

# The Effect of Manager Gender on Hedge Fund Risk and Performance

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# **THE EFFECT OF MANAGER GENDER ON HEDGE FUND RISK AND PERFORMANCE**

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## Abstract

### PURPOSE OF THE STUDY:

This master's thesis examines among the hedge funds managed by a sole manager, whether differences in performance and risk between ones managed by female (female funds) and ones managed by male managers (male funds) exists. For simplicity, in this study such differences are referred as the "gender effects" of hedge fund managers. I also explore whether the gender effect on performance can be explained by the gender effect on risk.

### DATA AND METHODOLOGY:

The primary data is extracted from the Academic Lipper TASS database. The sample use in this study includes 5697 live hedge funds that began operation in the period January 1994 to December 2013. The excluded funds are the ones that was borned outside that period of time or the ones that have ceased functioning. Manually collected data regarding managers' gender is used to complement the primary data. Other data including Fung-Hsieh factors and three month T-bill rate and are retrieved on David A. Hsieh's data library website and DataStream database.

Hedge funds managed by a sole female manager are matched with similar hedge funds managed by a sole male manager using Propensity Score Matching method. The variables used for matching are the size of the funds, management fee, incentive fee, leverage usage, and managers' capital investment. The gender effects on performance and risk are calculated as the average differences between the paired funds in Fung-Hsieh 8-factor risk adjusted return and net volatility.

### FINDINGS OF THE STUDY:

There is a weak evidence that female funds overperform equivalent male funds by 0.17 percent monthly return over the period January 1994 to December 2013. However, during the two financial crises 1997 and 2008, female funds net excess return of about 0.16 and 0.31 monthly respectively compared to male funds, significant at 1 percent level. Volatility is not found to be significantly different for male and female funds. The gender effect on returns is not adequately explained by the gender effect on volatility, accounting for about 4 percent of the variance. I propose several explanations for the gender effect on performance based on the existing literature.

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**Keywords** gender, hedge fund, manager, risk, performance, return, volatility

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## TABLE OF CONTENTS

TABLE OF CONTENTS .....	1
1.Introduction.....	3
2.Literature review .....	6
2.1 Differences between men and women on a psychological level .....	6
2.2 Differences between men and women on an organizational level .....	8
2.3 Individual and group thinking.....	9
2.4 Hedge funds and mutual funds .....	10
2.5 Glass ceiling against women.....	10
3.Hypothesis.....	11
4.Data .....	11
4.1 Data source.....	11
4.2 Survival bias.....	12
5.Methodology.....	12
5.1 Overview.....	12
5.2 Identifying hedge funds with a single female manager .....	13
5.3 Propensity score matching (PSM) .....	13
5.4 Measurements for hedge fund performance and risk .....	23
6.Result.....	27
7.Discussion .....	35
7.1 Why female funds offer positive returns over male funds? .....	35
7.2 Why female funds do not have lower volatility than male funds? .....	37
7.3 Limitations.....	37
8.Conclusion .....	38
9.References.....	40

## LIST OF TABLES

Table 1: Number of hedge funds in each inception year – investment strategy cluster .....	15
Table 2: Summary statistics of matching variables .....	19
Table 3: The probit model for PSM, matching male and female funds .....	20
Table 4: Propensity score .....	22
Table 5: Summary statistics of the matching variables in female fund-male fund pairs.....	22
Table 6: Summary statistics for Fung-Hsieh factors .....	25
Table 7: Summary statistics for Fung-Hsieh factor loadings .....	26
Table 8: The gender effect of female manager on risk-adjusted returns and volatility .....	31
Table 9: The regression of gender effect of female manager on alpha vs gender effect of female manager on volatility .....	32
Table 10: The probit model for PSM, matching female and pre-verified male funds.....	33
Table 11: The gender effect of female manager on risk-adjusted returns and volatility, matching female and pre-verified male funds .....	34

## LIST OF FIGURES

Figure 1: The gender effect of female manager on risk adjusted return .....	29
Figure 2: The gender effect of female manager on net return volatility .....	29

## 1. Introduction

In early 2014, consulting firm Rothstein Kass (now KPGM) had reported that hedge funds run by women had outperformed ones managed by men, two years in a row. From January 1, 2013 through the end of November 2013, those female led hedge funds provide an average of 9.8 percent returns compared to the 6.13 percent returns on the HFRX Global Hedge Fund index. Several articles suggesting the superior of women in the hedge fund industry had then circulated the media, including popular websites such as International Business Time, New York Times, and Reuters <sup>1</sup>. The main suggested reason for the alleged superior performance of female led funds is that women tend to be more risk-averse than men, and such risk-aversion net them better return in the turbulent market after the 2008 crisis. However, there are contradictory ideas that the over-performance is not due to managers' gender but to unrelated factors such as the size effect, as women tends to manager smaller funds <sup>2</sup>. Inspired by those opinions from the media, this paper focuses on identifying potential gender differences in hedge fund industry with regards to fund performance and riskiness. In this paper, I will refer to such differences stemmed from the managers' gender as "gender effect". Further extrapolating those ideas, I also explore whether the gender effect on performance can be explained by the gender effect on risk, based on the reasoning that the higher risk-aversion of female manager might be reflected in their funds' lower risk level.

The differences between men and women in making decision and how those differences affect organizations' behaviour have been popular topics in academic literature. A rich body of psychological research has pointed out that women likely take less risk than men do in a variety of situations (Byrnes, Miller and Schafer, 1999). Another feature in female mentality is a lower level of overconfidence compared to man (Barber and Odean, 2001; Bengtsson et al., 2005; Huang and Kisgen, 2013). The higher risk aversion and less overconfidence may influence how women make financial decisions. One of first study supports the notion of gender difference in financial decision making is an article by Lewellen, Lease, and Schlarbaum (1977) that identifies gender as one of the most important determinants of investors' investment strategy.

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<sup>1</sup> [www.ibtimes.co.uk/women-hedge-fund-managers-made-more-money-men-2013-1432348](http://www.ibtimes.co.uk/women-hedge-fund-managers-made-more-money-men-2013-1432348)  
[www.dealbook.nytimes.com/2014/01/15/want-better-hedge-fund-returns-try-one-led-by-a-woman/](http://www.dealbook.nytimes.com/2014/01/15/want-better-hedge-fund-returns-try-one-led-by-a-woman/)  
[www.reuters.com/article/2014/01/15/hedgefunds-women-idUSL2N0KO1XR20140115](http://www.reuters.com/article/2014/01/15/hedgefunds-women-idUSL2N0KO1XR20140115)

<sup>2</sup> [www.economist.com/blogs/economist-explains/2014/01/economist-explains-20](http://www.economist.com/blogs/economist-explains/2014/01/economist-explains-20)

From then, there has been an abundance of literature supports the gender effect in decision-making (see Bruce and Johnson, 1994; Croson and Gneezy, 2009; Hudgens and Fatkin, 1985; Johnson and Powell, 1994; Sunden and Surette, 1998; Booth and Nolen, 2012.)

Understandably, gender has been used as a proxy for risk aversion and overconfidence in organizations leaders, including boards of directors, CEOs, and mutual funds managers to assess whether their personal characteristics affect their firms, producing mixed results. Martin et al. (2009), Elsaid et al. (2011), and Faccio et al. (2014) find lower levels of several risk measurements in companies with female CEOs. Atkinson et al. (2003) and Ruenzi et al. (2014) study female mutual funds managers to find no difference in fund performance and risk in female managed funds compared to the male. Gender as a proxy for overconfidence is used by Levi et al. (2014) to find out that less overconfident female directors tend to less overestimate merger gains, which results in fewer bids in M&A deals.

More recently, there has been studies suggest men to be more prone to sensation seeking and competitive behaviours (Levi et al., 2010; Grinblatt and Keloharju, 2008). Such behaviours have potentials to affect firms and funds managed by men. However, there are not as many studies focusing on dominance and sensation seeking as compared to risk aversion and overconfidence.

Details analysis of existing literature will be presented in the literature review section.

With all the studies on corporations and mutual funds, it is a curiosity to see no peer-reviewed paper dedicated to the effects of manager gender on hedge fund performance and risk yet. Therefore, this thesis is an attempt to bridge such gap. The result will give insight into whether there are differences in female and male managed hedge fund performance and risk as well as their relationship. On a broader scope, my thesis contributes to the ongoing research on how leaders' personal characteristics may affect their organizations. Finally, I am also exploring the use of *propensity score matching* (PSM) method in financial research. PSM is extremely popular in the field of biomedical, but its use in economics and finance has been relatively limited. In suitable situation, PSM could be very useful in saving time and resources while providing meaningful results.

This study is conducted on 79 *hedge funds with a sole female manager* (referred as “female fund”) among nearly 6000 currently active hedge funds from TASS database during the period from January 1994 to June 2014. Each female fund is matched with a *hedge fund with*



*a sole male manager* (referred as “male fund”) using PSM method. Risk-adjusted returns from Fung-Hsieh 8-factor extension model (Fung and Hsieh, 2004) and net return volatility are calculated for each fund as measurements for fund performance and risk. From these data, the gender effect can be analysed using the average differences in risk-adjusted returns and volatility between female fund-male fund pairs.

Based on the claim of superior performance of female managed hedge fund from media reports, my first hypothesis is that female funds would have higher risk-adjusted return compared to male funds. My result shows weak support for the hypothesis in the whole period, suggesting female funds on average earn 0.17 percent more than male funds in monthly risk-adjusted return only at 10 percent confidence level. However, during two financial distress periods January 1997 – December 1998 and January 2007 – December 2009, there is strong support that female fund earns 0.16 percent and 0.31 percent more in monthly risk-adjusted return respectively.

On the notion that female managers may be more risk averse, my second hypothesis is that female funds have less net return volatility than male funds, reasoning that such risk aversion of the manager might transfer into funds’ operation. The result does not support this hypothesis. In the whole sample period as well as the subperiod January 2007 – December 2009, the average difference in volatility between female funds and male funds is not found to be significantly different from zero. Only during the financial crisis 2008, female funds have lower volatility than male funds. My proposed explanations for this finding are (1) female hedge fund managers are not inherently more risk averse than males; (2) even if the female managers are more risk averse, they may still choose the investment with the same riskiness as the men do; and (3) the net return volatility, as a risk measurement, does not reflect the lower risk that female managers might have taken.

My final hypothesis is that the differences in risk-adjusted return can be explained by the differences in volatility. Over the sample period, the explain power of volatility differences is very poor, accounting for about 4 percent of total variance of risk-adjusted return differences. From the findings, I conclude that there should be other explanations for the superior performance of female funds other than the volatility argument. I propose four possible explanations based on the existing literature.

- (1) There are different characteristics associating with female managers other than the gender-specific risk aversion that also affect fund performance.

- (2) Male managers may make more value-destroying trades, especially during the periods of financial turbulence.
- (3) There is a potential glass ceiling in the hedge fund industry that forces female managers to be better than their peers to attain a same position, thus the females have better capacity to create superior performance.
- (4) Female managed funds may face additional survivor risks. There may be lower capital inflows into female managed hedge funds compared to similar-performing male managed ones. Less capital inflow may lead to higher probability of non-superior female managed funds to cease operation.

Limitations of the study include the use of the sub-optimal PSM for time series data, the lack of data and the usage of only one measurement for performance (risk-adjusted returns) and risk (volatility). The rest of the thesis is organized as follows. Section II reviews the existing literature. Section III restates the hypotheses. Section IV introduces the data. Section V presents about the methodology. Section VI shows the results. Section VII discusses the possible explanations for the gender effect on fund return and volatility and limitations. Section VIII concludes.

## **2. Literature review**

### **2.1 Differences between men and women on a psychological level**

The focus of gender study relevant to this paper has been on the topics of risk aversion, overconfidence, sensation seeking and competitiveness.

There is a widespread consensus in academic literature that women are generally more risk-averse than men are. The meta-analysis of 150 studies by Byrnes, Miller and Schafer (1999) concludes that male participants are more likely to take risks than female participants in a variety of situation, including making financial decisions. Jianakoplos and Bernasek (1998) find out that single female hold less risky asset than sing male. Powell and Ansic (1997) conduct an experiment to show that females are less prone to risk-seeking than males irrespective of familiarity and framing, costs or ambiguity. However, Schubert, Brown, Gysler and Brachinger (2000) suggest that context, framing, and ambiguity matter with respect to gender differences in risk attitude as under controlled environment, gender-specific risk behaviours may not arise. Another experiment by Meier-Pesti and Goetze (2006) suggests that femininity affect financial risk-taking positively, while masculinity has the

reverse effect. Regarding allocating assets in retirement savings account, women also exhibit a larger risk aversion (Bajtelsmit, Bernasek and Jianakoplos, 1999). Furthermore, when making decision to invest in mutual funds, women exhibit less risk-taking than men in their most recent, largest, and riskiest mutual fund investment decisions (Dwyer, Gilkeson and List, 2002). On the other hand, Nelson (2014) argues that the evidence for the claim “women are more risk averse than men” is much weaker than has been portrayed.

There are evidences that men are more susceptible to overconfidence than women. Overconfidence is a cognitive bias in which a person's subjective confidence in his or her judgments is reliably greater than the objective accuracy of those judgments (Pallier et al. 2002). Overconfidence is extremely common in both men and women, with DeBondt and Thaler (1995) argue “Perhaps the most robust finding in the psychology of judgment is that people are overconfident”. Barber and Odean (2001) state that in areas such as finance men are more overconfident than women, leading to two predictions: men will trade more than women will, and the performance of men will be hurt more by risk-adjusted live trading. Bengtsson, Persson and Willenhag (2005) use a large set of exam data from Stockholm University to find that male students are more inclined than female students to aim for higher grades. Striving for higher grades could be due to overconfidence in male students, or their more competitive nature. Niederle and Vesterlund (2007) demonstrate in their experiment that men are more overconfident. On the other side of the argument, Johansson-Stenman and Nordblom (2010) find no support for the popular hypothesis that men are more overconfident than women based on their field experiment.

Sensation seeking is “a trait defined by the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience.” (Zuckerman, 1994). The meta-analysis by Brown, Cross, and Cyrenne (2013) using Zuckerman's Sensation Seeking Scale supports the view that men and women differ in their propensity to report sensation-seeking characteristics. Grinblatt and Keloharju (2009) present arguments supporting men are more prone to sensation seeking behaviour. Men are more attracted to risky sport activities, violence, alcohol and drug abuse, and gambling. Investors with sensation seeking tendency trade more frequently.

Men could be found to be more competitive than women in several studies. Niederle and Vesterlund (2007) find out men have a preference for performing in a competition based on their observation that 73 percent of the men in their experiment choose to participate in a

competitive tournament incentive scheme, while only 35 percent of the women do so. In a different experiment, Gupta, Poulsen and Villeval (2005) show similar result when men, given the choice between a tournament and a piece-rate pay scheme before performing a real task, choose the tournament option significantly more often than women..

An interesting manifestation of men's lower risk aversion, higher confidence, sensation seeking and competitiveness is that they tend to make more stock market trades than women. Grinblatt and Keloharju (2009) support that men trade more than women within all age groups, potentially linking to increased male sensation seeking tendency. Barber and Odean also document a 45 percent increase in trading frequency made by men compared to women, reducing men's net return by 2.65 percentage points a year as opposed to 1.72 percentage points for women.

## **2.2 Differences between men and women on an organizational level**

Gender study on an organizational level has been mainly on leaders of corporations and mutual funds. The manifestations of gender effect on organizations are not always in line with male and female personal cognitive traits.

Study has attempted to find the gender effect on companies based on CEOs' gender (Martin et al. 2009, Elsaid et al., 2011, Faccio et al., 2014). All three studies on CEOs' gender suggest that female CEOs tend to reduce measurements associated with risk. Martin et al. propose that firms with relatively high risk are more likely to appoint females CEOs so that risk might decrease. However, the abnormal returns associating with appointing a female CEO is not significantly different from a male.

Female members in boards of directors seem to affect companies differently from males. Adams and Ferreira (2009) find that chief executive officer turnover is more sensitive to stock performance and directors receive more equity-based compensation in firms with more gender-diverse board. In 2003, a new law was introduced requiring that 40 percent of Norwegian firms' directors be women, at the time only 9 percent were women. Ahern and Dittmar (2012) find that the women quota in Norwegian firms' board led to higher leverage and more acquisitions, and deterioration in operating performance. Admittedly, the effect could be due to younger and less experienced boards that firms have to hastily assemble, rather than the effect of an increase in number of female board member.

In merger and acquisition, Levi et al. (2014) find out that less overconfident female directors tend to less overestimate merger gains, which results in fewer bids.

With regards to mutual funds, Atkinson et al. (2003) find that male- and female-managed funds do not differ significantly in terms of performance, risk, and other fund characteristics. Ruenzi et al. (2014) also suggest no difference in mutual fund performance. However, both papers document significantly lower capital inflows into female-managed mutual funds than into male managed funds. On the other hand, Welch and Wang (2013) find some evidence that the percentage of female managers managing a fund is negatively related to the fund's performance over time. In addition, female managers have more conservative investment strategies; tend to hold a higher total number of assets (stocks) and fewer assets in their top 10 holdings than do male managers.

An interesting common point about the mentioned papers in companies and mutual funds is the perception of the market toward female leaders. Despite find no difference in risk and performance measurements of female and male managed mutual fund, Atkinson and Ruenzi both find significant lower capital flows into female managed funds, about one third lower than male managed funds. Martin (2009) also supports the view that the market perceives female CEOs to be relatively more risk averse. Lee et al. (2007) report that investor reactions to the announcements of female CEOs are significantly more negative than those of their male counterparts. While the market perception in case of female CEOs could be reasonably supported if decreasing firm risk measurements is undesirable for shareholders, the disparity between female managed mutual funds characteristics and their capital flows could be a sign of disservice to them.

### **2.3 Individual and group thinking**

There are evidences that working in a group will significantly alter the decision making process of each individual. Cooper and Kagel (2005) shows that teams consistently play more strategically than individuals play and generate positive synergies in more difficult games. Another research on mutual funds suggests that extreme opinions of single manager in a team average out and, consequently, teams make less extreme decisions than individuals do (Bär, Kempf, and Ruenzi, 2010). Teams are also found to follow less extreme investment styles and their portfolios are less industry concentrated than those of single managers are. Teams are eventually less likely to achieve extreme performance outcomes. Based on those examples, it is reasonable to suspect that hedge funds managers will also change their

behaviour when working in a group. Therefore, to avoid the bias caused by the team effect and exemplify the gender effect, this paper only considers hedge funds with a sole manager.

## **2.4 Hedge funds and mutual funds**

As many studies quoted earlier are based on mutual funds, it should be noted that while mutual funds and hedge funds are both investment vehicles, there is a main critical difference between them. Hedge funds, unlike mutual funds, are not regulated by SEC and not required to disclose their asset holdings. Therefore, hedge fund managers enjoy much greater flexibility in choosing their investment strategies, enabling them to pursue very high risk-high return or experimental and exotic investment styles. Liang (1999) found that hedge funds follow dynamic trading strategies, have low systematic risks, and there are low correlations between strategies. However, hedge funds cannot be advertised to the public and their investors are required to be accredited; i.e. they must have a minimum net worth. As a result, normal investors who can participate in mutual funds usually cannot invest in hedge funds directly.

Hedge funds also differ from mutual funds in their pursuit of alpha return. Therefore, hedge funds usually have a management fee structure designed to motivate managers to seek alpha (Liang, 1999). This is the case when managers' stock picking skill matters the most. Therefore, I expect differences in fund performance due to managers' skill would be more noticeable in hedge funds.

## **2.5 Glass ceiling against women**

The term "glass ceiling" is to describe organizations' failure to promote women into top leadership roles (Eagly and Carli, 2007). There has been evidence of such barrier in the corporate ladder against women. Lyness and Thompson (1997) find out executive women having less authority, receiving fewer stock options, and having less international mobility than men. Women at the highest executive levels reported more obstacles than lower level women. Barreto et al. (2009) assess that women are underrepresented in the upper echelons of organizations. Part of the problem seems to stem from the perception of women as leaders, for example, female managers are often stereotyped as either competent or warm - but not both.

With the large influx of women into the professional world over the last two decades, it is possible that the glass ceiling has weakened or disappeared, if it had existed in the first place. However, given the fact that the hedge fund industry is still dominated by male managers, evidenced by the overwhelming number of male managed fund, I consider the glass ceiling a potential problem for female managers.

### **3. Hypothesis**

There are three hypotheses that will be explored in this paper.

Hypothesis 1: female funds have higher risk-adjusted return compared to male funds

Hypothesis 2: female funds have less net return volatility than male funds

Hypothesis 3: The differences in risk-adjusted return between female funds and male funds can be explained by their differences in volatility

### **4. Data**

#### **4.1 Data source**

The hedge fund data is gathered from the Academic Lipper TASS database. The database is the largest hedge fund database in the world, documenting more than 6000 live funds from 1990 to June 2014 together with around 7000 graveyard fund. Funds that are active as of 2014 are live funds. Those have stopped reporting to TASS before that are moved to the graveyard section. Due to the lack of manager information for graveyard funds, only live funds are included in the study. Furthermore, to match the hedge fund data with the data available on Fung-Hsieh factors, only funds that began operation in the period January 1994 to December 2013 are included in this research. Fund that started in 2014 are excluded because they have too few observations. In total, 5697 hedge funds are included in my sample.

The commercial version of TASS database contains name and contact for fund manager. However, the academic version lacks any manager information. Therefore, managers' gender is checked from funds' websites, LinkedIn and online resources. Any funds that managers cannot be reliably identified will be dropped out of the sample.

Other data including Fung-Hsieh factors and three month T-bill rate and are retrieved on David A. Hsieh's data library website <sup>1</sup> and DataStream database.

## **4.2 Survival bias**

Because gathering manager data for dead funds is near impossible, this study only includes active funds as of June 2014. Therefore, survival bias should be expected. Survival bias means that weak performing funds eventually have to close down, possibly leading to overestimating the hedge fund average return. However, any systematic survival risks that affect both male and female managed funds are expected to be even out when comparing female funds and male funds. I suggest there could be a possible additional survival risk specifically for female managed funds that could explain the thesis results. Detail analysis is presented in section VII.

# **5. Methodology**

## **5.1 Overview**

To answer the research question, propensity score matching (PSM) will be used to estimate the gender effect on measurements of hedge fund performance and risks. The research process is conducted in three steps:

1. Identify the female funds.
2. Use PSM to find a matched male fund for each female fund
3. Calculate Fung-Hsieh risk adjusted returns and volatility for each female fund-male fund pair and estimate the gender effect. The gender effect is then tested for statistical significance using paired-sample t-test.

The use of PSM instead of more simple and direct multivariate linear regression is motivated by the fact that the database is large (around 6000 funds in 10 years), and requires large amount of additional hand-collecting data not feasible within the resource and time constraints of this research. As the hedge fund database lacks any information regarding managers, such information must be obtained from funds' websites. For reliable linear regression analysis, all funds in the sample must be looked up and classified accordingly to manager characteristics. Random sub-sampling would risk omitting female hedge funds, which are already quite rare.

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<sup>1</sup> <https://faculty.fuqua.duke.edu/~dah7/HFRFData.htm>



On the other hand, with PSM, only the data on female funds and their matching male funds must be verified. Isolating all female from males is not as crucial as with regression analysis, as all the pairs can be quickly checked after matching so that any erroneous pairs can be fixed and PSM can be rerun until appropriate matching is achieved. As long as the initial process of identifying female fund is randomized enough, it should be equivalent to random sampling.

Data processing is done in Stata and Microsoft Excel. More details of each step in the research process will be discussed next.

## **5.2 Identifying hedge funds with a single female manager**

Female fund is defined as a fund with only one top manager who is female. Consultants, analysts, and administration staffs are not taken into account. The gender of the current top manager is confirmed via the fund's website based on available pictures and the biography published on the pronoun used ("she"/"her"). No effort is made to distinguish whether the gender is biological or self-identified. After that, the time she has been leading the fund is determined based on fund's website. In total, 79 female funds whose managers remain the same throughout the sample are identified. They are not all female funds that could exist in the sample, due the limited time for hand collecting data. The rest of the funds are classified as unidentified funds. In addition, 3857 funds are verified to have one or several male managers.

## **5.3 Propensity score matching (PSM)**

PSM is a statistical matching technique that can match and compare individuals in two groups in pair. It can deal with multiple matching criteria by constructing a propensity score for each individual in each group based on chosen matching variables, and then match them based on the score alone. Originally, PSM is extensively used in the biomedical field to evaluate the effect of treatments on patients. PSM then has seen sparse usage as a statistical analysis tool to estimate causal effect in finance and economics. Dehejia and Wahba (1999) use PSM to study labour market policies, while Hitt and Frei (2002) research the influence of online banking on customer profitably. PSM applies for all situations where one has a treatment, a group of treated individuals and a group of untreated individuals (Caliendo and Kopeinig, 2005). In my study, PSM is adapted to analyse the effect of manager gender on hedge fund activity. The 'treatment' can be thought as 'being female', 'female manager hedge funds' as the 'group of treated individuals', and 'male manager hedge funds' as the untreated group.

Idealistically, our thesis question could be best answered by finding out what happens with the fund when a manager gender is swapped, with all other variables being the same. PSM can be a reasonable estimate for such unrealistic experiment. The following section presents step-by-step to conduct PSM, mostly based on the guidance from Caliendo and Kopeinig, (2005).

The PSM method used in this thesis is an adaptation of Caliendo and Kopeinig's method, with a combination of clustering and nearest-neighbor matching. First, I identify the variables crucial to hedge fund performance. Two variables are used in separating funds into clusters: inception year and investment strategy. Five other variables are used to calculate propensity score: fund size at inception, management fee, incentive fee, whether the fund used leverage, and whether the fund managers have personal capital in the fund. Only funds within the same cluster will be matched with each other, based on the propensity score.

Each fund is classified into an inception-strategy cluster so that all the funds in a same cluster have the same inception year and follow the same investment strategy. Inception year and investment strategy can be thought as hard constraints that require perfect matching. Investment strategy is one of the largest factors in hedge fund performance; with about 20 percent of the cross sectional variable in performance is explained by differences in investment style (Brown and Goetzmann, 2001). With regard to inception date, comparing funds with the same birth year allows the exclusion of time-varying effects and focus on cross-sectional differences between female funds and male funds. Furthermore, matching with cluster also eliminates the need to control for fund age, which could be a potential factors influencing performance (see Golec (1996), Carhart (1997), Howell (2011)).

Table 1 exhibits the number of fund in each inception-strategy cluster. Panel 1A shows the number of female fund across all clusters, and panel 1B shows the aggregate data for all available funds. Female funds are found in 10 investment styles: Convertible arbitrage, emerging markets, equity market neutral, event driven, fixed income arbitrage, fund of funds, global macro, long/short equity hedge, managed futures and multi-strategy. The largest number of funds is in fund of funds, multi-strategy and long/short equity hedge with 26, 13 and 11 funds respectively. There have been female funds beginning operation throughout the period 1994-2013, with larger number from 2002 onward. This trend is in line with the general trend that more hedge funds are birthed each year since 2002.

**Table 1: Number of hedge funds in each inception year – investment strategy cluster**

This table shows the number of hedge funds in each inception year – investment strategy cluster. All funds in the same cluster have the same inception year and investment strategy. Panel A shows the number of female funds. Panel B shows the total number of hedge funds in the sample.

**Panel A: Female funds**

Inception Year	Investment strategy											Total
	Convertible Arbitrage	Emerging Markets	Equity Market Neutral	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Long/Short Equity Hedge	Managed Futures	Multi-Strategy	Other	
1994	-	-	1	-	-	1	-	-	-	-	-	2
1995	-	-	-	-	-	1	-	-	1	-	-	2
1996	-	1	-	-	-	-	-	-	-	-	-	1
1997	-	1	-	-	-	-	-	-	1	1	-	3
1998	-	-	-	-	-	-	-	-	-	1	-	1
1999	-	-	-	-	-	-	-	1	1	-	-	2
2000	-	-	-	-	-	1	-	1	-	-	-	2
2001	-	-	-	-	1	-	-	-	-	-	-	1
2002	-	-	-	-	-	2	-	-	-	1	-	3
2003	-	1	-	1	-	-	-	-	1	1	-	4
2004	-	-	-	-	-	3	-	-	1	-	-	4
2005	-	-	-	-	-	3	1	-	-	-	-	4
2006	-	-	-	-	-	-	-	1	2	1	-	4
2007	-	1	1	1	-	2	-	1	-	2	-	8
2008	-	-	-	-	-	4	-	2	-	-	-	6
2009	-	-	1	-	1	3	2	-	-	-	-	7
2010	-	-	-	-	1	1	1	-	-	3	-	6
2011	1	-	-	1	-	2	-	3	-	2	-	9
2012	-	-	-	-	-	2	1	-	-	-	-	3
2013	-	-	-	-	-	3	-	2	1	1	-	7
<b>Total</b>	1	3	2	3	3	26	5	11	7	13	-	79

**Panel B: All hedge funds**

Inception Year	Investment strategy											Total
	Convertible Arbitrage	Emerging Markets	Equity Market Neutral	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Long/Short Equity Hedge	Managed Futures	Multi- Strategy	Other	
1994	1	4	3	-	1	18	-	14	3	-	-	44
1995	2	2	0	1	-	14	-	7	4	1	-	31
1996	-	5	2	6	2	18	2	9	10	6	1	61
1997	1	3	2	1	1	24	2	11	6	3	4	58
1998	2	4	-	6	1	23	5	12	10	5	1	69
1999	2	4	3	3	3	38	3	26	11	12	5	110
2000	2	5	1	6	2	41	3	28	5	4	1	98
2001	3	9	3	7	9	84	3	37	8	14	7	184
2002	1	7	5	4	5	92	5	49	11	20	7	206
2003	3	16	1	12	4	139	5	54	17	29	8	288
2004	6	21	7	5	4	158	9	76	23	52	12	373
2005	1	25	14	9	8	159	13	93	22	44	11	399
2006	2	21	12	15	9	181	18	75	20	67	4	424
2007	-	32	18	17	5	166	17	104	17	153	20	549
2008	1	20	13	9	13	143	12	68	17	182	28	506
2009	4	39	12	12	14	222	68	76	49	113	40	649
2010	15	18	11	16	17	124	35	65	22	170	38	531
2011	23	23	6	16	11	111	36	80	24	99	30	495
2012	13	11	2	5	6	94	22	59	20	88	53	373
2013	3	13	12	9	8	81	18	55	26	35	25	285
<b>Total</b>	85	282	127	159	123	1931	276	999	326	1094	295	5697

On the next step, a propensity score is estimated for each hedge fund. The score is estimated as the conditional predicted probability from the following probit model. The propensity score can be simply interpreted as the probability of the fund belongs to the female fund group given the fund characteristics.

$$\begin{aligned} \Pr(D = 1 | Size, M\_fee, I\_fee, Lev\_dummy, PC\_dummy) \\ = \Phi (\beta_1 Size + \beta_2 M\_fee + \beta_3 I\_fee + \beta_4 Lev\_dummy + \beta_5 PC\_dummy) \end{aligned} \quad (1)$$

$D = 1$  when the fund is a female fund, 0 otherwise

$\Phi$  is the cumulative distribution function of the standard normal distribution

Size: Asset under management of the fund at its inception

M\_fee: management fee

I\_fee: incentive fee

Lev\_dummy = 1 if the fund use leverage, 0 otherwise

PC\_dummy = 1 if principals have money invested, 0 otherwise

Presented is a probit model with the a dummy variable representing the ‘treatment’ (female fund) and ‘non-treatment’ (male fund) as the dependent variable, and a groups of independent variables of our choosing. The independent variables should be the one that may influence the chance that a manager is in the ‘female group’ and fund performance or risk. Based on that insight, the size, management fee, incentive fee, leverage usage, and managers’ capital investment are chosen. I present the reasoning for choosing those variables in the following paragraph.

### 1. *Fund size*

Ammann and Moerth (2005) reveals empirical evidence for a positive relationship between fund sizes and returns. He also finds that very small hedge funds tend to underperform on average. Potential explanation is that the larger the fund, the lower its expense ratio. The size is estimated as the first reported net asset under management in million USD after the fund’s inception.

### 2. *Management fee*

There is little direct link between management fee and hedge fund performance. However, I reason that for the same performance and incentive fee, investors would prefer funds with lower management fee. Therefore, funds may have to offer additional return to justify their management fee. The average management fee is on average

around only 1 percent annually compared to 20 percent in incentive fee, so it may not be a crucial factor.

### 3. *Incentive fee*

The incentive fee represents the largest cut manager can take from hedge fund returns, averaging 20 percent of profits (Liang, 2001). Intuitively, higher incentive fee would better motivate managers to generate more profits. Ackermann et al. (1999) shows that incentive fees explain some of the higher performance of hedge funds over mutual funds. On the other hand, Agarwal et al. (2009) argue that the incentive fee percentage rate by itself does not explain performance. However, other proxies for managerial incentives including the delta of the option-like incentive fee contracts, higher levels of managerial ownership, and the inclusion of high-water mark provisions in the incentive contracts, are associated with superior performance.

### 4. *Leverage usage*

Leverage could increase the volatility of hedge fund returns (Liang, 1999), and could be an important factor in fund performance. However TASS only has the average leverage ratio for the whole period 1994-2014. As the leverage level can change with time, a more consistent proxy is whether the funds use leverage at all. Therefore, a dummy variable that takes the value of 1 if leverage is used and 0 otherwise is chosen.

### 5. *Manager's capital*

Similar to higher incentive fee, investing one's own money in the funds may create more incentive for managers to pursuit high return. Moreover, manager's capital in the funds could be an assurance for investors, which in turn may positive affect fund performance. The dummy variable takes the value of 1 if there is manager's capital invested, and 0 otherwise.

Table 2 shows that statistics for the five mentioned variables. In panel 2A are the statistics for the female fund group. In panel 2B, the statistics for the whole sample is shown. Table 3 shows the coefficients, their stand deviation and t-value for the probit model (1). Only the coefficient for the *size* variable is statistically significant.

**Table 2: Summary statistics of matching variables**

This table shows the summary statistics for Size (hedge fund size at its inception – calculated as total asset under management on the earliest reporting date, in million USD), Management fee (in percent), Incentive fee (in percent), leverage dummy (=1 if the fund use leverage, =0 otherwise), and the personal capital dummy (=1 if managers have money invested in the fund, = 0 otherwise). Panel A shows the statistics for female funds, panel B shows the statistics for all hedge funds.

**Panel A: female funds**

	<b>Mean</b>	<b>Std</b>	<b>Min</b>	<b>Max</b>
<b>Size</b>	21.51	47.25	0.12	166.15
<b>Management fee</b>	0.98	1.29	0	4
<b>Incentive fee</b>	20.19	18.57	5	20
<b>Leverage dummy</b>	0.81	0.39	0	1
<b>Personal capital</b>	0.33	0.47	0	1

**Panel B: All hedge funds**

	<b>Mean</b>	<b>Std</b>	<b>Min</b>	<b>Max</b>
<b>Size</b>	58.15	121.05	0.08	248.65
<b>Management fee</b>	1.29	0.62	0	6
<b>Incentive fee</b>	20.19	7.23	0	50
<b>Leverage dummy</b>	0.49	0.5	0	1
<b>Personal capital</b>	0.13	0.32	0	1

**Table 3: The probit model for PSM, matching male and female funds**

This table shows the results of the estimation for the probit model

$$\Pr(D = 1|Size, M\_fee, I\_fee, Lev\_dummy, PC\_dummy) \\ = \Phi(\beta_1 Size + \beta_2 M\_fee + \beta_3 I\_fee + \beta_4 Lev\_dummy + \beta_5 PC\_dummy)$$

The dependent variable is the dummy variable which takes value of 1 if the fund is a female fund, 0 otherwise. The independent variables are Size (hedge fund size at its inception – calculated as total asset under management on the earliest reporting date, in million USD), M\_fee (Management fee in percent), I\_fee (Incentive fee in percent), Lev\_dummy (leverage dummy, =1 if the fund use leverage, = 0 otherwise), and PC\_dummy (personal capital dummy, =1 if managers have money invested in the fund, = 0 otherwise).

\*\*\*: the coefficient is significant at 1% level

\*\*: the coefficient is significant at 5% level

\*: the coefficient is significant at 10% level

	<b>coefficient</b>	<b>std</b>	<b>t</b>	
<b>_cons</b>	0.268	0.098	2.736	***
<b>Size</b>	0.536	0.126	4.274	***
<b>Management fee</b>	-0.001	0.001	-1.265	
<b>Incentive fee</b>	0.019	0.013	1.468	
<b>Leverage dummy</b>	0.437	0.293	1.489	
<b>Personal capital</b>	0.255	0.325	0.782	

Pseudo R_squared	0.254
n	5697

The next step is to estimate the propensity score for each fund. It is the conditional predicted probability from probit model (1). Next, a match is found for each female fund. There are several matching algorithm, for example nearest neighbour matching, Caliper and Radius matching, and kernel matching. I will use the most straight forward algorithm, nearest neighbour matching. Nearest neighbour matching can be done with or without replacement. I choose the algorithm without replacement, which means each fund can only be in a single match. For each female fund, the unidentified fund in the same inception-strategy cluster with the closest propensity score to it is chosen as a match candidate. The chosen unidentified fund will then be checked; if it is a legitimate “male fund” then the match is confirmed. If not, the match is discarded; the unidentified fund is



either removed from the sample or moved to the female fund group. This step is then repeated until every female fund is matched with a unique male fund. The matching quality will be verified after all pairs are matched.

To increase matching quality, 8 worst-matched female fund-male fund pairs, meaning ones highest propensity score differences, are excluded, representing 10 percent of the sample. Table 4 shows that propensity score before and after truncating 8 worst-matched pairs. Panel 4A presents the average score for female fund and male fund group. The average score for female fund goes down from 0.74 to 0.67, while the average score for male fund goes up from 0.52 to 0.54 after truncating. Panel 4B tests for the mean difference between two groups. While the difference in score between female fund and female fund group is not statistically significant both before and after truncating, the average difference has been reduced by 0.09 to 0.13 in the latter case. Table 5 verifies that all matching characteristics are not significantly different between female fund-male fund pairs, up to 10 percent significance level.

There is a concern is that female managed funds left in the unidentified group will negatively affect the probit regression used to estimate propensity scores because they would be incorrectly classified ( $D=0$ ). I address this issue by performing robustness check by rerunning the matching procedure with the fund group confirmed to have only one or many male managers. The matching will confirmed to be robust. Therefore, I consider the matching to be satisfactory.

**Table 4: Propensity score**

This table shows the average propensity score before and after omitting 8 female fund-male fund pairs with largest difference in score. Panel A shows the average score of female fund and male fund separately. Panel B shows the average difference in score between female fund-male fund pairs.

**Panel A: The average propensity score of female funds and male funds before and after truncating**

	Before(n = 79)		After (n =71)	
	Female	Male	Female	Male
<b>Average</b>	0.74	0.52	0.67	0.54
<b>Std</b>	0.28	0.41	0.25	0.38

**Panel B: The average propensity score difference between female fund-male fund pairs before and after truncating**

	Before (n = 79)	After (n=71)
<b>Average</b>	0.22	0.13
<b>Std</b>	0.24	0.25
<b>z</b>	0.78	0.61
<b>p value</b>	0.44	0.54

**Table 5: Summary statistics of the matching variables in female fund-male fund pairs**

This table show the statistics for the matching variable after the PSM procedure and the test for differences in means of those variables.

	female fund		male fund		p value
	Mean	Std	Mean	Std	
<b>Size</b>	21.51	47.25	29.92	58.75	0.27
<b>Management fee</b>	0.98	1.29	0.97	1.62	0.17
<b>Incentive fee</b>	20.19	18.57	21.47	14.45	0.31
<b>Leverage dummy</b>	0.81	0.39	0.90	0.28	0.26
<b>Personal dummy</b>	0.33	0.47	0.32	0.36	0.30

#### 5.4 Measurements for hedge fund performance and risk

I choose the risk adjusted return, or alpha, from Fung-Hsieh extended 8 factor model as the measurement for hedge fund performance. Total return volatility is used as the measurement for fund risk.

While the more or less standard measurement for mutual fund performance is the excess returns from a variety of CAPM variations, measuring hedge fund performance is particularly troublesome because of its dynamic hedging and diverse strategies. Common models to estimate the hedge fund risk-adjusted return, hence the information ratio, include Fama and French (1993) 3-factor model; Agarwal and Naik (2004) option-based model; and Fung, Hsieh, Naik, and Ramadorai (2008) 7-factor model. In this study, I use an extension of Fung-Hsieh 7 factor model with the addition of an eighth factor, the emerging market risk factor, as suggested by Hsieh on his data library website. The emerging market risk factor is especially relevant for funds specialized on emerging markets, which presenting in our sample. Table 6 shows the summary statistics for all eight factors used in Fung-Hsieh model.

$$r_{i,t} = \alpha_i + \beta_1 S\&P_s + \beta_2 SCLC + \beta_3 10Y + \beta_4 CredSpr + \beta_5 BDOpt + \beta_6 FXOpt + \beta_7 ComOpt + \beta_8 Eme \quad (2)$$

Two equity-oriented risk factors: the excess return of the S&P500 index over the 3-month T-bill rate (S&P); and a small-minus-big cap factor (SCLC) constructed as the difference between the Russell 2000 index monthly return and S&P 500 month total return.

Two bond-oriented risk factors: the yield spread the monthly change in the 10-year treasury constant maturity yield over 3-month T-bill (10Y), and the change in the credit spread of Moody's BAA bond over the 10-year Treasury bond (CredSpr)

Three trend-following risk factors: the excess returns on portfolio of lookback straddle options on currency (FXOpt), commodities (ComOpt) and bonds (BDOpt).

Emerging market risk factor: the excess return of the MSCI Emerging Market index monthly total return over the 3-month T-bill rate (Eme).

Data for the risk factors are retrieved from Hsieh's Data Library.

As similar to how alpha is calculated in Fung et al. (2008) and Li et al. (2011), the alpha is estimated from model (2) using data from a rolling window of the most recent 24 month period.

Based on Li et al., the alpha estimation is repeated at the beginning of each quarter as opposed to each year in Fung et al. to obtain higher fidelity. Table 7 shows the summary statistic of each coefficient in regression model (2) over the whole period 1994-2014 for female funds and their matched male funds. The average month alpha for female funds is 0.56%, while the male funds have an average monthly alpha of 0.41%. Fung-Hsieh model is able to explain up to a maximum 71% of female fund return variation and averaging at 55%. In case of male funds, up to 76% of return variation is explained, averaging 64%. I consider the explanatory power of the model adequate for this research.

The preferable risk measurement is total return volatility, since it has the advantage of being model-free and certain hedge fund investors do care about absolute performance (Li, Zhang, and Zhao, 2011). Total return volatility is calculated quarterly based on monthly return in a 24-month period rolling window to match how the alpha is calculated. Since the regression is repeated every quarter, the risk-adjusted returns alpha and volatility are allowed to be time-varying. This allows me to analyse the variation over time of the gender effect on alpha and volatility.

**Table 6: Summary statistics for Fung-Hsieh factors**

This table shows the summary statistics for the independent variables in the regression model (2)

$$r_{i,t} = \alpha_i + \beta_1 S\&P_s + \beta_2 SCLC + \beta_3 10Y + \beta_4 CredSpr + \beta_{51} BDOpt + \beta_6 FXOpt + \beta_7 ComOpt + \beta_8 Eme$$

S&P: the monthly excess return of the S&P500 index over the 3-month T-bill

SCL: difference between the Russell 2000 index monthly return and S&P 500 month total return

10Y: the yield spread the monthly change in the 10-year treasury constant maturity yield over 3-month T-bill

CredSpr: the change in the credit spread of Moody's BAA bond over the 10-year Treasury bond

BDOpt: lookback straddle options on bonds

FXOpt: lookback straddle options on commodities

FXOpt: lookback straddle options on currency

Eme: the excess return of the MSCI Emerging Market index monthly total return over the 3-month T-bill rate

All measurements are in percent, per month.

The variables are retrieved from <https://faculty.fuqua.duke.edu/~dah7/HFRFData.htm>

	<b>Mean</b>	<b>STD</b>	<b>Min</b>	<b>Max</b>
<b>S&amp;P</b>	0.57	4.31	-16.94	10.72
<b>SC-LC</b>	0.09	3.64	-16.38	18.41
<b>10Y</b>	0.37	2.21	-7.87	9.53
<b>Cred Spr</b>	0.26	2.12	-14.25	8.13
<b>BD Opt</b>	-1.66	15.23	-25.63	68.86
<b>FX Opt</b>	-0.35	19.21	-30.13	90.27
<b>Com Opt</b>	-0.24	14.18	-24.65	64.75
<b>Eme</b>	0.61	7.04	-29.45	17.56

**Table 7: Summary statistics for Fung-Hsieh factor loadings**

This table shows the summary statistics for the factor loadings in the regression model (2), across all female funds and male fund for the whole period 1994-2014.

$$r_{i,t} = \alpha_i + \beta_1 S\&P_s + \beta_2 SCLC + \beta_3 10Y + \beta_4 CredSpr + \beta_{51} BDOpt + \beta_6 FXOpt + \beta_7 ComOpt + \beta_8 Eme$$

S&P: the monthly excess return of the S&P500 index over the 3-month T-bill

SCL: difference between the Russell 2000 index monthly return and S&P 500 month total return

10Y: the yield spread the monthly change in the 10-year treasury constant maturity yield over 3-month T-bill

CredSpr: the change in the credit spread of Moody's BAA bond over the 10-year Treasury bond

BDOpt: lookback straddle options on bonds excess return over the 3-month T-bill

FXOpt: lookback straddle options on commodities excess return over the 3-month T-bill

FXOpt: lookback straddle options on currency excess return over the 3-month T-bill

Eme: the excess return of the MSCI Emerging Market index monthly total return over the 3-month T-bill rate

All measurements are in percent, per month.

	female funds				male funds			
	Mean	STD	Min	Max	Mean	STD	Min	Max
<b>alpha</b>	0.56	3.47	-2.12	3.39	0.41	2.74	-3.26	3.87
<b>S&amp;P</b>	0.08	1.45	-2.77	1.32	0.06	1.72	-3.21	1.69
<b>SC-LC</b>	0.35	0.80	-0.92	0.55	0.25	0.59	-0.61	0.71
<b>10Y</b>	-0.07	0.79	-0.33	0.27	0.01	0.75	-0.32	0.27
<b>Cred Spr</b>	0.23	1.23	-1.38	0.80	0.25	0.54	-1.18	0.99
<b>BD Opt</b>	0.04	0.77	-0.06	0.09	-0.01	0.15	-0.33	0.18
<b>FX Opt</b>	0.003	0.07	-0.07	0.09	-0.04	0.06	-0.07	0.09
<b>Com Opt</b>	0.01	0.60	-0.29	0.07	0.05	0.69	-0.19	0.09
<b>Eme</b>	0.02	0.19	-0.35	0.06	0.02	0.66	-0.62	0.26
<b>R_squared</b>	0.55	0.28	0.18	0.71	0.64	0.47	0.09	0.76

## 6. Result

In each quarter, the *average gender effect of the manger being female* on hedge fund performance and risk is estimated as the average difference of monthly alpha and monthly volatility difference between all female fund-male fund pairs.

$$AGEF_{alpha,t} = E(\alpha_{Female Fund_{i,t}} - \alpha_{Male Fund_{i,t}})$$

$AGEF_{alpha,t}$  is the *agender effect of female manager on risk adjusted return (alpha) over period t*

$\alpha_{Female Fund_{i,t}}$  is the *risk adjusted return the female fund in the pair i over period t*

$\alpha_{Male Fund_{i,t}}$  is the *risk adjusted return the male fund in the pair i over period t*

$$AGEF_{\sigma,t} = E(\sigma_{Female Fund_{i,t}} - \sigma_{Male Fund_{i,t}})$$

$AGEF_{\sigma,t}$  is the *average gender effect of female manager on volatility over period t*

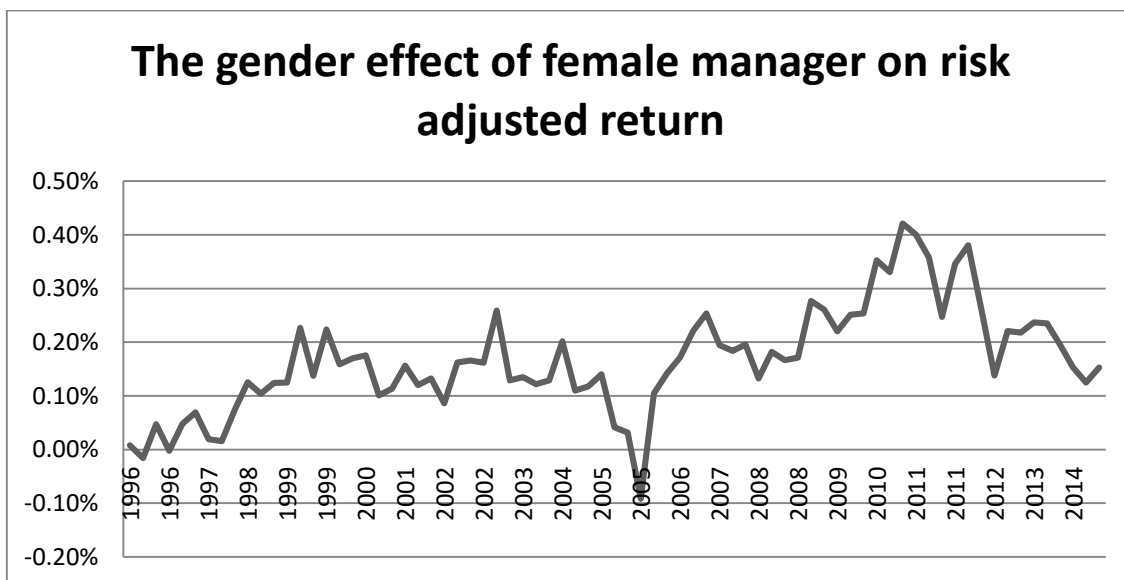
$\sigma_{Female Fund_{i,t}}$  is the *volatility of the female fund in the pair i over period t*

$\sigma_{Male Fund_{i,t}}$  is the *volatility of the male fund in the pair i over period t*

Figure 1 illustrates the time-varying average differences in alpha, while figure 2 shows the average difference on volatility. As can be seen from the graph, the gender effect of female manager on monthly risk-adjusted return is on an increasing trend. There seems to be two major periods that the gender effect on alpha is positive: from 1998 to 2005, and from 2007 to 2014. Meanwhile, the trend line of gender effect on volatility is nearly flat. The gender effect on volatility seems to be positive during the period 2000 to 2008, and negative during the rest.

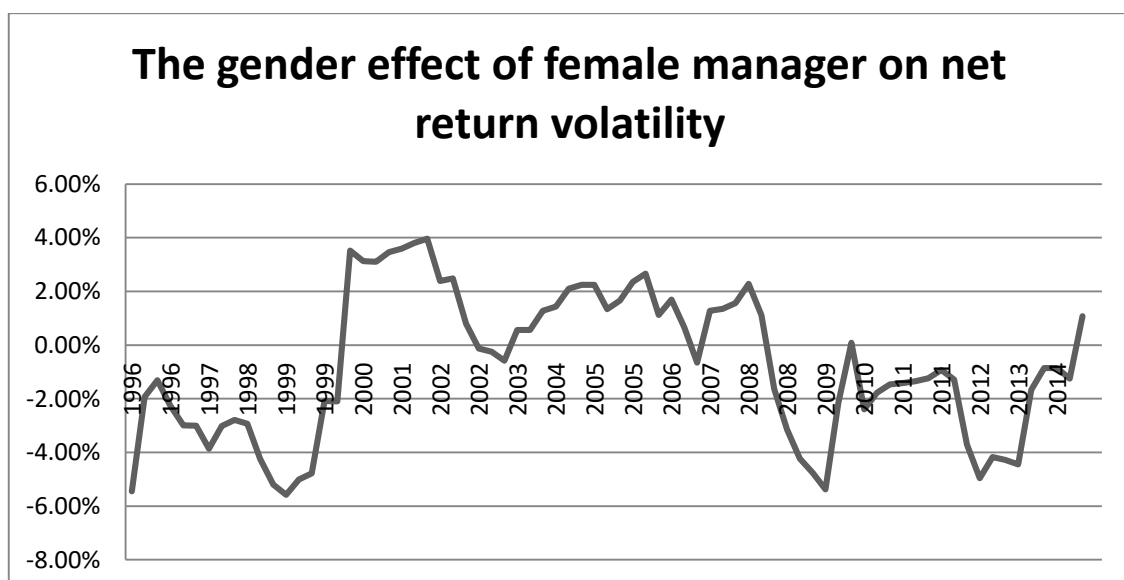
**Figure 1: The gender effect of female manager on risk adjusted return**

This graph shows the time-varying gender effect of female manager on risk adjusted return (alpha) over the period Jan 1994-Jun 2014. The first data is calculated on Jan 1996. The gender effect on alpha is calculated each quarter, based on the return of the latest 24 months. The gender effect is displayed as monthly return.



**Figure 2: The gender effect of female manager on net return volatility**

This graph shows the time-varying gender effect of female manager on net return volatility over the period Jan 1994-Jun 2014. The first data on volatility is calculated on Jan 1996. The gender effect on alpha is calculated each quarter, based on the return of the latest 24 months. The gender effect is displayed as monthly volatility.





The two first hypotheses can be tested with the gender effect of female manager and its standard deviation using t-test. The first hypothesis will be rejected if the gender effect of female manager for alpha is not significantly greater than zero. The second hypothesis will be rejected if the gender effect of female manager on volatility is not significantly smaller than zero. Estimate the standard deviation of gender effect of female manager to use in the paired-sample t-test is not straight forward because previous estimation steps have added variation beyond the normal sampling variation (Heckman, Ichimura, and Todd, 1998). Two main methods can be used to estimate the standard error, either by bootstrapping, or as the squared root of the variance approximation by Lechner (2001). I choose to use Lechner model instead of bootstrapping to avoid repeating verifying unidentified fund when resampling. In this case, because matching without replacement is used, Lechner's variance coincides with the usual variance formula, which simplifies the calculation greatly.

Table 8 shows the gender effect of female manager on alpha and volatility, its standard deviation and the result of two-tail paired-sample t-test for zero mean difference. Panel 8A, 8B, 8C shows the results for the whole period Jan 1994-Jun 2014, the subperiod Jan 1997-Dec 1998 and the subperiod Jan 2007- Dec 2009 respectively. The two subperiods are chosen to cover two major financial distress periods in the last two decades: the 1997 Asian financial crisis and the Global financial crisis of 2007-2008.

The gender effect of female manager on alpha is found to be 0.17 percent monthly over the Jan 1994-Jun 2014 period, significant at 10 percent level. I consider this result to be a weak support for the hypothesis that funds with female managers earn superior return compared to those with male managers. However, during two financial distress period Jan 1997-Dec 1998 and Jan 2007- Dec 2009, the gender effect of female manager on alpha is 0.16 percent and 0.31 percent, both significant at 1 percent level. Therefore, I support the notion that female managers earn a significant positive return over their male counterparts at least during the time of financial turbulence.

The gender effect of female manager on monthly net return volatility is not found to be significantly different from zero during the whole period 1994-2014 and the subperiod 2007-2009. During the subperiod 1997-1998, gender effect of female manager on monthly volatility is negative 3.5 percent, significant at 1 percent level. As the difference is only found to be significant in one distress period, the result is insufficient to conclude that the net return volatility of female managed funds to be different from those of similar male managed funds.

To test whether the differences in volatility can explain the differences in risk-adjusted return, I run a simple regression model in which the gender effect of female manager on volatility is the independent variable, and the gender effect of female manager on alpha is the dependent variable for the whole period 1994-2014.

$$AGEF_{alpha,t} = a + \beta * AGEF_{\sigma,t}$$

*AGEF<sub>alpha,t</sub> is the AGEF on risk adjusted return over period t*

*AGEF<sub>σ,t</sub> is the AGEF on volatility over period t*

Table 9 show the results of the above regression model. The coefficient for  $AGEF_{\sigma,t}$  is not statistically significant even at 10 percent level. More importantly, the model only explains about 4 percent of the variation in the gender effect of female manager on alpha. Therefore, I conclude that the difference in volatility cannot explain a significant portion of the difference in risk adjusted returns.

To test for robustness and address the concern that female managed funds left in the unidentified group will negatively affect the matching procedures, I re-estimate the probit model (1) and repeat the PSM process but using the funds from the verified one-or-several male manager group as the potential match for female fund, instead of the unidentified group. Table 10 show the result of the probit model estimated with the verified group. The coefficient is not every different from first estimation. After a similar matching process, only 6 out of 71 female fund-male fund pairs change compared to the original matching. Tablet 11 shows the gender effect of female manager on alpha and volatility. The results are in agreement with the previous one: gender effect of female manager on alpha is positive and significant at 10 percent level throughout the period and at 5 percent level during the two financial crisis periods. The gender effect of female manager on volatility is not statistically significant on any tested periods. Therefore, the first results obtained are considered robust with regards to the matching procedure.

**Table 8: The gender effect of female manager on risk-adjusted returns and volatility**

This table show the gender effect of female manager on risk-adjusted returns and volatility for the whole period 1994-2014 and two subperiods 1997-1998 and 2007-2009. Panel A shows the gender effect of female manager for the period 1994-2014. Panel B shows the gender effect of female manager for the period 1997-1998. Panel C shows the gender effect of female manager for the period 2007-2009. All measurements are in percent per month.

\*\*\*: the coefficient is significant at 1% level

\*\*: the coefficient is significant at 5% level

\*: the coefficient is significant at 10% level

**Panel A: gender effect of female manager for the period Jan 1994- June 2014**

	<b>Average</b>	<b>std</b>	<b>Min</b>	<b>Max</b>	<b>t</b>	<b>p value</b>
<b>risk adjusted return</b>	0.174	0.103	-0.092	0.421	1.689	0.092 *
<b>Volatility</b>	-0.781	2.715	-5.578	3.967	-0.288	0.774
<b>N (months)</b>	246					

**Panel A: gender effect of female manager for the period Jan 1997- Dec 1998**

	<b>Average</b>	<b>std</b>	<b>Min</b>	<b>Max</b>	<b>t</b>	<b>p value</b>
<b>risk adjusted return</b>	0.163	0.045	0.101	0.227	3.622	0.000 ***
<b>Volatility</b>	-3.505	0.857	-5.204	-2.787	-4.091	0.000 ***
<b>n (months)</b>	24					

**Panel A: gender effect of female manager for the period Jan 2007- Dec 2009**

	<b>Average</b>	<b>std</b>	<b>Min</b>	<b>Max</b>	<b>t</b>	<b>p value</b>
<b>risk adjusted return</b>	0.315	0.064	0.220	0.421	4.922	0.000 ***
<b>Volatility</b>	-1.98	2.734	-5.373	2.283	-0.438	0.664
<b>n (months)</b>	36					

**Table 9: The regression of gender effect of female manager on alpha vs gender effect of female manager on volatility**

This table show the result of the regression model (3)

$$AGEF_{alpha,t} = a + \beta * AGEF_{\sigma,t}$$

$AGEF_{alpha,t}$  is the gender effect of female manager on monthly risk adjusted return over period t

$AGEF_{\sigma,t}$  is the gender effect of female manager on monthly volatility over period t

\*\*\*: the coefficient is significant at 1% level

\*\*: the coefficient is significant at 5% level

\*: the coefficient is significant at 10% level

	<b>coef.</b>	<b>std</b>	<b>t</b>	<b>p</b>
<b>_cons</b>	0.17	0.01	13.78	0.00 ***
<b>dif in vol</b>	-0.01	0.00	-1.23	0.22
R_squared	0.041			
Adj. R squared	0.028			

**Table 10: The probit model for PSM, matching female and pre-verified male funds**

This table shows the results of the estimation for the probit model

$$\Pr(D = 1 | Size, M\_fee, I\_fee, Lev\_dummy, PC\_dummy) \\ = \Phi (\beta_1 Size + \beta_2 M\_fee + \beta_3 I\_fee + \beta_4 Lev\_dummy + \beta_5 PC\_dummy)$$

The dependent variable is the dummy variable which takes value of 1 if the fund is a female fund, 0 if it is a MF. The independent variables are Size (hedge fund size at its inception – calculated as total asset under management on the earliest reporting date, in million USD), M\_fee (Management fee in percent), I\_fee (Incentive fee in percent), Lev\_dummy (leverage dummy, =1 if the fund use leverage, =0 otherwise), and PC\_dummy (personal capital dummy, =1 if managers have money invested in the fund, = 0 otherwise).

\*\*\*: the coefficient is significant at 1% level

\*\*: the coefficient is significant at 5% level

\*: the coefficient is significant at 10% level

	<b>coefficient</b>	<b>std</b>	<b>t</b>
<b>_cons</b>	0.36	0.12	2.93 ***
<b>Size</b>	0.57	0.10	5.59 ***
<b>Management fee</b>	0.00	0.00	-0.29
<b>Incentive fee</b>	0.03	0.02	1.17
<b>Average dummy</b>	0.33	0.25	1.32
<b>Personal dummy</b>	0.13	0.39	0.32

Pseudo R_squared	0.376
n	3936

**Table 11: The gender effect of female manager on risk-adjusted returns and volatility, matching female and pre-verified male funds**

This table show the gender effect of female manager on risk-adjusted returns and volatility for the whole period 1994-2014 and two subperiods 1997-1998 and 2007-2009. Panel A shows the gender effect of female manager for the period 1994-2014. Panel B shows the gender effect of female manager for the period 1997-1998. Panel C shows the gender effect of female manager for the period 2007-2009. All measurements are in percent per month.

\*\*\*: the coefficient is significant at 1% level

\*\*: the coefficient is significant at 5% level

\*: the coefficient is significant at 10% level

**Panel A: gender effect of female manager for the period Jan 1994- June 2014**

	<b>Average</b>	<b>std</b>	<b>Min</b>	<b>Max</b>	<b>t</b>	<b>p value</b>
<b>risk adjusted return</b>	0.184	0.110	-0.092	0.421	1.679	0.094*
<b>Volatility</b>	-0.660	1.905	-5.578	3.967	-0.346	0.729
n (months)	246					

**Panel A: gender effect of female manager for the period Jan 1997- Dec 1998**

	<b>Average</b>	<b>std</b>	<b>Min</b>	<b>Max</b>	<b>t</b>	<b>p value</b>
<b>risk adjusted return</b>	0.142	0.032	0.101	0.257	4.364	0.000***
<b>Volatility</b>	-3.240	0.732	-5.104	-2.387	-4.429	0.000***
n (months)	24					

**Panel A: gender effect of female manager for the period Jan 2007- Dec 2009**

	<b>Average</b>	<b>std</b>	<b>Min</b>	<b>Max</b>	<b>t</b>	<b>p value</b>
<b>risk adjusted return</b>	0.351	0.114	0.200	0.421	3.079	0.004***
<b>Volatility</b>	-1.366	2.405	-5.273	2.183	-0.568	0.574
n (months)	36					

## 7. Discussion

In section VI, the evidences suggest there is a positive increase in risk adjusted return associating with female manager, especially during the financial crises. On the other hand, the gender effect on volatility remains inclusive. The gender effect on volatility cannot explain the variation in the gender effect on risk adjusted return. In this chapter, I will offer explanations on those results as well as consider the limitation of this study.

### 7.1 Why female funds offer positive returns over male funds?

Even though the evidence for positive gender effect of female manager on risk adjusted return is weak for the whole sample period, for the specific periods of financial turbulence 1997-1998 and 2007-2009, the result is highly significant. Based on the literature reviewed, four plausible explanations are offered to explain this positive superior performance.

Firstly, female managers in my sample may have characteristics that are not inherent to their gender, but may explain their fund returns. Li et al. (2009) shows that managers from higher-SAT undergraduate institutes tend to have higher risk-adjusted return. They also mention some weaker evidence that more established managers, who have more number of working years, tend to have lower returns. The female managers may happen to have graduate from higher SAT colleges than their peers, or have less working year. Those characteristics are not inherent to their gender, but nevertheless can influence their fund performance. More concrete evidence for this argument can be obtained if after including SAT score of managers and their working year as matching criteria, the gender effect of female manager on alpha decreases.

Secondly, male managers may have the tendency to make more value-destroying trades. Grinblatt and Keloharju (2009), and Barber and Odean (2001) have pointed out that men trade significantly more than women. If male managers trade more than female managers and achieve the same total return, their net return would be lower due to trading fees. This tendency to trade more may amplify during the financial crises and negatively affect male managed hedge funds even more. More risk-seeking would encourage male managers to invest more compared to females during the high volatility period. Managers with overconfident issue may overestimate their ability to beat the odd and make a profit even in the time of crisis. Excessive competitiveness may push managers to prove themselves among their peers by trading against the odd. A weaker argument can be made for the sensation seeking tendency as well when managers derive personal joy from high-risk trading, but I find it difficult to justify how professional fund managers would hurt their investors' asset to satisfy

personal pleasure. A counter point could be made against the argument that male managers may trade more. Professional, highly trained hedge fund managers should have enough knowledge to actively avoid those mentioned mental pitfalls. However, it should be noted that even highly sophisticated investors can fall victims to behavioural bias (see Grinblatt and Keloharju (2001) – disposition effect, Kaustia et al. (2008) – anchoring effect). If this effect is true, then the superior performance of female funds would reduce after controlling for number of trade, or trading volume.

Thirdly, there could be a glass ceiling in the hedge fund industry, forcing female managers to be better than their peers to attain the position of fund manager. There is no study on the glass ceiling in hedge fund industry yet, though mixed evidences are available in other business. If this ceiling exists, a woman would have fewer chances of becoming a manager than a man of similar skill level. Therefore, female managers who have made it to the top of the hedge fund hierarchy may on average have better investment skills and knowledge than their male peers. In an environment where individual skills are highly value like the hedge fund industry, those female managers may have a good chance to capitalize on their knowledge to produce better return. Similar results are not observed in the mutual fund industry potentially because either the glass ceiling in mutual fund industry is non-existent, or insufficient to force a skill gap between two genders. It is also possible that managers have more difficulty to capitalize on their investment skills due to legal constraints around mutual funds. Anecdote evidences of increasing female present in the hedge fund industry and the attention they are receiving make me believe that the glass ceiling could be thinning, if it has existed in the first place. Therefore, support for this argument could be made if the gender effect of female manager on alpha decrease in the future, or after controlling for a measurement of such glass ceiling.

Finally, female managed funds may face additional survivor risks. , Atkinson and Ruenzi both find significant lower capital flows into female managed funds compared to similar male managed ones. Getmansky (2012) documented that increasing fund returns and flows reduces liquidation probability in hedge fund. Fung et al (2008) also suggest additional capital inflows attenuate the ability of alpha-producing hedge funds to continue delivering alpha in the future. If the same dynamic relationship between capital flow – returns – liquidation probability is assumed for both female funds and male fund, lower capital flow for female funds may require them to have superior returns just to have the same chance of survival as male funds. In short, unfair capital inflows may lead to higher probability of non-superior female managed funds to cease operation. The positive gender effect of female manager could be considered an artifact of the survivorship bias against female funds. More positive gender effect of female manager during the crises could be due to



surviving funds compensate for a possible increase in survivorship bias during such time. To test for this argument, defunct funds should be included in research sample, or the research model should control for capital flows.

## **7.2 Why female funds do not have lower volatility than male funds?**

I offer three possible explanations why the volatility is not found to be significantly different between female funds and male fund.

First, female hedge fund managers may not be inherently more risk averse than males, even if the average female investors are. Some specific personal characteristics may be advantageous to achieve the manager position, which may result in female managers have the same level of risk aversion as males. The casual idea of hedge fund industry as a high risk- high reward game may attract more females with risk-seeking tendency. Better insight may be gained by using variables other gender to proxy to risk aversion, for example, personal leverage (see Cronqvist et al. (2012), Cain et al. (2014)).

Second, even if the female managers are more risk averse, they may still choose the investment with the same riskiness as the men do. Managers may favour strategies resulting in a risk profile suitable for their investors' taste, especially when their funds are catering for a small number of investors. In such case, male and female managers may strive for similar volatility if it suits their investors, even though their personal risk tolerance levels are different. In effect, their personal risk tolerant level is not adequately reflected in their funds' investment strategies. This effect can be controlled for if funds are matched based on their customer base.

Finally, the net return volatility may not show the lower riskiness that female managers could have made with their investment. This could be due to the limit of net return volatility as a measurement of risks, or the risk of the strategies that fund managers choose may not materialize in the past yet, thus not captured by past return volatility. A potential amendment for this issue is using different measurements of risk, for example, the standard deviation of risk adjusted return alpha, or the semi-variance.

## **7.3 Limitations**

As with any study, this thesis faces several limitations. It is important to keep those limitations in mind when interpreting the results. Identifying the limitations could also help improve the study in the future.

The simple propensity score matching method presented in this paper, though useful, is not optimal for such research involving time-series as the funds are only matched once at the beginning. With complete data on managers' gender, a multivariate regression model could be more accurate to pinpoint the gender effect. The main advantage that PSM method offers is time saving and the ability to find meaningful result from incomplete data.

The lack of data is also a major weakness in this study. Not only data on defunct funds are unavailable, data on managers other their gender is also missing, mostly due to the limited time available for hand collecting data. Therefore, funds are only matched based on funds' features, not their managers' characteristics. Potential important variables mentioned previously include working experience, education, and personal leverage level.

The study could benefit from more measurements of performance and risk as well. Though I am convinced that Fung-Hsieh risk adjusted return and net return volatility do an adequate job, more measurements would certainly add more robustness.

## **8. Conclusion**

In this paper, I use propensity score matching method to find out whether there is a performance and risk difference between hedge funds with a sole female manager and the ones with a sole male manager during the period 1994-2014. The difference is dubbed the average gender effect of the manager being female. I find that propensity score matching is able to produce very good match between two qualified funds. The measurements for hedge fund performance and risk are the Fung Hsieh 8-factor model and the net return volatility.

There is weak support for the claim that female managers provide more risk-adjusted return throughout the period than male managers, however, during the crisis periods of 1997-1998 and 2007-2009, female have significantly better returns, averaging 0.16 and 0.31 percent monthly, respectively. There is no support for a difference in net return volatility between male and female manager.

Four explanations are provided to explain the reason for superior return of female managers. Firstly, there could be different characteristics associating with female managers other than the gender-specific risk aversion that also affects fund performance. Secondly, male managers may make more value-destroying trades, especially during the periods of financial turbulence. Thirdly, there is a potential glass ceiling in the hedge fund industry that forces female managers to be better than their

peers to attain a same position. Finally, female managed funds may face additional survivor risks. There may be lower capital inflows into female managed hedge funds compared to similar male managed ones. Less additional capital may lead to higher probability of non-superior female managed funds to cease operation.

Three explanations are provided on why the volatility of female managed fund and male managed fund is not significantly different, even though women are widely regard as more risk averse than men. Firstly, female hedge fund managers may be not inherently more risk averse than males. Secondly, even if the female managers are more risk averse, they may still choose the investment with the same riskiness as the men do. Finally, the net return volatility may not show the lower riskiness that female managers could have made.

Limitations of the study include the use of the sub-optimal PSM, the lack of data and the usage of only one measurement for performance (risk adjusted returns) and risk (volatility). However, I believe my thesis would provide useful insight into the different between men and women as leaders of business organizations and how personal traits of the leaders may affect the whole organizations.

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