On the Performance and Risk Attributes of Hedge Funds in China

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Abstract

This article studies the performance and risk attributes of hedge funds in China using a new hedge fund database (e.g., the CHRFC Research Database). We examine potential biases embedded in this database and find that the hedge funds are less affected by those well-documented biases, e.g., the survivorship bias (0.41% per year) and the backfill bias (0.02% per year), compared with their estimations in the literature of US-based hedge fund databases. We then develop a composite index to investigate the performance attributes and risk characteristics of Chinese hedge funds. Our analysis shows that hedge funds in China as a group, as represented by the composite index, performed better than the stock market indices, especially on a risk-adjusted basis, while in the cross section there are wide variations in both performance and risk measures among funds. Using an extension of the Fama-French three-factor model to identify both economic variables and risk factors that drive the dynamics of the return-risk patterns of hedge funds, we find that both SMB and HML factors are helpful to interpret risk exposures of Chinese hedge funds.

Keywords: Chinese Hedge Funds; China Hedge Fund Composite Index; Risk-adjusted Performance; Risk Attributes

JEL classification: C10, G10, G23

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1 Introduction

Since hedge funds encompass a wide range of possible investment strategies, they provide a viable investment opportunity set for investors. The hedge fund industry in China has grown rapidly from nearly non-existent to managing over $200 billion in assets in recent years. Despite the dramatic development of the hedge fund industry in China, there exist very few comprehensive studies on this subject. This is mainly due to the difficulty of accessing reliable hedge fund data and the concern of data quality and selection bias in the existing commercial database. Yet, as a new investment vehicle for Chinese investors, hedge funds in China have some distinctive features different from their Western counterparts, including a client base of individual investors instead of institutional investors, unique fund-raising channels of relatively short-term funds and the limited arsenal of hedging instruments. These features make them an interesting subject to study in order to better understand the dynamics and characteristics of asset management in the second largest economy in the world.

In this paper, we study the performance characteristics and risk attributes of Chinese hedge funds using a database constructed by the China Hedge Fund Research Center (CHRFC) at Shanghai Jiao Tong University. After examining the magnitudes of biases embedded in the database, we develop a new hedge fund index - the CHFRC China Hedge Fund Index (or "CHFI") to track the overall performance of the sector, and document wide dispersions of performance among those funds in the index through cross-sectional distributions of performance characteristics. We then investigate the risk attributions of the excess returns of hedge funds through an extension of the Fama-French three-factor model.

Hedge funds have gained their global prominence amongst various investment vehicles in over half a century since Albert W. Jones established a fund in 1949 by simultaneously taking long and short positions in equity. Spectacular hedge fund activities, including the crisis on the British Pound led by George Soros in 1992 and the near collapse of the Long-Term Capital Management in 1998, have captured public fascination, regulatory attention, and academic interest of finance scholars. Fung and Hsieh (1997) examine the return characteristics of hedge funds and find that hedge fund returns have very low correlations with the returns of the indices of standard asset markets (e.g., equity, currency, and commodity markets, etc.), a feature that is different from those of traditional trad-

able assets (e.g., stocks, bonds and mutual funds). Empirical studies conducted by Liang (1998, 2001),Brown, Goetzmann and Ibbotson (1999) and Amin and Kat (2003) suggest that hedge funds do offer better risk-return trade-offs with lower market risks, higher Sharpe ratios and higher abnormal returns over time, resulting in a marked improvement in performance evaluation in comparison to other asset classes.

Moreover, the studies conducted by Fung and Hsieh (2004a,b) and Fung, Hsieh, Xu and Yau (2004) explore the risk attributions of the excess returns towards risk factors. They find that equity long-short hedge funds have significant alpha to both conventional and alternative hedge-fund like factors, and this finding conveys important information about how hedge funds alter their bets in a time-varying manner. Also, these studies suggest that higher moments of returns have little impact on the performance measure with excess returns. Kosowski, Naik and Teo (2007) employ a robust bootstrap procedure, and find that top hedge fund performance cannot be explained by luck, and that hedge fund performance persists at annual investment horizons, while Fung, Hsieh, Naik and Ramadorai (2008) shows that capital inflows attenuate the ability of hedge funds to persistently deliver high alpha in the future, and Jagannathan, Malakhov and Novikov (2010) document that there is a strong linkage between the performance persistence among superior funds and these funds' decisions to liquidate or close. Recently, Bollen and Pool (2009) present evidence to argue that the standard measure of performance may cause the incorrect estimations about abnormal returns, leading to the underestimation of hedge funds' exposures to risk factors.

Despite the well-documented industrial practice and academic research on hedge funds in developed countries, they came to investors' radar screens in China only a few years ago, especially after the launch of China's first equity index futures in 2010. Due to the limited access to reliable hedge fund data, it is difficult to exactly estimate the current size of the hedge funds industry in China, and to systematically evaluate the performance of hedge funds. Building on the database newly constructed by the China Hedge Fund Research Center (CHFRC), we develop a hedge fund composite index (CHFRC Hedge Fund Index) with a set of data-matching criteria to improve data quality and mitigate data biases (see e.g., Ackermann, McEnally and Raverscraft (1999), Liang (2000), Fung and Hsieh (2002), Agarwal, Fos and Jiang (2013), among others), and use it to measure the aggregate performance of the hedge fund industry in China.

We begin by examining potential biases embedded in the CHFRC Research Database, mainly including "surviving bias" and "backfill bias", following the methodology proposed by Malkiel (1995) and Fung and Hsieh (2000). More specifically, two groups of fund portfolios investing in the samples in the database are constructed to estimate the magnitudes of both surviving bias and backfill bias. Unlike the manner used by Fung and Hsieh (2000), we initially fix one year as a typical investment horizon, due to the distinctive short-term nature of the hedge funds in China (usually with the maturity of less than two years), as suggested by their descriptive statistics. Our analysis indicates that the hedge funds in the database is not affected greatly by those well-documented biases, for example, the average survivorship bias of 0.41% and the average backfill bias of 0.02% per year. Nevertheless, these magnitudes are significantly lower than the estimations from the well-known databases in the literature, e.g., the survivorship bias of 3.0% and the backfill bias of 1.4% per year in the TASS database estimated by Fung and Hsieh (2000) and the survivorship bias of 2.17% per year in the HFR database estimated by Liang (2000), while Edwards and Caglayan (2001) estimate the survivorship bias to 1.85% annually in the MAR database.

Based on the CHFRC Hedge Fund Index, we find that over the period between January 2007 and December 2015, the CHFRC Composite Index has outperformed the blue-chip HS300 stock index and its volatility is only less than half of that of the HS300 index. This pattern persists over different subperiods within this time span. The CHFRC Composite Index also shines in terms of Sharpe ratio, Sortino ratio, and maximum drawdown, beating the broader market indices across different time periods. While this result may be an indication of the lack of market efficiency in China, it also illustrates the ability of the hedge fund managers as a group to outperform the market index while controlling risk exposures.

We further investigate the time-series and cross-sectional variations of performance and risk characteristics of hedge funds in our database. We find that the composite index has high correlations with the stock market index, reflecting the fact that the majority of the funds in our sample invest primarily in stocks and only a small fraction of them pursue the market-neutral strategy. Cross-sectionally, there are broad distributions of returns, volatility, Sharpe and Sortino ratios, and maximum drawdown among fund products in any given year, representing divergent skills and strategies between these funds.

Moreover, we explore the risk attribution of the excess returns of hedge funds. We follow the standard procedure of performance evaluation that examines the abnormal returns (alpha) after accounting for exposures to risk factors (factor loadings), while being aware of the shortcomings of this procedure pointed out by Bollen and Pool (2009). We use the Fama-French three-factor model proposed by Fama and French (1993) to study the contributions of three risk factors, as constructed for the Chinese stock market by Chen, Shao, Hu and Wang (2015), to the returns of hedge funds in China. The empirical results suggest that hedge funds are more likely to invest in small-cap stocks, indicated by the positive influence of the SML factor on the excess returns of hedge funds, and these funds also incline to invest more in growth stocks, implied by the negative influence of the HML factor on hedge fund excess returns.

As a first systematic study on the hedge fund industry in China, this paper represents a step towards a comprehensive understanding about the nature of hedge funds as an investment vehicle in China, and contributes to the literature on hedge funds in general.

The rest of the paper is organized as follows. In the next section, we present the overview of the hedge fund industry in China, including the market size, business models, trading strategies and regulation issues. In Section 3, the framework for a new hedge fund index is proposed, including the database description and the index construction. Potential issues of bias are also discussed. In Section 4, we employ five measures to exam the performance characteristics of hedge funds in China. Section 5 further analyzes the risk attributions of the returns of hedge funds in the Fama-French three-factor model. Section 6 concludes.

2 Hedge Fund Industry in China

This section provides a brief review of the hedge fund industry in China.[1] More specifically, the development of its hedge fund market, including hedging instruments, fund products and market characteristics, is first introduced. We then discuss the business models widely employed in this industry. These models play substantial roles in shaping the unique features of the industry in the context of the economic growth and reform in

[1]According to the definition of hedge funds by the SEC (SEC (2012)), the other types of funds, including private equity funds and venture capital funds, are excluded in this review.

China. In addition to business models, the trading strategies widely used in the industry are described, and a summary of regulation policies on the hedge fund industry is also presented.

2.1 Evolution of the Hedge Fund Industry

Despite the seventy-year worldwide history of the hedge fund industry, its development in China was limited because of strick capital regulations, less effective market mechanisms and the lack of financial instruments available for managing risks. In the early 2010, the China Securities Regulatory Commission (CSRC) approved two of the most important financial instruments - margin trading on individual stocks and financial futures on the CSI 300 Index (or CSI300), a capitalization-weighted stock market index designed to replicate the performance of 300 large stocks traded in the Shanghai and Shenzhen stock exchanges. They were ever considered as fundamentals for developing hedge funds in China in terms of managing risks in financial markets, apart from derivatives on commodities. The introduction of these new trading instruments greatly promotes the growth of hedge funds, which finally makes it emerge as a financial industry in the sense of Haugen (2001).

In the early 2015, the CSRC further approved another three important trading instruments - financial futures on the SSE 50 Index (or SSE50) that is a weighted index replicating the performance of the top 50 blue-chip stocks traded in the Shanghai Stock Exchange, and futures on the CSI 500 Index (or CSI500) that tracts the performance of the top 500 small- and medium-size stocks with good liquidity and representativeness from Shanghai and Shenzhen stock markets, and options on the EFT 50 Index Fund (or EFT50) that tracts the historical performance of the SSE50.[2] These innovative financial derivatives enrich the portfolio of trading instruments and further enable institutional investors (e.g., hedge fund managers) to mitigate risk from price fluctuations and manage market volatility effectively.

The encouraging development of financial instruments in the recent years greatly boosts the hedge fund industry. Figure 1 reports the monthly increments of the number of hedge funds and of the associated notional value during the period from December 1,

[2]Meanwhile, a number of fixed-income relevant financial futures, including 5-year Treasury Bond futures and 10-year Treasury Bond futures, have been available at China Financial Futures Exchange (CFFE) since September, 2013.

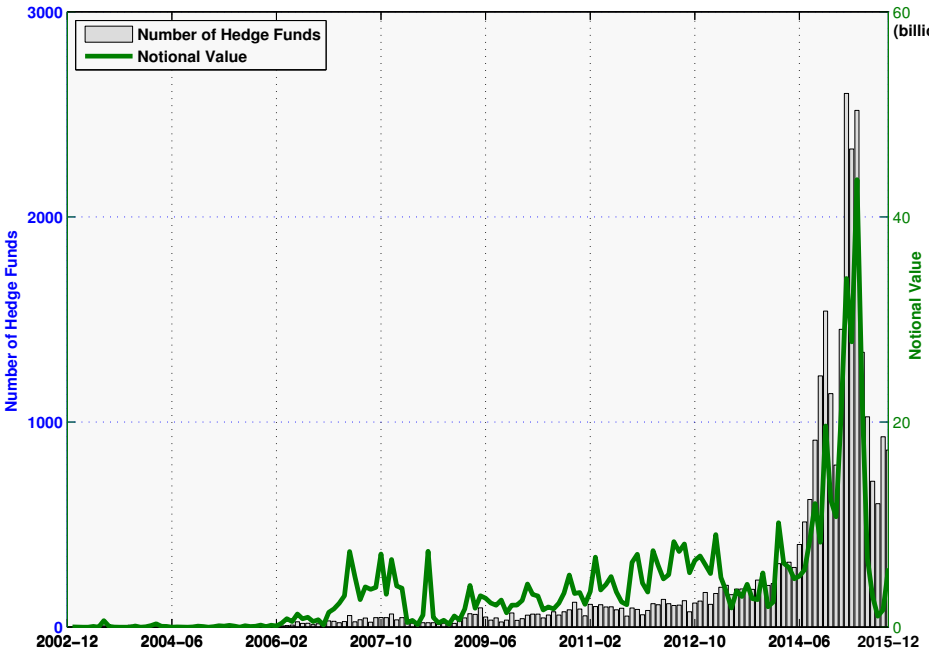

Figure 1: **Monthly Increments in Fund Number and Notional Value.** The monthly growth of the number of hedge funds is presented in single bars, while the solid line plots the total notional amount of the issued funds in each calendar month. The time period is from December 1, 2002 to December 31, 2015.

2002 to December 31, 2015. It is well documented that the monthly number of new issued hedge funds started to slowly increase in 2006, speeded up after the availability of new hedging instruments in 2010, dramatically grew up with the peak level of 2, 602 in April, 2015, substantially declined to 602 in October, 2015 after the financial turmoil in the summer, and regained the pace back to 863 by the end of December, 2015. Accordingly, the monthly notional value increments of hedge funds also experienced both a significant growth from about 4 million RMB in late 2012 to the peak value with about 43.63 billion RMB in early June, 2015 and a dramatic decline from the peak value to the one of 1.05 billion RBM in October, 2015. In total, over 30, 000 hedged funds have been issued since this industry was established in China since 2002, apart from those that were not reported publicly.

Furthermore, the monthly statistics reported by the Asset Management Association of China (AMAC), the regulatory body of the hedging fund industry on behalf of the CSRC, show that in the privately offered fund market, there are 10, 563 institutions that manage 13, 355 hedge funds, as of November 31, 2015, corresponding to 44.56% of the institutions in the market and 60.11% of all the issued funds, respectively. Roughly speaking, these

hedging funds represent the market value of over 1.70 trillion RMB, namely, 35.56% of the total notional value in the privately offered fund market. [3]

2.2 Business Models in Hedge Fund Industry

To a large extent, the evolution of the hedge fund industry in China is deeply rooted in its business models through which hedge funds can raise funds from and issue products to investors. Apart from financial instruments, these business models indeed dynamically shape the salient characteristics of this industry from the perspective of the relationship between fund managers and investors. Historically, two stages in the development of the business models employed in the hedge fund industry have been experienced due to strict regulations on hedge funds' access to investors.

In the first stage when the hedge fund sector was established in early 2003, all the hedge funds were functioned through the so-call "accounts channel business" with qualified financial institutions. In the most of cases, hedge fund managers had to resort to those trust companies in China (e.g., China Resources SZITIC Trust Co. and Hwabao Trust Co. and etc.) in order to issue their products and raise funds, by paying an annual transaction fee with no more than 0.5%, because these trust companies usually have large market share and significant influence on potential investors. Within this business model, the issuer of hedging funds plays a role of investment advisor, while the trust companies, as financial intermediaries, monitor and assess the performance of hedge funds from the point of view of investor protection. Yet, this model may lead to extra constraints on fund managers in terms of the investments in certain financial assets.[4]

Moreover, trust companies in turn have commitments to provide a number of professional services. First, the trust companies may provide guarantees for retail investors on their own names in order to help fund managers attract more investors. Second, on behalf of investors, trust companies had to validate the net values of hedge funds in a monthly basis to ensure the transparency of investment information provided by hedge funds. Third, they also took responsibilities of risk management for hedge funds to avoid fund liquidation in extreme market conditions from the perspective of professional finan-

[3]See the official website at http://www.amac.org.cn/tjsj/xysj/smdjbaqk/390109.shtml for more information.

[4]Within this business model, for example, hedge fund managers are not allowed to trade both financial and commodity derivatives due to the restrictions imposed by trust companies.

cial institutions. Since this business model well balances both return and risk between fund managers and fund investors, it is still a prevailing manner for most hedge funds in the industry until early 2014.

Apart from the collaboration with trust companies, those hedge funds that prefer to trade futures contracts or other derivatives may resort to mutual fund companies and their subsidiaries through which hedge funds can raise funds and issues products with less transaction cots. Within this business model, mutual fund companies plays the similar role with trust companies, but hedge funds have a wider range of choices on financial assets to optimize investment returns and effectively manage market risks. Yet, these assets must be in the pool of the assets under management of mutual fund companies. Also, investors have less access to hedge funds directly because of the restrictions imposed by mutual fund companies, which finally reduces the liquidity of fund products. Moreover, hedge funds are not allowed to take opposite trading positions with mutual fund companies, indicating the lost of investment opportunities in volatile markets. Alternatively, such hedge funds can collaborate with either securities companies or futures companies without restrictions on asset pools and trading strategies throughout securities managed accounts or futures managed accounts. Compared to trust companies, however, these important providers of accounts channel business to hedge funds (e.g., mutual fund companies, securities companies and futures companies) often disclose less transparent and frequent information to investors, which may raise the concern on investor protection.

Table 1: **Descriptive Statistics for Fund Issues in Major Business Models.** As of December, 2015, the total 21,939 hedge funds have been issued through the major business models.

	Accounts Channel Business				License-based Business
	Trust	Mutual Funds and Subsidiaries	Securities	Futures	(Private Funds)
Number of Funds	8,137	174	48	56	13,524
Percentage(%)	37.09	0.79	0.22	0.25	61.64

Unlike the conventional accounts channel business in which hedge funds are issued throughout financial intermediaries, a new business model, "private equity fund manager license", emerged recently and turned to be available to hedge funds. This model allows fund managers to access to investors directly in the absence of financial intermediates. On March 18, 2014, the AMAC released new regulation rules on hedging funds, and also issued the licenses to 50 private fund companies, 33 of which (about 66%) specialize in

securities investments. This is widely regarded a milestone in the development of the hedging fund industry in China, indicating that the hedge fund industry in China evolves into a new era. The new rules suggest that a private fund company who prefers to issue new products to investors need simply register to the AMAC and file for product issues. As a result, those qualified private fund companies can work as fund managers to raise funds and issue products to investors directly, independent of other financial intermediaries. It is certain that the issuers of hedge funds have more control on investment decision-making, and issue costs can be substantially reduced. Therefore, this business model restructures the hedge fund industry in China, and nowadays dominates the issues of hedge products, namely, over 60% of the overall issued funds. This is well documented in Table 1 that summaries the descriptive statistics of funds issued through the four major business models we have discussed in this section.

2.3 Trading Strategies, Investment Styles and Classification

In general, trading strategies characterize the risk and return profiles of hedge funds. They are the key for fund manager to earn good returns for investors. The conventional trading strategies are widely used in the hedge fund industry in China, including the long-short strategy that tracts the undervaluation and overvaluation of equity, the global- macro strategy that places directional bets on the prices of underlying assets with relatively high leverage from a global perspective, the relative-value arbitrage strategy that takes arbitrage opportunities within a broad array of securities, and the event-driven strategy that earns profits from prices changes as a consequence of events (e.g., merge and acquisition deals) that happen in markets. The first panel in Table 2 reports the statistics of those funds that follow specific trading strategies, which shows that there are about $2,744$ funds that favor only one of these four strategies as of December, 2015. Also, this panel suggests that most fund managers tend to focus on the first two strategy categories (about 70%), which is attribute to both the deepened economic connections worldwide and the tremendous development of Chinese' financial markets in recent years.

In fact, most fund managers prefer to diversify trading strategies in terms of the variants of these conventional strategies to achieve better investment performance, when facing dynamical financial markets with growing uncertainty and fierce competition. The second panel in Table 2 suggests that about $21,676$ funds hedge funds indeed employ

Table 2: **Descriptive Statistics for Trading Strategies Employed by Hedge Funds.** As of December 31, 2015, there are in total 24,420 funds issued in the two categories. Note that hybrid funds usually involve investments in at least two asset classes, and so this category may contain those funds that trade financial futures and commodity futures.

Panel I: Conventional strategies					
	Long/short	Global-macro	Relative Value	Event-driven	Total
Number of Funds	769	1,148	468	359	2,744
Percentage (%)	28.02	41.84	17.06	13.08	100
Panel II: Varieties of combined sub-strategies					
	Equity	Fixed Income	Hybrid Funds	Currency Market	Total
Number of Funds	20,071	1,169	414	22	21,676
Percentage (%)	92.60	5.39	1.91	0.10	100

more diversified strategies to improve fund performance by investing in specific financial sectors, which is about eight times than those funds with a single strategy reported in the first panel. More specifically, it turns out that among them 20,071 funds (about 92.60%) employ a variant of conventional strategies to invest in equity markets, while 1,169 funds (about 5.39%) concentrate on fixed-income products by virtue of the diversity of trading strategies.

The relative small weight of those funds concentrating a single strategy (about 11.24%) in Table 2 shows that the industrial practitioners are used to classify hedge funds in terms of investment type towards specific financial sectors, rather than investment style. This is partially because that due to both the complexity of the hedge fund business and the distinctive characteristics of China's financial markets (for example, the dominant influence of government policies on markets), it is relatively difficult to follow the terminology in the literature (e.g., Fung and Hsieh (1997) and Brown and Goetzmann (2003)) to identify the investment styles of hedge funds in China. This manner then makes it very challenging to compare the performance of the hedge fund industry in China with its western counterpart from the perspective of international asset allocation.

2.4 Hedge Fund Regulations

A legislation framework has been established to support the evolution of the hedge fund industry in China. Overall, the regulations on hedge funds experienced two substantial reforms. At its initiation stage, the fundamental legislative system, mainly consisting of

"Law on Securities Investment Fund", "Securities Law", "Trust Law", "The Company Law" amongst others, has been established since 1998, and they lay a solid foundation for the prosperity of the hedge fund industry in China.

As a result, the CSRC conducted the hedge fund regulation under the authority of "Law on Securities Investment Fund" that firstly came into force 1998 and was amended in late 2012. In June 2012, the AMAC, a new regulatory representative of the CSRC, was founded mainly for the purpose of hedge fund regulation, indicating that the regulation on hedge fund proceeded into a new era. On behalf of the CSRC, the AMAC transforms the channel-based hedge fund industry into a license-based business, which resulted in the promulgation of "The Interim Measures for the Supervision and Administration on Private Investment Funds" in 2014. As suggested in Table 1, this reform great promotes the growth of the industry, and finally turns the license-based business model into a widely accepted manner of fund issues in the industry.

3 CHRFC China Hedge Fund Index (CHFI) - A New Hedge Fund Index

This section introduces a new index, the CHRFC China Hedge Fund Index (CHFI). This index is created based on the CHRFC Research Database which will be discussed in detail. Also, we discuss the biases of sampling embedded in the present hedge fund research database, and finally present the construction of the CHFRC composite index (or CHFI) and its sub-indices on specific financial sectors.

3.1 CHFI Research Database and Hedge Fund Index Sample

The hedge fund research in China is substantially subject to the less transparency of information, as hedge funds, private investment vehicles, do not disclose investment activities quite often, apart from fund net values or historical return statistics but with dubious quality. Fortunately, the CHRFC Research Database is created and used mainly for hedge fund research in China. To improve the quality of relevant information, this database takes full advantage of all the available financial information vendors in China, and finally narrows down to the four major vendors who can guarantee the data quality

of hedge funds to a large extent. Specifically, it is assembled and constructed from the major four data vendors, including Wind Information Co. (Shanghai), Rongzhi Investment Consultant Co. (Shenzhen), Suntime Technology Co. (Shanghai) and Greatwisdom Technology Co. (Shanghai). These data vendors collect the information relevant to hedge funds throughout various sources, containing those hedge funds that have been issued to invest in securities markets (mainly in stock markets, fixed-income markets and derivatives markets) in both the accounts channel business (e.g., trust companies, securities companies, mutual fund companies and subsidiaries, and futures companies) and the license-based business (e.g., private fund companies) since 2007.

Over 80% of the hedge funds that are recorded by these four data vendors report returns to fund investors on a weekly/monthly basis, and about 15% of them reports on a daily basis, while only a few do so on a quarterly basis (less than 4%). Meanwhile, about 45% and 60% of these funds have investment horizons with less than 2 years and 10 years, respectively, while about 34% of them have not clearly specified horizons at inception. In particular, only less than 1% of hedge funds have perpetual maturities. These then represent the prevailing specification about the investment horizon of fund operation when a hedge fund is issued in China. It is notable that these hedge funds have relatively short investment maturities, compared with the industry practice discussed in Fung and Hsieh (1997) and Amin and Kat (2003) among others.

Moreover, a majority of the funds report returns net of all fees, mainly including incentive fees (with a prevailing rate of 20% in over 70% of hedge funds), management fees (with an average rate of 1%) and sales/commision fees (with an average rate of 1.2%). In addition to these fees, the extra channel-relevant fees (with a prevailing rate of 0.5% in over 90% of hedge funds) among others are charged when the funds are issued throughout specific accounts channel businesses (e.g., trust companies, mutual fund companies, securities companies and futures companies), which is slightly different from the practice mentioned in Liang (1998).

In order to characterize the "universe" of hedge funds, a number of procedures are further applied to improve data quality in the process of raw data collection from these data vendors due to the nature of voluntary reporting in the industry. First, we compare the raw hedge fund information provided from data vendors, and select hedge fund samples recorded by at least two vendors to reduce the dependence on a specific vendor.

Second, we develop a set of data-matching algorithms to improve data quality. By setting a threshold on the net value of a fund, for example, the extreme historical net values of hedge funds monthly reported among data vendors are removed because of high impossibility, which may circumvent noises in raw data. Also, we validate the consistence of the net value of each fund among data vendors, and ensure the duplication of its net value record in at least two data vendors. Third, since the cumulative net value of a hedge fund is extremely important for the construction of a hedge fund composite index, we obtain the cumulative fund net values by validating those values reported by data vendors or calculating the values, based on the available information about fund net values and dividends, when such data are missing. Note that each cumulative fund net value in the database is an adjusted net value after deducting both management fees and dividends.

In sum, it is required that each hedge fund sample that can be selected into the CHRFC Research Database should satisfy a set of criteria so that the the completeness and accuracy of information can be guaranteed. More specifically, these criteria are presented as follows:

- Each hedge fund sample is recorded in at least two financial data vendors.
- The key fund information, including fund name, fund manager, fee structure, issue time and channel, investment scope/type and etc., should be fully disclosed in various sources.
- The threshold of fund investment is at least 1 million RMB.
- Those funds are issued through the accounts channel business and license-based business.
- Those funds are issued mainly for dividends and price differences by trading securities.
- Those funds are invested directly in securities markets, excluding TOT/TOF (Trust of Trust/Trust of Fund), MOM (Managers of Managers) and FOF (Fund of Fund) structure products and those currency funds.

Moreover, we exclude all the sub-units of trust-relevant and currency-market-relevant funds issued by hedge funds through trust companies and securities companies. Therefore,

the CHRFC Research Database contains the hedge fund samples that had net value records during the period from January 1, 2007 to December 31, 2015. Furthermore, for any fund sample entering into the index construction, we take the first date of reporting fund net value as the date of fund establishment, and include this fund at the end of the seventh month into the CHRFC Research Database for the purpose of index construction, disposal of the historical records in the past six months. This then generates a relatively smaller sample set (called the index sample) from the CHRFC Research Database. As a result, the fund numbers both in the database and in the index sample from 2007 to 2015 are reported in terms of investment category in Table 3.

Table 3: **Fund Numbers in Database versus in Index Sample.** As of December 31, 2015, there are 7,989 hedge funds available in the CHRFC Research Database, while 6,143 funds of them enter the sample set of hedge fund index construction. All the funds in the database were issued and recorded by the four major data vendors from January 1, 2007 to December 31, 2015. Note that the number of those hedge funds that enter the sample for the index construction in each year is presented in parentheses.

Fund Number in Database (in Index Sample) by Category						
Year	Total Funds	Equity Funds	Fixed-income Funds	Managed Futures Funds	Hybrid Funds	Others
2007	273(69)	223(51)	9(9)	0(0)	4(4)	37(5)
2008	461(280)	408(255)	10(8)	0(0)	4(4)	39(13)
2009	861(470)	785(430)	36(23)	0(0)	12(6)	28(11)
2010	1479(895)	1348(828)	49(38)	0(0)	47(20)	35(9)
2011	2183(1536)	1953(1419)	82(46)	0(0)	91(60)	57(11)
2012	2832(1836)	2315(1615)	301(106)	1(0)	136(98)	79(17)
2013	4333(2531)	3030(1919)	797(346)	29(6)	330(204)	147(56)
2014	8594(3626)	5694(2624)	1043(527)	141(36)	512(329)	1204(110)
2015	7989(6143)	5838(4647)	751(510)	82(57)	402(381)	916(548)

More specifically, the impressive annual growth of the number of hedge funds in the CHRFC Research Database in 2014 is mainly caused by the introduction of the licence-based business model in the hedge fund industry. Meanwhile, 7,989 funds are selected into the CHRFC Research Database in 2015, showing a slight annual decline in the fund samples due to the financial turmoil in the summer, while 6,143 funds in the database enter into the sample for the hedge fund index construction. It clearly shows that i) most of hedge funds in China fall into the equity category, equivalently about 73.08% in the database and 75.65% in the index sample; ii) managed futures funds emerge as a new fund category in recent years (since 2014), and their weight in the fund index is relatively minor due to its small portion in the whole index sample (about 0.93% in 2015), and iii)

the number of hedge funds entering into the index construction is substantially increasing in 2015, showing that the substantial improvement of data quality since the imposition of disclosure rules on hedge funds by the AMAC in 2014.[5]

We further infer the average life of hedge funds both in the database and in the index sample using the information about the time period of fund net value reporting. To estimate the survivorship of hedge funds, we count those funds who have the historical records in the database during the same time period. To reduce the truncation bias, the life time of a typical hedge fund in the database (or in the index sample) is calculated in terms of calendar months from the inception date of a fund recorded by the data vendors towards the date of its final net value report recorded in the database (the index sample) by the end of December 31, 2015. Consequently, the descriptive statistics about the life periods of these funds are reported in Table 4.

Table 4: **Inference on Survivorship of Hedge Funds in China.** As of December 31, 2015, the statistics about the life periods of hedge funds both in the database and in the index sample are reported, and the numbers in the first four columns are reported in terms of calendar months. Note that for those funds with the life period of six calendar months, only the final net value record (in the seventh month) is selected for the index construction.

	Mean	Median	Min	Max	Std Dev	Skewness	Kurtosis
Funds in Database	19.84	12	2	154	18.45	2.29	8.61
Funds in Index Sample	22.68	14	6	154	19.31	2.09	7.35

On average, the hedge funds in the database (or in the index sample) can survive for about 19 (or 22) calendar months, suggesting the relative short survivorship of hedge funds in China. This is consistent with the fact that almost half of hedge funds (about 45%) collected by the major data vendor have investment horizons with less than 2 years, as we discussed before, which is partially supported by the fact of the structure of equity markets in China - relatively longer bear markets and shorter bull markets. In particular, there are only 725 (707) funds in the database (in the index sample) who have been continuously operating for over five years in the past nine years, as of December 31, 2015, which corresponds to 6.55% and 8.17% of the total funds, respectively. Moreover, these

[5]The AMAC intends to impose stricter disclosure rules on hedge funds. Accordingly, a draft of "Administrative Measures on Information Disclosure of Private Equity Funds" has been widely discussed since November, 2015.

magnitudes show that the CHRFC Research Database is comparable with those widely used hedge fund databases (e.g., TASS and HFR). For example, the study conducted by Moerth (2007) suggests that in total there were about 1,349 funds with 60-month consecutive track records available in three dominating hedge fund databases, namely, TASS (850), HFR (228) and Hedegfund.net (271), during a period from May 2000 to April 2005. Nevertheless, the hedge funds with 10-year consecutive track records in the CHRFC Research Database is much fewer (only 6 funds as of December 31, 2015), while the number of such funds is 480 from May 1995 to April 2005 according to Moerth (2007). This evidences the distinctive feature of the hedge fund industry in China, partially which relates to the current immature development of this industry.

3.2 Bias Inference in the CHRFC Research Database

Before introducing a new hedge fund index constructed from the CHRFC Research Database, it is necessary to investigate in detail the magnitudes of measurement biases existing this database, as the index can inherit errors in a hedge fund database. The biases in those well-known hedge fund databases, e.g., TASS, HFR and CSFB/Tremont (CT), have been carefully studied in the literature, including Brown, Goetzmann and Ibbotson (1999), Fung and Hsieh (2000), Liang (2000), Bollen and Pool (2009), Agarwal, Fos and Jiang (2013) and Aiken, Clifford and Ellis (2013) among others.

There are three main sources of difference between the performance of hedge funds in the database and that of hedge funds in the population (see Fung and Hsieh (2000)). First, the survivorship bias is usually regarded as a natural consequence of the way the hedge fund industry evolved through the birth, growth and death of individual funds. It is created when those funds, termed "defunct funds" that have stopped reporting information or ceased operation are purged from the database due to less valuable information to investors. As a result, those "surviving funds" in the database are still in operation and are reporting to data vendors at the end of the data sample, which may result in the overestimation of fund performance, as disappearing funds (or defunct funds) presumably perform much worse than surviving funds.

Currently, both defunct funds and surviving funds are recorded in the CHRFC Research Database, which allows deriving the magnitude of survivorship bias. However, the relative short investment horizon of the hedge funds in China, usually less than two years,

poses a challenge for bias estimation, compared with those funds in the well-known hedge fund databases (e.g., TASS and HFR). That's, about half of hedge funds in the CHRFC Research Database disappear within two years, as suggested in Table 4. Keeping this constraint in the mind, we initially fix one year as a typical investment horizon, although the whole sample period starts from January 2007 to December 2015 (in total 9 years).

Following the procedure proposed by Malkiel (1995) and Fung and Hsieh (2002), we construct an "observable" portfolio that attempts to measure the performance of the entire industry, and a "surviving" portfolio that represents the experience of an investor who avoids all defunct funds. Both portfolios are rebalanced in the same manner as Fung and Hsieh (2002), but with the investment horizon of one year. The surviving portfolio hence includes only those funds that survived until the end of a year. The annualized returns of both portfolios from 2007 to 2015 are reported in Panel I of Table 5. In this way, we estimate the magnitude of survivorship bias in each year during the whole sample period, which reports in Panel II of Table 5. These magnitudes show that unlike the empirical results in the literature (e.g., Fung and Hsieh (2000)), the surviving portfolio tends to overestimate the historical performance of the fund returns in the CHRFC Research Database in fives years, indicated by those positive values, and to underestimate the fund performance in the rest of time, indicated by those negative numbers. This pattern closely relates to the short investment horizon of most hedge funds in China. Namely, when those funds achieve good return records, the fund managers incline to liquidate the funds at (even prior to) the maturity of investment in order to keep "hot money" in their pockets when facing uncertain markets, which may lead to the underestimation of the performance of funds in the database. This is also confirmed with the steadily growing attribution rates in Panel II of Table 5, defined as the percentage of dead funds in the total number of funds in each year, especially in 2015 when there was a financial turmoil in summer.

We thus infer the average survivorship bias of 0.41% per year with a standard deviation of 2.71% from 2007 to 2015.[6] This suggests that the historical performance of hedge funds is overall upward-biased in the CHRFC Research Database. But its magnitude is much smaller than the survivorship bias estimations in those widely used databases (e.g., 3.0%

[6]Alternatively, we may estimate the average survivorship bias of the 1.80% per year with a standard deviation of 1.97% in terms of absolute magnitude if the sign of estimation is omitted.

per year in the TASS database by Fung and Hsieh (2000), 2.17% per year in the HFR database by Liang (2000) and 1.85% per year in the MAR database by Edwards and Caglayan (2001)).

Table 5: **Estimation of Survivorship Bias and Backfill Bias in the CHRFC Research Database.** As of December 31, 2015, the annualized returns of the constructed portfolios are reported in Panel I, while the estimations of both the survivorship bias and the backfill bias in the CHRFC Research Database are reported in Panel II, including the attrition rate which is defined as the percentage of dead funds in the total number of funds in each year. By following the terminology in Fung and Hsieh (2000), the survivorship bias is measured as the net difference of the returns of the surviving portfolio minus those of the observable portfolio, and the backfill bias is calculated as the net difference of the returns of the observable portfolio minus those of the adjusted observable portfolio.

Panel I: Annualized Returns of Portfoilios									
	2007	2008	2009	2010	2011	2012	2013	2014	2015
$\text{Return}_{Observable}(\%)$	69.27	-33.19	38.57	5.99	-16.72	3.14	9.75	20.75	23.50
$\text{Return}_{Surviving}(\%)$	67.25	-36.83	40.44	6.61	-17.02	2.84	10.57	21.24	29.67
$\text{Return}_{Adjusted}(\%)$	67.69	-36.00	41.94	6.07	-16.80	2.95	9.99	22.03	23.04
Panel II: Survivorship and Backfill Bias Estimation									
Survivorship Bias(%)	-2.02	-3.64	1.87	0.62	-0.30	-0.30	0.83	0.49	6.17
backfill Bias(%)	1.58	2.81	-3.37	-0.08	0.08	0.19	-0.25	-1.28	0.46
Attrition Rate(%)	8.78	18.29	13.94	14.37	14.71	20.15	20.72	23.79	49.70

Second, a "backfill bias" may be introduced when a new fund enters into the database, and its past performance history (prior to the entry date) is then appended to the database, as hedge funds usually undergo an incubation period. This happens when a data vendor backfills the fund's performance for the purpose of attracting investors, which thus leads to an upward bias on average returns. Conventionally, the incubation period in a database is inferred from the lag between the inception date of a fund and the date it entered the database. Due to the nature of hedge funds in China, less than 0.02% of funds have been issued before the entry date of these funds entering the CHRFC Research Database, while the first entry date is set on December 31, 2006. So the conventional method cannot be applied to the CHRFC Research Database. However, in terms of the construction of a hedge fund index, we do restrict those new funds who append the past performance history with more than six months in order to circumvent the problem of data manipulation, which implies that by assumption the incubation period

is about six months in the CHRFC Research Database. We then take this time gap as the incubation period to estimate the magnitude of backfill bias.

Again, we follow Fung and Hsieh (2000)'s approach to construct an observable portfolio as defined before, and an "adjusted observable portfolio" that is constructed in the same manner of the observable portfolio but after deleting the fund returns in the incubation period. Their annualized returns in the past nine years are reported in Panel I of Table 5. Also, we restrict the investment horizon to be one year for both portfolios, suggesting that no returns need be dropped for those hedges surviving for the year, but the first six months of returns need be removed for any new fund entering the CHRFC Research Database within a year. The backfill bias is then measured as the average difference between these two portfolios, as reported in Panel II of Table 5. The positive (negative) values in this row indicate that the returns of hedge funds in the incubation period turn to be higher (lower) because of the backfill bias. Therefore, we can estimate the magnitude of the average backfill bias with 0.02% per year with a standard deviation of 1.72% from 2007 to 2015, Again, this value is significantly lower than the estimations in other widely used databases (e.g., 1.4% per year in the TASS database by Fung and Hsieh (2000)).[7] This evidence shows that the historical performance of hedge funds in the incubation period has not been made up intentionally, despite the slightly upward-biased average returns, and further confirms the presence of the weak backfill bias in the CHRFC Research Database.

Third, selection biases may emerge when the sample of funds in the database is not a representative sample of the universe of hedge funds. Although it is difficult to measure the magnitude of the selection bias empirically, Fung and Hsieh (1997) suggest that such bias could be limited. To avoid a voluntary decision on entry to the CHRFC Research Database, we only take into account those funds that have the net value records in the consecutive three calendar months prior to the date when these funds are selected to enter the database and those funds that have been issued for at least six months (an incubation period by assumption) for the index construction. Also, each fund sample in the CHRFC Research Database must be recorded in at least two financial data vendors, as we mentioned before, which may mitigate the problem of sample differences that

[7] In terms of absolute magnitude, the backfill bias can be estimated with 1.12% per year with a standard deviation of 1.24% if the sign of estimation is omitted.

exist among the data vendors. Meanwhile, this way of sample selection ensures that the database may provide a sufficiently long history so that the performance of hedge funds in a variety of market environments can be assessed.

3.3 Construction of the CHRFC China Hedge Fund Index (CHFI)

Based on the CHRFC Research Database, we employ the approach mentioned above to select hedge fund samples and construct the CHRFC China Hedge Fund Index (CHFI). This hedge fund index is developed by the China Hedge Fund Research Centre (CHFRC), Shanghai Jiaotong University. More specifically, we following the convention in the literature (e.g., Fung and Hsieh (1997), Liang (1998), Ackermann, McEnally and Raverscraft (1999) and Brown, Goetzmann and Ibbotson (1999)) to use the monthly fund returns to iteratively calculate the index at each calendar month as follows:

$$\begin{aligned} Index(t) &= Index(t-1) \times (1 + Avg(return)_t), \\ Avg(return)_t &= \frac{1}{N} \sum_{i=1}^{N} \frac{Accumulated\_Nav_{i,t}}{Accumulated\_Nav_{i,t-1}} - 1, \end{aligned} \tag{1}$$

where Index(t) denotes the index point at the t^{th} calendar month, and $Avge(return)_t$ represents the average return of all accounted samples in this month, and $Accumulated\_Nav_{i,t-1}$ is the accumulative net value of the i^{th} fund sample in the same month, while N is the size of the index sample set in the month. The basis point of the CHFI is set as 1000, and the starting date is December 31, 2006. In this way, the CHFI is then constructed from the index sample set which is further collected from the CHFI Research Database using averaging individual monthly hedge fund returns. Currently, the CHFI in the t calendar month is updated on a monthly basis, namely, before 15^{th} in the $t+1$ calendar month.

Figure 2 plots the time series of the CHFI in the past nine years.[8] Overall, it is obvious that the CHFI outperformed the CSI300 that measures the performance of the top 300 blue-chip shares in most of the time, but relatively under-performed the CSI500 that measures the performance of the top 500 small- and medium-size shares, which well explains the role of hedge funds as an alternative investment in China. More interestingly, the performance of the CHFI was much better than the other two indices in the 2008 financial crisis, which may vividly demonstrate the nature of hedge funds in terms of the

[8]The full coverage of the CHFI is available at http://hf.cafr.cn/content/page/19.html.

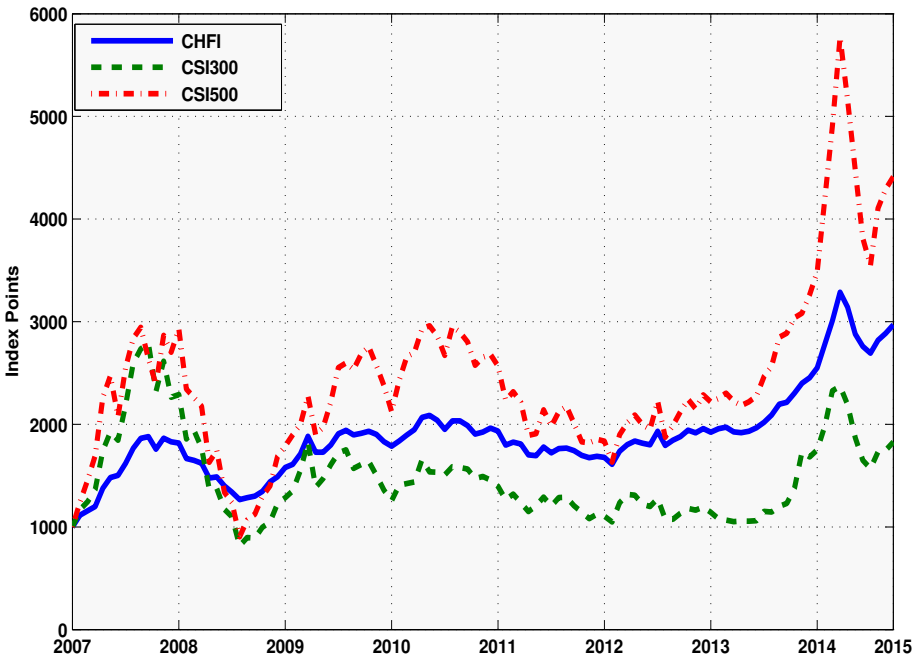

Figure 2: **CHRFC China Hedge Fund Index (CHFI) (2007.01 - 2015.12).** The solid line plots the time series of the CHRFC China Hedge Fund Index (CHFI) in the past nine years from January 2007 to December 2015, while the dynamics of the CSI300 and CSI500 are reported in the dashed line and the dash-dotted line, respectively.

stability of returns even in depressed market situations, although it may not be able to take full advantage of market rallies in late 2014 and in early 2015.

As suggested in Table 2, most hedge funds prefer to diversify trading strategies to improve performance, but usually concentrate on a specific financial sector. Motivated by this observation, we create the specific hedge fund indices for three main financial sectors, i.e., stock markets, fixed-income markets and futures markets, as plotted in Figure 3. These three specific indices aim to evaluate the overall performance of hedge funds in each specific financial market, and further provide benchmarks for fund investors. Note that the basis point of the three sub-indices is set as 1000, but with distinctive starting dates: December 31, 2011 for those funds mainly investing in fixed-income products, and December 31, 2013 for those funds mainly investing in futures and other derivatives products, due to their different stages of development.

Unlike the other two indices, the top panel in Figure 3 shows that the CHFI-Stock is highly correlated with the CHFI. This is consistent with the fact that most of hedge funds in China fall into the equity category (about 73.08% in the CHFI Research Database), as reported in Table 3. Different from the CHFI-Stock, the CHFI-FIX that measures

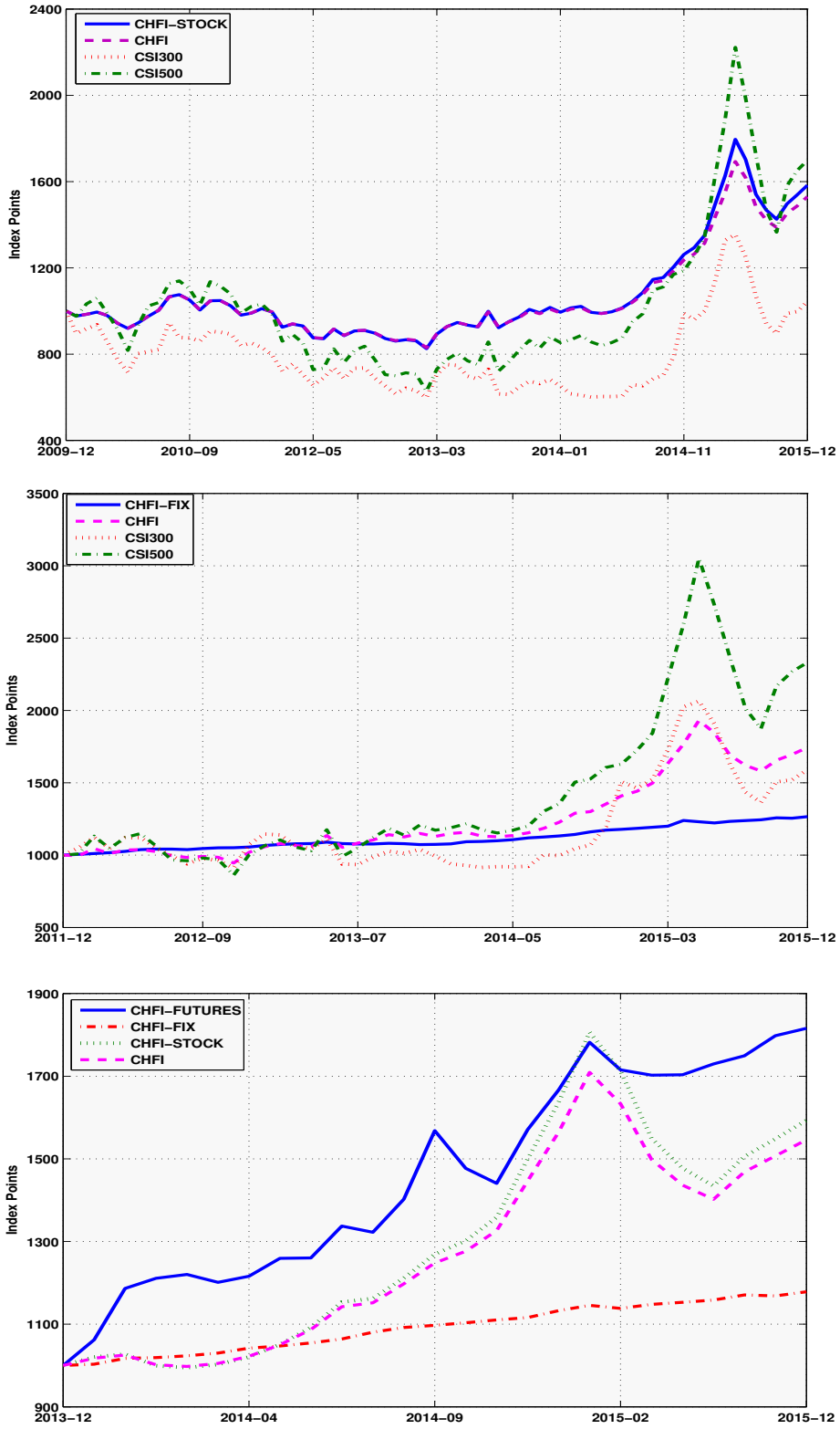

Figure 3: **Sub-China Hedge Fund Index (CHFI).** The solid line plots the time series of the sub-China Hedge Fund Index (CHFI) in each financial sector (stock markets, fixed-income markets and futures markets), while the dynamics of the China Hedge Fund Index (CHFI) is reported in the dashed line.

the performance of those funds mainly investing in the fixed-income products (with the weight of more than 80%) is steady and slightly upward inclined over time, as plotted in the second panel, relatively independent of the CHFI dynamics, which is consistent with the nature of fixed-income-relevant hedge funds. As suggested in Table 3, managed-futures funds have a very small portion in the index sample set (and in the CHFI Research Database as well), but their performance is much higher than the CHFI and its derivative indices, as plotted in the bottom panel, which partially results from the leverage nature of these funds.

Although both the live and defunct funds (including those funds cease operation and stop reporting) are saved in the CHFI Research Database, all the funds that are selected for the CHFI construction in the current month should have reported their net values in the past calendar month, given a lag of one month in the index updating. From the perspective of investors' interest, those funds in the index sample set that turn to be defunct are removed accordingly when the information about these funds tends to be certain (about whether they surely cease operation or temporarily stop reporting) in the following months. This way may facilitate the monthly update of the CHFI, and also mitigate the survivorship bias that may be inherited from the CHFI Research Database in the sense of Fung and Hsieh (2002), associated with the restriction of a six-month incubation on each new fund that is selected as an index sample.

4 Empirical Performance of Hedge Funds in China

This section further conducts an analysis on the performance attributes of hedge funds in the risk-return framework, in terms of five key financial measures to exploit the evolution of these attributes over time. Also, we study the statistic dependence of these terms which actually provides comprehensive information about the risk characteristics of hedge funds in China.

4.1 Performance Attributes of Hedge Funds

We measure the performance of hedge funds that enter the CHFRC Research Database in terms of annualized returns, standard deviations, maximum drawdowns, Sharpe ratios and Sortino ratios. These conventional measures are widely used in the literature to

characterize the fundamental aspects of the performance of hedge funds, and so they allow us to assess how well hedge funds perform in dynamic market environments.

4.1.1 Annualized Returns

The top panel of Figure 4 presents the dynamics of the annualized returns of the composite index (CHFI) during the period from January, 2007 to December, 2015.[9] It suggests that the returns of the hedge funds in China in the past nine years were subject to the dramatic changes in market conditions to a large extent (e.g., the market rally in 2007 and the financial crisis in 2008), but less volatile than the benchmark performance of the CSI300 Index. Moreover, it is evident that the hedge funds can earn positive returns in the most time of the nine years, apart from two exceptional years (e.g., 2008 and 2011).

The sub-panels below in Figure 4 further plot the empirical distributions of the sample hedge funds that enter to the CHFI. Their empirical returns pose a thin-tail, high-kurtosis and skewed pattern, subject to the shifts in market environments, showing that all the annualized returns of hedge funds in China in the recent years are not normally distributed. For example, the long left tail of the return distribution in 2012 suggests that a number of hedge funds have made huge losses due to the depressed market, support by a negative skewness (-0.36), while the long right tails from 2013 to 2015 imply that the increasing number of hedge funds have made large profits. Overall, $70\% - 80\%$ of hedge funds have made returns that fall into the range of $[\bar{R} - \sigma, \bar{R} + \sigma]$ where $\bar{R}$ stands for the average annualized return across the hedge fund samples, and σ denotes the standard deviation of these returns, suggesting that it is relatively difficult for fund managers to make higher returns (with the possibility less than 10%).

Despite an impressive average annualized return of 20.86%, the performance of hedge funds turns to be divergent in 2015 when a financial turmoil has been experienced, which is supported by the large volatility of the annualized returns. This makes the distribution of the return disperser, compared with those distributions in the preceding years. Also, the relatively long right tail implies that there exists a substantial portion of hedge funds that have made high returns. This seems to suggest that compared with the historical

[9]The annualized return of the ith fund, a compounded rate, is defined as $R_i = [(1+r_1)(1+r_2)\cdots(1+r_n)]^{\frac{12}{n}}] - 1$, where r_j denotes the monthly return in the j^{th} month $(0 < j \leq n)$ in the sample period. The same principle is also applied to a hedge fund index.

performance of their western counterparts, as reported in Lhabitant (2006), the managers of hedge funds in China have quite distinctive capabilities of earning returns in volatile markets, and also these hedge funds as a whole can make persistent returns for investors with an average annualized return of 17.26% in the past nine years, as shown in the top panel of Figure 4.

4.1.2 Standard Deviations of Fund Returns

Unlike the annualized returns, their standard deviations are less affected by the market conditions. The top panel of Figure 5 shows that the annualized volatility of the hedge fund index returns was relatively stable over the past nine years, especially in the recent years, and that its magnitude was much lower than the volatility of the CSI300 Index.[10] This is well documented that the hedge funds in China do perform better than the market benchmark pursue higher absolute returns for investors in the sense of effectively managing market volatility.

The following four sub-panels in Figure 5 also report the empirical distributions of the volatilities of the sample fund returns over the period from 2012 to 2015. Compared with the distribution of the sample hedge fund returns, their volatility in each year (except 2015) is distributed less dispersedly (indicated by the moderate kurtosis), ranging from zero to 50%. Associated with the left-skewed pattern of the volatility distributions, as plotted in Figure 5, it shows that there exists a large portion of hedge funds (over 30%) that have much low volatilities in relation to the average level of volatility in the industry. Moreover, it seems that the volatility of the fund returns is not normally distributed, but its distribution is persistently stable over years, implying that hedge funds manage volatility quite efficiently in the most of time before 2015.

Subject to the financial turmoil in the summer of 2015, the hedge fund industry experienced high deviations of fund returns with an average volatility of 31.29%, which is confirmed by the top panel in Figure 5. Also, the wide band of each volatility category shows that there exists a portion of hedge funds that may have experienced quite large volatilities when the dramatic shifts in market environments occur, showing their poor

[10]The standard deviation (volatility) of the sample hedge funds is defined as $\sigma_p = \sqrt{\frac{\sum_i^n (r_i - \bar{r})^2}{n-1}}$, while $\bar{r}$ represents the mean of the monthly returns in the sample period. Then the annualized volatility of these hedge fund returns is equal to $\sigma = \sigma_p \times \sqrt{12}$.

performance in managing market risk in extreme market conditions. This then seems to suggest that as a tradeoff of relatively high annualized returns, the performance of the hedge funds in China has experienced relatively higher deviations at the same time (with an average volatility of 13.48%, compared with their western counterparts, for example, an average volatility of 7.95% from 1996 to 2005 reported by Lhabitant (2006), although they significantly outperform the benchmark of the CSI300 Index which has an average volatility of 30.42% from 2007 to 2015.

4.1.3 Maximum Drawdowns

Usually, a drawdown measures the decline from the peak value of a fund to its lowest point over a period of time, and so a maximum drawdown gauges the maximum cumulative loss from drawdowns.[11] Although the hedge funds in China presents the stability in the volatility of fund returns, the top panel in Figure 6 shows that the annual maximum drawdowns are still volatile over time, suggesting that the performance of hedge funds is affected substantially by the extreme market conditions (e.g., the financial crisis in 2008 and the depressed market in 2011 and 2015). On average, the funds have suffered from the maximum drawdwn of 12.08% which significantly outperformed the CSI300 Index (with an average maximum drawdown of 27.17%) in the sample period. Also, the performance of hedge funds in terms of the historical maximum drawdwn is comparable with those funds in the U.S., for instance, which experienced the average level of 13.81% in the period from 1996 to 2005 (see Lhabitant (2006)).

To understand better the distribution of maximum drawdowns in the sample funds, the sub-panels below in Figure 6 further plot the distributions of the monthly maximum drawdowns of the sample fund returns in the recent years, instead of an annual basis. In each year, most of the maximum drawdowns are clustered towards the mean of the distribution. Also, it is clear that the weight of the hedge funds with low drwadowns has steadily increased since 2012, and consequently about 50% of hedge funds experienced the maximum drawdowns with less than 5% in 2014, which reflects the persistent improvement of the market in the period. However, the sample hedge funds in 2015 were subject

[11] The maximum drawdown of fund returns is defined as $\max(\frac{D_i - D_j}{D_i})$, where $\min(t) < i < j \leq \max(t)$, and $\min(t)$ and $\max(t)$ denote the starting point and ending point of a fixed time period t, while D_i and D_j represent the net fund values at time point i and j in the period, respectively.

to substantial exposure to tail risk, implied by the high average maximum drawdown rate of 20.48%, which suggests that the performance of hedge funds deteriorated in 2015. Overall, the empirical distributions of the monthly maximum drawdown in the past four years show that there always exited a small portion of hedge funds that were subject to very high monthly drawdowns (larger than 20%). Note that the monthly-measured maximum drawdowns may be much larger than the daily- (weekly)-measured maximum drawdowns which could result in the underestimation of the real maximum drawdowns.

4.1.4 Sharpe Ratios

The Sharpe ratio is widely accepted as a measure t to examine the risk-adjusted performance of a hedge fund. The top panel in Figure 7 plots the dynamics of the Sharpe ratios of the hedge funds in the sample period from 2007 to 2015.[12] Similar to the empirical performance of the fund index in Figure 4, the dynamics of its Sharpe ratios in the past nine years are quite volatile, showing their substantial exposure to the dramatic shifts in market conditions (e.g., the market rallies in 2007, 2009 and 2014 and the market downturns in 2008 and 2011). In particular, the hedge funds still gain an annualized Sharpe ratio of 1.09, suffering from the depressed market in 2015. On average, all the sample hedge funds produce an average Sharp ratio of 0.86 over the sample period, while this risk-adjusted return nearly doubles the one generated by the CSI300 Index. Notably, this average annualized Sharp ratio in magnitude is close to the average ratio of 0.80 produced by hedge funds in U.S. from 1996 to 2005 according to Lhabitant (2006).

The following four sub-panels in Figure 7 report the empirical distributions of the Sharpe ratios of the sample hedge funds in the period from 2012 to 2015. Roughly speaking, the distribution of the Sharpe ratios is relatively stable over time, implying that the risk-adjusted returns of hedge funds in China are less affected by the market conditions, although the distribution in 2015 turns to be slightly disperse subject to the impact of the financial turmoil in summer. More importantly, these empirical distributions present the pattern of long tails. The persistently long left tails suggest that a certain portion of hedge funds actually under-perform even by generating negative Sharpe ratios in relation to the average performance in the industry (with a ratio of 0.86), especially in 2013,

[12]The Sharpe ratio of a hedge fund is defined as $\frac{R-R_f}{\sigma}$, where R and σ denote the annualized return and volatility of the fund, and R_f is the one-year risk-free deposit rate in the bank account.

while the exponentially-declining right tails show that although it is extremely difficult to earn high risk-adjusted returns, there exist a small portion of hedge funds that have such capabilities to do so, relatively independent of market environments.

4.1.5 Sortino Ratios

The Sortino ratio is often used to measure the downside-risk-adjusted return of a hedge fund. Figure 8 plots the dynamics of the Sortino ratios of the hedge fund index during the sample period from 2007 to 2015.[13] Compared with the empirical annualized Sharpe ratios in Figure 7, the dynamics of the Sortino ratios of the CHFI plotted in the top panel show that the performance of the sample hedge funds is substantially improved after adjusting downside risks, associated with an average annualized Sortino ratio of 2.84 higher than the average ratio (of 1.95) produced by the benchmark of the CSI300 Index. These observations further suggest that less downside risks in the hedge fund industry may make more contributions to funds' risk-adjusted returns in the variety of market environments, especially in the market rallies in 2007 and 2014.

The four sub-panels below in Figure 8 further report the empirical distributions of the Sortino ratios of the sample hedge funds in the recent years. Unlike the Sharpe ratios, the Sortino ratios are distributed with the long right and short left tails. This suggests that booming markets can substantially enhance the Sortino ratios of hedge funds due to the less possibility of the occurrence of downside risks (e.g. with the ratio up to 12.15 in 2007 and 8.30 in 2014, respectively), while glooming markets certainly deteriorate Sortino ratios (e.g., with the ratio down to -2.09 in 2008). Also, the long right tails in the distributions imply that there are an increasing portion of hedge funds that are capable to generate high Sortion ratios of more than 6 especially in the recent three years.

4.1.6 Means of Statistic Measures

For the sake of completeness, Table 6 reports the means of the five statistic measures of all the hedge funds in the index sample set, as discussed in the preceding sections, to disclose the comprehensive information about the dynamics of these measures in the

[13]The Sortino ratio of hedge funds is defined as defined as $\frac{R-R_f}{\sqrt{\frac{1}{n}\times\sum_{i=1}^{n}\max(R_f-r_i,0)^2}}$, where R denotes the annualized return of the fund in n periods, and R_f is the one-year risk-free deposit rate in the bank account, while r_i is the annualized return of the hedge fund in the i^{th} period.

sample period from 2007 to 2015. As suggested in the table, all measures, apart from the volatility term, were worsened due to the impact of the financial crisis in 2008, recovered temporarily in 2009, substantially improved in the recent years and again turned to be deteriorated in 2015. These observations suggest that the hedge funds in China are heavily affected by the shifts in market conditions, and further the products issued the hedge funds are actually lack of heterogeneity.

	Calendar Year								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annualized Return	74.63%	−29.22%	48.94%	5.98%	−16.44%	1.16%	9.62%	25.24%	21.92%
Annualized Volatility	28.89%	21.47%	25.07%	17.28%	16.68%	15.84%	17.76%	17.29%	31.62%
Maximum Drawdown	8.29%	29.07%	11.08%	11.42%	17.85%	11.81%	10.07%	7.27%	20.62%
Sharpe Ratio	2.85	-1.58	1.91	-0.07	-1.42	-0.21	0.22	1.15	0.76
Sortino Ratio	20.44	-0.94	9.84	1.89	-1.07	0.07	0.84	2.90	1.72

Table 6: **Means of Key Statistic Measures for Hedge Funds.** The sample period starts from January, 2007 to December, 2015.

4.2 Relationship between Return and Risk among Hedge Funds

From the perspective of tradeoff between return and risk, it is well known in finance theories that high volatilities should always be compensated by high returns in order to attract investors to bear more risks. The empirical results reported by Fung and Hsieh (1997), Liang (1998) and Lhabitant (2006) among others provide the strong and supportive evidence for the presence of this relationship in the western hedge fund industry. Then, it is interesting to investigate whether or not this prominent tradeoff relationship still holds in the hedge fund industry in China.

This section further studies this relationship using the annualized returns and volatilities of all the sample hedge funds over four years from 2011 to 2015. Figure 9 presents the scattered plot for the return and volatility of hedge funds as a set of points, and so each point represents a hedge fund product in the sample. The red line denotes a regression of annualized returns on annualized volatilities after adjusting to the one-year risk-free interest rate. Overall, the positive coefficients of the volatility term in the regression model seem to suggest that this well-known paradigm also holds in China' hedge fund industry, namely, high volatilities (risks) always being compensated by high returns.

However, the contributions of the volatility term may vary over time. Figure 9 shows

that among these four years, the hedge fund returns in 2014 is mainly driven by the dynamics of the volatilities of these funds' returns. That is, one unit change in volatility may lead to 1.48 times changes in fund returns, which is much larger than the contributions of the volatility term in other years. Interestingly, there is a substantial component in fund returns which can be fully explained by volatility, indicating that there are other unspecified risk factors that may have power to drive the dynamics of hedge fund returns in China. For example, about 10.5% return out of the average 21.92% return of all the sample hedge funds in 2015, as reported in Table 6, cannot be captured by the volatility term. This further motivates us to conduction an analysis on risk attributions of hedge fund returns within the Fama-French framework.

5 Risk Attributions of Hedge Fund Returns

In principle, hedge funds, as alternative investments, aim to achieve positive returns on investment regardless of whether markets are rising or falling (or "absolute returns", alphas). However, the performance of hedge funds in the industry is influenced more or less by market conditions (e.g., the funds that follow equity long-short strategies), which in turn positions hedge funds and further determines their value to asset allocations. As suggested by the statistical analysis in Section 4, the performance of the hedge funds in China is affected by the equity markets to a large extend, although its risk characteristics are similar to those funds in the developed countries (e.g., US and UK).

Therefore, it is necessary to further investigate the risk attributions of hedge fund returns and examine the dependence of the performance of fund returns on the market factors, as well as measure the sensitivities of returns towards market factors in terms of beta. This section first identifies the appropriate market factors that may represent the market performance in order to better understand the relation between excess returns and market factors. We then employ a three factor model proposed by Fama and French (1993) to exploit the contributions of the three risk factors to the returns of hedge funds in China. Note that all equity hedge funds are used only for analysis, due to their close link to the equity markets and their high weight in the sample.

5.1 Relation between Excess Returns and Market Factors

Due to the unique nature of hedge funds in China, for example, less weights on large-cap (blue-chip) stocks and more weights on medium and small-cap stocks, the identification of an appropriate market factor is a key to disclose the relation between fund returns and market risk factors:

$$E(R_h - R_f) = \alpha + \beta(E(R_M) - R_f) + \epsilon, \tag{2}$$

where $E(R_h)$ denotes the expected annualized return of a hedge fund, and R_f stands for the one-year risk-free deposit interest rate, while $E(R_M)$ presents the expected annualized return of the market portfolio. In this way, the term alpha (α) explains the so-call absolute return, which is independent from the market movements, while the term beta (β) measures the sensitivity of the excess fund return towards the market risk factor represented by the market portfolio.

We preliminarily employ the CSI300 Index as a market factor, and then collect the results of the regression in Model (2) on all the sample hedge funds in the CHFI. Figure 10 reports the distributions of alphas and betas in the top panels, respectively. More specifically, 86.07% of hedge funds with positive alphas suggest that most funds can earn positive excess returns. As shown in the top-left panel, most alphas are allocated around 0.5%, and 68.41% of hedge funds have alphas larger than 0.5%, indicating that about 2/3 of funds could make annualized absolute return with 6%. However, these observations are not statistically significant in that in both cases (e.g., $\alpha > 0$ or $\alpha > 0.5\%$), the resulting weights of the sample funds with a t-statistics ($|t| > 2$) are less than 10%.[14]

Moreover, 98.22% of hedge funds can achieve positive betas, 72.25% of which are statistically significant (with $|t| >$), showing that the performance of most hedge funds are highly correlated with the CSI300 Index. Also, the top-right panel in Figure 10 plots the distribution of the estimators for β with a mean of 0.5. In this distribution, 35.29% of betas are less than 0.2, implying that about 1/3 of funds are less affected by market movements and a small portion of funds are negatively correlated with the CSI300 Index. On the other hand, 57.56% of beta estimators fall into the range of $[0.4, 0.8]$, while about 7% of funds have betas larger than 0.8. All these observations suggest that when the

[14]Let $\hat{x}$ be an estimator of parameter x. Then the t-statistics of a variable x is calculated as $\frac{\hat{x}-x_0}{\sqrt{\frac{(\hat{x}-\bar{\hat{x}})^2}{n-2}}}$ under $H_0 : x_0 = 0$, and the critical value for the t-statistics is set as 2 in this study, associated with a confidence level of 5% on both sides.

CIS300 Index is used as a market risk factor, it seems that most of hedge funds in China are positively correlated with market movements, which is partially related to the high weight of hedge funds that concentrate on equity markets.

Actually, most of hedge funds in China heavily invest in medium- and small-cap stocks. The representativeness of the CIS300 Index as the market risk factor is hence concerned provided that it is constructed from the large-cap stocks in both the the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SSE). In order to verify the performance of the CIS300 Index in terms of the attributions of fund returns, we alternatively use a cross-market portfolio to represent the market factor. The annualized return of this cross-market portfolio is constructed simply using the yields of all stocks in both stock markets, weighted by the market values of these stocks. Accordingly, the percentage of hedge funds that achieve positive betas decreases from 98.22% to 87.90%, while the weight of hedge funds that have statistically significant and positive βs (with $|t| > 2$) increases from 72.25% to 75.32%. The two panels below in Figure 10 plot the distributions of the estimators for both α and β, and these estimators may further be allocated into the different ranges as follows:

Market Risk Factor	α		β		
	≥ 0	$\geq 0.5\%$	≤ 0.2	$(0.2, 0.8]$	$(0.8, 1.0]$
Cross-Market Index	57.30%	31.50%	26.48%	58.69%	14.80%
CSI 300 Index	86.07%	68.41%	35.29%	57.56%	7.00%

Table 7: **Allocation of α and β Estimators within Two Market Factors.** The sample period starts from January, 2011 to December, 2015.

In Table 7, the benchmark for α is set as $\alpha = 0.5\%$ which is a prevailing risk-free return in the fixed-income market in China, while the three categories for β indicate the sensitivity of the performance of hedge funds towards the market factor, namely, from the minor impact ($\beta \leq 0.2$) to the severe impact ($\beta > 0.8$). Table 7 suggests that the performance of hedge funds in China is positively correlated with both market risk factors, and that more than 57.32% of funds can make positive returns, and even more than 31.50% of funds have the chance to earn the annualized excess returns of 6%, yet which is weakly statistically evident. To better understand the effectiveness of two indices as market risk factors, we further compare the differences between the distributions of αs and βs that are estimated based on these factors.

The distribution differences in Figure 11 are calculated by subtracting the α estimators under the cross-market index from ones under the CSI300 Index (in the left panel) and so do the β estimators (in the right panel). The differences in αs are mainly clustered around zero, among which the positive ones have the dominant weight of 96.63%. This implies that the medium- and small-cap stocks make substantial contributions to the excess returns of hedge funds which are independent from the CSI300 Index. Moreover, the differences in βs are mainly clustered around -0.11%, while the percentage of the positive and negative ones are 12.37% and 48.52%, respectively. As a result, the relatively low weight of the negative differences in βs, associate with the dominating weight of the positive differences in αs, conforms that the excess returns of hedge funds in China is more sensitive to the cross-market index than the CSI300 Index.

5.2 Fama-French Three-Factor Model

By taking the cross-market index (portfolio) as the market risk factor, we further employ the Famm-French three factor model to exploit the risk attributions of the returns of the hedge funds to the other two factors, namely, the small (market capitalization)-minus-big (SMB) factor and the the high (book-to-market ratio)-minus-low (HML) factor, which is expressed as follows:

$$E(R_h - R_f) = \alpha + \beta_{Market} \cdot (E(R_M) - R_f) + \beta_{SMB} \cdot SMB + \beta_{HML} \cdot HML + \epsilon, \quad (3)$$

where the SMB factor measures the historic excess returns of small cap stocks over big cap ones, while the HML factor measures the excess returns of value stocks over growth ones.

To mimic underlying risk factors related to the size and book-to-market ratios, we follow the method proposed in Chen, Shao, Hu and Wang (2015) to construct two portfolios, SMB and HML. The SMB (small minus big) is the difference between the simple average of the monthly returns on the three small-cap stock portfolios (Small-Low , Small-Medium and Small-High) and the three big-stock portfolios (Big-Low, Big-Medium and Big-High). Since the two components of SBM present the returns on small and big-stock portfolios with the same weighted-average book-to-market ratios, the SMB portfolio then captures the different returns behaviors of small and big stocks, and is largely unaffected by book-to-market ratios. Similarly, the a HML (high minus low) portfolio can

be constructed in the way that HML is the difference between the simple average of the returns on the two high B/M portfolios (Small-High and Big-High) and the two low B/M portfolios (Small-Low and Big-Low) with the identical weighted-average stock size.

After including the size factor (SMB) and the value factor (HML) into the analysis, the mean of the distribution of αs increases from 0.2 to 0.52, while the weight of hedge funds that make positive excess returns decreases from 57.30 to 51.23%. Also, over 1/4 of hedge funds have the chance to make risk-free excess returns with 6% after deducting the exposures to the SMB and HML factors. Equivalently, this accounts for 29.70% of αs larger than 0.5% in the distribution plotted in the top-left panel of Figure 12. However, these empirical observations are not fully supported by the evidence that in either case, the percentage of hedge funds that obtain returns with a statistical significance (e.g., $|t| > 2$) is less than 15%.

Moreover, the weight of positive βs increases from 87.90% to 89.55%, among which the 64.65% of hedge funds in the sample are positively correlated with the market factor at the statistically significance level (e.g., $|t| > 2$). Meanwhile, the distribution mean of βs increases slightly from 0.43% to 0.52% after introducing two additional risk factors. On the one hand, the weight of hedge funds that generate $\beta \leq 0.2$ declines from 26.48% to 21.40%, showing that less hedge funds can make market-independent excess returns, while the percentage of hedge funds with $\beta \in (0.8, 1]$ poses a significant increase from 14.80% to 20.20%, indicating that more hedge funds indeed have substantial risk exposures to the cross-market factor. These changes then lead to a downward effect in the left tail of β's distribution and an upward effect in its right tail, compared to the one in the right-bottom panel of Figure 10 that are estimated only in the presence of the cross-market factor. On the other hand, there is a minor decrease in the weight of hedge funds with $\beta \in (0.2, 0.8]$ (from 58.69% to 57.24%), implying that the kurtosis of β's distribution slightly increases, and that the number of hedge funds subject to the market risk is roughly unchanged. All these empirical results seem to suggest that both the SMB and HLM factor are helpful to disclose more information about risk exposures of hedge funds' returns to the cross-market risk.

Also, these two risk factors can make contributions to exploit the risk attributions of excess returns towards the specific aspects of investments made by hedge funds. First, the percentage of positive coefficients related to the SMB factor is 57.19%, larger than

the weight of negative ones (with 13.66%), implying that the SMB factor has the positive impact on the excess returns of hedge funds, and so the changes in the prices of small-cap stocks may have substantially affect the performance of hedge funds. Second, unlike the SML factor, the HML factor is associated with relatively smaller positive coefficients (31.73%) than the negative ones (51.35%). This then suggests that the performance of hedge funds is negatively correlated with the HML factor, as the hedge funds incline to invest in stocks with high growth rates. However, both empirical results are not fully supported due to their less significant weights in the fund sample where only 3.42% of fund samples are statistically significant for the SMB factor (e.g., $|t| \geq 2$), and the weight is just 7.61% for the HML factor.

6 Conclusions

In strong contrast with the mutual funds in which a substantial amount of work has been done, the lack of work in the area of hedge funds is due to the difficulty in accessing private hedge fund data, especially in China. To deal with this problem, this article proposes a new index (namely, the China Hedge Fund Index, or CHFI) that is created based on a new hedge fund database constructed from all the reliable sources provided by the major data vendors. We then use this index to conduct a comprehensive study on both the risk characteristics of the performance of hedge funds in China and the risk attributions of the excess returns of these funds that enter into the composite index.

We first employ five key measures to characterize the risk attributes of the hedge fund performance, including (annualized) returns, volatilities, maximum drawdowns, Sharpe ratios and Sortino ratios. The statistical analysis shows that all these measures show the time-varying patterns and are subject to the dynamics shifts in market conditions to a large extent. Partially, these features are closely related to the early stage of the development of the hedge fund industry in China. Nevertheless, the statistical results also disclose that the performance of hedge funds gradually present the well-know paradigm that high risks tend to be compensated by high returns, especially in the recent years from 2012 to 2015. Roughly speaking, this thus suggests that this theoretical relation between returns and risks has its solid root in such a risky industry even in China.

We further exploit the risk attributions of the excess returns of hedge funds within

the Famma-French framework. First, the effectiveness of two market factors - the CSI300 Index and a cross-market index is carefully compared, in terms of sensitivities of the excess returns of hedge funds to these two factors. It is found that the latter factor has the relatively stronger interpretation power about the excess returns of hedge funds, and thus the cross-market index is used as the market factor in the empirical analysis. By further including the size factor (SML) and the value factor (HML) into the Fama-French three-factor model, the empirical results show that the SML factor has the positive influence on the excess returns of hedge funds, provided that hedge funds are more likely to invest in small-cap stocks, while the HML factor is negatively related to the performance of hedge funds, given that these funds incline to invest more in growth stocks. All these findings are consistent with the literature, although they are not fully support by the evidence with the statistical significance. Moreover, other important factors, such as trading strategies, management fees, fund size, fund age, and leverage and etc., that may facilitate to explain the performance of hedge funds, are not taken into account in this study, which will be investigated in future researches.

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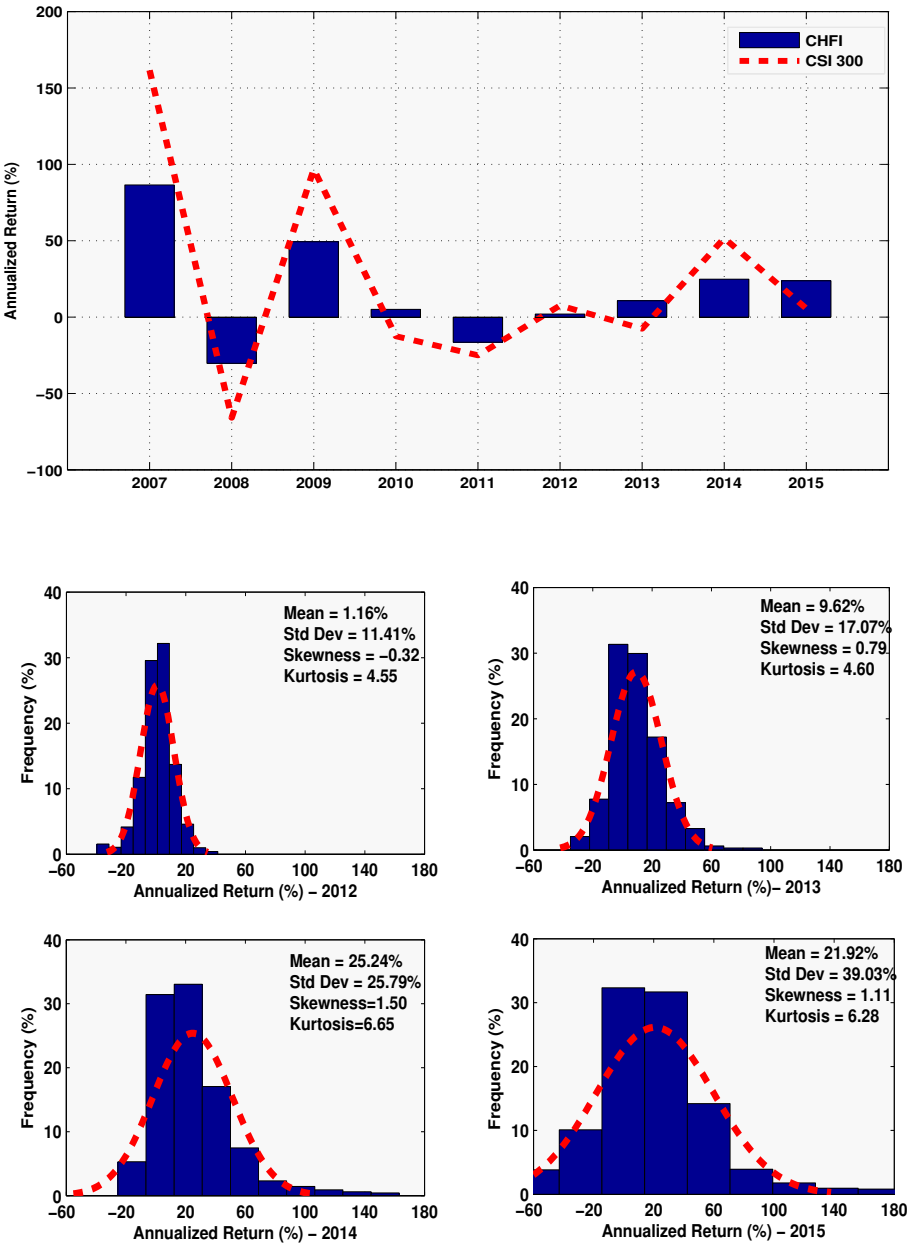

Figure 4: **Time Series and Distributions of Annualized Returns of Hedge Funds.** The top panel plots the time series of the annualized returns of the China Hedge Fund Index (CHFI) in the past nine years, while the four sub-panels below report the empirical return distributions of all the sample hedge funds in the recent four years from 2012 to 2015.

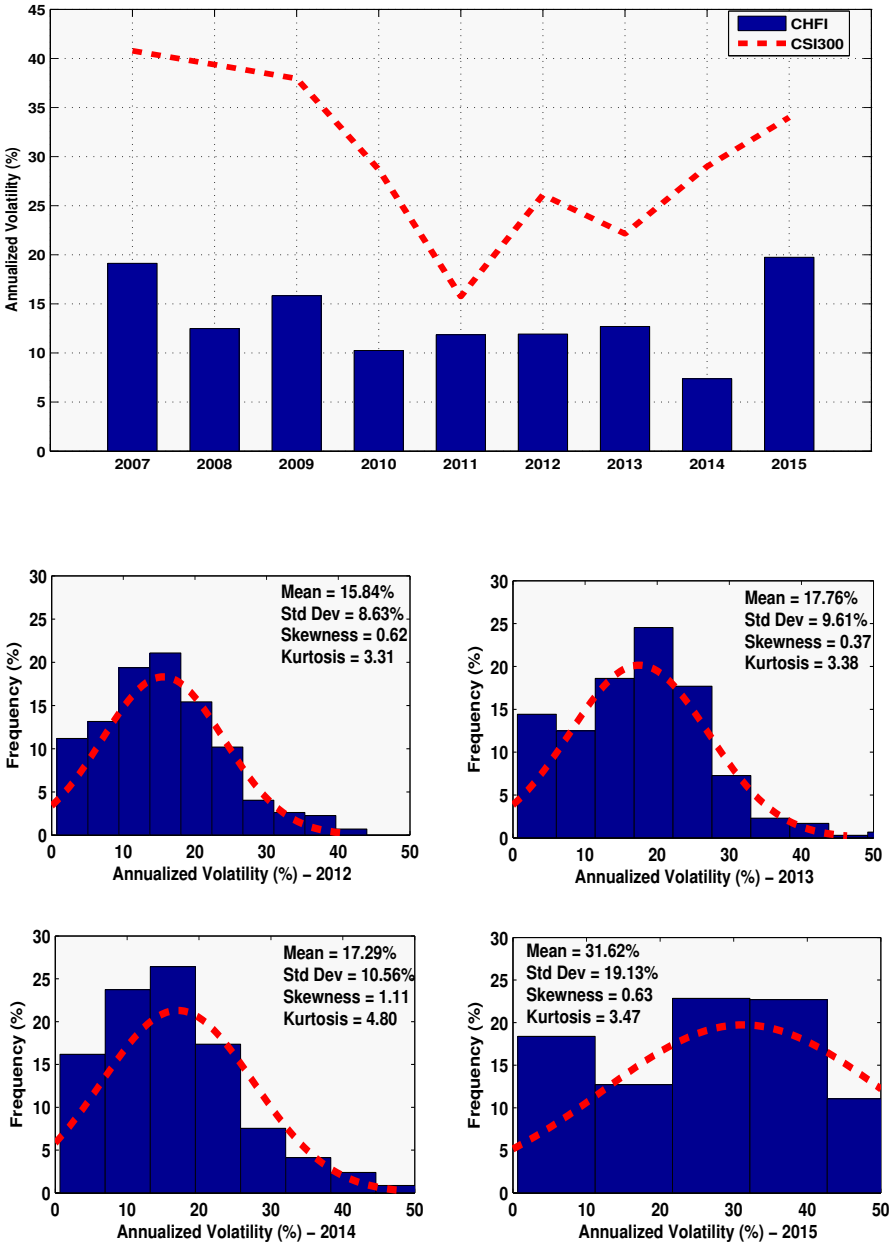

Figure 5: **Time Series and Distributions of Annualized Volatilities of Hedge Funds.** The top panel plots the time series of the annualized volatility of the China Hedge Fund Index (CHFI) in the past nine years, while the four sub-panels below report the empirical volatility distributions of all the sample hedge funds in the recent four years from 2012 to 2015.

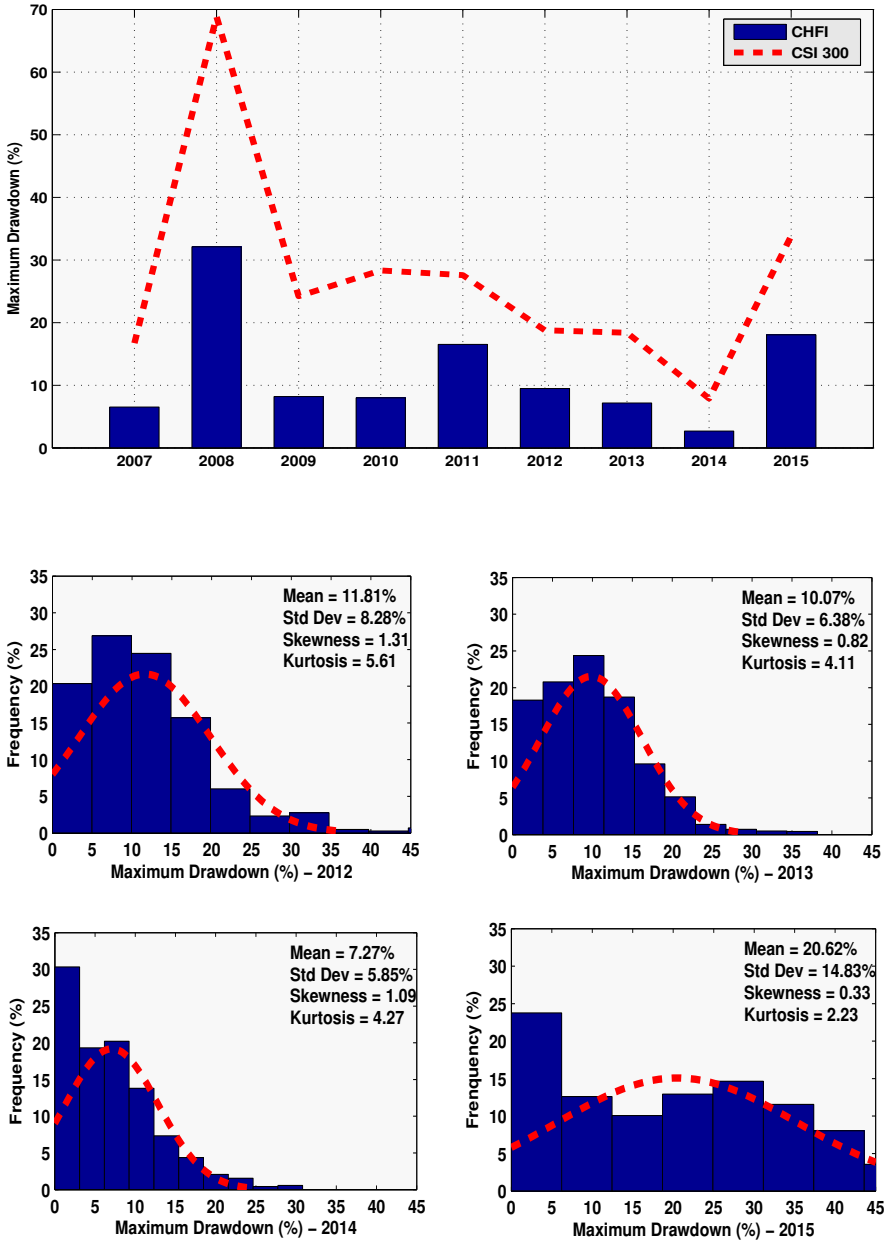

Figure 6: **Time Series and Distributions of Maximum Drawdowns of Hedge Funds.** The top panel plots the time series of the annualized maximum drawndowns of the China Hedge Fund Index (CHFI) in the past nine years, while the four sub-panels below report the empirical distributions of the maximum drawndowns of all the sample hedge funds in the recent four years from 2012 to 2015.

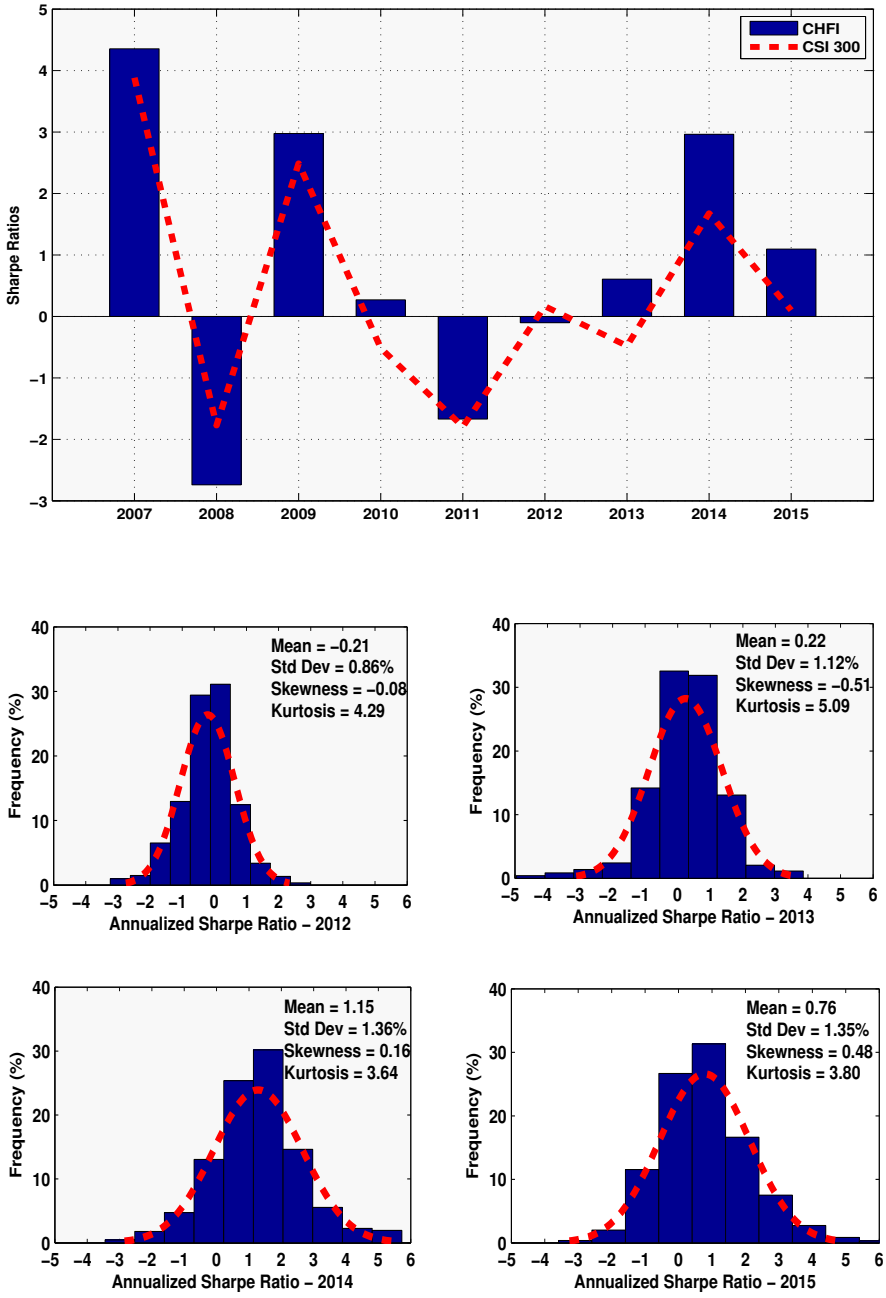

Figure 7: **Time Series and Distributions of Sharpe Ratios of Hedge Funds.** The top panel plots the time series of the Sharpe ratios of the China Hedge Fund Index (CHFI) in the past nine years, while the four sub-panels below report the empirical Sharpe ratio distributions of all the sample hedge funds in the recent four years from 2012 to 2015.

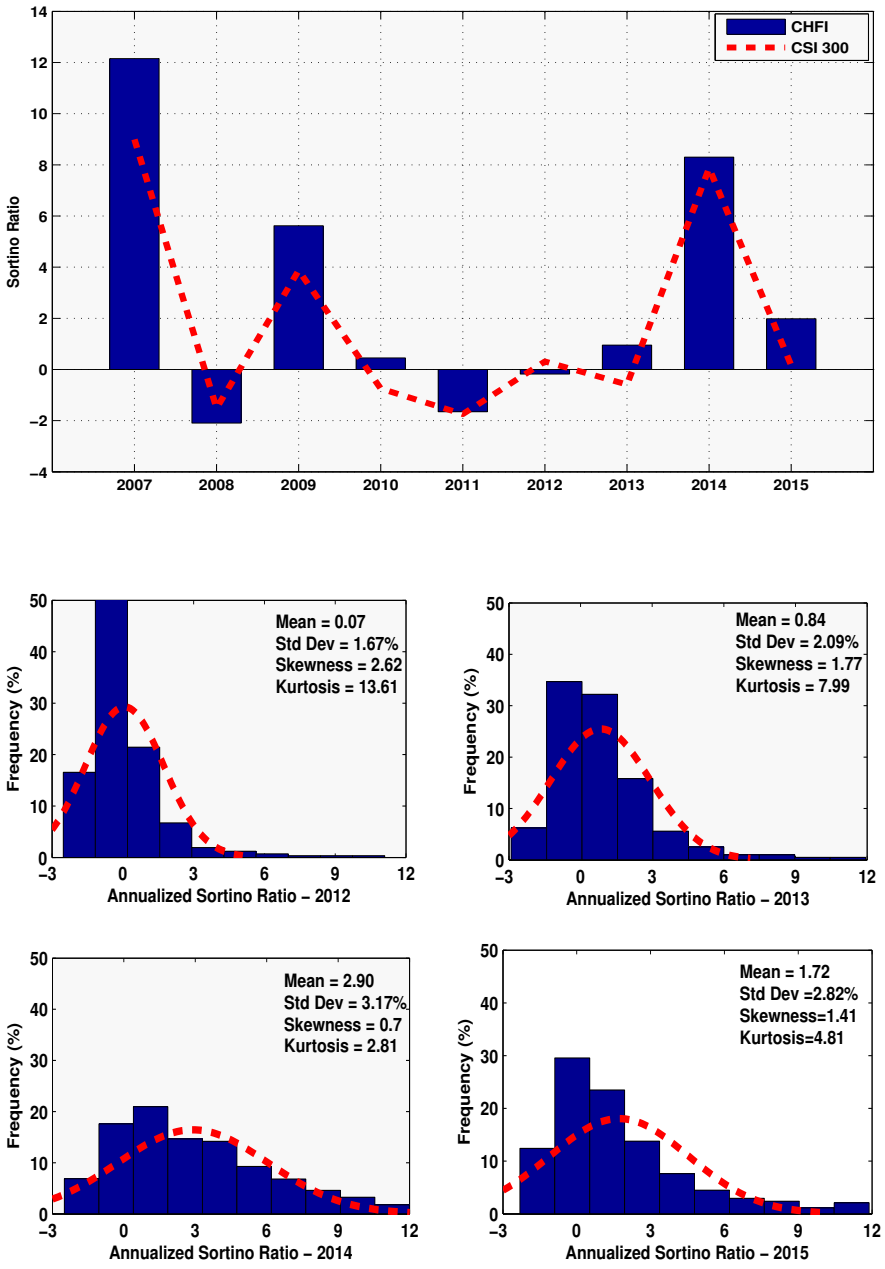

Figure 8: **Time Series and Distributions of Sortino Ratios of Hedge Funds.** The top panel plots the time series of the Sortino ratios of the China Hedge Fund Index (CHFI) in the past nine years, while the four sub-panels below report the empirical distributions of the Sortino ratios of all the sample hedge funds in the recent four years from 2012 to 2015.

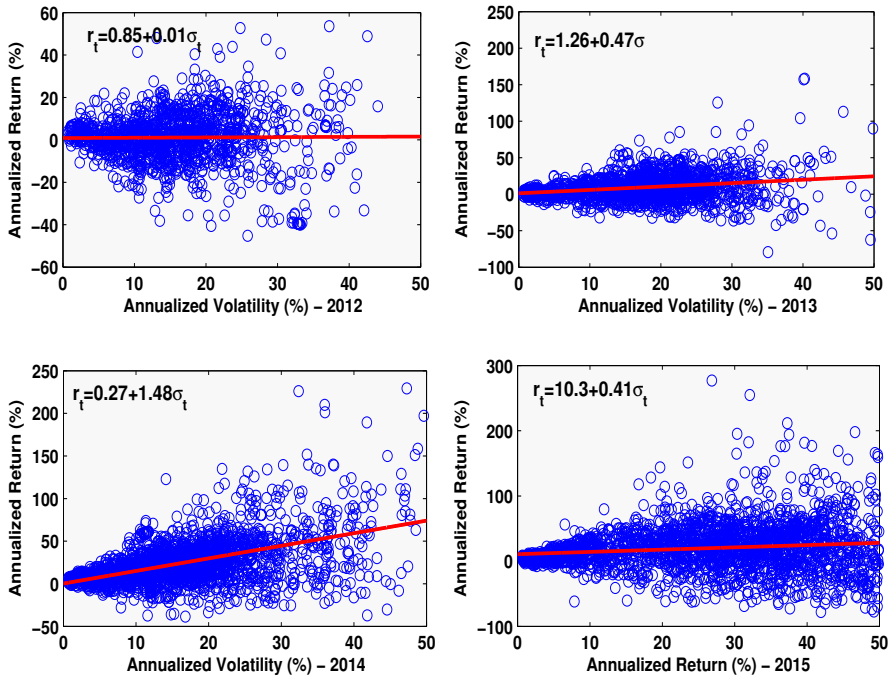

Figure 9: **Scatter Plots of Returns vs Volatilities.** The first four panels show the scatter plots of the annualized returns of all the sample hedge funds against their volatilities in the recent years from January, 2012 to December, 2015. Note that both the return term and the volatility term are scaled up by 100 in the regression denoted by the solid line.

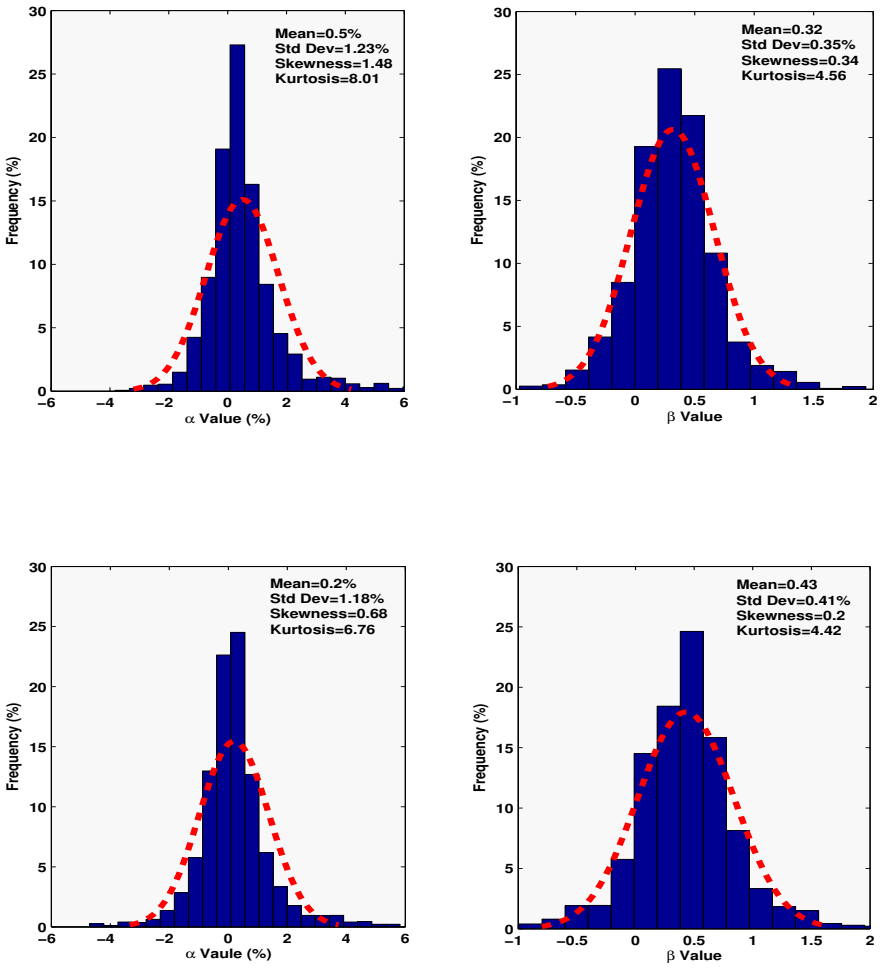

Figure 10: **Distributions of αs and βs with CSI300 Index and Cross-Market Index.** The top panels plots the empirical distributions of αs and βs respectively, when the CSI300 Index is used as the market factor, while the two panels at the bottom plot the distributions of these regression coefficients using the cross-market index as the market factor.

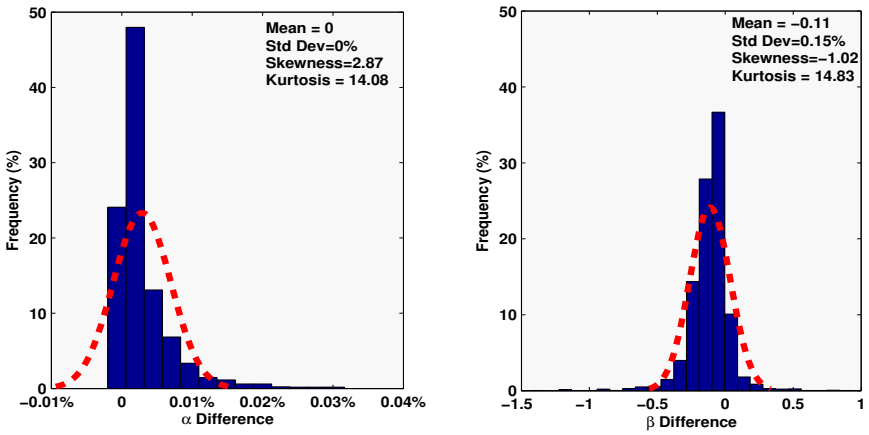

Figure 11: **Differences between αs and βs with Two Market Factors.** The left panel plots the differences between αs estimated from two market indices (e.g., the CSI300 Index and the cross-market index), while the right panel plots the differences between βs estimated from two market indices.

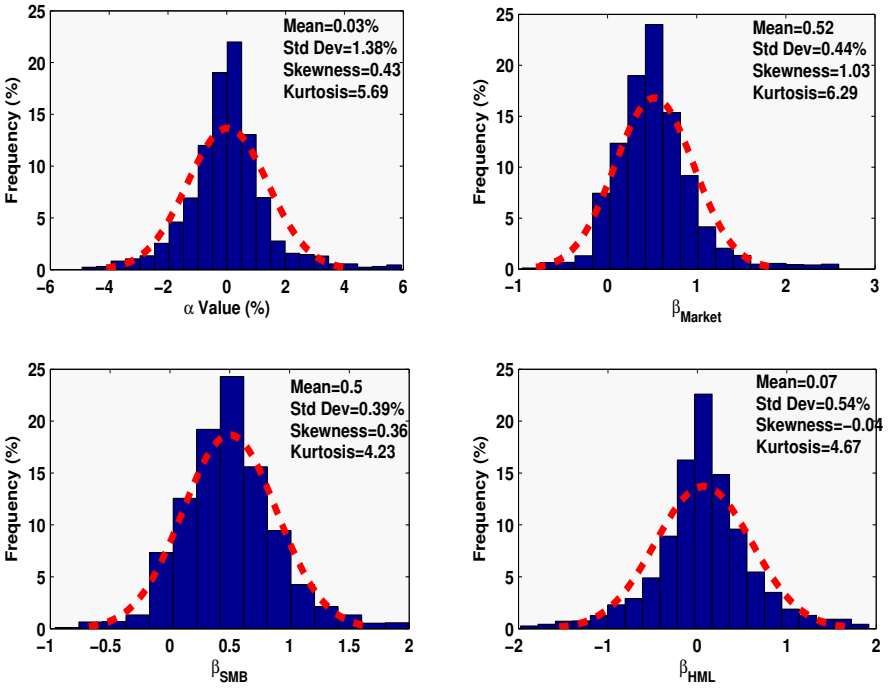

Figure 12: **Distributions of Three Risk Factors in Fama-French Model.** The four panels plot the distributions of the three risk factors (e.g., the market factor, the SMB factor and the HML factor) in the Fama-French model. The sample period is from 2011 to 2015.