions on the weights given the short selling restriction, we will limit our analysis to the upper bound limit.

Therefore, in the optimization problem, we will impose four different levels of maximum allocation starting from a 40% in the first optimization problem to a 10% maximum allocation in the last optimization problem (the other two optimization problem will have a limit of 30% and 20% respectively). Hence, we will solve for the optimization problem with a different upper-bound level each time. By consequence, we will end up with four conventional optimal portfolios (A, B, C, & D) and four Islamic finance portfolios (E, F, G, & H).

As such, the first four conventional portfolios (A, B, C, & D) only adhere to the maximum allocation restriction ranging from 40% to 10% whereas the second set of four Islamic finance portfolios (E, F, G, & H) will have to adhere to the Islamic finance restrictions as well as the upper-bound constraints. We will test how these additional constraints affect these strategies. To compare their performance, the SR will be used since it is the key performance indicator used to compare the risk-adjusted returns and overall portfolio performance.

Furthermore, we will use a different data set for both strategies (conventional & Islamic finance), expand the time period of historical data used to calculate the expected return, variance and covariance, then use a different risk free rate that is higher than zero to test for robustness. Again, we will solve the optimization problem for the two strategies and compare their performance using the SR. we find that the conventional strategy still outperform the Islamic finance strategy although the different in SR shrinks. Similarly, the weights are more balanced in the Islamic finance strategy as compared to the conventional one suggesting a more practical solution.

Finally, to start uncovering the impact of short selling on the performance of both strategies, we will run an "experiment" during which a short sale restriction is imposed on the conventional strategy while we eliminate that restriction from the optimization problem of the Islamic finance strategy. We find that short selling restriction have a major role in the performance of both strategies as well as balancing the weights of the optimal portfolios.

It's fascinating that some investors are still attracted to Islamic finance and SRI in general although there is not strong evidence that they outperform conventional investment. To uncover some of the reasoning behind that, we will discuss briefly the expectation and needs of such investor by reviewing some of literature in this area and reviewing survey results that was conducted by the author to gain some understanding of investor's preference for these types of investments.

3.2 Asset Selection Criteria

In this section, we will review the selection process of the risky assets for both strategies: Islamic finance and conventional. For the Islamic finance strategy we need to ensure that all assets adhere to the Islamic financial rules before considering it as part of the opportunity set. So, first, we will review these restrictions and how it affects the type of assets we can select. Next, we will discuss how the assets will be selected for the Islamic finance in our particular case. Finally, For the conventional strategy, there are no restrictions imposed on the opportunity set; therefore, the number of risky assets that we can add to the opportunity set will be intentionally larger than the one we selected for the Islamic finance strategy.

3.2.1 Types of Restrictions on the Islamic Finance Strategy

To be able to select the risky assets for the Islamic finance strategy, we will need to identify the risky assets that abide by its rules. These rules differ from SRI criteria since there are added restrictions specific to the prohibition of the interest and the linkage of the finance to productivity. However, in the late 1990's, the Down Jones (DJ) Islamic Board attained an agreement (Fatwa) allowing investment in assets that deal with interest within certain limits (DJIM, 1999).

The Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) also approved the DJ selection criteria while incorporating some adjustments. The AAOIFI clearly emphasized that dealing with interest is strictly prohibited; however, it allowed it when the amount of debt/interest in each asset does not exceed certain ratios. In addition, AAOIFI issued standard number 21 which clearly states that, "it is not

permitted to sell shares that the seller does not own and the promise of a broker to lend these at the time of delivery is of no consequence," hence the prohibition of the short selling for an Islamic finance strategy.

To select the risky assets that can be included in the Islamic finance opportunity set or the universe of available assets, the assets must pass two main criterions: (1) qualitative screening and (2) quantitative screening. The qualitative screening is based on the industry and the type of the activities that the company engages in. Some assets that belong to industries such as conventional financial industry or engage primarily in activities that are deemed non-permissible by the Islamic finance rules (such as alcohol, speculation, and gambling) are excluded from the universe.

AAOIFI standard No. 21 rule No. 3, which is specific for dealing in shares (investing in the equity market), provide an exemption for "corporations whose primary activity is lawful, but they make deposits or borrow on the basis of interest." Rule No. 3/4/1 clarifies that exemption as follows: "that the corporation does not state in its memorandum of association that one of its objectives is to deal in interest, or in prohibited good or materials like pork (swine) and the like."

The quantitative screening is based on the amount of allowed interest rate dealings. The first rule is related to the assets held in companies that belong to an industry that is permissible under the Islamic finance rules but engages in additional activities that are deemed non permissible. In this case, there is a limit on the income that could be generated from those activities; otherwise, the asset have to be excluded. AAOIFI rule No. 3/4/4 states that:

> The amount of income generated from prohibited component does not exceed 5% of the total income of the corporation irrespective of

> the income being generated by undertaking a prohibited activity, by ownership of a prohibited asset or in some other way. If a source of income is not properly disclosed then more effort is to be exerted for identification thereof giving due care and caution in this respect.

In addition, the AAOIFI standard N.21 rule No. 3/4/2 and rule No. 3/4/3 declared the specific financial ratios as guideline for exclusion or inclusion from the universe of risky assets. First, the debt ratio should be exceeding 30% of the market capitalization of the corporation[21]. Second, the account receivables ratio should be below 30% of the market capitalization of total equity[22]. Here, the AAOIFI felt the need to re-emphasize that raising loans on interest or interest-taking is prohibited regardless of the form or amount. However, since it is almost impossible to find assets that do not deal with "interest" in one form or another, the rule had to be relaxed in order to initiate such markets (the principle of necessity).

Given that these rules require a thorough research and understanding of each asset and calculating all the financial ratio, and the fact that there are three well known Islamic finance investment funds in the U.S. that are actively managed by professional investment managers and declare that they abide by the Islamic finance rules, we will rely on their research to select the risky assets that would fit the Islamic finance requirements in our analysis. These are Amana fund, Iman fund, and Azzad fund, the first one follow the Fiqh Council of North America (FCNA), while the other two funds follow the AAOIFI rulings. In addition, the Iman fund opts to use a stricter financial ratios requirement that

[21] AAOIFI rule No. 3/4/2: "The collective amount raised as loan on interest – whether long-term or short-term – does not exceed 30% of the market capitalization of the corporation, knowing that raising loans on interest is prohibited whatsoever the amount is."

[22] AAOIFI rule No. 3/4/2: "The total amount of interest-taking deposits, whether short- medium- or long-term, shall not exceed 30% of the market capitalization of total equity, knowingly that interest-taking deposits are prohibited whatsoever the collective amount is."

is lower than the one prescribed by AAOIFI for interest dealings (i.e. 30%). Therefore, we will use their top ten risky assets list for our analysis.

The Iman Mutual fund is an Islamic mutual fund offered by Allied Asset Advisor Inc. out of Oak Brook, IL that follows AAOIFI criteria but starts with lower financial ratios to ensure compliance to the rules at all time and allow adjustments when needed on a reasonable timeframe to protect the investor's risk from selling the assets at unfavorable rates. Also, the Iman fund is aiming to minimize the interest dealing in its portfolio to make it more attractive to investors who are looking for "pure" Islamic finance investments. This suggests that some investors might be inclined to invest in Islamic finance even though the performance is not better than non-Islamic finance investment due to their SRI type of investment.

The Iman fund is affiliated with the North American Islamic Trust (NAIT) that owns more than 60% of the fund and thus holds voting rights. The fund is generally a growth fund looking for the long-term capital appreciation instead of income (CNN Money, 2017). The Iman fund invests 80% of its assets in stocks that are represented in the Dow Jones Islamic and Dow Jones Islamic Market U.S. index and has $40 million dollars under management. As of 9/30/2017, about 81% of the Iman holdings are in U.S. stocks while the other 19% are in foreign stocks. The main sectors that the Iman fund holds are technology, health care and consumer cyclical, which represent 40%, 20% and 16%, respectively. In the period between 2006 and 2011, the Iman fund consistently outperformed the S&P. In the past year, Iman fund declared an annual return of 20%, which is higher than the S&P 500 TR past year return of 18.6% as of 9/30/2017. Their expense ratio is one of the lowest at 1.35% in 2017.

Although we assume that there is no active management of the portfolios during the investment period, we assume that the Iman fund selection process ensured that his assets met a stricter requirements than the AAOIFI and therefore compliant to the Islamic principles. This selection method will help us avoid the difference existing in the way multitudes of organizations are proposing to manage the screening process and allows us to focus on the optimization problem itself. Therefore, we will identify the top ten US based assets (companies) from the IMAN fund (Morning Star, 2017; Iman Fund, 2015) to select the risky assets that are deemed acceptable by Islamic finance standards. A few of the original top ten Iman fund companies are not U.S.-based; therefore, they will be excluded.

We will assume that during the static period of the analysis there is no change in any of these assets' financial ratios or fundamentals. Thus, there is no need to balance the portfolio during the period of the investment. In addition, we will not consider dividend issues or consumption to easily track a single period problem. However, we assume that the probability distribution is likely built on the basis of historical data following the Brandimate (2006) method.

3.2.2 Selection Criteria of the Conventional and Islamic Finance Strategy

The conventional strategy does not require any restriction on the risky assets so the opportunity set is usually larger for this strategy and not limited. Therefore, we have more liberty in selecting the risky assets. Since the Iman fund top ten risky assets are also assets that any fund manager can invest in them. The risky assets selected will be based on two sources: The Dow Jones Industrial Average Index (DJIAI) and the Iman fund (Morning Star, 2017; Iman Fund, 2015).

Since the conventional portfolio has no restrictions on the risky assets selection, the opportunity set is expected to be larger than the Islamic finance strategy. Besides, the assets listed under the Iman fund are well known companies that a conventional investor will have no issue investing in them if they provide the optimal risk return combination. In fact, one of the top ten companies listed under Iman is Apple, which is also listed under top ten assets of the DJIAI. Hence, adding risky assets that are listed under the Iman fund would just be another way of ensuring that the conventional portfolio is not restricted.

Therefore, the assets selected for the optimization problem of the conventional portfolio will be a mix of the DJIAI and the Iman fund's top nine listed stocks while the Islamic finance investment strategy will be limited to the Iman fund top ten listed assets. Hence, a combination of the top nine companies listed in DJIAI and the top ten of the Iman fund is considered with the exception of one asset (RELEX PLC)[23].

[23] RELX PLC (SASDAQ: RELX) was excluded since it is not a U.S. based company. RELX is a U.K. based company that provides information solutions for professional customers in North America and Europe. The company publish research and educational content and offers database and workflow solutions for scientist and academics and other professionals

Consequently, the conventional portfolio opportunity set includes nine assets from the DJIAI listed both in the NYSE and the NASDAQ. Table 3.1 show a list of all nine assets and their corresponding sectors and industries.

Table 3.1: Conventional Portfolio Set from DJIAI: Sector and Industry

COMPANY	*SECTOR*	*INDUSTRY*
(1) 3M Co (NYSABAE: MMM),	Industrial goods and the Diversified Machinery	Producer Manufacturing
(2) American Express Co (NYSE: AXP)	Financial sector	Financial Conglomerates
(3) Apple Inc. (NASDAQ: AAPL)	Electronic Technology	Telecommunications Equipment.
(4) Boeing Co (NYSE: BA)	Electronic Technology	Aerospace & Defense.
(5) Caterpillar Inc. (NYSE: CAT)	Producer Manufacturing,	Trucks/Construction/Farm Machinery.
(6) Chevron Corp. (NYSE: CVX)	Energy Minerals	Integral Oil.
(7) Cisco Systems Inc. (NASDAQ: CSCO)	Electronic Technology	Computer Communications
(8) Coca-Cola Co (NYSE: KO)	Consumer Non-Durables	Beverages non-alcoholic.
(9) Walt Disney Co (NYSE: DIS)	Consumer Services	Media Conglomerates

Note: List of the top nine U.S. based assets from the DJIAI selected to the opportunity set as part of the conventional strategy and their corresponding sector and industry.
Source: Data collected from CNN Money & Yahoo Finance

In addition, the conventional portfolio opportunity set includes eight U.S. based risky assets from the Iman fund. Table 3.2 lists these assets, as well as their respective sectors and industries, that will be included in the conventional opportunity set as well as the Islamic finance opportunity set. Since AAPL is already included above, in table 3.1 as part of the DJIAI listed assets, it will not be listed in table 3.2 although it is part of the Iman top ten assets. Here we notice that DJIAI and Iman fund both list AAPL as part of their holdings (listing) which shows that an assets can meet the Islamic finance requirement and also be part of a conventional strategy (or conventional index), there is no restriction on that.

Table 3.2: Conventional Portfolio Set from Iman Fund: Sector and Industry

COMPANY	*SECTOR*	*INDUSTRY*
(1) Amazon.com, Inc. (NASDAQ: AMZN)	Retail Trade	Industry: Internet Retail.
(2) Johnson & Johnson (NYSE: JNJ)	Health care field, Sector: Healthcare,	Industry: Drug Manufacturers.
(3) Exxon Mobil Corp. (NYSE: XOM)	Energy Minerals	Industry: Integrated Oil.
(4) Microsoft Corporation (NASDAQ: MSFT)	American Multinational Technology, Sector: Technology	Industry: Business software & services.
(5) Gilead Sciences Inc. (NASDAQ: GILD)	Healthcare	Industry: Biotechnology.
(6) Altera Corp. (NASDAQ: ALTR)	Technology	Industry: Semiconductor.
(7) Facebook Inc. (NASDAQ: FB)	Information Providers.	Industry: Internet Information Providers.
(8) The Priceline Group, Inc. (NASDAQ: PCLN)	Information Providers.	Services, Industry: Business Services.

Note: List of the top eight U.S. based assets from the Iman fund selected to the opportunity set as part of the conventional strategy and their corresponding sector and industry. These assets, in addition to AAPL, will also constitute the opportunity set for the Islamic finance strategy.
Source: data collected from Yahoo Finance & Morning Star

On the other hand, the Islamic finance strategy will be limited to the top ten assets in the Iman fund included in the conventional portfolio with the exception of one asset as explained above (RELEX PLC). I assume that the Iman fund manager completed the analysis needed to ensure that these assets met the AAOIFI requirements. The same risk-free rate is used to calculate the SR for both strategies (conventional and Islamic finance). There will be no re-balancing or active management of the portfolio during the analysis period. Hence, during the static period of the analysis we assume that there is no change in any of these assets' financial ratios or fundamentals.

To find the optimal solution to the quadratic programing problem for both strategies, we use the aforementioned constrained mean-variance model. We will set the

initial expected return to a given constant and use the portfolio validity equation (the sum of the weights equal to one). No constraint on short selling will be imposed on the conventional maximization problem. On the other hand, to find the optimal solution of the Islamic finance strategy we will impose constraints on short selling in addition to the initial constraint of a given expected return and the portfolio validity equation. Also, a risk-free asset with a deterministic return rate and variance which is equal to zero will be used to find the SR and thus the market allocation line for both strategies.

The historical return of each asset can be downloaded directly from Yahoo Finance[24] using a free software for statistical computing and graphics called R[25]. The software allows great control and sophistication in calculating covariance. The main packages we use are "quadprog", "StockPortfolio", and "ggplot2" to retrieve the real returns of the risky assets, solve the optimization problem, and plot the graphs. To get all of the 17 stocks/risky assets data we use a function called "get returns" which is part of the "StockPortfolio" package in R that downloads a collection of stock data from Yahoo Finance using the tickers listed above.

We set the frequency of the stock data to be downloaded as default, which is monthly, and use the default for argument "get" which return the stock returns for which all stocks had data and drop any dates with NA; since this is a monthly data, minor corrections are made when appropriate. So, the start date will be based on the available data where all the stocks had data, which is in this case 2012:06. The output is an object of class "StockReturns" which is a list the stock returns, where the first row is the most

[24] Yahoo Finance (https://finance.yahoo.com/)

[25] R-CRAN (https://www.r-project.org/)

recent and the last row is the oldest. Therefore, we have the return of 17 stocks, observed once per month between 2012-06-01 and 2015-12-01.

3.3 Descriptive Statistics

In this section we will review the descriptive statistics of the risky assets for both strategies. Therefore, the variance-covariance matrix for all portfolios, the real returns, and calculated variances for each risky asset will be reported. We will also show the assets' real return over the time period of this analysis. The minimum variance portfolio selection method depends on the covariance matrix and its corresponding correlation matrix which we estimated using historical data.

Table 3.3 reports the sample covariance matrix on real returns over the period June 2012 to December 2015. It is clear that FB has the highest real return (3.7%) and the highest variance (13.02%). Meanwhile, CAT has the lowest expected real returns (-0.27%) while JNJ has the lowest standard deviation (3.84%).

Table 3.3: Variance-Covariance Matrix of Expected Real Returns (2012:06 – 2015:12)

	MMM	AMZN	JNJ	XOM	MSFT	GILD	ALTR	FB	PCLN	AXP	AAPL	BA	CAT	CVX	CSCO	KO	DIS
MMM	0.0018																
AMZN	0.0014	0.0065															
JNJ	0.0009	0.0009	0.0015														
XOM	0.0013	0.0010	0.0009	0.0020													
MSFT	0.0005	0.0015	0.0008	0.0010	0.0043												
GILD	0.0010	0.0019	0.0009	0.0011	-0.0002	0.0061											
ALTR	0.0007	0.0007	0.0001	-0.0003	-0.0003	-0.0005	0.0047										
FB	0.0008	0.0019	0.0005	0.0002	-0.0013	0.0030	0.0008	0.0169									
PCLN	0.0017	0.0025	0.0007	0.0013	0.0021	0.0015	0.0008	0.0035	0.0072								
AXP	0.0011	0.0005	0.0007	0.0009	0.0009	0.0004	0.0007	-0.0007	0.0014	0.0020							
AAPL	0.0013	0.0018	0.0006	0.0009	0.0009	0.0018	0.0007	0.0002	0.0012	0.0004	0.0047						
BA	0.0012	0.0025	0.0009	0.0006	0.0006	0.0014	0.0001	0.0007	0.0015	0.0008	0.0013	0.0031					
CAT	0.0009	0.0010	0.0006	0.0014	0.0016	0.0011	0.0005	0.0013	0.0014	0.0008	0.0007	-0.0001	0.0036				
CVX	0.0014	0.0009	0.0011	0.0020	0.0016	0.0011	0.0001	0.0002	0.0015	0.0009	0.0011	0.0005	0.0018	0.0030			
CSCO	0.0013	0.0020	0.0005	0.0008	0.0015	0.0006	0.0014	0.0011	0.0017	0.0008	0.0013	0.0010	0.0010	0.0012	0.0043		
KO	0.0008	0.0014	0.0011	0.0007	0.0009	0.0004	0.0000	0.0004	0.0007	0.0006	0.0009	0.0011	0.0004	0.0007	0.0005	0.0018	
DIS	0.0013	0.0019	0.0010	0.0014	0.0016	0.0012	0.0007	0.0017	0.0022	0.0010	0.0010	0.0013	0.0012	0.0017	0.0015	0.0011	0.0028
Exp Ret	1.71%	2.89%	1.46%	0.20%	1.88%	3.59%	1.44%	3.70%	2.03%	0.69%	1.14%	2.05%	-0.27%	0.14%	1.55%	0.64%	2.28%
Std Dev	4.22%	8.05%	3.84%	4.45%	6.56%	7.79%	6.87%	13.02%	8.47%	4.51%	6.85%	5.52%	5.96%	5.44%	6.57%	4.24%	5.33%

Sources: Yahoo Finance.

Abbreviations: 3M Co (NYSE: MMM), (2) American Express Co (NYSE: AXP). (3) Apple Inc (NASDAQ: AAPL). (4)Boeing Co (NYSE: BA). (5) Caterpillar Inc (NYSE: CAT). (6)Chevron Corp (NYSE: CVX). (7) Cisco Systems Inc (NASDAQ: CSCO)(8) Coca-Cola Co (NYSE: KO). (9) Walt Disney Co (NYSE: DIS).(10) Amazon.com, Inc. (Amazon.com Inc (NASDAQ: AMZN). (12) Johnson & Johnson (NYSE: JNJ). (13) Exxon Mobil Corp. (Exxon Mobil Corp (NYSE: XOM). (14) Microsoft Corporation (NASDAQ: MSFT). (15) Gilead Sciences Inc. (NASDAQ: GILD). (16) Altera Corp. (NASDAQ: ALTR). (17) Facebook Inc. (NASDAQ: FB). (18) The Priceline Group, Inc. (NASDAQ: PCLN).

Table 3.4: Correlation Matrix of Expected Real Returns (2012:06 – 2015:12)

	MMM	AMZN	JNJ	XOM	MSFT	GILD	ALTR	FB	PCLN	AXP	AAPL	BA	CAT	CVX	CSCO	KO	DIS
MMM	1																
AMZN	0.406	1															
JNJ	0.543	0.307	1														
XOM	0.671	0.276	0.540	1													
MSFT	0.168	0.289	0.321	0.329	1												
GILD	0.312	0.297	0.305	0.318	-0.041	1											
ALTR	0.231	0.122	0.044	-0.088	-0.069	-0.086	1										
FB	0.148	0.182	0.095	0.038	-0.154	0.296	0.085	1									
PCLN	0.472	0.364	0.214	0.342	0.369	0.232	0.135	0.317	1								
AXP	0.568	0.144	0.402	0.459	0.291	0.103	0.230	-0.122	0.369	1							
AAPL	0.447	0.318	0.224	0.301	0.208	0.346	0.145	0.019	0.199	0.141	1						
BA	0.528	0.556	0.433	0.243	0.153	0.319	0.014	0.102	0.329	0.335	0.335	1					
CAT	0.341	0.200	0.262	0.525	0.397	0.246	0.128	0.162	0.274	0.309	0.180	-0.029	1				
CVX	0.607	0.205	0.529	0.832	0.458	0.250	0.040	0.035	0.336	0.350	0.291	0.151	0.561	1			
CSCO	0.462	0.373	0.205	0.289	0.339	0.123	0.307	0.130	0.313	0.275	0.292	0.267	0.262	0.333	1		
KO	0.423	0.402	0.692	0.372	0.307	0.123	0.016	0.075	0.183	0.306	0.294	0.481	0.166	0.305	0.169	1	
DIS	0.597	0.446	0.509	0.596	0.447	0.282	0.180	0.251	0.494	0.413	0.271	0.441	0.363	0.577	0.427	0.495	1

Sources: Yahoo Finance.

Abbreviations: 3M Co (NYSE: MMM), (2) American Express Co (NYSE: AXP). (3) Apple Inc (NASDAQ: AAPL). (4)Boeing Co (NYSE: BA). (5) Caterpillar Inc (NYSE: CAT). (6)Chevron Corp (NYSE: CVX). (7) Cisco Systems Inc (NASDAQ: CSCO)(8) Coca-Cola Co (NYSE: KO). (9) Walt Disney Co (NYSE: DIS).(10) Amazon.com, Inc. (Amazon.com Inc (NASDAQ: AMZN). (12) Johnson & Johnson (NYSE: JNJ). (13) Exxon Mobil Corp. (Exxon Mobil Corp (NYSE: XOM). (14) Microsoft Corporation (NASDAQ: MSFT). (15) Gilead Sciences Inc. (NASDAQ: GILD). (16) Altera Corp. (NASDAQ: ALTR). (17) Facebook Inc. (NASDAQ: FB). (18) The Priceline Group, Inc. (NASDAQ: PCLN).

Table 3.4 reports the correlation matrix for the same period. The highest correlation is between XOM and CVX at 0.832, which is natural since the nature of these assets is the same. The lowest correlation is between MSFT and FB at (-0.154) although they belong to the same industry. There are also higher correlations between JNJ and KO and XOM and MMM while there are lower correlations between FB and AXP and XOM and ALTR.

Figure 3.1 below shows the real return over time of the seventeen stocks. Figure 3.2 shows the real return over time of the nine stocks that will be included in the optimization problem of the Islamic finance portfolio.

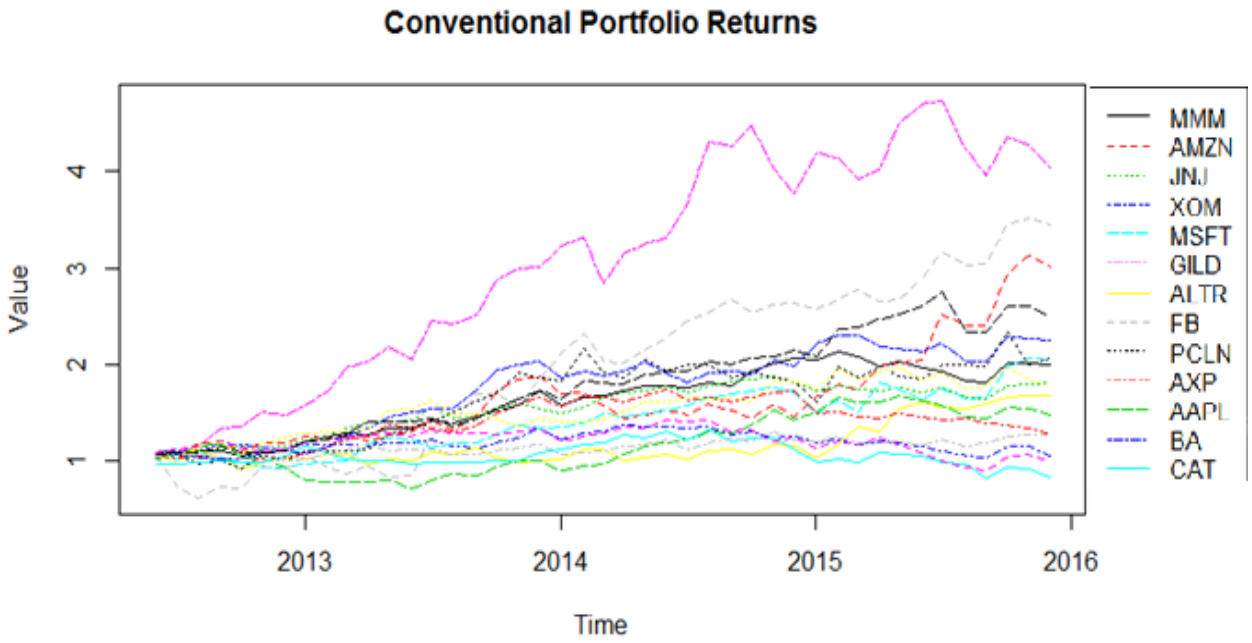

Figure 3.1: Risky Assets Real Returns – Conventional Strategy

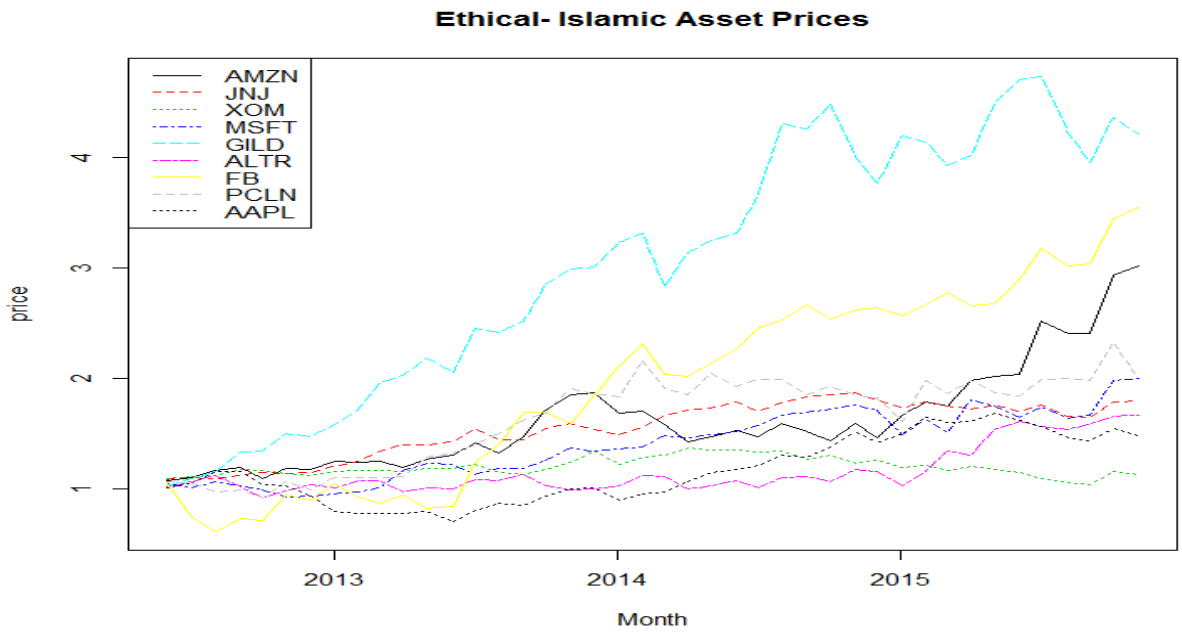

Figure 3.2: Risky Assets Real Returns – Islamic Finance Strategy

Next, we use "Solve.QP"[26] function from the "Quadporg" package to find the efficient frontier for the two portfolios. This function has the following arguments: (1) Dmat is the covariance matrix that is calculated based on the return data and the one that we want to minimize based on our quadratic optimization problem. (2) Dvec is a vector of the average returns of each security--to find the minimum portfolio variance we set all to zero. To find the points along the efficient frontier we use a loop to allow these returns to vary. This is also the vector which appears in the optimization problem. (3) Amat is the matrix of constraints; the sum of the portfolio weights has to equal to one and the constraint on short selling for the Islamic portfolio. (4) bvec is a vector of values that is matched up against the Amat matrix to enforce our constraints holding the values of β_0

[26] Original R code was taken from the following web-site: http://economistatlarge.com/portfolio-theory/r-optimized-portfolio downloaded November 15th, 2015. Couples of tweaks/enhancement were made to fit the data and the required constraints.

which is set to zero as a default. (5) meq which tells the solve. Qp function which columns in the Amat matrix to treat as equality constraints. In this case, we only have one equality equation so we will set this to one “1”.

Once we find the efficient frontier for each portfolio, we solve for the optimal point on the efficient frontier and calculate the SR. The results are shown in the next section.

3.4 Empirical Results

3.4.1 Conventional versus Islamic Finance Strategy

In this section, we report the estimated optimal portfolio weights for the conventional and Islamic finance strategies using the constrained minimum variance model. In addition, we report the expected portfolio's returns, portfolio's standard deviations and SRs (the tangency portfolios) for the two strategies. The same real return on the risk-free asset is used and the same borrowing/lending rate is used whenever short selling is allowed (i.e. conventional portfolio). Given the current environment of risk-free rates and the fact that Islamic investors only borrow and lend at zero risk-free rate in theory, we assume that the risk free rate is equal to zero for both conventional and Islamic finance.

The efficient frontier for the conventional portfolio with no constraints on short selling and the Islamic portfolio, which does not allow for short selling are presented in Figure 3.3. This figure describes the portfolio opportunities; the horizontal axis shows portfolio risk, measured by the standard deviation of portfolio return; the vertical axis shows expected return. The efficient (minimum variance) frontier, traces the combinations of expected return and risk for conventional portfolios of risky assets that minimize return variance at different levels of expected return.

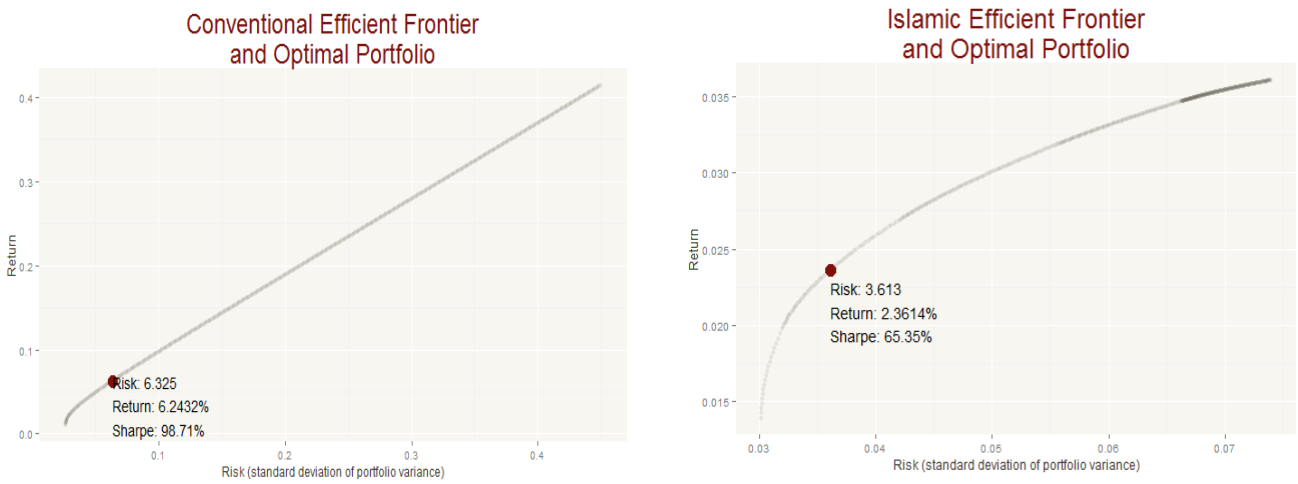

Figure 3.3: The Efficient Frontier for the Conventional and Islamic Portfolios

The fact that we eliminated many risky assets from the Islamic portfolio and did not allow for short selling limited the Islamic portfolio opportunity set and impacted its performance. This begs the question of why investors would be attracted to this type of investments. If the performance of the Islamic finance strategy is lower than the performance of the conventional strategy, would an investor be willing to invest the wealth in the Islamic finance strategy? Are there other reasons that make attract investors to the Islamic finance strategy? We will explore than in later section.

On the other hand, we observe the weights allocated to the risky assets for each portfolio are different; Table 3.3 shows the details of these allocations. Since the conventional portfolio allows short selling there were nine short positions on the following risky assets: XOM, PCLN, AXP, AAPL, BA, CAT, CVX, CSCO and KO. One would question the practicality of this strategy given the complication of short selling assets. Chiarella et al. (2016) argue that there are other factors, not accounted for in this

framework such as administrative cost and the time lag between borrowing and obtaining the borrowed capital or even the uncertainty of getting the capital, which will make it difficult or even impossible to achieve this strategy[27].

Table 3.5: Efficient Weights for Conventional and Islamic Finance Strategies

	Conventional (No Restrictions)	Islamic (Restricted)
MMM	1.51	–
AMZN	0.01	0.04
JNJ	0.50	0.18
XOM	–0.13	0.00
MSFT	0.92	0.24
GILD	0.48	0.27
ALTR	0.27	0.19
FB	0.12	0.07
PCLN	–0.25	0.00
AXP	–0.31	-
AAPL	–0.23	0.00
BA	–0.16	-
CAT	–0.40	-
CVX	–0.86	-
CSCO	–0.20	-
KO	–0.55	-
DIS	0.29	-
Total	1.00	1.00

Source: Yahoo Finance
Abbreviations: 3M Co (NYSE: MMM), (2) American Express Co (NYSE: AXP). (3) Apple Inc (NASDAQ: AAPL). (4)Boeing Co (NYSE: BA). (5) Caterpillar Inc (NYSE: CAT). (6)Chevron Corp (NYSE: CVX). (7) Cisco Systems Inc (NASDAQ: CSCO)(8) Coca-Cola Co (NYSE: KO). (9) Walt Disney Co (NYSE: DIS).(10) Amazon.com, Inc. (Amazon.com Inc (NASDAQ: AMZN). (12) Johnson & Johnson (NYSE: JNJ). (13) Exxon Mobil Corp. (Exxon Mobil Corp (NYSE: XOM). (14) Microsoft Corporation (NASDAQ: MSFT). (15) Gilead Sciences Inc. (NASDAQ: GILD). (16) Altera Corp. (NASDAQ: ALTR). (17) Facebook Inc. (NASDAQ: FB). (18) The Priceline Group, Inc. (NASDAQ: PCLN).

[27] Chiarella et al. (2016) p.49-50

It is worth mentioning here that CAT had the lowest real return but not the lowest variance. Also, XOM and CVX had high correlations at 0.832, so they were both short sold. In addition, MSFT and FB had the lowest correlation and were both selected as long positions. Finally, JNJ was allocated a positive weight knowing that it had the lowest variance.

In contrast, the Islamic portfolio had no short positions since short sale is forbidden. However, the risky assets that were selected for the Islamic portfolio and had short positions on the conventional portfolio had a zero weight. Specifically, XOM, PLCN, and AAPL had zero weights allocated to them. Therefore, only six risky assets out of the original nine were allocated a positive weight with a high concentration on two assets GILD at 0.27 and MSFT at 0.24.

The model, also, allocated a high positive weight on two risky assets for the conventional portfolio on MMM and MSFT had weights equal to 1.51 and 0.92 respectively. This is mainly due to the limited constraints imposed on the conventional strategy. This might affect the magnitude of losses that an investor might encounter if both companies declared bankruptcy as we experienced during the latest financial crisis. On the other hand, we notice that a weight was assigned to each asset within the opportunity set whether it was positive or negative which is consistent with the expectation that diversification is beneficial and the more the portfolio is diverse, the better the expected outcome.

On the other side, the Islamic finance strategy had a relative concentration of weights on two assets (MSFT and GILD) yet those weight concentrations were not to the level of the conventional strategy. The optimal weight for MSFT was 24% while GILD

optimal weight was 27%, noting that all the weights are positive for the Islamic finance strategy. It is apparent from these weights distribution that with the addition constraints we get more balanced portfolio. This can be a good way for managing the overall risk of the investment. In following section, we will impose additional constraints on the maximum allocation (optimal weights) to further test this hypothesis.

Table 3.4: The Optimal Portfolios' Key Performance Indicators

	Standard Deviation	Expected Return	Sharpe Ratio
Conventional Portfolio	0.06325	0.06243	0.98713
Islamic Portfolio	0.03613	0.02361	0.65354

Table 3.4 shows the results of the standard deviation, expected return and the SRs for the two different portfolios. The conventional portfolio has higher standard deviation (risk) and higher expected return than the Islamic finance portfolio. The results fit perfectly the theoretical framework where more risk requires more return. The standard deviation of the conventional portfolio is 6.3% while the expected return is 6.24%. In contrast, the Islamic finance portfolio has a standard deviation of 3.61% and an expected return of 2.36%.

When we compare the SR of the conventional and Islamic finance portfolios, the same holds; the conventional portfolio has a higher SR than the Islamic finance one at 98.7% and 65.3% respectively. Clearly, the conventional portfolio in this context is a better strategy than the Islamic finance. The Islamic finance investor is impacted by the limited set of the opportunity and the constraint on the short sell. In addition, the risk and return of the conventional portfolio is much higher than the Islamic finance. We could argue that it might be a more prudent strategy in the long term however as the weights

are more balanced for the Islamic finance strategy as compared to the conventional strategy. In addition, it's a more realistic strategy since it might be harder if not impossible to short all the positions to obtain the conventional optimal position.

Given the fact that the conventional optimal portfolio had a high concentration of the weights in few assets while the Islamic finance strategy has more balanced weights, we should test the effect of the additional constraints on the performance of the portfolios. To do so, we test next the hypothesis that adding more restrictions can balance these weights so that they become more economically reasonable by adding a maximum allocation constraint.

3.4.2 The Case of Upper-Bound Constraints

In previous section, we compared the Islamic finance and conventional strategy performance and concluded that the restrictions imposed on the Islamic portfolio, specifically on the opportunity set (e.g. negative screening and limited opportunity set) and the short sale impacted negatively the performance of the Islamic portfolio. However, we noticed that the optimal weights distribution was more balanced within the Islamic finance strategy compared to the conventional strategy where we noticed a great positive concentration in few assets. In this section, we will add additional constraints to both strategies to test the hypothesis that additional constraints will improve the portfolio strategy performance, especially the economically reasonable weights per asset hypothesis.

Ang (2012) argues that the minimum variance portfolio—as a special case of the mean-variance portfolio, which imposes constraints on the mean, volatility, and correlation—reduces the sampling error and thus performs better than the

unconstrained portfolios. Similarly, Chiarella et al. (2016) found that imposing constraints balances the portfolio weights and reduces portfolio risk as compared to unconstrained mean-variance utility models. Furthermore, they deduced that the constrained model is more appealing to practitioners because of its realistic constraints even though it does not explicitly characterize the investor's risk preference.

The hypothesis is that additional constraints would help the portfolio weights to have economically reasonable positions. Though in practice, the need to limit the risk of each asset to a certain level to avoid complete wealth loses, as some investors experienced during the latest financial crisis, is real. In fact, many pension funds and government retirement funds limit their exposure to a certain sector, industry or asset to abide by certain guidelines or meet investor's requirements.

Here, again, the constrained mean-variance model and its key performance indicators (notably return, variance and SR) are used to compare the portfolios' performance. Similarly, we assume that during the period of our analysis there is no change in any of these assets' financial ratios or fundamentals, so no active management is needed for the Islamic portfolio to be compliant. The same goes for the conventional strategies. In addition, we do not consider dividend issues or consumption to easily track a single period problem. However, we assume that the probability distribution is likely built on the basis of historical data following the Brandimarte (2006) method.

Both conventional and Islamic finance strategy will follow similar selection processes as noted above to select the risky assets. No constraint on short selling is imposed on the first set of the four conventional portfolios while short selling will not be allowed for the second set of the four Islamic finance portfolios. An upper-bound

constraint will be imposed on both strategies (conventional and Islamic finance). In total, we will solve for eight optimization problems: (1) The first set of four (portfolio A, B, C, and D) will follow the conventional methodology with the additional maximum allocation constraint imposing a limit on the weights of all assets to a certain level equal to either 40%, 30%, 20%, and 10% respectively. (2) The second set of four portfolios (E, F, G, and H) will follow the Islamic finance methodology in addition to the maximum allocation constraint that will limit the weights of all assets to certain level equal to either 40%, 30%, 20%, and 10% respectively.

To construct the portfolio, we use the same combination of risky assets that we used in previous section for conventional and Islamic finance portfolios (a combination of the top nine companies listed in DJIAI and the top ten of the Iman Islamic mutual fund with the exclusion of one asset (RELEX PLC). See section 3.2.2 for more details. Therefore, we have the return of 17 stocks, observed once per month between June 2012 and December 2015. A risk-free asset with a deterministic risk-free rate and variance, which are both equal to zero, is used to find the SR and thus the market allocation line. In addition, we report the expected portfolio returns, standard deviations and SRs (the tangency portfolios) for each strategy. The same real return on the risk-free asset is used and the same borrowing/lending rate is used whenever short selling is allowed. Given the current environment of risk-free rates, we assume that it is equal to zero for all portfolios.

First, we will review results of the conventional strategy optimal portfolios (A, B, C and D) which do not require any restriction other than the varying maximum allocation on the optimal weights as explained above. We will impose a maximum allocation of 40%

on conventional portfolio A, a 30% maximum allocation on portfolio B, a 20% maximum allocation on portfolio C and a 10% maximum allocation on portfolio D.

Then, we will review the results of the optimization of the Islamic finance strategies (E, F, G and H), which adhere to the same restrictions of maximum allocation (ranging from 40% to 10%). Therefore, we will impose a 40% maximum allocation on the weights of portfolio E, a 30% maximum allocation on the weights of portfolio F, a 20% maximum allocation on the weights of portfolio G, and a maximum allocation of 10% on the weights of the portfolio H.

The efficient frontier and the tangency portfolio for each conventional portfolio (A, B, C and D) are presented in Figure 3.4 below while Table 3.7 shows the results of the optimization problem for the conventional strategy with varying maximum allocation. Keeping everything constant, we notice that the lower the maximum allocation, the lower is the SR and the risk (standard deviation). Thus, from pure technical performance using the SR as the key indicator, the portfolio with maximum allocation of 40% (A) is the best among these four portfolios.

We notice the same trend for the risk and return criteria; the greater the maximum allocation the higher is the risk and the expected return. However, we notice that the portfolio D had much lower expected return while there was minimum difference in the risk compared to portfolio C. This indicates that after a certain level of maximum allocation the additional constraint does not provide any additional benefit. There is a minimum value from further limitation on the maximum allocation.

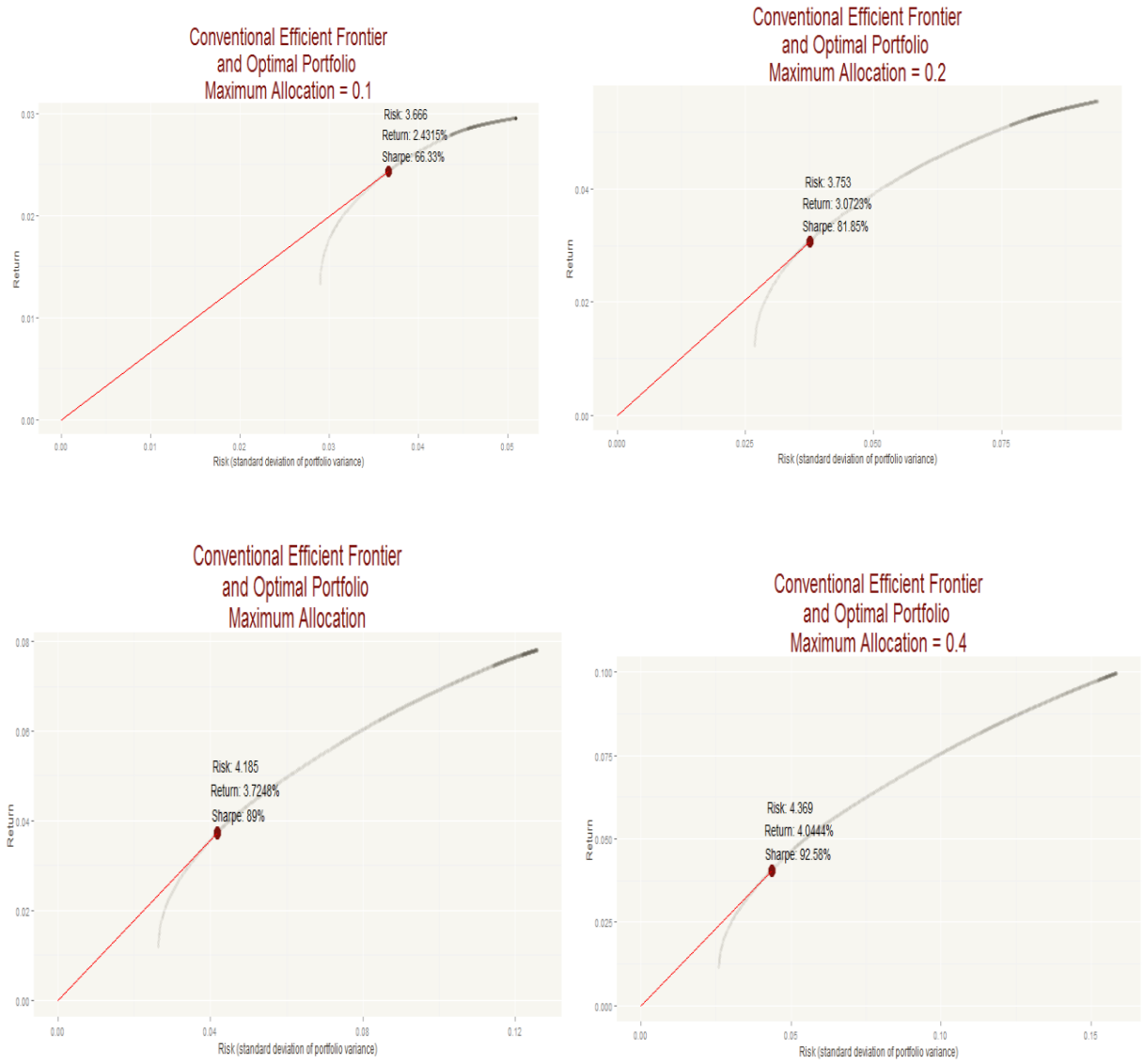

Figure 3.4: Efficient Frontier and Optimal Conventional Portfolios with Varying Maximum Allocation Restrictions

Table 3.7: Performance Indicators for Conventional Portfolios

	Portfolio A (**40%**)	Portfolio B, (**30%**)	Portfolio C (**20%**)	Portfolio D (**10%**)
Standard Deviation	4.3%,	4.1%,	3.7%,	3.6%,
Expected Return	4.0%,	3.7%,	3.0%,	2.4%,
Sharpe Ratio	92.58%.	89.0%.	81.85%.	66.33%.

Table 3.8 shows the optimal weights for the tangency portfolios. Portfolio A had three assets (MMM, JNJ and MSFT) while seven assets had a short position (PCLN, AXP, AAPL, CAT, CVX, CSCO and KO). The rest of the assets had positive allocations but lower than the maximum. Portfolio B had five (MMM, JNJ, GILD, DIS and MSFT) while six assets had a short position (PCLN, AAPL, CAT, CVX, CSCO and KO) and the rest of the assets had positive allocations but lower than the maximum.

Table 3.8: Conventional Tangency Portfolios' Weights Depending on Maximum Allocation Restriction

	Portfolio A Conventional Max All. = 0.4	**Portfolio B** Conventional Max All. = 0.3	**Portfolio C** Conventional Max All. = 0.2	**Portfolio D** Conventional Max All. = 0.1
MMM	0.40	0.30	0.20	0.10
AMZN	0.01	0.02	0.05	0.10
JNJ	0.40	0.30	0.20	0.10
XOM	0.18	0.17	0.20	0.10
MSFT	0.40	0.30	0.20	0.10
GILD	0.32	0.30	0.20	0.10
ALTR	0.23	0.22	0.20	0.10
FB	0.08	0.08	0.09	0.10
PCLN	-0.14	-0.13	-0.11	-0.04
AXP	-0.02	0.03	0.10	0.10
AAPL	-0.07	-0.06	-0.03	0.04
BA	0.03	0.06	0.12	0.10
CAT	-0.21	-0.18	-0.14	-0.11
CVX	-0.52	-0.43	-0.31	-0.13
CSCO	-0.04	-0.01	0.01	0.10
KO	-0.35	-0.27	-0.18	0.03
DIS	0.30	0.30	0.20	0.10
Total	1.00	1.00	1.00	1.00

Source: Historical return were downloaded from Yahoo finance
Abbreviations: 3M Co (NYSE: MMM), (2) American Express Co (NYSE: AXP). (3) Apple Inc (NASDAQ: AAPL). (4)Boeing Co (NYSE: BA). (5) Caterpillar Inc (NYSE: CAT). (6)Chevron Corp (NYSE: CVX). (7) Cisco Systems Inc (NASDAQ: CSCO)(8) Coca-Cola Co (NYSE: KO). (9) Walt Disney Co (NYSE: DIS).(10) Amazon.com, Inc. (Amazon.com Inc (NASDAQ: AMZN). (12) Johnson & Johnson (NYSE: JNJ). (13) Exxon Mobil Corp. (Exxon Mobil Corp (NYSE: XOM). (14) Microsoft Corporation (NASDAQ: MSFT). (15) Gilead

Sciences Inc. (NASDAQ: GILD). (16) Altera Corp. (NASDAQ: ALTR). (17) Facebook Inc. (NASDAQ: FB). (18) The Priceline Group, Inc. (NASDAQ: PCLN).

Limiting the maximum allocation to 20% impacted the combination of portfolio C, so none of the assets had a weight that's higher than 20%. At the same time, four assets had a negative weight while CVX has the highest negative weigh of (-31%). On the other hand, the weights in portfolio D were limited to 10% and only three assets were assigned a negative weight (suggesting a short sell). This portfolio is the closest to the equality-weighted portfolio, later we will notice that it also had the lowest SR among all conventional portfolios.

The following three assets had short position in all the above four portfolios: PCLN, CAT and CVX. The following three assets had the highest possible allocation in each optimal portfolio: MMM, JNJ and MSFT. However, in sum, the weights are now much more balanced compared to optimal weight with no maximum allocation constraints. We no longer noticed a huge concentration on any specific assets, especially since we have a cap (max allocation).

Even the assets that were short sold their optimal negative weights were not out of balance. As an example, the CVX had originally a negative weight of -86% in the first optimization solution of the conventional strategy without any constraints; however, with the additional maximum allocation constraints, its optimal weight is -52%. This can suggest that the portfolio is more balanced with the additional restriction.

Table 3.9: Conventional Optimal Portfolios' Key Performance Indicators - Maximum Allocation Restriction

	Standard Deviation	Expected Return	Sharpe Ratio
Conventional Portfolio with Maximum Allocation = 0.4	0.04369	0.04044	0.92580
Conventional Portfolio with Maximum Allocation = 0.3	0.04185	0.03725	0.89003
Conventional Portfolio with Maximum Allocation = 0.2	0.03753	0.03072	0.81853
Conventional Portfolio with Maximum Allocation = 0.1	0.03666	0.02432	0.66329

Table 3.9 shows the portfolio's key performance indicators: standard deviation, expected return, and SR. Portfolio A, has the highest SR, expected return as well as the highest risk. Portfolio D has the lowest SR, expected return as well as risk. Results show that as we tighten the max allocation allowed, the risk and the return goes down respectively. It is also noted that the performance of the portfolios dramatically shifted from 92% to 66% as the maximum allocation moves from 40% to 10% while the risk (standard deviation) only changed from 44% to 37%. At the same time, the expected return was almost cut in half, from 40% to 24%.

It will be up to investor preference and risk tolerance to determine which strategy would work better to meet his/her goals. However, it is clear that portfolio A performed better than any other conventional strategy with maximum allocation constraints. It is also worth noting that, as we have noticed in the original conventional strategy, the portfolios were well diversified when all assets were allocated a weight – whether it was a positive or negative weight. The distributions of the weights are different but all assets participated to some degree in the construction of the optimal portfolio.

On the other hand, the estimated optimal Islamic finance portfolio's weights for the set of four Islamic finance portfolios that restrict short selling and limit the maximum allocation of each risky asset, were different.

Figure 3.5 shows the Islamic finance efficient frontier for portfolio E (with maximum allocation = 40%), portfolio F (with maximum allocation = 30%), portfolio G (with maximum allocation = 20%), and portfolio H (with maximum allocation = 10%) as well as their respective optimal portfolio results.

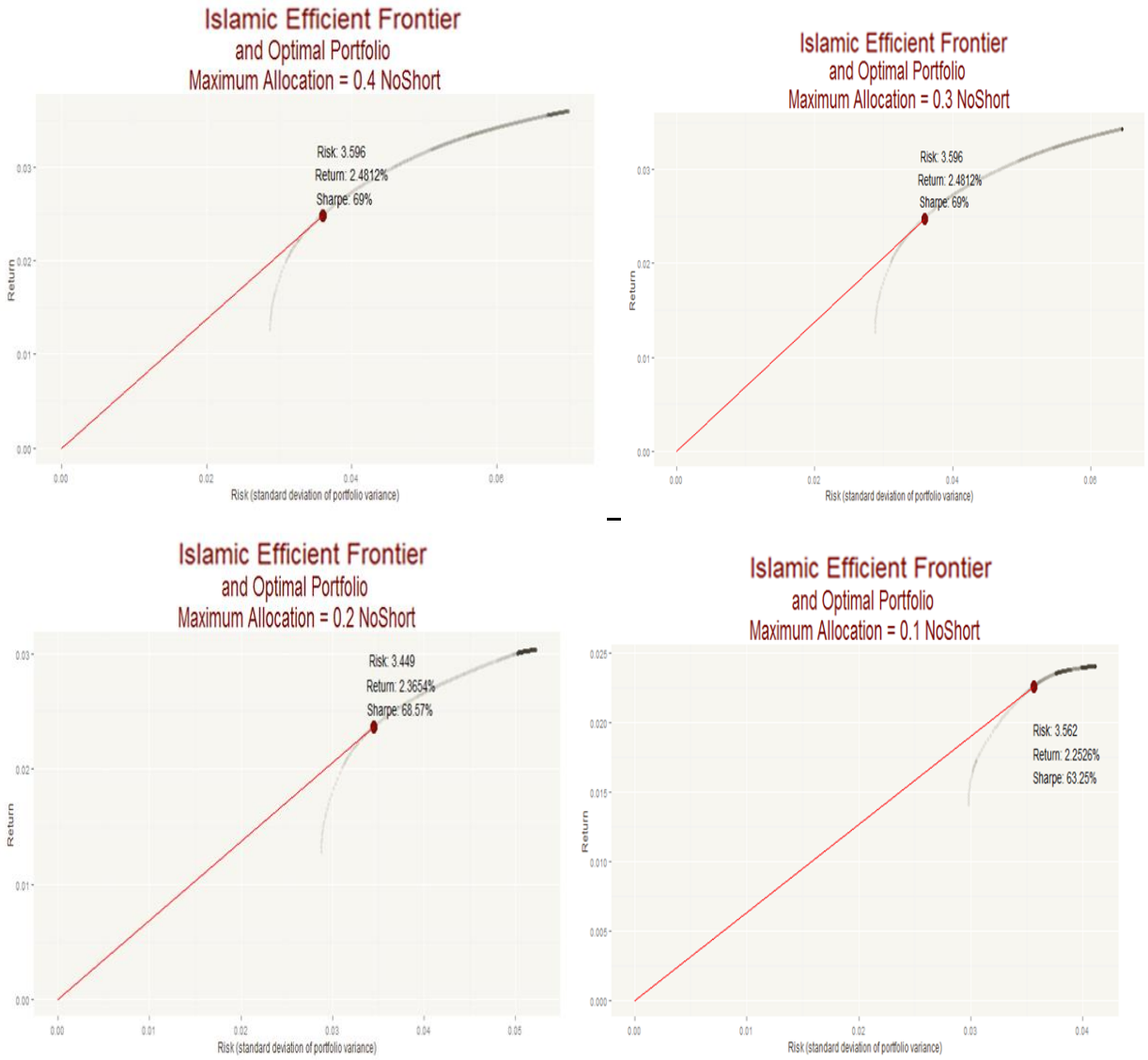

Figure 3.5: Efficient Frontier and Islamic Optimal Portfolios with Varying Maximum Allocation Restrictions

Further, Table 3.10 shows the weights for the tangency portfolios. We observe that Portfolios E and F had similar optimal weights. However, when compared to the original Islamic finance strategy solution with no maximum allocation constraints (see section

3.4.1) we notice that the number of assets that were allocated a weight increased by two. In addition, the actual weights of the assets within the optimal portfolio changed.

Table 3.10: Islamic Finance Tangency Portfolios' Weights Depending on Maximum Allocation Restrictions

	Islamic Finance No Short Selling Max Allocation = 0.4	Islamic Finance No Short Selling Max Allocation = 0.3	Islamic Finance No Short Selling Max Allocation = 0.2	Islamic Finance No Short Selling Max Allocation = 0.1
MMM	0.07	0.07	0.09	0.10
AMZN	0.00	0.00	0.00	0.09
JNJ	0.04	0.04	0.08	0.10
XOM	0.00	0.00	0.00	0.00
MSFT	0.21	0.21	0.20	0.10
GILD	0.26	0.26	0.20	0.10
ALTR	0.17	0.17	0.16	0.10
FB	0.07	0.07	0.07	0.10
PCLN	0.00	0.00	0.00	0.00
AXP	0.00	0.00	0.00	0.09
AAPL	0.00	0.00	0.00	0.00
BA	0.12	0.12	0.13	0.10
CAT	0.00	0.00	0.00	0.00
CVX	0.00	0.00	0.00	0.00
CSCO	0.00	0.00	0.00	0.01
KO	0.00	0.00	0.00	0.00
DIS	0.07	0.07	0.07	0.10
Total	1.00	1.00	1.00	1.00

Abbreviations: 3M Co (NYSE: MMM), (2) American Express Co (NYSE: AXP). (3) Apple Inc (NASDAQ: AAPL). (4)Boeing Co (NYSE: BA). (5) Caterpillar Inc (NYSE: CAT). (6)Chevron Corp (NYSE: CVX). (7) Cisco Systems Inc (NASDAQ: CSCO)(8) Coca-Cola Co (NYSE: KO). (9) Walt Disney Co (NYSE: DIS).(10) Amazon.com, Inc. (Amazon.com Inc (NASDAQ: AMZN). (12) Johnson & Johnson (NYSE: JNJ). (13) Exxon Mobil Corp. (Exxon Mobil Corp (NYSE: XOM). (14) Microsoft Corporation (NASDAQ: MSFT). (15) Gilead Sciences Inc. (NASDAQ: GILD). (16) Altera Corp. (NASDAQ: ALTR). (17) Facebook Inc. (NASDAQ: FB). (18) The Priceline Group, Inc. (NASDAQ: PCLN).

At the same time, portfolio G optimal weights were allocated to the same assets as in portfolios E and F with a slight difference in the actual weights of some assets. As an example, GILD optimal weight in portfolios E and F was 26% while it was 20% in portfolio G to meet the restriction of maximum allocation of 20%. However, in portfolio H, optimal weights were allocated to new assets such as AMZN and CSCO. We also note that the assets that has zero weights in the original optimization solution of the Islamic finance strategy kept the same weights across all other portfolios (E, F, G and H).

Table 3.11 shows that the different Islamic finance optimal portfolios shared almost similar SRs. Especially we notice that portfolio E & F had the exact same standard deviation, expected return and SR. Since the initial optimization problem for the Islamic

finance portfolio had weights that are lower than 0.3, the results of the optimization problem with maximum allocation of 0.3 and 0.4 were very similar. However, we notice a slight increase in the Sharpe Ratio of portfolio E & F (of 69%) as compared to the initial optimization problem SR of 65%.

Table 3.11: Islamic Finance Optimal Portfolios' Key Performance Indicators – Maximum Allocation Restrictions

	Standard Deviation	Expected Return	Sharpe Ratio
Islamic Portfolio with Maximum Allocation = 0.4	0.03596	0.02481	0.68997
Islamic Portfolio with Maximum Allocation = 0.3	0.03596	0.02481	0.68997
Islamic Portfolio with Maximum Allocation = 0.2	0.03449	0.02365	0.68572
Islamic Portfolio with Maximum Allocation = 0.1	0.03562	0.02253	0.63247

However, when compared to the initial Islamic finance solution discussed in previous section, we find that the performance of the strategies is different. The SR increased from 65% originally to 69% with the additional constraints of maximum allocation. The level of the maximum allocation constraints did not make a difference with regards to the 30% or 40% case since the optimal solution was the same in terms of the risk and return as well as the SR. Portfolios E and F had identical performance and optimal weights. This can be driven from the fact that the original optimal weights of the Islamic finance strategy included optimal weights that are lower than 30%; the highest optimal weight was allocated to Gilead Sciences Inc. (GILD) at 27%. Still, we notice that adding the maximum allocation constraint improved the performance of the model and identified an optimal portfolio that has higher SR.

Compared to the original Islamic finance SR of 65% we noticed that portfolio G had a higher performance while portfolio H had a lower performance. At the same time, the risk

and expected return were not too different. In fact, portfolio G had similar expected return and standard deviation, of 24% and 36% respectively, as the original Islamic finance strategy while the portfolio G performance was higher (SR of 68% vs. 65%). Clearly, portfolio G is a better strategy than the initial Islamic finance strategy with no additional maximum allocation restrictions.

On the other hand, it is noticeable that portfolio H shows a decrease in the SR (63% vs. 65%) compared to the original Islamic finance portfolio while the risk is slightly higher and the expected return is slightly lower (23% vs. 24%). Therefore, although the additional max allocation restriction of 20% still benefited the overall performance of the Islamic finance portfolio, lowering the maximum allocation restriction to 10% did not generate any additional benefits. Overall, the portfolio manager has to find the best technical solution (by adding additional constrains to improve performance) while adhering to the Islamic finance rules to satisfy the investors' requirements.

In this section, results showed that the additional constraints on optimal weights allocation improved the performance of the Islamic finance strategy as well as balanced the optimal weights; especially in the case of max allocation of 20%. At the same time, the additional restriction helped balance the optimal weights of the conventional portfolio although at the expense of its performance. Clearly, we can deduce that the additional restriction can provide solutions to some of the technical issues that a portfolio manager might encounter. Depending on the investor's preference, tactics can be used to answer various investors' needs.

In this section, we assumed that the interest rate is equal to zero to (1) simplify the analysis, (2) meet the Islamic finance requirement which prohibit interest rate dealings

and only allows for interest free loans (i.e. Al-Quard Al-Hassan) and (3) mimic the current environment of low interest rates that is experienced after the 2008 financial crisis. To test for robustness, we will use an interest rate that is higher than zero in the next section.

At the same time, we will make changes to the opportunity set for both Islamic finance and conventional strategies in the next section in order to get broader perspective on the performance of the two strategies. Initially, we used the Iman fund assets as part of the conventional opportunity set. There could be an argument that using the same assets for both strategies might impact the comparative study results by giving the conventional strategy an unfair advantage over Islamic finance strategy. Therefore, in the next section we will avoid that by differentiating between Islamic finance and conventional opportunity sets.

3.5. Test for Robustness Using a New Opportunity Set

In this section, we will perform a test of robustness by using different set of assets, increasing the interest rate, and extending the results to end of year 2017. Therefore, the interest rate that we will use in this case will be higher than zero. Also, we will expand the period of the analysis to include historical data up until year end 2017. In addition, using a different set of assets will change the structure of the conventional and the Islamic finance strategies which will allow the re-enforcement of the initial results described in previous sections and draw stronger conclusions.

Furthermore, we will conduct an experiment to understand the effect of short selling restriction on the two strategies. We will run a hypothetical scenario where the Islamic finance strategy does not have to abide by the short selling restriction while we will impose a short selling restriction on the conventional strategy. As usual, we will use the SR to compare the performance of the strategies. To avoid, any inherent bias, we will also use an interest rate that is higher than zero.

3.5.1. Selecting the New Opportunity Set Assets

Grounded on the fact that the conventional strategy does not require any restriction on the opportunity set or the universe of the risky assets and the expectation that we have more liberty in selecting the risky assets, we will solve the optimization problem to construct an optimal conventional portfolio by selecting the top 15 assets of the DJIAI.

Besides selecting fifteen assets instead of ten assets to be included in the opportunity set to ensure that the conventional portfolio has larger number of assets than the Islamic finance portfolio as it is not restricted, we also extend the time period of the test to the end of year 2017. We should note that some of the assets listed under the Iman fund are also listed under the DJIAI. As an example, AAPL and HD are listed under both portfolios, but that is just a simple coincidence.

Therefore, the assets selected for the optimization problem of the conventional portfolio will include the top fifteen assets of the DJIAI while the Islamic finance portfolios will be limited to the top ten U.S. based assets from the Iman fund.

The conventional portfolio opportunity set includes the following fifteen risky assets from the DJIAI listed both in the NYSE and the NASDAQ:

1 Boeing Co (BA),
2 Goldman Sachs Group Inc. (GS)
3 3M Co (MMM)
4 United Health Group Inc. (UNH)
5 Home Depot Inc. (HD)
6 McDonald's Corp. (MCD)
7 Apple Inc. (AAPL)
8 Caterpillar Inc (CAT)
9 International Business Machines Corp. (IBM)
10 Johnson &Johnson (JNJ)
11 The Travelers Companies Inc. (TRV)
12 United Technologies Corp. (UTX) Health care field
13 Chevron Corp. (CVX)
14 Visa Inc. (V)
15 Walt Disney Co (DIS)

On the other hand, the Islamic finance strategy will be limited to the top ten U.S. based risky assets of the Iman fund (all non U.S. based companies will be excluded). As noted above, we assume that the Iman fund manager completed the analysis needed to

ensure that these assets meet the AAOIFI requirements (Islamic finance restrictions). Therefore, the opportunity set will include the following ten assets:

1 Amazon.com, Inc. (AMZN)
2 Apple Inc. (AAPL)
3 Alphabet Inc. (NYSE: GOOGL)
4 Facebook Inc. (FB)
5 Nektar Therapeutics Inc. (NKTR)
6 Microsoft Corporation (MSFT)
7 Exxon Mobil Corp. (XOM)
8 NVIDIA Corp. (NVDA)
9 Accenture PLC (ACN)
10 Home Depot Inc. (HD).

The same risk-free rate will be used for the optimization problem including the SR calculations for both strategies. There will be no re-balancing or active management of the portfolio during the analysis period. Hence, during the static period of the analysis we assume that there is no change in any of these assets' financial ratios or fundamentals. In addition, we do not consider dividend issues or consumption to easily track a single period problem.

To find the optimal solution to the quadratic programing problem for both strategies, we use the constrained mean-variance model. We will set the initial expected return to a given constant and use the portfolio validity equation (the sum of the weights equal to one). No constraint on short selling will be imposed on the conventional maximization problem. On the other hand, to find the optimal solution of the Islamic finance strategy, short selling constraints will be imposed in addition to the initial constraint of a given expected return and the portfolio validity equation. Furthermore, a

risk-free asset with a deterministic return rate and variance that is not equal to zero will be used. The SR will be used as an indicator of the performance of the portfolio.

Using Yahoo Finance as a source of the historical assets return, the monthly return of 25 assets was downloaded over 60 months from January 2013 to November 2017 representing 150 observations. Using the adjusted closed price, we calculate the monthly returns for each asset. To calculate the average return we used the arithmetic average along the 60 monthly returns.

3.5.2 Description of the Statistical Properties

In this section, we review the descriptive statistics of the risky assets for each strategy. Therefore, the variance-covariance matrix for all portfolios, the correlation matrix and calculated variances for each risky asset will be reported. The minimum variance portfolio selection method depends on the covariance matrix and its corresponding correlation matrix which we estimated using historical data.

Table 3.12 reports the variance-covariance matrix of the ten assets that represent the Islamic finance strategy expected real returns over the selected period. It also reports the expected return and standard deviation of each risky asset. It is clear that NKTR and NVDA have the highest real return (5.35% each) and the highest standard deviation (23.37% and 9.60%, respectively). Meanwhile, XOM has the lowest expected real returns (0.24%) and the lowest standard deviation of 4.18%.

Table 3.12: Variance-Covariance Matrix of Assets Representing the Islamic Finance Strategy's Expected Real Returns and Standard Deviation (2013:01 - 2017:11)

	AMZN	AAPL	GOOGL	FB	NKTR	MSFT	XOM	NVDA	ACN	HD
AMZN	0.00589									
AAPL	0.00169	0.00425								
GOOGL	0.00265	0.00091	0.00320							
FB	0.00133	0.00124	0.00121	0.00828						
NKTR	0.00317	0.00119	0.00003	-0.00125	0.05463					
MSFT	0.00139	0.00122	0.00152	-0.00024	0.00091	0.00366				
XOM	0.00045	0.00017	0.00001	-0.00032	0.00016	0.00032	0.00175			
NVDA	0.00175	0.00189	0.00108	-0.00063	0.00060	0.00188	0.00072	0.00921		
ACN	0.00112	0.00136	0.00095	0.00070	0.00163	0.00099	0.00048	0.00121	0.00218	
HD	0.00107	0.00079	0.00091	-0.00007	0.00354	0.00051	0.00061	0.00078	0.00095	0.00209
Expected return	**2.84%**	**2.03%**	**1.90%**	**3.37%**	**5.35%**	**2.35%**	**0.24%**	**5.35%**	**1.61%**	**2.06%**
Standard Deviation	**7.67%**	**6.52%**	**5.65%**	**9.10%**	**23.37%**	**6.05%**	**4.18%**	**9.60%**	**4.66%**	**4.57%**
Obs.	59	59	59	59	59	59	59	59	59	59

Source: Yahoo Finance

Abbreviations: (1) Amazon.com, Inc. (AMZN) (2) Apple Inc. (AAPL) (3) Alphabet Inc. (GOOGL) (4) Facebook Inc. (FB) (5) Nektar Therapeutics Inc. (NKTR) (6) Microsoft Corporation (MSFT) (7) Exxon Mobil Corp. (XOM) (8)NVIDIA Corp. (NVDA) (9) Accenture PLC (ACN) (10) Home Depot Inc. (HD)

Table 3.13: Correlation Matrix of the Assets Representing the Islamic Finance Strategy's Expected Real Returns (2013:01 – 2017:11)

	AMZN	AAPL	GOOGL	FB	NKTR	MSFT	XOM	NVDA	ACN	HD
AMZN	1									
AAPL	0.33871	1								
GOOGL	0.60972	0.24713	1							
FB	0.19035	0.20917	0.23481	1						
NKTR	0.17666	0.0781	0.0025	-0.0588	1					
MSFT	0.29926	0.30788	0.44353	-0.0438	0.06406	1				
XOM	0.13929	0.06281	0.00419	-0.0844	0.01596	0.12548	1			
NVDA	0.23822	0.30168	0.19951	-0.0721	0.02684	0.32446	0.17828	1		
ACN	0.31375	0.4481	0.36035	0.16533	0.14933	0.35	0.24667	0.27035	1	
HD	0.3048	0.26491	0.3519	-0.0169	0.33155	0.18521	0.32059	0.17822	0.44521	1

Source: Yahoo Finance

Abbreviations: (1) Amazon.com, Inc. (AMZN) (2) Apple Inc. (AAPL) (3) Alphabet Inc. (GOOGL) (4) Facebook Inc. (FB) (5) Nektar Therapeutics Inc. (NKTR) (6) Microsoft Corporation (MSFT) (7) Exxon Mobil Corp. (XOM) (8)NVIDIA Corp. (NVDA) (9) Accenture PLC (ACN) (10) Home Depot Inc. (HD)

Table 3.13 reports the correlation matrix for the same period. The red cells represent the lowest correlations while the green represent the highest correlations. The

highest correlation is between AMZN and GOOGL at 61%, which is natural since they both are in the same industry. FB is negatively correlated with couple of assets such as NKTR, HD and MSFT. However, the lowest correlation is between FB and XOM at -8%.

Table 3.14: Variance-Covariance Matrix of Conventional Strategy's Expected Real Returns and Standard Deviation (2013:01 - 2017:11)

	BA	GS	MMM	UNH	HD	MCD	AAPL	CAT	IBM	JNJ	TRV	UTX	CVX	V	DIS
BA	0.00404														
GS	0.00127	0.00393													
MMM	0.00077	0.00091	0.00160												
UNH	0.00077	0.00081	0.00081	0.00202											
HD	0.00099	0.00136	0.00094	0.00070	0.00209										
MCD	0.00072	0.00024	0.00058	0.00034	0.00042	0.00137									
AAPL	0.00103	0.00085	0.00126	0.00066	0.00079	0.00041	0.00425								
CAT	0.00089	0.00162	0.00084	0.00058	0.00099	0.00062	0.00125	0.00432							
IBM	0.00046	0.00126	0.00054	0.00031	0.00055	0.00012	0.00101	0.00108	0.00257						
JNJ	0.00071	0.00025	0.00082	0.00047	0.00039	0.00066	0.00066	0.00032	0.00040	0.00142					
TRV	0.00118	0.00101	0.00134	0.0007	0.00112	0.00088	0.00135	0.00076	0.0006	0.00095	0.00214				
UTX	0.00117	0.00121	0.00114	0.00092	0.0008	0.00044	0.00081	0.0014	0.00071	0.00072	0.00087	0.00216			
CVX	0.00121	0.00182	0.00094	0.00048	0.00083	0.00065	0.00054	0.00176	0.00113	0.00077	0.00109	0.00108	0.00299		
V	0.00118	0.00069	0.00076	0.00031	0.00083	0.00051	0.00098	0.00039	0.00019	0.00028	0.00089	0.0004	0.0002	0.00212	
DIS	0.0016	0.00153	0.00079	0.00075	0.0012	0.00056	0.00078	0.00087	0.00072	0.00053	0.00108	0.00092	0.00115	0.00104	0.00263
Expected Return	**2.80%**	**1.24%**	**1.75%**	**2.63%**	**2.06%**	**1.35%**	**2.03%**	**1.28%**	**-0.09%**	**1.40%**	**1.22%**	**0.95%**	**0.62%**	**2.08%**	**1.41%**
Standard Deviation	**6.35%**	**6.27%**	**4.00%**	**4.50%**	**4.57%**	**3.70%**	**6.52%**	**6.57%**	**5.07%**	**3.77%**	**4.63%**	**4.65%**	**5.47%**	**4.60%**	**5.13%**

Source: Yahoo Finance

Abbreviations: (1) Boeing Co. (BA) (2) Goldman Sachs Group Inc. (GS) (3) 3M Co (MMM) (4) United Health Group Inc. (UNH) (5) Home Depot Inc. (HD) (5) McDonald's Corp. (MCD) (7) Apple Inc. (AAPL) (8) Caterpillar Inc (CAT) (9) International Business Machines Corp. (IBM) (10) Johnson &Johnson (JNJ) (11) The Travelers Companies Inc. (TRV) (12) United Technologies Corp. (UTX) (13) Chevron Corp. (CVX) (14) Visa Inc. (V) (15) Walt Disney Co (DIS)

Table 3.14 shows the variance-covariance matrix of the fifteen assets that represent the conventional strategy during the same period; it also reports the expected return and standard deviation of each risky asset. CAT has the highest standard deviation of 6.57% while MCD has the lowest standard deviation. BA has the highest expected return of 2.8% while IBM has the lowest expected return of -0.09%. Overall, we notice that the Islamic finance strategy assets have higher expected returns (ranging from 1.61% to 5.35%) compared to the conventional assets (ranging from -0.09% to 2.8%). At the same time,

the standard deviation from the Islamic finance strategy seems to be higher (ranging from 4.18% to 23.37%).

Table 3.15: Correlation Matrix of Assets Representing the Conventional Strategy (2013:01 – 2017:11)

	BA	GS	MMM	UNH	HD	MCD	AAPL	CAT	IBM	JNJ	TRV	UTX	CVX	V	DIS
BA	1.00														
GS	0.32	1.00													
MMM	0.30	0.36	1.00												
UNH	0.27	0.29	0.45	1.00											
HD	0.34	0.47	0.52	0.34	1.00										
MCD	0.31	0.10	0.39	0.20	0.25	1.00									
AAPL	0.25	0.21	0.48	0.23	0.26	0.17	1.00								
CAT	0.21	0.39	0.32	0.20	0.33	0.25	0.29	1.00							
IBM	0.14	0.40	0.27	0.14	0.24	0.06	0.31	0.32	1.00						
JNJ	0.30	0.11	0.55	0.28	0.22	0.48	0.27	0.13	0.21	1.00					
TRV	0.40	0.35	0.72	0.34	0.53	0.52	0.45	0.25	0.25	0.55	1.00				
UTX	0.40	0.42	0.61	0.44	0.38	0.25	0.27	0.46	0.30	0.41	0.40	1.00			
CVX	0.35	0.53	0.43	0.20	0.33	0.32	0.15	0.49	0.41	0.37	0.43	0.42	1.00		
V	0.40	0.24	0.41	0.15	0.39	0.30	0.33	0.13	0.08	0.16	0.42	0.19	0.08	1.00	
DIS	0.49	0.48	0.39	0.33	0.51	0.29	0.23	0.26	0.28	0.27	0.45	0.39	0.41	0.44	1.00

Source: Yahoo Finance

Abbreviations: (1) Boeing Co. (BA) (2) Goldman Sachs Group Inc. (GS) (3) 3M Co (MMM) (4) United Health Group Inc. (UNH) (5) Home Depot Inc. (HD) (5) McDonald's Corp. (MCD) (7) Apple Inc. (AAPL) (8) Caterpillar Inc (CAT) (9) International Business Machines Corp. (IBM) (10) Johnson &Johnson (JNJ) (11) The Travelers Companies Inc. (TRV) (12) United Technologies Corp. (UTX) (13) Chevron Corp. (CVX) (14) Visa Inc. (V) (15) Walt Disney Co (DIS)

Table 3.15 reports the correlation matrix for the same period. As above, the red cells represent the lowest correlations while the green represent the highest correlations. The highest correlation is between MMM and TRV at 72% while the lowest correlation is noticed between MCD and IBM at 6%. Unlike the Islamic finance strategy assets, there are no strong negative correlations between any assets, mainly positive correlations.

Next, we solve for the optimization problem to find the efficient frontier for each strategy: conventional and Islamic finance, then we solve for the optimal point on the efficient frontier and calculate the SR. The results are presented in the next section.

3.5.3 Empirical Results of the Two Strategies

In this section, we report the estimated optimal portfolio weights for the conventional and Islamic finance strategy using the constrained mean-variance model. In addition, we report the expected portfolio's returns, portfolio's standard deviations. The SRs will be reported as well and used to assess the performance of the two strategies. The strategy that has the highest SR is the one that is deemed to perform better than the other one. We should note that the same real return on the risk-free asset is used and the same borrowing/lending rate is used whenever short selling is allowed (i.e. conventional portfolio). A risk free rate of 0.12% was used given the current environment of risk-free rates; we assume that it is equal for both conventional and Islamic finance strategies.

The efficient frontier for the conventional portfolio with no constraints on short selling and the Islamic portfolio, which does not allow for short selling are presented in Figure 3.7. Results show that the conventional strategy's efficient frontier and the optimal portfolio has a risk rate of 3.7%, return of 3.1% and a SR of 83.9% while the Islamic finance strategy efficient frontier and optimal portfolio has a risk rate of 4.2%, expected return of 3.2% and a SR of 78.2%.

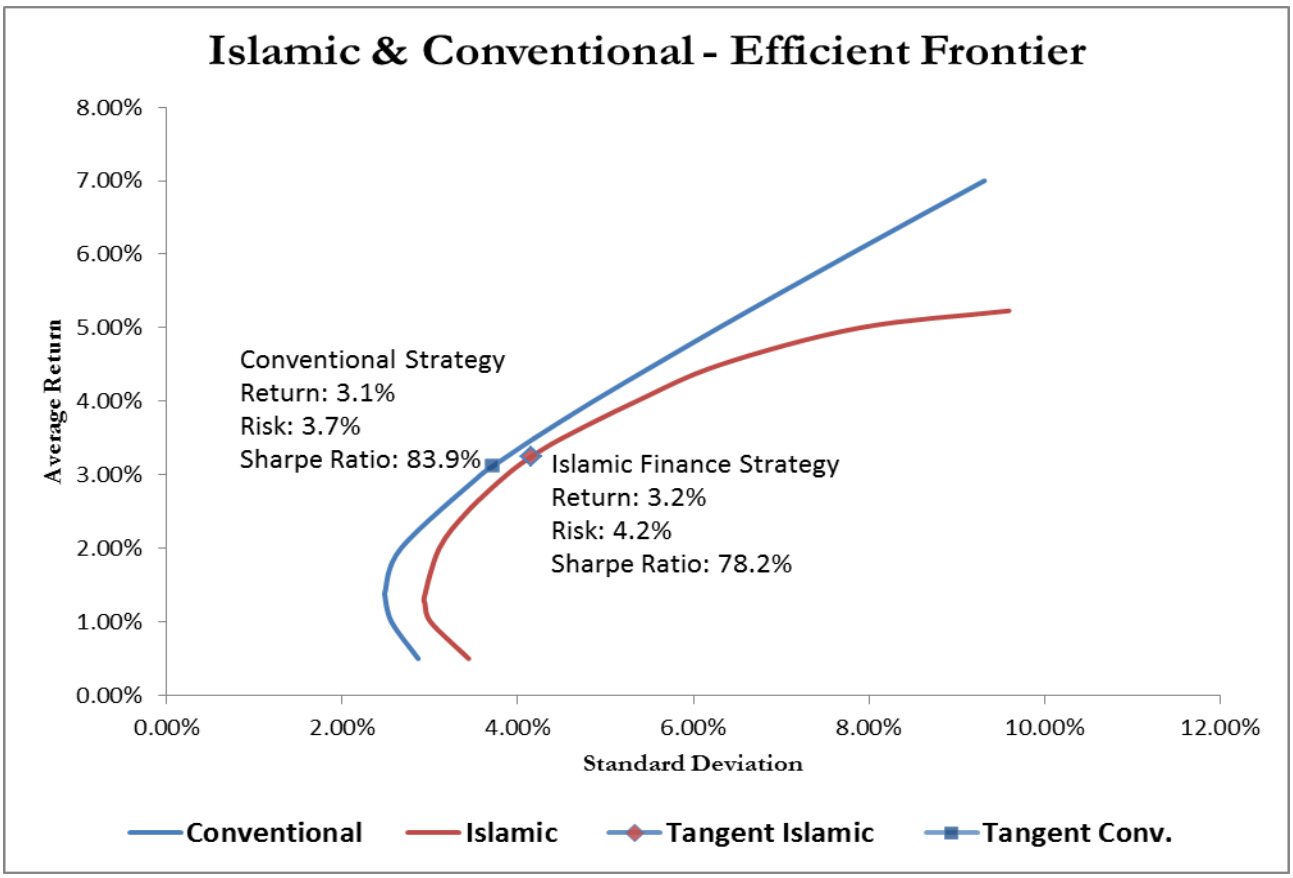

Figure 3.7: The Efficient Frontier for the Conventional and Islamic Finance Portfolios

Figure 3.7 describes the portfolio opportunities, the x-axis show the portfolios risk, measured by the standard deviation of portfolio's return; the vertical y-axis shows expected return. The efficient (minimum variance) frontier, traces the combinations of expected return and risk for conventional portfolios of risky assets that minimize return variance at different levels of expected return.

The optimal conventional portfolio has an expected return of 3.1% and a standard deviation of 3.7% while the optimal Islamic finance portfolio has an expected return of 3.2% and a standard deviation of 4.2%. It is interesting that the conventional portfolio has slightly a lower return and lower risk than the Islamic finance strategy. At the same time,

the conventional SR, which allows for a comparison of the two strategies, is higher than the Islamic finance strategy by a couple of points (5.7%). Clearly, the conventional portfolio performance is better than the Islamic finance portfolio. The fact that we eliminated many risky assets from the Islamic portfolio and did not allow for short selling limited the Islamic portfolio opportunity set and impacted its performance.

Table 3.16: Efficient Weights for Conventional Finance Strategy

Conventional Strategy Assets	Optimal Weights
BA	**22%**
GS	4%
MMM	32%
UNH	**46%**
HD	**29%**
MCD	**19%**
AAPL	7%
CAT	**8%**
IBM	-13%
JNJ	**34%**
TRV	**-51%**
UTX	-37%
CVX	-8%
V	**21%**
DIS	**-13%**

Source: Yahoo Finance
Abbreviations: (1) Boeing Co. (BA) (2) Goldman Sachs Group Inc. (GS) (3) 3M Co (MMM) (4) United Health Group Inc. (UNH) (5) Home Depot Inc. (HD) (5) McDonald's Corp. (MCD) (7) Apple Inc. (AAPL) (8) Caterpillar Inc (CAT) (9) International Business Machines Corp. (IBM) (10) Johnson &Johnson (JNJ) (11) The Travelers Companies Inc. (TRV) (12) United Technologies Corp. (UTX) (13) Chevron Corp. (CVX) (14) Visa Inc. (V) (15) Walt Disney Co (DIS)

On the other hand, the weights allocated to the risky assets for each portfolio are different; Tables 3.16 and 3.17 show the details of these allocations. Since the conventional strategy allows short selling, there were five short positions on the following risky assets: IBM which originally had a negative return, TRV, UTX which has a low

expected return of 0.95% and a high standard deviation of 4.63%, CVX which also had a small expected return of 0.62% and a high standard deviation of 5.47%, and DIS.

The rest of the assets representing the conventional portfolio were assigned a positive weight with varying ranges. UNH was assigned the highest positive weight of 46% while BA, which had the highest expected return of 2.8 was assigned a weight of 22%. It should be mentioned that BA also had a high standard deviation of 6.35%.

Table 3.17: Efficient Weights for Islamic Finance Strategy

Islamic Finance Strategy Assets	Optimal Weights
AMZN	**1%**
AAPL	0%
GOOGL	0%
FB	**24%**
NKTR	**3%**
MSFT	**15%**
XOM	0%
NVDA	**26%**
ACN	0%
HD	**31%**

Source: Yahoo Finance
Abbreviations: (1) Amazon.com, Inc. (AMZN) (2) Apple Inc. (AAPL) (3) Alphabet Inc. (GOOGL) (4) Facebook Inc. (FB) (5) Nektar Therapeutics Inc. (NKTR) (6) Microsoft Corporation (MSFT) (7) Exxon Mobil Corp. (XOM) (8)NVIDIA Corp. (NVDA) (9) Accenture PLC (ACN) (10) Home Depot Inc. (HD)

In contrast, the Islamic finance portfolio had no short positions since short sale was not allowed. However, four risky assets had a zero weight in the optimal Islamic finance portfolio. Specifically, AAPL, GOOGL, XOM and CAN had zero weights allocated to them. In addition, two assets were allocated less than 5% of the efficient weights such as

AMZN with 1% and NKTR with 3%. Therefore, four assets were allocated most of the weight (HD: 31%, NVDA: 26%, FB: 24% and MSFT: 15%).

The model allocated a high positive weight on three risky assets for the conventional portfolio, UNH, JNJ and MMM (46%, 34%, and 32% respectively). This is mainly due to the limited constraint imposed on the model. This might impact the magnitude of losses that an investor might encounter if the companies declared bankruptcy as we experienced during the latest financial crisis. However, we noticed that a weight was assigned to each asset within the opportunity set whether it was positive or negative which is consistent with the expectation that diversification is beneficial and the more the portfolio is diverse the better the expected outcome.

On the other side, the Islamic finance strategy had a relative concentration of weights on two assets HD and FB (31% and 24% respectively); however, that concentration was not to the level of the conventional strategy. It is apparent from these weight distributions that with the additional constraint, we get a more balanced portfolio. We also observed, in previous section, that the additional constraints improved the performance of the Islamic finance strategy when it was within specific norms.

Table 3.18: The Optimal Portfolios' Key Performance Indicators

	Expected Return	Standard Deviation	Sharpe Ratio
Islamic Finance Optimal Portfolio	**3.2%**	**4.2%**	**78.2%**
Conventional Optimal Portfolio	**3.1%**	**3.7%**	**83.9%**

Table 3.18 shows the results of the standard deviation, expected return and the SRs for the two strategies. The conventional portfolio has lower standard deviation and

lower expected return than the Islamic finance portfolio. The standard deviation of the conventional portfolio is 3.7% while the expected return is 3.1%. In contrast, the Islamic finance portfolio has a standard deviation of 4.2% and an expected return of 3.2%, here we notice that both strategies have similar returns but the Islamic finance strategy have higher standard deviation. In this case, higher return did not yield higher performance.

When we compare the SR for both conventional and Islamic finance portfolios, we notice a different trend. The conventional portfolio has a higher SR than the Islamic finance at 83.9% and 78.2% respectively. Clearly, the conventional portfolio in this context is a better strategy than the Islamic finance. The Islamic finance strategy is impacted by the limited set of the opportunity and the constraint on the short sell. In addition, the risk and return of the conventional portfolio is lower than the Islamic finance.

In this section, we noticed that by limiting the opportunity set and imposing short selling restrictions, the diversification benefits were limited and it impacted the portfolio performance. To understand which variable played a bigger role in the performance of the optimal solution, we will hold the opportunity set constant and adjust the short selling restriction for both strategies next.

3.5.4 Short Selling Restriction Effect Experiment

To understand the impact of the short selling restriction on each of the strategies, we performed the following "experiment": relaxing the short selling restriction on the Islamic finance strategy while imposing short selling restriction on the conventional strategy. By making these adjustments we notice a considerable change in the risk and

return characteristics of each strategy as well their SR. Table 3.19 reports the results of this experiment. In the case of the Islamic portfolio, the SR improved by 2.8% going from 78.2% to 81%. At the same time, the expected return and the standard deviation increased from 3.2% and 4.2% to 4.38% and 5.4% respectively. Therefore, both risk and return increased.

Table 3.19: Results of Short Selling Effect Experiment

	Expected Return	Standard Deviation	Sharpe Ratio
Islamic _With Short Sale	4.38%	5.40%	81.0%
Conventional_No Short Sale	2.11%	3.03%	69.7%

However, when we compare the performance of the Islamic finance strategy and the original conventional strategy while allowing short selling we notice that there is still a difference, although minimal. In this case, the SR of the original conventional strategy is 83.9% while it is 81% for the Islamic finance strategy with short selling allowed. In addition, the return and the standard deviation of the Islamic finance strategy are higher than the original conventional strategy (illustrated in section 3.4.1).

In contrast, the conventional strategy SR decreased significantly when we imposed short selling constraints. The SR in the experiment went from the original 83.9% to 69.7% which represent a 14.3% decrease. At the same time, the standard deviation decreased slightly going from 3.7% to 3.03% while the expected return decreased from 3.1% originally to 2.11%. Clearly, the allowance of short selling was deterministic in the performance of the portfolio. When we add this constraint, the performance of the conventional strategy suffers significantly.

Table 3.20: The Optimal Weights for the Short Selling Effect Experiment

Islamic Finance Strategy Assets	Yes - Short Sell	Conventional Strategy Assets	No-Short Sell
AMZN	10%	BA	9%
AAPL	-11%	GS	0%
GOOGL	-20%	MMM	0%
FB	33%	UNH	39%
NKTR	2%	HD	11%
MSFT	29%	MCD	8%
XOM	-29%	AAPL	2%
NVDA	35%	CAT	0%
ACN	-8%	IBM	0%
HD	59%	JNJ	10%
		TRV	0%
		UTX	0%
		CVX	0%
		V	21%
		DIS	0%

We also notice similar trend on the optimal weights for both strategies as shown in table 3.20 for the relaxed constrained Islamic finance strategy, all assets that originally (section 3.4.1) had zero optimal weight now have negative weights suggesting short positions. In addition, there is a great concentration on one asset, HD, with a 59% optimal weight, which reflects the risk of heavily investing in few assets. Here, the Islamic finance portfolio no longer has a balanced portfolio since we illuminated the short selling condition.

On the other hand, the restricted conventional strategy optimal efficient weights results show that all assets that had previously negative optimal weights now have zero weights due to the short selling restriction. Similarly, UNH had the highest optimal weight

of 39% while V had the second highest optimal weight of 21% but compared to the Islamic finance strategy with no short selling, the weights are much more balanced.

It is clear that adding or deleting restriction influence the investment strategy performance as well as the efficient weights of the optimal portfolio. However, to balance the weights of each strategy and avoid catastrophic losses, many fund managers opt to add additional restriction, especially on the upper or lower bound of the asset allocation to limit the risk exposure to certain assets. Adding restriction might lower the value of SR (signaling lower performance) however, it might lead to a more balanced and realistic optimal investment strategy.

We can conclude from this "experiment" that adding the short selling restriction impacted the performance of the Islamic finance portfolio positively; nevertheless, the initial limitation of the opportunity set plays a role in the overall performance of the portfolio and limits the diversification benefits as compared to a conventional strategy with no restriction even if it's an unrealistic strategy.

The question that still unanswered is as follows: why are investors are still attracted to these types of investments? Why we still notice a growth in the Islamic finance industry? To shed some light on these questions, we will explore some of the literature around the SRI and Islamic finance performance, especially the perception of the SRI and Islamic finance investors. In addition, we will review briefly survey data results collected in late 2015 from about 100 U.S. investors as part of a qualitative study I conducted which asked questions related to their expectation of profit and return on investment.

3.6 General Investors' Perception of SRI and Islamic Finance

In the previous sections we realized that the conventional strategy performance is better than the Islamic finance strategy, which is a special case of SRI, although the latter offers a more balanced and realistic portfolio. At the same time, the SRI and Islamic finance investments keep growing year over year. So what are some of the drivers of this growth? Why are investors attracted to these kinds of investments?

To understand the investors' perceptions about the SRI in general and Islamic finance as a special case, a review of the literature specific to the studies conducted on the performance of the SRI and a review of research that compares the performance of Islamic finance strategies is presented. Also, a review of studies that asked investors directly about their perception of these types of investments and what kind of value they expect from it (e.g. pure financial vs socio-economic) is offered.

However, the comparative studies conducted to differentiate the performance of SRI from the conventional portfolios exhibited mixed results. A few papers such as Derwall et al. (2005) suggested that SRI funds would outperform the conventional funds or at least share similar performance. In contrast, many papers found that SRI funds underperform compared to other conventional funds. Riedl and Smeets (2013) cited the following papers, among others, showing that SRI funds underperform its conventional counterparts: Kempf and Osthoff (2007), Fabozzi et al. (2008).

Similarly, given the growth of the Islamic finance investments, one would expect that Islamic strategies would outperform the conventional strategy. This would especially be true when applying the mean-variance model where it is generally expected that the investor will only hold the Islamic finance strategy if the risk and return profile of this

portfolio is performing better than the conventional one. However, most studies give a mixed signal on the performance of the Islamic finance strategy generally compared to the conventional strategy. In fact, the research at hand suggests that the conventional strategy outperforms the Islamic finance strategy.

Interestingly, Riedl and Smeets (2013) aimed to answer this question differently to uncover the drivers of desire to invest in SRI. Results of their working paper show that the social preferences are the main driver of investment in socially responsible mutual funds instead of the return and risk expectations and perception. To set apart their study, they used three different data sources: (1) the administrative data of the investment history and choices of a mutual fund in the Netherlands, (2) paid field experiments and (3) a collection of additional data from conducting a survey of investors.

By linking the administrative data to the survey results and behavior data as part of a one shot trust game they were able to elicit risk preferences from investors and study the role of social preferences for portfolio choice. They were also able to control for various variable such as investment knowledge, income level, age and gender to name few. They provide evidence that social preference matters in portfolio choice. This might explain in part why investors would still hold SRI and Islamic finance portfolios regardless of whether their performance is better than the conventional portfolios or not.

Another explanation refers to the possibility that Islamic finance strategies perform better during a crisis. In fact, some research suggests that the Islamic finance indexes performed better during financial crisis because they were more conservatives. Empirical literature suggests that Islamic finance performs better than conventional equity portfolios during the declining phase of capital markets (Alam and Rajjaque, 2010;

Merdad et al., 2010; Ashraf, 2013; Hoepner et al., 2011). The findings of these studies suggest that the better performance of Islamic investments can be attributed to the selection screening criteria and restriction imposed on the assets screening criteria; leading to the prohibition of certain investment/assets that are excessively leveraged and/or engaged in lending activities or risky activities.

However, other studies indicated that the performance is almost identical and there is no major difference between Islamic finance and conventional strategies. Charpa (2008; 2009) indicates that Islamic finance banks have not been immune to the financial crisis, which might indicate a possible correlation between Islamic finance and its conventional counterpart, as it lives under the same umbrella and is governed by the same game rules. At the same time, Hassan and Dridi (2010), argue that the effect was moderate and the factors that impacted their performance were different. Specifically, Islamic finance banks were not engaged with toxic assets, which had a positive impact but poor risk management practice had a negative impact.

Evidently, there is a need for more details about the perceptions and the expectation of investors who seek Islamic finance investment strategies. For this reason, I conducted an online survey in late 2015 asking mainly U.S. investors about their perception, need and expectation (including risk and profit) when thinking about Islamic finance. More than 100 investors responded to the email survey without offering any kind of incentive to participants.

The included survey had four major topics: awareness, perception, needs and expectations. The survey was sent via email to random number of investors who are either aware or unaware of the existence of Islamic finance products. Results show that

46% of respondents were extremely familiar with Islamic finance products, 36% were moderately familiar and 18 were slightly familiar. In addition, 88% of the respondents were Muslim while 12% were non-Muslim. Also, most of the respondents indicated that they are highly educated and affluent. As an example, 50% of respondent declared an income of $90K or higher, 62% declared that they completed graduate school, and 69% declared that they are employed full-time.

Furthermore, we received other socio-economic data and they specify awareness of the different types of investments. We notice that, out of the 126 respondents, 69% were male while 31% were female and 91% were from the United States while 9% non-U.S. investors. In terms of their awareness of the type of Islamic finance products available, 75% respondent recognized the existence of the Islamic mortgages, 69% were aware of the Islamic investment companies while 43% recognized the existence of the Islamic banking services such as checking and savings accounts.

Also, most of the respondents owned conventional products and did not trust that the Islamic finance products were 100% Islamic. The statistics shows that 34% respondents owned Islamic finance products while 66% owned the conventional financial products. In addition, out of the 34%, only 33% of respondents believed that their investment was fully Islamic while the majority (67%) believed that it their investment was not. These scores can explain why investors do not own as much Islamic finance products as they do conventional products and also show that there is available opportunity if Islamic finance products are marketed the right way. Moreover, when asked if they are willing to recommend the product they own to their friends and

colleagues the results were very surprising -- only 25%[28] said that they are willing to recommend their products to others.

When asked about the importance of profit when choosing these products, 58% of respondents declared that profitability was extremely important or very important. However, when asked about what they expect as a profit from the Islamic products, only 10% believed that the Islamic finance products offer more profit than conventional financial products, 6% believed that they offer no profit at all but the majority either thought that they offer less profit or the same (31% and 53% respectively). Clearly, the perception is that Islamic finance products offer basically minimum financial benefit. Another important indicator showing that the focus on the financial performance of Islamic finance might not be the right strategy to attract growth.

The follow up questions concerned the most important consideration for investing in the Islamic finance products. Surprisingly, the number one condition was that potential investors are convinced that their products are 100% Islamic. The second concern was related to the relationship investors have with the people who are selling and managing it while the third concern was related to availability of the product in their area. Profit was ranked number four on the list. Clearly, the choice of Islamic finance is not only driver by performance but rather the trust that the investors have in these product that they deliver the true promise of Islamic finance. Thus, bridging trust component will be essential in defining the growth of the Islamic financial market more so than the limited financial ROI.

[28] Based on the Net Promotor question: How likely is it that you would recommend the products that you own to a friend or colleague? The scale of this question range from 0 to 10, Individuals who scores 6 or lower are considered detractors, individuals who score 7 or 8 are considered neutral and only individual who score 9 or 10 are considered promoters. 93 individuals answered this question. For more details about survey methodology in the appendix

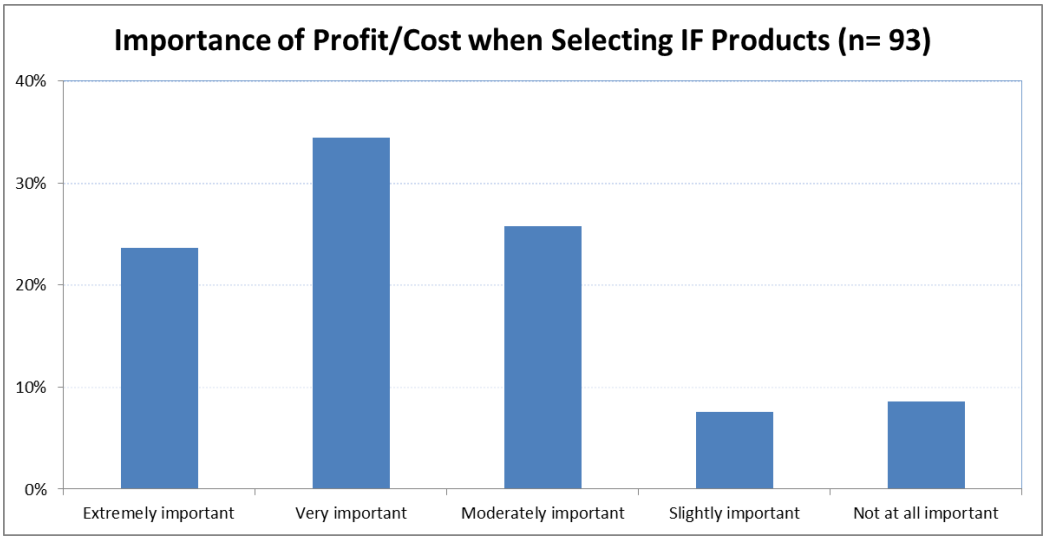

Figure 3.7: Survey Response - How important is profit/cost to you when choosing Islamic finance products and services?

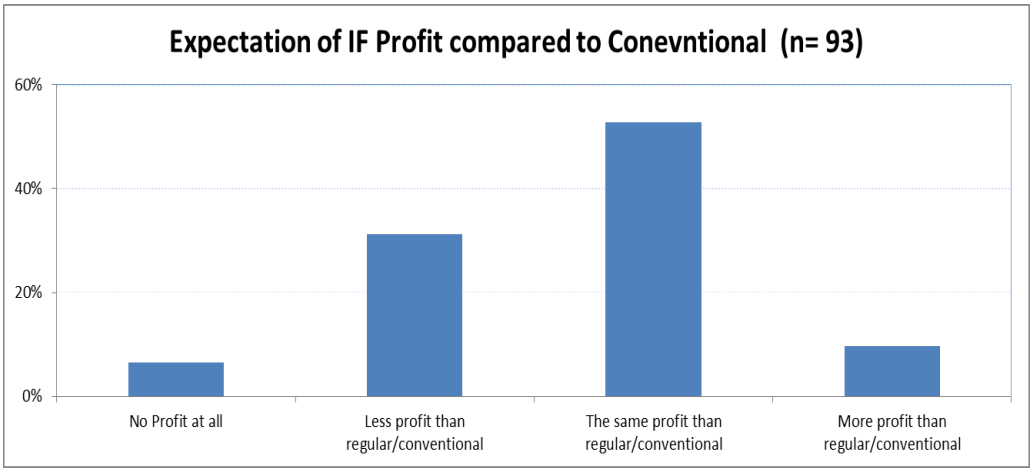

Figure 3.8: Survey Response - What kind of profit do you think the Islamic products offer?

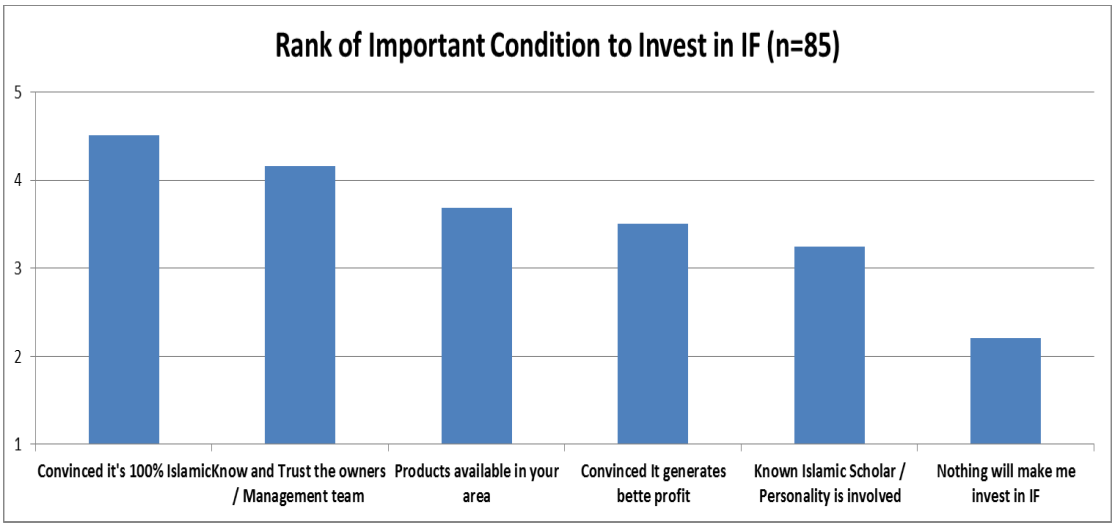

Figure 3.9: Survey Response - Under which conditions would you invest in Islamic finance products? Please rank from the most important condition to the least important condition.

Another reason that might be specific to Islamic finance is the role of *Zakah* in making the decision to weather invest in the capital market or keep wealth as cash or cash equivalent. Adding *Zakah* to the equation might lead investors to prefer investing, in the capital market as an example, than paying 2.5% of their wealth to the unprivileged population at the end of the year. To test this hypothesis we can leverage the *Zakah* concept as a risk neutral asset that has a negative rate of return since payment of *Zakah* on any wealth that is in the form of cash or cash equivalent subject to Islamic finance rules is a requirement that need to be met on a yearly basis. More analysis is needed to confirm or negate this hypothesis.

3.7 Conclusion

Two constrained mean-variance models were evaluated in theory as well as in practice by using the actual U.S. assets data to draw conclusions on the effect of Islamic finance restrictions on the portfolio optimization problem. Thus, we used the constrained

mean-variance model to construct two portfolios, conventional and Islamic finance. We did not impose any constraints on the conventional portfolio on the nature of the assets allowed nor did we forbid short selling positions. In contrast, we imposed two main constraints on the Islamic portfolio first, by limiting the type of assets based on Islamic finance restrictions and second, by prohibiting short selling.

We, then, used the constrained mean-variance model to construct the conventional and Islamic portfolios. The SR was used as the key indicator of the performance of the strategies, which implicitly includes the investor's preference of risk and return to compare the performance of the two portfolios. Results showed that adding restrictions to the mean-variance model makes the weights more balanced while weakening the diversification benefits. We conducted various analyses using different data sets and adding maximum allocation constraints, but results did not change. The conventional strategy outperformed, as measured by SR, the Islamic finance strategy in all cases although the Islamic finance strategy's the weights were much more balanced.

Although, when only SR is taking in consideration, the conventional portfolio outperform the Islamic finance strategy; results showed that the weights of the assets in the Islamic portfolio were more balanced than the weights of assets in the conventional portfolio. Therefore, imposing constraints balanced portfolio weights and reduced risk as compared to the unrestricted portfolio. In addition, Arguments were presented that the conventional portfolio might not be a realistic portfolio. In fact, Chiarella et al. (2016) argue that there are other factors not accounted for in this framework, such as administrative cost of short selling and the time lag between borrowing and obtaining the

borrowed capital, which will make it difficult or even impossible to achieve the Conventional strategy[29].

In fact, the Islamic finance market keeps growing on a yearly basis and investors are attracted to this type of investment. Although the conventional portfolio is attractive for many risk-taker investors, having a stable return seems to be an option for a risk-averse investor who is also looking for socially responsible investments. Since the Islamic finance investor aims at the contribution to the socio-economic objectives and the creation of a just society, the long-term strategy is fit to meet his objectives. The need for other studies focusing on the long-term is apparent.

Also, understanding the perception, need and expectation of the socially responsible investor will be essential to keep the growth of this market. For the case of Islamic finance investors and SRI investors, social preferences matter in their portfolio choices. The need to market these products as true Islamic finance products that abide to the full requirement and retstrictions of the Islamic finance might be more important than the actual financial performance. More research is warranted in this space.

[29] Chiarella et al. (2016) p.49-50

APPENDICES

Appendix A – Constrained Mean Variance Analysis with R

The historical monthly prices of the risky assets used for all analysis was downloaded from Yahoo Finance website using "R" a free software widely used for statistical analysis. The code to download and solve the optimization I modified an existing code that was developed by Matuszak (2013). Few adjustments were added to solve for the various cases we analyzed in this dissertation, especially a short selling condition and upper-bound constraints were added each time it was needed for the optimization problem.

To get started, we need to install R program and the necessary packages that will help us complete the optimization problem as well as the graphs. The main packages we use are "quadprog"[30] (to solve the optimization problem), "StockPortfolio" (to download stock data), and "ggplot2" (for developing graphs) to retrieve the real returns of the risky assets, solve the optimization problem, and plot the graphs. To get the stocks/risky assets data we use a function called "get returns" which is part of the "StockPortfolio" package in R that downloads a collection of stock data from Yahoo Finance using the tickers listed above.

To download the historical adjusted prices of the assets that we use for the optimization problem, from yahoo Finance, using a function in R called "getReturns[31]." The frequency of the stock data to be downloaded is set to the default, which is monthly,

[30] More detail can be found at: https://cran.r-project.org/web/packages/quadprog/quadprog.pdf

[31] More details can be found at: https://www.rdocumentation.org/packages/stockPortfolio/versions/1.2/topics/getReturns

and the default for argument "get" is used - which return the stock returns for which all stocks had data and drop any dates with NA. Since this is a monthly data, minor corrections are made when appropriate. So, the start date will be based on the available data where all the stocks had data. The output is an object of class "StockReturns" which is a list the stock returns, where the first row is the most recent and the last row is the oldest. Using the adjusted closed price (which are adjusted for dividend and splits by Yahoo Finance), the monthly returns for each asset are calculated using arithmetic averages (where r_{it} represent the simple return of an asset i, *Pt* is the adjusted monthly price of the asset i at time *t*. We are defining the return from time (*t-1)* to time *t*.

$$Total\ Return\ (r_{it}) = \frac{Adjusted\ price\ t - Adjusted\ price\ t-1}{Adjusted\ price\ t}$$

The Mean return of asset i: $\overline{r_i}$

$$\overline{r_i} = \frac{1}{N}\sum_{i=1}^{N} r_{it}\ , i = 1, \ldots$$

The mathematical equation of the variance covariance matrix is as follow, where A is the excess return matrix for the N risky assets and M period of return data:

$$A = \begin{matrix} r_{11} - \overline{r_1} & \ldots & r_{N1} - \overline{r_N} \\ \ldots & \ldots & \ldots \\ r_{1M} - \overline{r_1} & \ldots & r_{NM} - \overline{r_N} \end{matrix}$$

$$VarCov\ Matrix = A^T A = \frac{MMULT(A^T, A)}{M}$$

R software allows great control and sophistication in calculating covariance using Pearson method which assumes that the data is normally distributed. To solve for the

efficient frontier a function called "Solve.QP[32]" is used. This function has the following arguments:

(1) Dmat is the covariance matrix that is calculated based on the return data and the one that we want to minimize based on our quadratic optimization problem.

(2) Dvec is a vector of the average returns of each security--to find the minimum portfolio variance we set all to zero. To find the points along the efficient frontier we use a loop to allow these returns to vary. This is also the vector which appears in the optimization problem.

(3) Amat is the matrix of constraints; the sum of the portfolio weights has to equal to one and the constraint on short selling for the Islamic portfolio.

(4) bvec is a vector of values that is matched up against the Amat matrix to enforce our constraints.

(5) meq which tells the "Solve. QP" function which columns in the Amat matrix to treat as equality constraints. In this case, we only have one equality equation so we will set this to one "1".

Once the program is set, to find the efficient frontier for each case, we can change the arguments of the function (Return of the assets selected = returns, short selling condition: short, upper-bound constraint = max.allocation) to attain different portfolios. See example of the code below:

```
"eff <- eff.frontier(returns=returns$R, short="yes", max.allocation=.45,
risk.premium.up=.5, risk.increment=.001)"
```

[32] More details can be found at: https://www.rdocumentation.org/packages/quadprog/versions/1.5-5/topics/solve.QP

The last step is to calculate the Sharpe Ratio and the corresponding portfolio expected return and variance. Using the "ggplot2[33]" function we can plot the efficient frontier and the tangency portfolio.

Appendix A – Survey Questionnaire

Figure 10 illustrates the Survey questionnaire flow starting with a screener to terminate any individual who is under the age of 18 years, questions related to their general awareness of the Islamic finance products, questions related to the trust on Islamic Finance, questions related to the importance of profit / cost when they make decision in investing in the Islamic finance products, then demographics questions.

[33] For easy access to the data visualization capability of the this function, refer to the following recourse: https://www.rstudio.com/wp-content/uploads/2015/03/ggplot2-cheatsheet.pdf

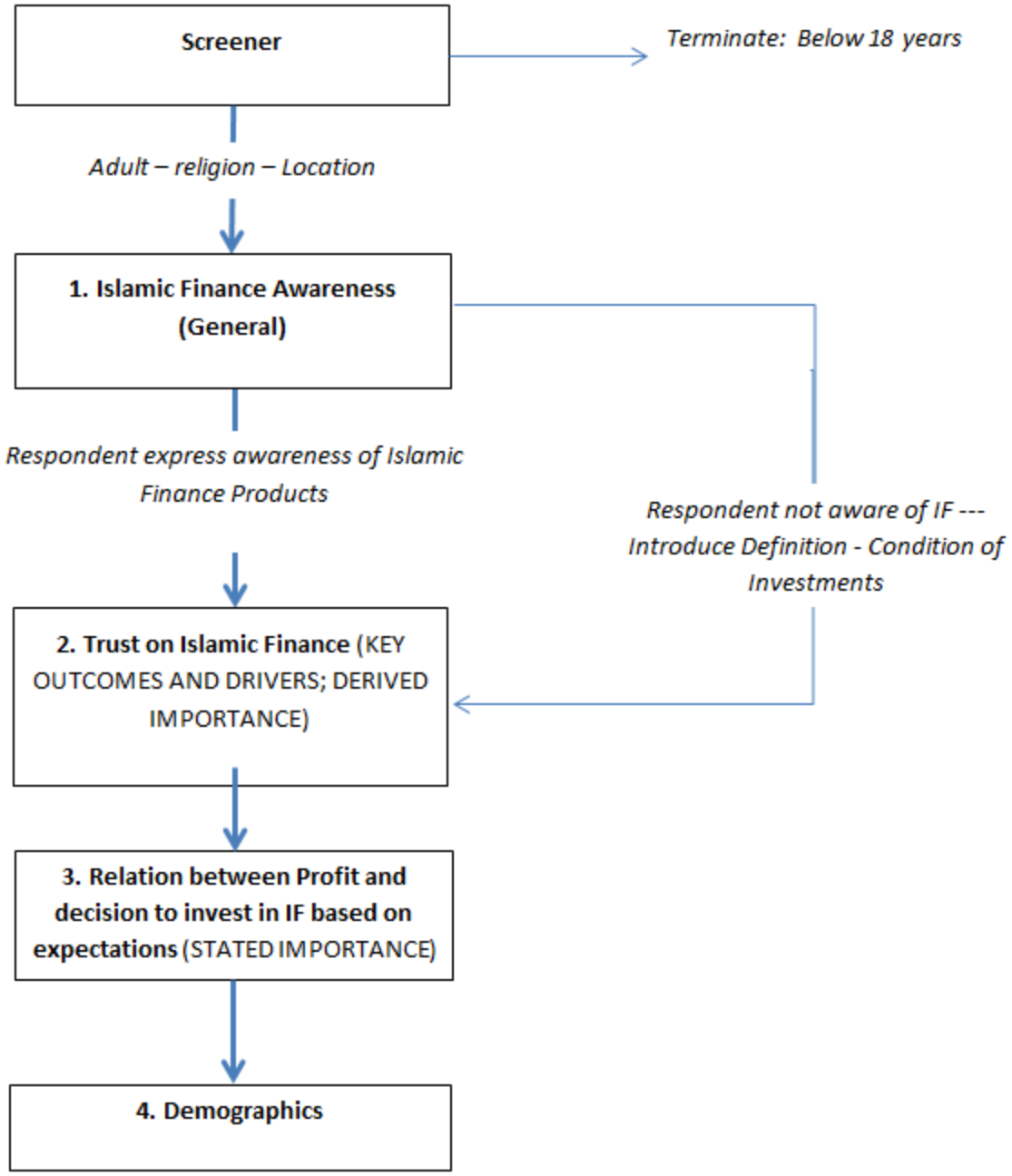

Figure 3.10 – Survey questionnaire flow

The questions are as follows:

SECTION 1: ISLAMIC FINANCE AWARENESS (GENERAL)

BASE: ALL

Q1. Are you familiar with the Islamic Finance and Islamic Finance products?

Yes
No

IF "No" IS SELECTED, INTRODUCE ISLAMIC FINANCE DEFINITION

Islamic Finance / Islamic Finance Products
Islamic Finance refers to a unique form of socially responsible investment/finance. It includes a range of financial transactions (i.e. Banking, Investment and mortgage) that conform to laws of the religion of Islam. The following are the two basic principles behind it:

1- The prohibition of interest collection and payment
2- The prohibition of investing in industries considered sinful such as: alcohol, pornography and armaments
3- The prohibition of uncertainty, speculation & gambling, hence money has no inherent value in itself.

Q2. Are you aware of any Islamic Finance Products available in your area?

Yes
No

Q2a. How familiar are you with Islamic finance?

Extremely familiar
Moderately familiar
Slightly familiar
Not familiar

Q2b. Are …?

Muslim
Non-Muslim

Q3. Which of the following products you believe available as Islamic Finance products?

Islamic Mortgage
Islamic Investments companies (Stocks, Bonds/Sukuk, etc.)
Islamic banking Services (Checking accounts, Savings Accounts, Credit Cards, etc.)
None of the above

Q3a. Which, if any, of the following financial products do you currently own? (check all that apply)

Islamic Mortgage
Islamic Investments (Stocks, Bonds/Sukuk, etc.)
Islamic banking Services (Checking accounts, Savings Accounts, Credit Cards, etc.)
Regular Mortgage (conventional)
Regular Investment (Conventional)
Regular banking (conventional checking, savings, etc.)
None of the above

Q3b. How satisfied are you with the selection of financial products and services you own?

Extremely satisfied
Very Satisfied
Moderately satisfied
Slightly satisfied
Not at all satisfied

SECTION 2: TRUST IN ISLAMIC FINANCE PRODUCTS (SPECIFIC)

For the next few questions, we'd like you to think about the Islamic Finance services that you heard of, know of or think they exist today.

Q4. How likely is it that you would recommend the products that you own to a friend or colleague?

0 – not at all
1
2
..
10 very likely

Q4a. Do you trust that these products are 100% Islamic (Follows Islamic laws)?

Yes
No

Q5. Please explain why you "trust or don't trust" that these products follow Islamic Laws 100% (Open end)

SECTION 3: RELATION BETWEEN PROFIT & DECISION TO INVEST IN IF

Q6. How important is profit/cost to you when choosing the Islamic products and services?:

Extremely Important
Very important
Moderately important
Slightly important
Not at all important

Q6a. What kind of profit do you think the Islamic Finance Products offer?

No profit at all
Less profit than regular/conventional Financial Products
The same profit than regular/conventional
More profit than regular/conventional Financial Products

Q7. Under which condition would be willing to invest in Islamic Finance Products, please rank from the most important condition to the least important condition (how important are the following service aspects to you?):

ROWS – RANDOMIZE

You are convinced that it is 100% Islamic
You are convinced that it generates better profit
You know that these products are available in your area
You Know and trust the people selling/managing the Islamic finance products
You know that an Islamic known personality is advertising these products
Nothing will make me invest in these products
Other criteria, please specify (Open End)

COLUMNS

7 - Very important
1 - Not important at all

SECTION 4: DEMOGRAPHICS

And now, just a few more questions about you

BASE: ALL

D1. What is the highest level of education you have completed? (Select one)

Some high school or less
High school graduate
Some college, no degree
2-year college degree/technical school
4-year college degree
Post-graduate degree

BASE: ALL

D2. Which of the following best describes you? (Select one)

Student
Employed
Stay-at-home parent – raising kid(s)
Stay-at-home spouse – no kids
Retired
Unable to work/disabled
Other (e.g., not employed, looking for work…)

BASE: ALL

D3. Which of the following best describes your current marital status? (Select one)

Living with a partner and married to him/her
Living with a partner and not married to him/her
Widowed, divorced or separated and living alone
Widowed, divorced or separated, and living with others (not a partner)
Single and living alone
Single and living with others
Other

BASE: ALL

D6. What range best describes the total combined annual income of all the members of your household? (Select one)

Less than $25,000
$25,000 to $49,999
$50,000 to $69,999
$70,000 to $99,999
$100,000 or more

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