Factor Analysis of the Chinese Stock Market

Master's Thesis

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MSc in Economics and Business Administration
- Applied Economics and Finance

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15th of May 2020

Character Count: 181.992

Number of Pages: 80

Copenhagen Business School, Spring 2020

Abstract

Being home to the world's largest population and 2nd largest economy, China has received much attention from abroad in recent years and investors are being recommended to shift parts of their equity allocation into Chinese equities. Hence, this master's thesis has performed a comprehensive factor analysis of the Chinese stock market in order to examine how foreign investors should implement Chinese equities into their portfolios.

By taken the point of departure in the solid theoretical foundation of asset pricing models, the nature of this research paper has been to empirically explore the factor approach in a Chinese setting, which has been neglected to a large extent in past research. In order to conduct such an analysis, a China-specific methodology has been adopted combining state-of-the-art methodology of past research to construct the following risk factors: The market, size, value, momentum, profitability, and investment. However, due to certain limitations, it is only the stocks listed on the Shanghai Stock Exchange that have been analyzed in this study.

Based on a sample period from 2012 to 2020, the study has found that none of the risk factors examined are statistically significant on the Shanghai Stock Exchange. However, as the average returns of the market, value and profitability factors all are relatively high, implementing an investment strategy by buying long the market, value- and robust profitable stocks while entering short positions in growth- and weak profitable stocks will turn out profitable. Importantly to foreign investors, the findings of the study have further outlined that the risk factors depend on the general performance of the stock market. Thus, depending on the investment horizon, risk preference and whether the investor believes it is possible to predict the future performance of the market, the investor should choose to either stay invested in the factors over the long, or implement a dynamic investment strategy that depends on the future market performance. Lastly, the performance of the asset pricing models concludes that the Fama-French five-factor model is the best in explaining the anomalies of the excess returns on the Shanghai Stock Exchange, which supports the need of including these five factors into the investor's investment strategy in order to beat the market; however, the impact of the investment factor is questionable.

Nevertheless, research that includes a longer sample period is needed in order to further enhance the recommendations to investors seeking to benefit from the characteristics of Chinese equities.

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1. Introduction

Emerging markets have received much attention in recent decades due to their economic growth outpacing developed markets. Of these emerging markets, the four countries Brazil, Russia, India and China stood out promisingly and in 2001 they were coined the term BRICs by Goldman Sachs (Marie, 2011). The BRICs were expected to deliver the greatest economic growth worldwide and to become dominant economies by the year of 2050, as they were developing rapidly in the beginning of the twenty-first century (Shum & Tang, 2010).

In particular, during the past four decades, China has been subject to a remarkable growth which the World Bank has described as "*the fastest sustained expansion by a major economy in history*" (Morrison, 2019). After abandoning the policies resulting in an isolated, inefficient and centrally controlled economy, China began implementing gradual market reforms and opening up to foreign trade and investments in 1979. Over the course of development, China had an average real GDP growth rate of 9.5% through 2018 and has lifted about 800 million people out of poverty (Morrison, 2019). In addition, China has become the world's 2nd largest economy – the world's largest measured on a purchasing power parity basis – while the economy has entered the maturity phase in which the Chinese government is embracing a new growth model relying on local consumption, services and innovation. Lastly, China has as of 2019 the world's largest population with about 1.38 billion people and continues to see comparatively high GDP growth rates even as it is slowing down (Paribas, 2019).

Such growth and liberalization policies look good for international investors, who see China as a potential target with outstanding expected returns, correlation benefits, and increased accessibility. However, due to its status as an emerging market and the heavy influence of its government, the capital markets of China work differently than traditional, developed capital markets that are entirely based on market-based capital flows. These differences in microstructure bring some investors in unfamiliar territory and possess challenges in terms of how to navigate through this environment. Therefore, this paper is investigating how international investors should implement Chinese equities using the increasingly relevant asset pricing models, which is a useful tool when examining investment opportunities in capital markets.

1.1. Relevance of the Topic

As mentioned above, China has experienced an incredible economic growth that has positioned it as one of the most interesting emerging markets to international investors who are searching for high returns. According to modern portfolio theory, efficient portfolios are constructed by optimizing the expected return for a given level of risk. Therefore, investors should include several assets in their portfolios with low covariance, as this would lower the overall portfolio risk. In this regard, Chinese equities might pose such an opportunity to foreign investors, as the equity markets in China have a different history and are organized in a different way than the markets of developed countries. Hence, the capital markets of China might be attractive to international investors seeking to add high expected returns and diversification benefits to its portfolio.

Traditionally, access to equity in China has been difficult for foreign investors due to the very gradual transformation process of its capital markets. However, as recent as 2018, China A shares were partial included in the MSCI ACWI and the MSCI Emerging Market (EM) Index, which marked the beginning of the increased accessibility of China's domestic equity markets for all international investors (Wei, 2019). As the inclusion rate of China A shares increased to 20% in 2019, China now constitutes about 33% of the entire MSCI EM Index, which is a higher weight than South Korea, Taiwan and India combined. In a scenario with an inclusion rate of 100% of China A share, Chinese equities would make up more than 40% of the MSCI EM index, suggesting the enormous potential of the domestic capital markets in China for foreign investors (MSCI, 2020). Such a development over the course of only two years have forced international investors to reexamine their portfolios and consider their appropriate allocation of Chinese equities, as Chinese equities have had an underweighted position in global and EM portfolios compared to the economic influence of the Chinese economy (MSCI, 2020). Therefore, by shifting a larger allocation of their portfolios to Chinese equities, foreign investors are now able to get a hold of equities that are linked to the economic growth of China, which both have the potential of delivering high returns and higher diversification to international portfolios (MSCI, 2020). In addition, the domestic Chinese stock market has some unique market characteristics that could be worth exploring for foreign investors.

One increasingly important and widely used tool of analyzing stock markets is asset pricing models. These models are based on a number of different risk factors that can be used in a variety of ways in order to explain stock return and implement investment strategies in practice (Israel & Ross, 2017). Such a factor analysis will analyze anomalies in returns of the Chinse stock market, based on the risk factors, that will allow investors to pursue strategies that will offer abnormal expected returns. By far most of the academic research of factor models has been focusing on developed markets. Therefore, much remain to be explored in emerging markets and in particular in China as its domestic market now has become increasingly accessible, and foreign capital inflows to China are expected to attract USD 400 billion over the next five to ten years (Wei, 2019).

1.2. Research Question

In order to accommodate for this lack of research, this paper aims at further adding research on the Chinese stock market using a factor model approach. This will be done by relying on previous research and combine the most useful methodology in a way that has not been examined before. Hence, this paper aims at answering the following research question.

How should an international investor implement Chinese stocks in a balanced portfolio using a factor approach?

In order to answer this research question, a number of sub questions will be examined throughout this paper, which will assist in answering the research question. The sub questions are listed below.

- How is the Chinese stock market regulated and organized?
- How does the risk-return relationship of the Chinese stock market impact the investor's investment decision for Chinese equities?
- How does the correlation patterns of the Chinese stock market further influence the investment decision?
- What risk factors are present in the Chinese stock market and how do they influence the investor's investment strategy?
- How do factor effects of the Chinese stock market behave and what implications does the behavior have for the investor?
- How do the asset pricing models perform on the Chinese stock market in time series regressions?

1.3. Delimitations and Limitations

Delimitations

Firstly, this paper examines the Chinese stock market from the perspective of a European investor who has a well-balanced equity portfolio mainly containing equities from developed markets i.e. Europe and North America. Secondly, this kind of research that analyses factor models can be set up in infinite different ways, as there exists a number of different risk factors and several different ways to construct each factor. Therefore, it has been a crucial task for this paper to clearly specify what factors are being examined and how they are calculated. This is described in detail in the methodology section.

In addition, transaction costs have not been taken into account for the study of this paper. This means that entering long-short positions of all the stocks examined in this paper is considered to be costless, which is of course not the case in practice. If one took the transaction costs into consideration, it could alter the conclusions of this paper, as the amount of long and short positions could turn out to be expensive if not impossible.

Lastly, this study does not consider currency fluctuations. All the stocks examined on the Chinese stock market are denominated in Chinese renminbi (CNY), and the prices and thereby the returns will consequently fluctuate when converted into the investor's own currency. This fact obviously has a crucial impact on the expected returns for the investor, but due to the scope and relevance of the research question, this will not be taken into account in this study.

Limitations

The biggest factor impacting this study has been the unfortunate development of the COVID-19 situation throughout the Spring of 2020. This has, among many other things, caused Copenhagen Business School (CBS) to close down as of the 12th of March 2020. As this data-driven study is almost exclusively based on stock market and accounting data, all the data used in this study rely on the data that were extracted through the Bloomberg terminal at CBS on the 7th and 8th of March 2020. During the time conducting the analyses, it has therefore not been possible to gather additional data in order to increase the quality. Despite this fact, it has still been possible to conduct an appropriate study with sufficient data that applies to the correct methodology in each analysis. However, a number of things could have been improved if there had been access to the data terminals during the time conducting the analyses. The most important improvements are listed in the following. Firstly, more data from earlier years would have been preferred. As will be explained in the methodology section, this study was able to extract stock and accounting data from 2010 to 2020, and, due to the matching requirements, 90 monthly data observations were used in the factor analyses. Even with the sufficient amount of data, the quality of the findings would have increased if more time series data could have been extracted and analyzed. In addition, this study is only conducting the factor analysis on the firms listed on the Shanghai Stock Exchange (SSE) and not for the entire Chinese market. This is due to the fact that only data of the firms listed on the SSE had been extracted before CBS shut down. Therefore, it has not been possible to include all the firms listed on the Shenzhen Stock Exchange (SZSE) as well, which is crucial for the conclusions. Furthermore, as described in the methodology section, monthly market capitalizations had not been taken out of Bloomberg either before the closing of CBS, which has resulted in a slightly alternative construction of the momentum factor, but largely it is not much different from the original one of Fama & French. Lastly, more appropriate interest rates could have been used as the risk-free rate to increase the overall quality of this study.

1.4. Structure

The structure of this paper is divided into multiple sections that will touch upon various aspects which will assist answering the research question. The paper has been structured in the following manner. The first section of the paper starts off with an introduction to the topic and briefly lay out what the relevance of the chosen topic is in today's modern world. This will lead to the formulation of the research question followed by several sub-questions that will assist answering the research question. Following this, the delimitation, limitations and this overview of the structure of the paper are being outlined. The second section will outline the methodology used in this paper. This includes reasons for every decision made in each of the analyses and is an important section in order to follow and understand the analyses conducted later. The third section includes the literature review, which first will briefly lay out the ideas behind modern portfolio theory and then go through past research of relevant academic work on asset pricing models. The fourth section contains a general analysis of the stock market in China. This will first start off with an introduction to the development and characteristics of the Chinese stock market and then turn to several analyses that investigates the risk-return relationship and correlations between other stock markets. The fifth section is where the analysis of the Chinese equity market using a factor approach will be conducted. It will first start off with the construction and summary statistics of the chosen risk-factors followed by the construction and summary statistics of the dependent variables which are constructed in the format of 5x5 portfolios. This will naturally open up for the time series regressions of the factor models in order to see how effective they are in explaining stock returns of the Chinese equity market. The sixth section contains a discussion of the results, which will compare the results of this paper with the results of previous research, while briefly discuss why risk factors work under the assumption of the efficient market hypothesis. Lastly, this paper will round off with a conclusion that answers the research question and looks at future research.

2. Methodology

Research design

This quantitative research paper has taken a deductive approach with heavy emphasis on using empirical data to test the theories on asset pricing models on the Chinese stock market in order to investigate the implications they have for international investors (Saunders, Lewis, & Thornhill, 2012). By taken the point of departure in the literature of Fama & French among many other researchers, the theoretical foundation is solid but still much remain to be explored and explained especially on the Chinese stock market. Exploring these issues is the nature of this paper, and the quantitative, empirical approach is the basis for the analyses and conclusions.

In the following sections, decisions for all the choices made in conducting this study have been outlined. Most emphasis have been placed on the factor analysis, as this analysis is the backbone of this research paper. However, the methodology section first starts off with explaining the methodical ideas and reasons behind the general analysis on the Chinese stock market as a whole.

2.1. General Stock Market Analysis

The purpose of the stock market analysis is to examine the attractiveness of Chinese equites to the international investors with a well-balanced portfolio. Thus, the analysis is conducted in order to understand why foreign investors might want to implement Chinese equities into their portfolio. The general analysis examines the risk-return relationship of the Shanghai Stock Exchange Composite Index and Shenzhen Stock Exchange Composite Index and their correlation to Western stock markets. Therefore, the analysis has calculated the returns, standard deviations, Sharpe ratios and correlation of the two Chinese indexes and for two Western indexes to put the results into perspective.

Chosen indexes

Four indexes have been used in the comparative analysis that examines the risk-return relationship and correlation of the Chinese stock market. As will be explained in details later, there are differences between the stocks listed on the Shanghai Stock Exchange and the ones listed on the Shenzhen Stock Exchange. Therefore, these indexes are each investigated and compared. The Shanghai- and Shenzhen Stock Exchange Composite Index are two capitalization-weighted indexes that tracks the performance of all A- and B-shares listed on the exchanges according to Bloomberg.

For the comparison to Western markets, the paper has chosen the STOXX Europe 600 Index to represent the European stock market and the S&P 500 to represent the American stock market, as they are comprehensive and largely representative of their equity markets (Blier, Provost, & Wu, 2017). The STOXX Europe 600 Index includes 600 firms across large, mid and small market capitalization companies in 17 European countries (STOXX, 2020); whereas the S&P 500 Index represent the 500 leading companies in the U.S. and corresponds to about 80% of available market capitalization (Bloomberg, 2020).

Risk-free rate

The choice of risk-free rate has been strongly affected by the fact that Copenhagen Business School closed the 12th of March, as highlighted in the limitation section. However, prior to the shutdown, two different interest rates had been extracted through Bloomberg for two different periods due to their availability. The interest rate used as the risk-free rate to calculate the excess returns in the factor mode analysis has been the monthly SHIBOR 3 months rate. SHIBOR stands for Shanghai Interbank Offered Rate and is not available to individual investors. Furthermore, the SHIBOR 3 months was first established in 2007, which meant another rate had to be used in order to calculate the Sharpe Ratios, as they go all the way back to 2000 in the analysis. Therefore, the other interest rate that had been extracted was the CHIBOR 1-month Index and has been used for the calculations of the Sharpe Ratios. The CHIBOR is an older curve that was established in 1996 and stands for the China Interbank Offered Rate (Porter & Xu, 2009).

In an ideal world with data availability, it would have been preferred to have used the rate of Chinese Treasury 1-month bonds, as this would have been the risk-free rate available to individual investors in the Chinese market.

2.2. The Factor Analysis

As the goal of this paper is to evaluate the implications of a factor investment approach in the Chinese stock market, three separate (but yet interlinked) factor analyses will be conducted. By combining the findings of each of the analyses, evidence will determine how investors should implement Chinese stocks into their portfolios. The way the three analyses have been set up and conducted is in line with the most relevant academic researchers in this field, such as Fama & French (1993, 2015), Guo et al. (2017) and Huang (2019) who all conduct similar analyses in order to investigate stock markets using a factor approach.

The analyses will be conducted as follows: the first analysis will construct and analyze the chosen risk factors, which will show whether the factor effects are present and significant in the Chinese stock market and how they can be used to form investment strategies. The second analysis will construct multiple 5x5 portfolios that will be used to further analyze the anomalies in average excess returns of the portfolios in more detail. Lastly, the third analysis is the time series analysis that analyzes the performance of the different asset pricing models on the Chinese stock market. The time series analysis will combine the independent factor variables and the dependent 5x5 portfolios in order to conduct these regressions.

The Risk Factors – Explanatory Variables

Regarding the methodology used in computing the factors of the Chinese stock market, this paper has primarily followed the procedures and methodology of Fama-French that they put forward in their paper from 1993. However, recent research shows that several amendments to the original methodology could be implemented and thereby increase the explanatory power of this study, as it is examining the Chinese stock market. Therefore, this paper combines several methodological contributions from multiple researchers while the main emphasis will be on the procedures of Fama & French (1993).

Firstly, this paper has chosen to include, calculate and examine the most well-established risk factors in the literature, which are the following:

1. The market factor (Mkt-Rf).
2. The size factor (SMB).
3. The value factor (HML).

4. The momentum factor (MOM).
5. The profitability factor (RMW).
6. The investment factor (CMA).

As will be discussed in more detail in the discussion, the idea behind the factors is that they represent anomalies in returns. Anomalies in this regard are patterns of returns that seem to contradict the efficient market hypothesis and therefore certain investment strategies outperforms the market (Bodie, Kane, & Marcus, 2017). However, according to Fama & French (1993), these anomalies (also known as factor effects) can be explained by the additional risk they expose. Hence, the additional returns are risk premiums, and they are therefore also known as risk factors.

The data used to calculate the above-mentioned factors have been extracted from Bloomberg the 7th and 8th of March 2020. The data included ranges between 2010-2020 and consists for all the firms included in the Shanghai Stock Exchange Composite Index. Therefore, this paper only includes and analyzes the factors of the Shanghai Stock Exchange (SSE). This means that it does not include the firms listed on the Shenzhen Stock Exchange (SZSE) which is crucial to note when interpreting the conclusions of this paper. Thus, the firms used in the analysis of the factor models are all the constitutions of the Shanghai Stock Exchange Composite Index in each respective year.

Following Fama-French (1993), accounting data has been retrieved for each firm listed on the SSE at the end of each year between 2010-2020. As the Chinese fiscal year follows the calendar year, the accounting data was extracted on December 31st for each year (Slater, 2017). The following account data has been retrieved: market capitalization, net assets (book equity), total assets, total revenue and EBITDA. In addition, market capitalization has also been taken out for each of the firms in the middle of the fiscal year on the 30th of June for each year. Lastly, monthly total returns over the same period of time for each of the firms have also been retrieved through Bloomberg.

In China, all public firms end their fiscal year by the end of December of year and must submit their annual reports by the end of April (Hu, Chen, Shao, & Wang, 2019). Therefore, the extracted accounting data from year $t-1$ is matched with the returns from July of year t to June of $t+1$. This lag of six months allows for the accounting data to be published and incorporated into the stock prices and therefore also the returns of the stocks (Hu, Chen, Shao, & Wang, 2019). This way of matching the accounting data of the end of the previous fiscal year with the returns of six months into the following year follows the conservative methodology of Fama & French (1992, 1993) as well as more recent literature.

According to the procedures, in order to compute the factors, all the stocks have to be divided into multiple portfolios based on certain firm characteristics depending on which factor that is being calculated (Fama & French, 1993). These portfolios are meant to illustrate the risk factors in returns which are related to the specific firm characteristics (these characteristics will be explained further into this section). However, before this construction can take place, a variety of filters and sorting had to be conducted on the stocks.

First, for each year, all the above data has been sorted for each individual stock. In order words, if a stock had a missing data point for any of the accounting data or returns for year *t*, it has been removed from the analysis. Moreover, stocks of firms that had a negative book equity value have also been excluded from the data set as in line with Fama & French (1993). Lastly, this paper does not exclude financial firms from the analysis as it does not examine the role leverage associated with stock returns as Fama & French do in their research paper from 1992. Instead, this study follows the methodology of the paper published by Fama-French in 1993, which does not consider leverage and therefore all firms from all sectors are included, as it will give a more thorough analysis of the SSE. Therefore, for each factor (apart from momentum) of each year, the exact same stocks have been used, which therefore should give reliable results.

In addition, as the research by Liu, Stambaugh, & Yuan (2019) suggest, 30% of the value of the 30% smallest firms measured on market capitalization stems from the potential reverse merger on the Chinese stock market. Therefore, the value of these firms is not reflected based on the underlying business, but rather due to its status as a shell company. In order to accommodate for this, this paper follows the ideas of Liu et al. (2019) and removes the smallest 30% firms of the data sample in order to remove the value of potential reverse merger.

After sorting the stocks, the portfolios are established. Following Fama & French (1993), six portfolios are formed based on size and the respective factor's firm characteristics in a 2x3 format. Two different HML factors are constructed. The first type of HML portfolios are formed on size and book-to-market equity ratio, whereas the second type of HML portfolios are formed on size and earnings-price ratio. RMW is formed on size and EBITDA-book equity ratio, and CMA is formed on size and the investment ratio, which is the percentage change in total assets from fiscal year *t – 2 to t – 1* (Fama & French, 2015). Lastly, the second variable used to construct the portfolios for the MOM factor is formed on past (12 months minus 1 month) total return of each stock. All of the portfolios are constructed in a 2x3 format; meaning that stocks have been spilt into two groups for size and three groups for the second ratio depending on the factor.

More specifically, all the stocks listed on the SSE have been divided into two groups based on their size which is measured as the market capitalization of the 30th of June of year t. This is done at the end of June of each year t of the period between 2012-2020. The size breakpoint is the median value of all the filtered stocks. Fama & French (1992) argued that forming portfolios on size produces a large spread of average returns and betas based on research by e.g. Chan and Chen (1988).

After the above step, the filtered stocks have been separated into three groups based on the second variable. The breakpoints for the second grouping are 30 % for the button, 40 % for the middle, and the last 30 % in the top of the ranked values of the different ratios. Moreover, when allocating the returns of the different stocks, it is important to note that this has been done in a value-weighted way, which has been based on the market capitalization of June 30th of year *t*. Therefore, six value-weighted portfolios have been constructed based on each of the individual risk factors. However, for the MOM factor, the first grouping on size ideally has to be conducted each month based on the market capitalization for each stock and not just on a yearly basis. This is unfortunately not possible for the paper to do, as CBS had closed down before this monthly data was extracted. As a consequence, this paper has used the yearly market capitalization of year *t* to form the MOM portfolios instead of the monthly. This methodology is not ideal and therefore the conclusions of the MOM portfolios have to be considered carefully. However, the prior returns, which are the most important data for the MOM factor, have been used on a monthly basis and therefore the MOM factor should still be reliable.

Based on the six portfolios for each risk factor, the monthly value-weighted returns are calculated for each month from July of year *t* to June in *t + 1*. This results in 90 observations for each portfolio from the 31st of July 2012 to the 31st of December 2019. The individual, monthly factors are hereafter calculated based on the monthly portfolios. Below, each factor, including its calculation, will be described in more detail (French, 2020).

The market factor is the excess returns of a market index. Therefore, the market factor is made up on a value weighted basis of the Shanghai and Shenzhen Stock Exchange Composite Index, so that it theoretically includes all investable shares on the market.

The size factor (SMB) is the difference in returns of small and large firms in which size is measured as a firm's market capitalization. The SMB factor is calculated as the average return on the nine small portfolios minus the average return on the nine large portfolios. Three of the nine portfolios are the ones used to calculate the HML factor, the other three are the ones used to calculate the RMW factor, and the last three comes from the calculations of the CMA factor.

The value factor (HML) has in this paper been calculated in two different ways, as the theory suggests the appropriate calculation may vary in different markets. The first value factor is based on B/M whereas the second is based on E/P. For each of these, the factor has been calculated as the average return on the two value portfolios minus the average return on the two growth portfolios. To keep it simple, this paper has only used one value factor, which has been calculated as $HML = HML\left(\frac{B}{M}\right) * 0.5 + HML\left(\frac{E}{P}\right) * 0.5$. This way of constructing the factor insures to capture as much as of the possible value effects in the Chinese equity markets, as Guo et al. (2017) found the B/M as the best value measure, whereas Liu et al. (2019) found E/P to be superior.

The momentum factor (MOM) is calculated as the average returns on the two portfolios with high prior returns minus the two portfolios with low prior returns. Essentially, a momentum-based strategy implies investors to go long in past winner stocks and go short in past loser stocks (Huang, 2019). Therefore, a momentum effect is based on the idea that past winner stocks will continue to provide a higher return than the loser stocks.

The operating profitability factor (RMW) has been calculated by subtracting the average returns on the two weak portfolios on the average returns on the two robust portfolios. In this paper, EBITDA has been used as the measure for operating profitability, and the breakpoints for the portfolios are based on EBITDA divided by the firm's book value of equity.

The investment factor (CMA) is the average return of the two portfolios with conservative investments minus the average the two portfolios consisting of the firms that have made heavy investments in the previous year. As a measure for investments, this paper uses the change of a firm's total assets from the end of the fiscal year of y_{t-2} to y_{t-1} for year t.

As can be seen in the calculations of each factor, they have been constructed using a long-short approach. Therefore, this paper assumes that the investors are able to short every available stock listed on the SSE, which is probably not the case in practice, as can be inferred from the section on the Chinese stock market.

Much of the theory, as explained in the theoretical overview, suggest that when using empirical asset pricing models to explain average stock returns, local version of the models perform better than global ones. Therefore, this paper conducts research based on a local version of the factor models and do not consider global versions.

The 5x5 Portfolios – Dependent Variables

The purpose of constructing 5x5 portfolios is to dip deeper into the factor effects and anomalies in average returns on the Chinese market. By constructing the portfolios on a 5x5 double sorting basis, it allows the subsets to produce large spreads of its two variables that enables the process of investigating anomalies in the return patterns.

Just as for the risk factors, this paper takes the point of departure in the original procedures and methodology of Fama & French (1993). The methodology for constructing the 5x5 portfolios follows the same ideas as for constructing the portfolios that are used to construct the factors. This means that all the sorting and matching of accounting data with the stock returns are done in the exact same way as explained above. However, instead of forming the portfolios on a 2x3 format, these portfolios are formed on a 5x5 basis, which therefore results in 25 sorted portfolios.

Three 5x5 portfolios are constructed, which are double sorted on five size quintiles and either five B/M, EBITDA/B or change in assets quintiles of excess stock returns. Therefore, one 5x5 portfolio is based on size and B/M, one is based on size and profitability, and the last one is based on size and investments. Each of these 5x5 portfolios are designed to analyze the anomaly in returns related to the specific variables they are formed on. As for the independent portfolios, these have been calculated on a value-weighted basis with the same monthly returns. Therefore, each of these portfolios have 90 data points showing average excess returns as well.

Times Series Analysis

By combing the explanatory factor variables with the dependent variables in the 5x5 format, the time series analysis analyzes how well the chosen asset pricing models perform in explaining the average excess returns on the Chinese stock market. Due to the findings of the first factor analysis, the following four factor models have been chosen for this comparative analysis: **(1)** Capital Asset Pricing Model, **(2)** Fama-French three-factor model, **(3)** Carhart four-factor model and **(4)** Fama-French five-factor model (Munk, 2018).

$$r_i - r_f = \alpha_i + \beta_{i,m}(r_m - r_f) + \epsilon_i \tag{1}$$

$$r_i - r_f = \alpha_i + \beta_{i,m}(r_m - r_f) + \beta_{i,SMB}SMB + \beta_{i,HML}HML + \epsilon_i \tag{2}$$

$$r_i - r_f = \alpha_i + \beta_{i,m}(r_m - r_f) + \beta_{i,SMB}SMB + \beta_{i,HML}HML + \beta_{i,MOM}MOM + \epsilon_i \tag{3}$$

$$r_i - r_f = \alpha_i + \beta_{i,m}(r_m - r_f) + \beta_{i,SMB}SMB + \beta_{i,HML}HML + \beta_{i,RMW}RMW + \beta_{i,CMA}CMA + \epsilon_i \tag{4}$$

In the above models, r_i is the expected return on asset i; r_f is the risk-free rate; β_i is the sensitivity of the factors on the return on asset i; α_i is the alpha of the return of asset i; ϵ_i is the error term.

The analysis is conducted by regressing each of the asset pricing models on each of the three 5x5 portfolios. As this paper is testing four different asset pricing models, this means that a total of 300 regressions are run in order to test the performance of the models across the anomalies in returns. The analysis uses standard ordinary least square (OLS) uni- and multivariate regressions to evaluate the performance of the models as in accordance with Fama & French (Stock & Watson, 2015).

3. Literature Review

3.1. Foundation of Modern Portfolio Theory

Modern portfolio theory is grounded in the famous work of Harry Markowitz (1952) "Portfolio Selection", which has laid the foundation for much modern finance literature (Fama & French , 1992). In his paper, Markowitz (1952) argues that in selecting a portfolio of securities, the investor must include the concept of diversification. Essentially, investors cannot simply maximize discounted expected returns, as it leaves out important aspects in explaining investment behavior. Therefore, Markowitz (1952) suggests that all rules of investment behavior that do not emphasize the importance of diversification must be rejected. This leads him to propose the 'expected return-variance of return (E-V) rule' as an explanation to investment behavior, which implies diversification for a range of expected returns and variances. Hence, for the optimal portfolio selection, the investor should optimize the relationship between a maximum return given a distinct variance. Doing this, the investor will get an efficient portfolio in which he cannot obtain a higher expected return without also increasing his risk. In practical terms, this means that the E-V rule tells investors that in order to obtain an optimal portfolio they should not just invest in many securities; but rather they should invest in securities with low covariance between each other (Markowitz, 1952). Therefore, investors need to diversify their securities across different industries or even countries as they typically have lower covariance due to different economic characteristics. These ideas gave birth to the concept of 'mean-variance analysis', which is a tool to determine optimal portfolios based on expected return given a certain variance (Munk, 2018). The concept of mean-variance has been the basis of the research on asset pricing models, and the models are inspired by this concept.

3.2. Asset Pricing Models

The field of asset pricing has a long history that includes many academic contributors. As the field became increasingly popular in the 1960s, the development of empirical models that could explain the behavior of capital markets took off.

Based on the work of Markowitz (1952), scholars such as Treynor (1961), Sharpe (1964), Lintner (1965) were some of the first to influence the academic and practical field of asset pricing (Fama & French , 1992). The most remarkable work of the three above-mentioned scholars was their development of the mean variance capital asset pricing model (CAPM), which is an analytical model used for pricing capital assets under conditions of market equilibrium (Black, 1972) (Ross, 1976). The CAPM has been, and still is, an important analytical tool used to price individual capital assets (Ross, 1976). The equation for the CAPM is shown in the methodology section as equation **(1)**.

The CAPM has been derived based on several important assumptions that are crucial for investors to understand when examining investment opportunities using this pricing model. The assumptions are listed below (Black, 1972):

1. *"All investors have homogenous expectations relating to returns for all assets".*
2. *"The common probability distribution describing the possible returns on the available assets is join normal".*

3. *“Investors choose portfolios that maximize their expected end-of-period utility of wealth, and all investors are risk averse”.*
4. *“An investor may take a long or short position of any size in any asset, including the riskless asset. Any investor may borrow or lend any amount he wants at the riskless rate of interest*”.

The assumptions of the model are somewhat restrictive and not comparable to the real world. However, Lintner has shown that the first assumption could be removed without altering the structure of capital asset pricing model (Lintner, 1969). On the other hand, the fourth assumption is according to Black (1972) the least good approximation for many investors which could alter the model in case it would be excluded. In addition, Ross (1976) criticizes the restrictiveness of the assumptions that the mean variance model is built upon. In particular, he mentions the assumption of normality in returns is difficult to justify (Ross, 1976).

The rationale behind the CAPM is that it revolves around the market portfolio, which is the portfolio containing all risky assets in the economy (Munk, 2018). The model has a linear relationship which stems from the assumptions of mean variance efficiency of the market portfolio and is based on the ideas of Markowitz (Ross, 1976). In addition, it is a market equilibrium model in which the market beta is the only asset-specific determinant that describes the asset’s risk premium. According to the CAPM, the optimal way of investing is by holding a combination of the risk-free asset and the market portfolio (Munk, 2018). Therefore, the different combinations of the two is only determined by the individual investor’s risk preference.

Turning to the empirical tests in order to see how the model works in practice, early studies of the CAPM have shown that the model do not correctly explain the returns on securities. Firstly, in his memorandum, Shannon Pratt concluded that stocks with a high level of risk do not provide the additional return that the CAPM suggest over the period between 1926-60 (Black, 1972). Secondly, another study during the period between 1960-68 finds contradicting relationships when comparing to the CAPM; namely the authors find that portfolios containing a high level of risk performs poorly, whereas low-risk portfolio performs well (Friend & Blume, 1970). Thirdly, Miller and Scholes even find a negative relation between risk and performance (Black, 1972).

In addition, Black, Jensen and Scholes also get returns that are contradicting the CAPM (Black, 1972). In their paper, the returns of stocks with a low level of beta is higher than what is suggested by the

CAPM, whereas stocks with a high level of beta provide a consistently lower return than the CAPM (Black, Jensen, & Scholes, 1972). This means that stocks with a high level of beta have negative alphas and low-beta stocks have positive alphas. As a result, the scholars find that a model with two factors instead of only the market beta explains much better the behavior of diversified portfolios when the assumption of riskless borrowing and lending opportunities is relaxed. The two-factor model is the same as the CAPM but also contains the return on a portfolio that has zero covariance with the return on the market portfolio. The results, using this model, does conclude that the mean of second portfolio was significantly greater than zero (Black, 1972). The two-factor model therefore is better at explaining the securities behavior than the CAPM.

The three-factor model – Fama & French

Fama & French (1992) also summarize several empirical contradictions of the CAPM and how adding additional factors to the model makes it better at explaining the behavior of capital assets. The most notably is the study by Banz (1981) in which he examines the relationship between stock return and the market value of the respective stock over the period between 1936-1975. The findings of his studies conclude that the stock of small firms provided a higher risk-adjusted return on average than the stock of large firms (Banz, 1981). He refers to this phenomenon as the ‘size effect’. Therefore, adding a factor that can explain the size effect would increase the level of explained average returns given the market beta of the stocks (Fama & French , 1992).

Other studies during the 1980s have found a positive relationship between average return on common U.S. stocks and their respective ratio of the firm’s book value of equity to its market value (Rosenberg, Reid, & Lanstein, 1985). This relationship is known as the book-to-market equity (B/M), and has also been confirmed to hold in the Japanese stock market (Fama & French , 1992).

In addition, Fama & French (1992) investigates a number of variables and examines how they explain the cross-section of average returns on American stocks. These variables are market beta, size, earnings-price ratio (E/P), leverage and B/M (Fama & French , 1992). They test these variables during the period of 1963-1990 and find that the market beta does not help explaining the average stock returns, whereas size, leverage, E/P and B/M do have strong relations to average return when conducting univariate tests. Considering multivariate tests, the results show that by combining size and B/M they absorb the effects of E/P and leverage in average returns. Therefore, Fama & French

(1992) argue that size and B/M are two variables that each proxies a dimension of risk of stocks in the American market. One possible explanation of the risk dimension that is captured in the B/M variable is that firms with poor prospects, and therefore low stock prices and high B/M ratios, have higher expected returns than firms with better prospects (Fama & French , 1992). In conclusion of their paper, the authors emphasize that the size and B/M variables are good estimators of the cross-section of average stock returns in the U.S.

In 1993, Fama & French further extent their research on the above variables and publish their groundbreaking work in which they formalize what is today known as the 'Fama-French three-factor model' (Fama & French , 1993). Their paper focuses both on stocks and bonds relating to their common risk factors, however, for the purpose of this thesis, emphasis will only be placed on their research regarding stocks. The way Fama & French continues their research on the two factors of size and B/M is by adopting the time series regression approach put forward by Black, Jensen and Scholes (1972) in order to test asset pricing models. Using this method, Fama & French regress monthly returns on stocks on the returns of a market portfolio and mimicking portfolios for size and B/M. This enables the authors to create time series regression slopes that have clear interpretations as risk factor sensitivities for the stocks (Fama & French , 1993). Their three-factor model is shown in the methodology section as equation **(2)**.

Regarding the stocks examined in their paper, the main results show that the three-factor model explains the cross-section of average stock returns on their data sample well (Fama & French , 1993). More specifically, Fama & French (1993) find evidence that size and B/M do mimic the sensitivity to common risk factors in stock returns, and that the portfolios based on SMB and HML capture much of the variation of the stock returns. The three-factor regressions produce alphas that are close to zero; meaning that the model explains much of the average stock returns (Fama & French , 1993). Dipping deeper into the regressions, it is evident that adding the market factor into the equation helps explain the difference between average returns on the stocks and the one-month treasury bill, and that the betas on the market factor are close to one for all their stock portfolios.

In 1998, Fama & French turns to the international perspective in their studies. Firstly, they classify firms with a high B/M or E/P (earnings to price) ratio as value stocks, whereas firms with low ratios are known as growth stocks (Fama & French, 1998). Furthermore, Fama & French (1998) state that value stocks have a strong premium in average returns for stocks listed in the U.S., and that this premium is associated with relative distress since value firms tend to have low earnings. In contrast, growth stocks are usually firms with strong earnings and therefore do not provide a premium (Fama & French, 1998). Baring these results in mind, Fama & French extent the research into twelve major countries within Europe, Australia and the Far East to examine if the similar patterns exists.

In conclusion, Fama & French (1998) confirm that value stocks produce higher returns than growth stocks in by far the majority of markets examined over the period of 1975–1995. More specifically, they find that the average returns on global portfolios of value stocks are 7.68% per year higher than for growth stocks. Finally, this value premium can be explained by a relative distress factor just as the U.S. listed stocks (Fama & French, 1998). Interestingly for the research of this paper, Fama & French emphasize that there also exists a value premium in emerging markets.

The four-factor model – Carhart

Additional factors that can explain the average returns of stocks have also been implemented into three-factor model by various researchers. In 1997, Carhart examined a four-factor model in which he added a momentum (MOM) factor to the traditional Fama-French model (Carhart, 1997). He argues that the MOM factor captures the variation of momentum-sorted portfolio returns. In his study, Carhart (1997) examines whether common factors in stock returns can explain the returns of equity mutual funds. He argues that the four-factor model including the MOM factor reduces the errors in average pricing of both the CAPM and the three-factor model, which suggests that it explains the cross-sectional variation in average stock returns better compared to the other models. Therefore, it is beneficial to consider and include the MOM factor. The formula is shown in the methodology section as equation **(3)**.

The rationale behind the MOM factor is that stocks that have done well previously will continue to do so and thereby outperform those that have performed poorly (Fama & French, 2012). Therefore, the MOM factor is the return on the winner stocks over the past year minus the return of the losers (Fama & French, 2012).

Fama & French later follow the approach by Carhart in their research and expand their research of factor models to the international markets. In 2012, they investigate value premiums in average returns and whether a four-factor model including the momentum factor is able to capture the value and momentum patterns in the four regions of North America, Europe, Japan and Asia Pacific (Fama & French, 2012). Prior to this study, other researchers have found that the four-factor model do not fully capture all the momentum in U.S. average stock returns (Avramov & Chordia, 2006). When interpreting the results of this research by Fama & French, it is important to keep in mind that the Asia Pacific region only accounts for 4.3 % of the global market capitalization in their research compared to 47.3 % for North America.

Firstly, Fama & French (2012) find value premiums in average returns in all of the regions examined, which supports earlier studies. There are additionally strong momentum returns in every region apart from Japan (Fama & French, 2012). What have not been proved before is that international value and momentum returns changes with size of the firm. Apart from Japan, small stocks tend to have larger value premiums, and the returns of the momentum factor are also higher for small stocks compared to big ones. Moreover, their results suggest that the HML and MOM portfolios are not being explained very well by global factor models. Therefore, Fama & French (2012) turn to local versions of the four-factor model and find that this model does a better job in explaining average returns on portfolios based on size and B/M; however, it is still not as successful in capturing portfolios based on size and momentum. The latter part is due to the fact that these size-momentum portfolios have some very extreme values in the winner or loser portfolios. Therefore, the issue regarding the momentum portfolios does create problems for the four-factor models (Fama & French, 2012).

The Five-Factor Model – Fama & French

In 2015, Fama and French started examining how other factors potentially could increase the explanatory power of their original three-factor model. As earlier research indicate, the profitability and investment patterns of stock returns have not previously been explained (Fama & French, 2015). Therefore, these are the two variables that the researchers include in their five-factor model, which has been shown in the methodology section as equation **(4)**, and the description of the factors can be found in the methodology section. However, originally, Fama & French (2015) measures profitability of a firm as "*annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses, all divided by book equity*", and not as EBITDA/B, as this paper has used.

In the research, Fama & French (2015) firstly find that their GRS tests for the five-factor model is rejected; meaning that the alphas of all the regressions are not zero. However, the model still explains between 71 % and 94 % of the cross-section variance of the returns for the portfolios based on size, B/M, profitability and investment; showing that it explains more variations than their three-model factor. However, the five-factor model has a problem in explaining the returns patterns of small stocks, which are characterized by having low average returns and behave like firms with a high level of investment despite a low level of profitability. Lastly, Fama & French (2015) find that the value factor becomes redundant for describing average returns when the profitability and investments factors are added into the model.

Two years after the publication of their five-factor model, Fama & French test it in international markets (Fama & French, 2017). Firstly, they conclude that global versions of the model perform poorly when testing on the different regions throughout the world using data between 1990 - 2015. Therefore, Fama & French focus on local versions in this paper. In addition, average returns increase with B/M and profitability but decrease with investment in the markets of North America, Europe and Asia Pacific. In the Japanese market, the same patterns can be found for average returns and B/M, however, there are no substantial patterns between average returns and profitability or investment. Furthermore, all factors increase the explanatory power of average returns for North America, however, for Europe and Japan the investment factor is redundant. In general, the results are very similar to the ones they find in 2015 for the U.S., which says that the five-factor model captures a large proportion of the variation of average returns while it fails to fully explain the low returns of small stocks that behave like firms with a low profitability while maintaining a high level of investments (Fama & French, 2017).

Factor models in China

Traditionally, there have been conducted very limited analyses of cross-sectional returns on the Chinese stock market even though it is now the second largest in the world (Hu, Chen, Shao, & Wang, 2019). For the purpose of this paper, very recent research of factor models has been conducted on the Chinese equity market as it has undergone a remarkable expansion and been subject to a variety of reforms. The findings of the recent research will be outlined below.

The work by Grace Xing Hu et al. (2019) examines the traditional size and value factors of Fama-French in Chinese stock returns. They examine stock returns over the period between 1995-2016, and find that the size-return relation does also exist in the Chinese market, in which average return on small firms is larger than for large firms (Hu, Chen, Shao, & Wang, 2019). On the other hand, regarding the value factor, which they calculate as B/M, they find no relationship in average returns. The time series regression analysis of the article shows that the three-factor model captures much of the variation of the stock returns in the Chinese market with significant alphas and high explanatory values. However, size continues to be the stronger factor in explaining the average stock returns. As a conclusion, Hu et al. (2019) state that the insignificant value effect contradicts earlier studies that do find a value effect. However, they explain this difference stems from several months of extreme values in the early years of their sample period in which the market only consisted of few stocks with high levels of volatility (Hu, Chen, Shao, & Wang, 2019).

The recent and much appreciated work of Bin Guo et al. (2017) tests the Fama-French five-factor model on the Chinese stock market. For the HML factor, the authors end up using B/M after accessing different options, and the profitability factor is based on return on equity (ROE) while the rest of the factors are calculated as in the original papers by Fama-French. For average stock returns, they find strong size, value and profitability patterns but weak for investment (Guo, Zhang, Zhang, & Zhang, 2017). More specifically, average returns decrease with size and increase with B/M and ROE. Moreover, the profitability factor does improve the model in explaining average returns, whereas the investment factor only adds limited value. In fact, the investment factor is redundant. Lastly, Guo et al. (2017) find the profitability factor is important for empirical asset pricing models in the Chinese stock market.

Building on the work of Guo et al. (2017), Tzu-Lun Huang (2019) tests whether the five-factor model by Fama & French is robust in the Chinese stock market and if differences in the microstructure of the market changes the performance of the models. Huang (2019) states that earlier studies, including the pioneering study of Guo et al. (2017), on the Chinese market fails to take conditions specific to the Chinese market into account when accessing it using asset pricing models. Therefore, the paper examines the differences in the shares traded on the SSE and the ones traded the SZSE, and also how the share-structure-reform of the Chinese market has impacted the explanatory power of asset pricing models (Huang, 2019).

The study considers data over the period between 1994-2016 and covers the traditional Fama-French three- and five factor models as well as the four-factor model of Charhart (1997). Furthermore, the study studies returns on individual stocks as opposed to earlier research that examines returns on portfolios as the dependent variable (Huang, 2019). In conclusion, Huang (2019) find that the five-factor of Fama & French performs better, as the RMW and CMA factors improve the model. Secondly, the size effect is significant in each of the different analyses, whereas the value effect is not existing on the SSE while being weak on the SZSE. The CMA factor is negative on the SSE and positive on the SZSE, which the author explains by the possible differences in market microstructure (Huang, 2019). It is also found that the MOM factor seems to be insignificant for the Chinese stock market. Considering the differences between the two stock exchanges, it is shown that the two exchanges are segmented in model performance; meaning all the impacts of the factors on the SSE are different from the impacts they have on the SZSE. However, the R^2 is much higher for the SSE than for the SZSE. In addition, the Share-Structure-Reform of 2005 causes a structural change and thereby strengthens the performance of the models post the implementation of this reform. Lastly, Huang (2019) stresses the importance of research using Chinese-specific factors, as the factors his research used were based on the original Fama-French factors.

One of the most relevant articles relating to empirical asset pricing models in China is the work by Jianan Liu et al. (2019). In this work, the authors adopt a China-specific methodology which is based on the original procedures of Fama and French (1993) but contains several modifications (Liu, Stambaugh, & Yuan, 2019). Such modifications are needed in order to increase the explanatory power of the factor models in the Chinese equity market as it is different from the American market on several aspects and also requested by Huang (2019).

The authors argue that simply applying a Fama-French U.S. three-factor model on the Chinese market does not capture the entire story due to the separation of China and its many differences relating to the economy and financial systems (Liu, Stambaugh, & Yuan, 2019). Therefore, in order to construct size and value factors, they suggest several modifications. Firstly, for the size factor, Liu et al. (2019) state that it is important to remove the bottom 30% of the entire sample of stocks. This is due to the fact that the initial public offering (IPO) process is very regulated in China while there is a growing demand for private companies to go public. Therefore, such firms seek alternative methods to become public such as a reverse merger (Liu, Stambaugh, & Yuan, 2019). A reverse merger is a situation in which a private firm acquires a publicly traded company (a shell company) and gains control over it. Then, the shell purchases all of the assets of the private firm by exchanging newly issued shares. According to the researchers, this phenomenon is very common in China due to the tightly regulated IPO constraints. As a result, the shell firms in China are typically very small firms as they are easier to acquire. 83% of all reverse mergers are relying on shell companies from the smallest 30% firms in China. Therefore, the stock of small firms do not only reflect the value of its underlying business; instead, they also reflect the value of a potential reverse merger (Liu, Stambaugh, & Yuan, 2019). In fact, the authors estimate that 30% of the value of the stocks in the bottom 30% of the market stems from the value of a potential reverse merger. In order words, almost one third of the value of the stocks in the bottom 30% is not related to its underlying business. In conclusion, Liu et al. (2019) removes the bottom 30% of stocks when constructing any of the factors in their paper. These 30% stocks correspond to 7% of the entire market capitalization.

In relation to the value factor, Liu et al. (2019) examine different ways of construction relating to the Chinese market characteristics. They test B/M, E/P, asset-to-market, and cash-flow-to-price, and end up concluding that E/P ratio dominates the others in the Chinese market – as in contrasts to the US market in which Fama & French (1992) finds that the B/M dominates. Hence, they argue that E/P is better to use to construct the value factor for the Chinese market.

Regarding their conclusions of the paper which contains monthly returns for the period between 2000-2016, Liu et al. (2019) firstly find that both size and value factors are important in China with both factors have average premiums larger 12% per year. Furthermore, each factor explains about 15% of variance of average returns. Secondly, they compare their China-specific three-factor model to an ordinary Fama-French three-factor model. In this comparison, they find that the China-specific model produces much smaller alphas than the ordinary model does. Specifically, the alphas of the size and value factor of the China-specific model are -0.5% and 4.1% respectively, whereas they are 5.6% and 16.7% respectively for the ordinary model (Liu, Stambaugh, & Yuan, 2019). Therefore, the China-specific model is clearly performing better in the Chinese market. Lastly, Liu et al. (2019) find that the anomaly related to profitability is explained by their China-specific factor model and that investment is not producing a significant alpha in the Chinese market. Consequently, they conclude that their China-specific three-factor model is dominating the original Fama-French three-factor model in China (Liu, Stambaugh, & Yuan, 2019).

4. General Analysis of the Stock Market in China

In the following part, several analyses on different aspects of the Chinese stock market will be conducted. First, the background and development of the Chinese stock markets will be outlined. This will be followed by analyses that examine the price development, the risk-return relationship and the exact correlation characteristics of the equity markets in order to examine how these attributes are influencing foreign investors' decision to invest in Chinese equities.

4.1. Background, Development and Characteristics

The contemporary stock market in China is much newer and has some distinctive features compared to more developed Western markets such as differences in market structures, government regulation, information asymmetry and investor composition (Huang, 2019). It was not until 1990, with the reforms and 'opening up' policies of Deng Xiaoping, that the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) were established (Paribas, 2019). Initially, the stock markets were small with only eight firms listed consisting of a total market capitalization of about USD 500 million. Due to the heavy influence of the Chinese state, the stock markets were much regulated and primarily used for state-owned enterprises (SOEs) to become privatized (Carpenter, Lu, & Whitelaw, 2019). At the time, two-thirds of outstanding shares were not tradable due to the government's heavy influence on SOEs. This left only one-third of the equity to private shareholders, which made the privatization process and initial public offerings (IPOs) a very gradual process (Valukonis, 2013). Therefore, in the early years of the modern Chinese stock market, it was primarily used as a platform for the government to fund its SOEs.

Over the years, the Chinese stock market has developed significantly, as the total number of listed firms on the two exchanges increased to 1060 by 2000 and to 3034 by 2016 (Hu, Chen, Shao, & Wang, 2019). In 2019, the stock market in China had become one of the largest equity markets in the world with more than 3600 stocks listed resulting in a market capitalization of about USD 9.3 trillion on the two exchanges (Paribas, 2019). Only the Nasdaq and the New York Stock Exchange are larger than the Chinese stock market with market capitalizations of respectively USD 11 trillion and USD 25 trillion.

One of the features unique to the Chinese stock market is the classification of different share classes (Hu, Chen, Shao, & Wang, 2019). The different kinds of shares are known as A-, B- and H shares. The A shares were initially only available for Chinese nationals and denominated in renminbi (RMB). B shares were open to foreign investors while primarily being denominated in USD on the SSE and HSK on the SZSE. Lastly, H shares are the shares of the mainland China-registered companies that are listed on the Hong Kong Stock Exchange (HKEX).

However, during its rapid development and short history, the equity markets in China have been subject to various reforms and easing of regulations which have in some respects changed the original structure (Li, 2012). During the first years, the stock exchanges had limits on daily stock price movements of 10% in order to keep the volatility down due to speculative behavior by individual investors. In a further attempt to formalize and improve the stock market, the securities law was passed through in 1999 aiming at protecting investors and improve governance (Li, 2012). However, it was not until 2005, that the government implemented the Share-Structure Reform that sought to fix the limitations of the non-investable shares that belonged to the government and which caused inefficient allocation of resources. This reform transformed the stock trading into a market-based process that was based on supply and demand and the restrictions on the non-investable shares were lifted (Huang, 2019). From an international point of view, this reform has helped increased the similarity of fundamental market mechanisms between the Chinese- and developed stock markets (Li, 2012).

In order to further liberalize the Chinese equity markets, the Chinese government lifted regulations that prohibited domestic investors trading B shares, and foreign investors became eligible to trade A shares in the beginning of the 2000s (Li, 2012). The latter part was due to the implementation of the Qualified Foreign Institutional Investors program in 2002. Four years later, a similar program was implemented that allowed domestic institutions to invest overseas which also helped increase the mobility of cross-border capital. As these reforms have been put into place, the trading of B shares have decreased substantially, which has resulted in just 100 companies having listed B shares in 2016 (Hu, Chen, Shao, & Wang, 2019). The Chinese market is now dominated by A shares – also by foreign investors. Therefore, just like the Chinese economy, the Chinese equity markets have increasingly opened up to the world, and the domestic Chinese equity has never been more accessible than now after the implementations of several structural reforms.

The way that the Chinese stock market has developed with the heavy influence of the state has imposed the equity markets with special characteristics that makes them distinguishable (Valukonis, 2013). A number of special features of the Chinese stock markets have been outlined in the rest of this section.

Over the course of the development, the SSE and SZSE have become different in a number of respects that are crucial to understand when examining the Chinese equity markets (Hu, Chen, Shao, & Wang, 2019). Firstly, the total market capitalization of the firms listed on the SSE is larger than the one of the SZSE even though the number of firms listed on the SZSE is larger than for the SSE (Huang, 2019). This is due to the fact that the firms listed on the SSE are mostly large SOEs, whereas the ones listed on the SZSE are typically smaller companies that engage in manufacturing and exporting. This also results in some degree of information asymmetry between the two exchanges, since exporting firms on the SZSE tend to have a closer relationship with its foreign investors (Huang, 2019).

The stock market in China is dominated by retail investors who make up for about 86% of all trading in the A share market. Such retail investor are normally focusing on short-term investing and driven by a momentum approach (Paribas, 2019). This might make the behavior of the Chinese equity market different from more developed markets, as the trading volume of such markets tend to be dominated by institutional behavior.

Concerning IPOs, this area is still tightly controlled by the authorities (Carpenter, Lu, & Whitelaw, 2019). The China Securities Regulatory Commission (CSRC) oversees the IPO process and have even suspended IPOs during the years of 2005 and 2013. Therefore, delistings are not common, as the listed firms can be a way for private firms to get listed if they take over the listed company. In addition, short selling was legalized in 2006 but it is difficult to put into practice in China (Carpenter, Lu, & Whitelaw, 2019).

Given the recent and very particular development of the Chinese equity markets, an important characteristic of the markets to international investors is its correlation to other markets. The results of early literature regarding correlation between the stock market in China and in developed countries have been mixed, which seems to be caused by changing correlation (Blier, Provost, & Wu, 2017). First, in a study on correlation between several Asia-Pacific markets and the EU and the US, it shown the Chinese markets that have the lowest correlation with the Western markets (Loh, 2013). In a study over time, Zhang and Li (2014) find an increasing correlation between the Chinese-and the American equity markets. They further argue that this increasing trend is especially seen after the financial crisis of 2008 (Zhang & Li, 2014). In general, according to the literature, the correlation between American stock market and the SSE and SZSE have been relatively week over years since the establishment of the modern Chinese markets (Blier, Provost, & Wu, 2017). However, many studies have found an increasing correlation since 2005-2007, which has been seen as a turning point for how developed markets have influenced the Chinese market due to the implementations of various liberalization policies in China and the decreased role of the government (Carpenter, Lu, & Whitelaw, 2019).

4.2. General Price Development

The general analysis of the Chinese stock market will in this section examine the price development over time of the SSE and SZSE in order to make their differences and similarities clear.

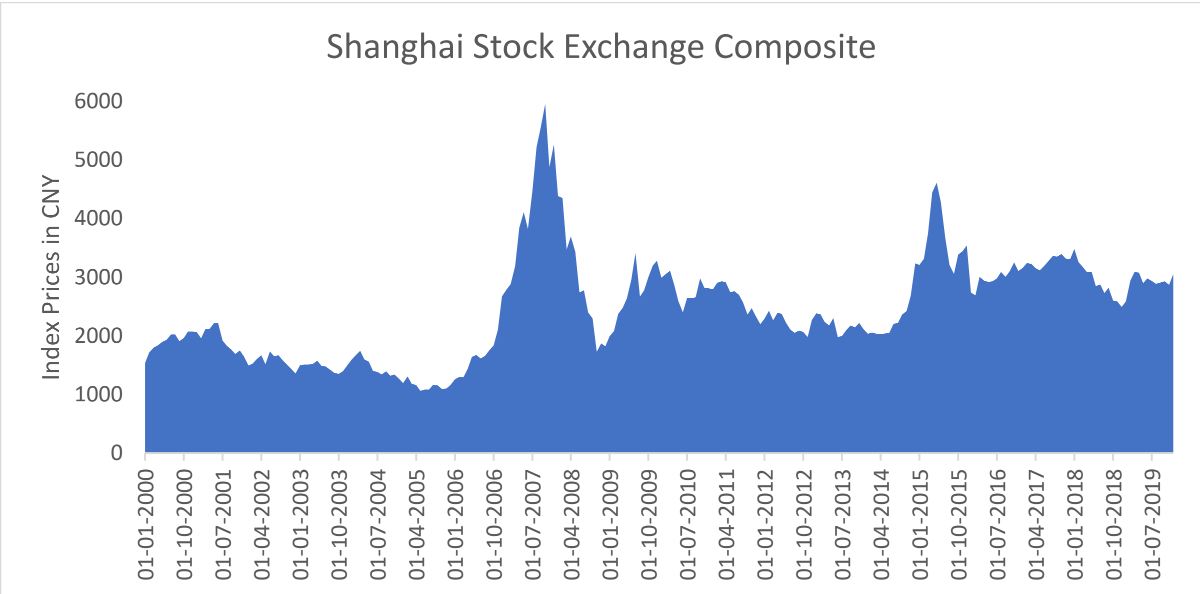

Figure 1: Price development of the SSE.

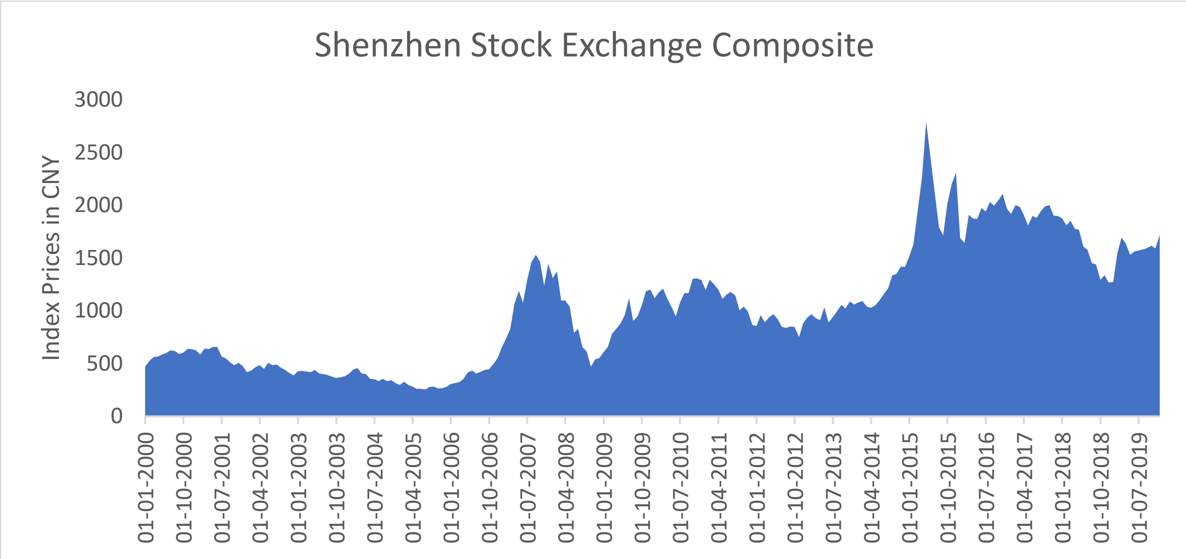

Figure 2: Price development of the SZSE.

According to figure 1 and 2 above, the price development patterns of the SSE and SZSE seem to largely follow each other over the period between the beginning of year 2000 to the end of year 2019. Especially in the first period up until 2006, the development of the two exchanges is very similar and none of them have any significant variations. In the rest of the years, they still follow a similar pattern, however, the price levels changes in percentages seem to differ throughout the years, which causes some spikes to be more significant than others during the same periods.

Overall, the two figures show that during the period of 20 years, the price of the SZSE increases more in percentage than that of the SSE. The SZSE trades at about CNY 500 in year 2000 and ends with a price of about CNY 1500 by the end of 2019, which results in an increase of roughly 200%. On the contrary, the SSE is trading at about CNY 1500 in 2000 and has a price of about CNY 3200 in 2019, which results in an increase of roughly 113%.

However, even though the patterns express much similarity, the level of the spikes in both charts are substantially different. Especially before and during the financial crisis of 2008-09, there is a sharp increase followed by a sharp fall in the price level of the SSE compared to a slightly flatter spike for the SZSE. Therefore, the returns and the volatility were much more extreme for the SSE than for the SZSE during the time of the financial crisis. On the contrary, the spikes that took place around 2015 and 2016 are sharper and more extreme for the SZSE than for the SSE, and in general the SZSE seems to be more volatile during the latest years prior to 2020. This extra volatility might also have been a factor for the increased returns in the latter half of the chart of the SZSE.

A crucial observation in the price development is the impact of the implementation of the Share-Structure Reform that was fully implemented in March 2006 (Huang, 2019). As already briefly described, this reform converted the restricted two-third of all outstanding shares into legally tradable ones for all domestic investors and thereby created a structural change as the trading process then became market-based. Figure 1 and 2 both show that from about 2006 the index prices start to take off and increase sharply compared to anything prior to the implementation of the Share-Structure Reform. This indicates that more trading has taken place as new market opportunities for domestic investors have opened. In addition, after the financial crisis, the stock prices also fluctuate much more than prior to the implementation of the reform.

4.3. Risk-Return Relationship

In order to analyze the attributes of the price development of the stock markets, this section will quantify the above figures. This will provide an exact picture of the risk-return relationship of the stock markets over the same period. Furthermore, to put the development of the Chinese stock markets into perspective, the following analyses will also include the indexes meant to represent the European stock market (the STOXX Europe 600) and the American stock market (S&P 500).

	Annual Return				Annualized Standard Deviation				Annual Sharpe Ratio			
Year	**SSE**	**SZSE**	**STOXX**	**SP500**	**SSE**	**SZSE**	**STOXX**	**SP500**	**SSE**	**SZSE**	**STOXX**	**SP500**
2000	39%	39%	0%	-6%	14%	14%	13%	16%	2.7	2.7	0.0	-0.4
2001	-21%	-25%	-17%	-13%	19%	21%	18%	19%	-1.1	-1.2	-1.0	-0.7
2002	-18%	-18%	-32%	-23%	23%	24%	23%	20%	-0.8	-0.8	-1.4	-1.2
2003	10%	-3%	14%	26%	16%	15%	16%	11%	0.6	-0.2	0.8	2.4
2004	-15%	-17%	10%	9%	18%	24%	6%	7%	-0.9	-0.7	1.5	1.3
2005	-8%	-12%	23%	3%	20%	21%	8%	7%	-0.4	-0.6	2.8	0.4
2006	130%	98%	18%	14%	28%	21%	8%	5%	4.7	4.7	2.2	2.5
2007	97%	163%	0%	4%	35%	43%	9%	9%	2.7	3.8	-0.1	0.3
2008	-65%	-62%	-46%	-38%	37%	42%	20%	20%	-1.8	-1.5	-2.3	-1.9
2009	80%	117%	28%	23%	32%	32%	20%	21%	2.5	3.7	1.4	1.1
2010	-14%	7%	9%	13%	24%	26%	13%	18%	-0.6	0.3	0.7	0.7
2011	-22%	-33%	-11%	0%	14%	22%	15%	15%	-1.6	-1.5	-0.8	0.0
2012	3%	2%	14%	13%	21%	27%	11%	10%	0.1	0.0	1.3	1.3
2013	-7%	20%	17%	30%	19%	24%	9%	8%	-0.4	0.8	1.9	3.6
2014	53%	34%	4%	11%	22%	13%	7%	8%	2.4	2.7	0.6	1.4
2015	9%	63%	7%	-1%	36%	49%	18%	14%	0.3	1.3	0.4	-0.1
2016	-12%	-15%	-1%	10%	27%	33%	11%	10%	-0.5	-0.5	-0.1	0.9
2017	7%	-4%	8%	19%	6%	12%	7%	4%	1.0	-0.3	1.1	5.1
2018	-25%	-33%	-13%	-6%	14%	14%	10%	15%	-1.8	-2.3	-1.3	-0.4
2019	20%	39%	18%	21%	17%	24%	10%	12%	1.2	1.6	1.7	1.7

Table 1: Return, Standard Deviation and Sharp Ratio

Table 1 shows the annual return, the annualized standard deviation and the annual sharp ratio for each of the four indexes. Overall, it can easily be seen that the largest and most extreme values all belong to the SSE and SZSE indexes for most of the variables. Regarding annual returns for the SSE and SZSE, the values range between positive 163% and negative 65%, which both implies huge opportunities for investors but also large risk. Both the SSE and SZSE had incredibly large returns of around 100% in both 2006 and 2007, which again were the years following the implementation of the Share-Structure Reform and therefore is a likely explanation for such huge returns. On the contrary, the STOXX 600 and the S&P 500 show relatively more stable returns that do not vary to similar extreme levels. However, the STOXX 600 still had a few years with very low returns and overall it seems like it has performed worse than the S&P 500 that has had a number of years with high, steady returns.

In terms of standard deviation, it is also the Chinese stock exchanges that dominate in terms of fluctuations with a high of 49% and a low of only 6%. Again, it is clear that both the European and American stock markets were much less volatile without such extreme standard deviations. For the Chinese markets, having such high returns and being volatile almost automatically results in extreme sharp ratios. As the Sharpe ratio is a measure of the risk-return relationship, it means that the Chinese equity markets have provided large returns per unit of risk (standard deviation) in certain periods with Sharpe ratios of as high as 4.7 (Munk, 2018). When interpreted, this mean that the stocks give 4.7 unit of return per unit of risk. However, the American S&P 500 index provided an even higher Sharpe ratio of 5.1 in 2017 due to its relatively high return and very low volatility. On the other hand, the Chinese stock markets only have 10 years with a positive Sharpe ratio compared to 12 and 13 for Europe and the U.S. respectively.

To sum up the brief overview, the STOXX 600 and S&P 500 generally show more steady rates even though they at times still fluctuates substantially, whereas the Chinese equity markets show much more extreme years in which returns are either very high or low in a very volatile environment. To get a better overview of the risk-return relationship, the data of 20 years has been divided into four periods of five years in which the average of each variable is shown in the below figures.

Average Annual Return

Average Annual Return					
Index	2000-2005	2005-2010	2010-2015	2015-2020	Average Annual Return
SSE	-0.89%	46.67%	2.66%	-0.22%	12.05%
SZSE	-4.70%	60.79%	6.02%	10.11%	18.06%
S&P 500	-1.36%	1.02%	13.44%	8.68%	5.44%
STOXX 600	-5.32%	4.70%	6.68%	3.51%	2.39%

Table 2: Average Annual Return

According to table 2, there is a very clear distinction between the developing equity markets in China and the developed markets in the West. The most significant difference is the average annual returns during the period between 2005–2010, in which the SSE and SZSE had an annual return of 47% and 61% respectively compared to 1% and 5% for the S&P 500 and STOXX 600. These incredible differences could be explained by two important events that took place that period: the implementation of the Share-Structure Reform and the financial crisis. These two events had different impacts on the stock markets, as the reform only impacted the Chinese equity markets very positively, whereas the financial crisis hit every stock market very hard.

Even though the European and American markets have performed relatively well in the latter half of the chosen period, the average annual return over the entire 20 years is still dominated substantially by the Chinese equities. The SZSE in particular has outperformed the other three indexes in two of the five-year periods and therefore has the greatest average annual return of 18% over the entire period. An average return of 18% a year is a large rate that investors would appreciate. However, an important thing to keep in mind for foreign investors is that the biggest impact of the high return stems from the liberalization policies that were implemented during the years when foreign investors faced many difficulties entering the domestic Chinese equity market. Therefore, given such a structural change, foreign investors should not necessarily expect to see similar stock return as in the few years following 2006.

The two Chinese exchanges also show certain differences even though they largely follow the same pattern. Firstly, the return is generally lower for the SSE than for the SZSE. Since there are more small-cap companies listed on the SZSE compared to more large-cap and SOEs listed on the SSE, this might be one of the reasonable explanations for this difference, as small-cap companies outperform big ones according to previous research (Banz, 1981). Secondly, an important observation for investors is the difference in the return over the last five-year period. While the SSE experience a slight negative return, the SZSE performed positively with a return of 10%. This indicates that the small-cap stock listed in Shenzhen do well in internationally good economic times and therefore might be more attractive to international investors than the large-cap SOEs listed on the SSE.

Average Annual Standard Deviation

Average Annual Standard Deviation					
Index	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**	**Average Annual Std**
SSE	17.90%	30.22%	19.94%	20.07%	22.03%
SZSE	19.52%	31.76%	22.17%	26.43%	24.97%
S&P 500	14.61%	12.73%	11.97%	10.95%	12.56%
STOXX 600	15.12%	13.04%	11.01%	11.39%	12.64%

Table 3: Average Annual Standard Deviation

Taken risk into consideration, the SZSE is also the riskiest of the four indexes as measured as the average annualized standard deviation shown in table 3. Both the average annual standard deviation of the SSE and SZSE are roughly twice as high as the ones of both the European and American markets. Again, it is especially the period between 2005–2010 that is particularly interesting, as the SSE and SZSE both had an annual volatility of more than 30%. The most volatile period for Europe and the U.S. is the first one in the year between 2000–2005. During this period, the dot com bubble burst and affected the stock prices badly, which might explain part of the extra volatility. Over the course of the four periods, it does not seem like the volatility of the SSE and SZSE is increasingly following the ones of developed markets in the West. On the contrary, the spread in volatility between the Chinese markets and the developed markets actually increases over time, suggesting a low correlation in volatility. The volatility decreases in Europe and in the U.S. from the period between 2010-2015 to the period between 2015–2020, whereas it increases in China – and even heavily for SZSE.

This huge difference in risk between the Chinese markets and the fully developed markets implies several considerations for investors, as they seek high returns but not necessarily high risk. In order to accommodate for this relationship, the Sharpe ratios for the periods are shown below.

Average Annual Sharpe Ratio

Average Annual Sharpe Ratio					
Index	2000-2005	2005-2010	2010-2015	2015-2020	Average Annual Sharpe Ratio
SSE	0.13	1.56	-0.02	0.04	0.42
SZSE	-0.04	2.03	0.45	-0.05	0.60
S&P 500	0.28	0.47	1.38	1.45	0.90
STOXX 600	-0.02	0.79	0.73	0.33	0.46

Table 4: Average Annual Sharpe Ratio

According to table 4, it is clear that the risk adjusted return also fluctuates substantially over time. With the STOXX 600 providing the most stable Sharpe ratios over time, it performs slightly higher than that of the SSE on average over the 20 years examined. This is due to the SSE having three periods with a Sharpe ratio close to 0 and only one that really stands out of 1.56. Therefore, the SSE has the lowest average annual Sharpe ratio over the entire sample period. On the other hand, even though the SZSE had a greater overall volatility, it still scores second on the average annual Sharpe ratio only beaten by the S&P 500. The average annual Sharpe ratio of the SZSE is 0.6 and stems mostly from the incredible high returns during the period between 2005 – 2010, as it had an average Sharpe ratio of 2.03 during those years.

The Sharpe ratio is a good measure for investors as it quantifies return per unit of risk, and therefore makes it easier to compare the risk-return tradeoff between the indexes. Naturally, an investor would invest in the stocks that give the highest Sharpe ratio. Therefore, the SSE seems like the least attractive stock market based on its average annual Sharpe ratio of 0.42 over the 20 years period. Next is the STOXX 600 with a Sharpe of 0.46 that ends up with a lower value than the SZSE. However, the Sharpe ratios of the STOXX 600 are less volatile throughout the years, whereas the high average annual Sharpe ratio of the SZSE is heavily impacted by the period between 2005–2010 in which its ratio was 2.03. Lastly, the American market scores the highest ratio and should, from an objective point of view, be prioritized by investors.

On the other hand, from a point of view of a well-diversified European investor, who will already be well-invested in the European and American markets, the Chinese market might seem full of risky opportunities that would be able to increase his expected returns of his portfolio. In this case, the investor’s investment opportunities will depend on two things: the level of risk aversion of the investor and the correlation between the markets. For the first part, as the Chinese market is comparatively more volatile, it requires investors to maintain a certain level of risk tolerance in order to find it an attractive market. This being the case, the investor might be able to increase his expected returns. Based on the Sharpe ratios, the SZSE would be the more attractive market to invest in, however, it is generally also more volatile than the SSE. Therefore, depending on the level of risk aversion of the investor, both the SSE and SZSE could be potential investment opportunities for investors looking for higher expected returns and growth opportunities with the SZSE providing a better risk-adjusted return. Secondly, the investor might also benefit from the correlation between his portfolio and the Chinese equity markets, which will be the analysis of the next section.

4.4. Correlation Analysis

Markowitz (1952) stated the benefits of having a well-diversified portfolio and how correlation between assets is meant to lower the overall risk of an investor's portfolio. Therefore, correlation analysis is a natural next step in the examination of the Chinese market, as it has already been shown that its development has been tightly regulated.

Correlation of returns from 2000 to 2020				
	SSE	*SZSC*	*STOXX*	*SP500*
SSE	1.00	0.89	0.31	0.31
SZSC	0.89	1.00	0.26	0.26
STOXX	0.31	0.26	1.00	0.83
SP500	0.31	0.26	0.83	1.00

Table 5: Correlation Matrix

In table five, correlations between the four indexes has been calculated based on monthly returns over the entire period of 20 years. The correlations show some very clear patterns between the Chinese- and the developed markets. Firstly, the correlation between the SSE and the Western markets is 0.31 for both the STOXX 600 and the S&P 500. A correlation of 0.31 is relatively low, which means the market returns are not related to each other to a great extent. The same is the case for the SZSE that has a correlation of only 0.26 with the developed markets, indicating they are even less related. Therefore, there are potential diversification benefits for a European investor who is mainly exposed to equities in these developed markets.

Examining the two Chinese equity markets, they have a correlation of 0.89 over the 20 years. This is a very high, positive correlation; meaning the returns of each index follow each other relatively close. In fact, the correlation between the SSE and SZSE is actually higher than the correlation between the STOXX 600 and the S&P 500, which also are positively correlated of 0.83. However, the correlation of 0.89 also highlights the small differences between the markets in China, which the investor needs to keep in mind when deciding to invest in the Chinese market.

Due to the regulated development of the SSE and SZSE, it is important for foreign investors to examine how the correlation has developed over time in order to examine what direction the integration between the Chinese market and the developed market is heading towards. Therefore, correlation analyses over four five-year periods based on returns are presented below.

Correlation of returns from 2000 to 2005				
	SSE	*SZSC*	*STOXX*	*SP500*
SSE	1.00	0.97	0.10	0.03
SZSC	0.97	1.00	0.08	0.02
STOXX	0.10	0.08	1.00	0.86
SP500	0.03	0.02	0.86	1.00

Correlation of returns from 2010 to 2015				
	SSE	*SZSC*	*STOXX*	*SP500*
SSE	1.00	0.77	0.33	0.34
SZSC	0.77	1.00	0.28	0.28
STOXX	0.33	0.28	1.00	0.84
SP500	0.34	0.28	0.84	1.00

Correlation of returns from 2005 to 2010				
	SSE	*SZSC*	*STOXX*	*SP500*
SSE	1.00	0.91	0.37	0.40
SZSC	0.91	1.00	0.27	0.34
STOXX	0.37	0.27	1.00	0.87
SP500	0.40	0.34	0.87	1.00

Correlation of returns from 2015 to 2020				
	SSE	*SZSC*	*STOXX*	*SP500*
SSE	1.00	0.89	0.44	0.51
SZSC	0.89	1.00	0.43	0.39
STOXX	0.44	0.43	1.00	0.73
SP500	0.51	0.39	0.73	1.00

Table 6: Five-year Correlation Matrices

Correlation between 2000 - 2005

Starting with the correlation matrix for the period between 2000–2005, it is clear that the integration between the Chinese markets and the developed markets was virtually nonexistent. This is reflected in the correlations of the SSE and SZSE on the S&P 500, which are almost zero, meaning there are no relationship between the returns of the stock prices on the markets. This is during the years when about two-thirds of the domestic A shares in China were not traded on market terms and the Chinese stock markets were in general tightly regulated. The European and American markets were on the other hand based on market mechanisms, and these differences are likely to have caused the very weak correlations. In addition, the correlation between the SSE and the SZSE is almost one, meaning they almost have a perfect, positive relationship.

Correlation 2005 - 2010

Turning to the correlations during the years between 2005–2010, substantial changes have occurred between the markets. These five years represent the period in which the implementation of the Share-Structure Reform took place and the liberalization policies on the Chinese stock markets were increased as well as the financial crisis was heavily affecting all stock prices throughout the world. These events could all have caused the correlations between the Chinese markets and the developed markets to increase considerably. During this period, the correlations between the SSE and the STOXX 600 and the S&P 500 were 0.37 and 0.40 respectively, which is a large increase compared to the previous period in which these correlations were virtually absent. Such increases might suggest that the markets have become more integrated.

Correlation 2010 - 2015

For the next period between 2010-2015, the correlations between the Chinese- and developed indexes have slightly weakened but the patterns are the same. However, the relationship between the returns of the SSE and the SZSE starts to differ considerably during these years with a correlation of 0.77 compared to 0.91 and 0.97 in the two previous five-year periods. Therefore, to an international investor, it is increasingly important to distinguish between the stocks of the two exchanges in China, as their differences have become more pronounced, which would affect their overall risk and return of their portfolio.

Correlation 2015 - 2020

Lastly, the most recent five-year period again shows a significant increase in the correlation between the Chinese stock markets and the developed markets and therefore implies greater integration between the modern financial markets. This, however, also lowers the benefits of holding Chinese stocks from the perspective of an international investor who is seeking to lower his overall risk by diversification.

In addition, the correlation between the SSE and the SZSE has increased in this period, resulting in a high, positive correlation of 0.89. This might indicate that the differences in microstructure of the two Chinese exchanges are not so strong as anticipated in the previous period. However, the SZSE still offers a much lower correlation with the S&P 500 compared to the SSE, thereby showing greater diversification benefits. This result emphasizes the importance of highlighting the characteristics of the Chinese exchanges to the foreign investor due to the extra benefits that are achievable when investing in the right segment of the market.

Overall, the correlation matrices show evidence of increasing correlation between the Chinese- and the developed markets in the West. This seems to be a continuing trend, indicating greater integration between the markets, which is in accordance with the liberalization processes of the Chinese markets and the greater access of domestic A shares for foreign investors. This is also in line with the findings of Blier et al. (2016) who find a similar increasing correlation. Such an increasing trend does, however, have a negative impact of the diversification benefits to an international investor seeking to lower his portfolio risk by investing in uncorrelated equity markets. Furthermore, evidence suggests that the SZSE has a considerable weaker correlation to the S&P 500 than any other of the relationships investigated. Therefore, it is important for international investors to consider what part of the Chinese market to invest in, as there are several differences and potential of gaining extra benefits to their portfolios.

How does the attributes of the Chinese stock market impact foreign investors' investment decisions for Chinese equities?

Markowitz (1952) argues that the optimal portfolio is constructed by optimizing the relationship between a maximum return given a chosen risk. A crucial part in obtaining an efficient portfolio is the need to diversify between securities from different industries or countries due to their particular economic attributes (Markowitz, 1952). From the point of view of an international investor with a well-balanced equity portfolio, it has been shown that the Chinese equity market can provide high returns and increase overall portfolio returns, as its average annual return has been much higher than for the European and American equity markets. However, these high returns do not come without increased risk, which also has been about twice as high for the Chinese markets. Therefore, when taking the level of risk into account, the equities listed on the SZSE have performed better than the large companies and SOEs listed on the SSE, which makes it relevant for investors to examine the microstructures of the exchanges before deciding to invest in the Chinese market as a whole. As the Sharpe ratio of the S&P 500 is remarkably high, it lowers the attractiveness of the Chinese market. However, the return per unit of risk is still substantially higher of the market in Shenzhen than in Europe but a large part of this high level of return per unit of risk might stem from the implementation of the Share-Structure Reform that should be treated as a structural change and not as a recurring event. Thus, investing in the Chinese market for foreign investors is a risky affair but opens a door for high returns even though past returns must be considered with care.

Following the second idea of Markowitz (1952), the correlation analysis show that European investors have much to gain by investing in Chinese equities if they are primarily exposed to European and American equities. This is due to the weak correlation patterns between these markets, which therefore would benefit the investor's portfolio by lowering its risk. However, the evidence suggests the correlations between the Chinese and the developed markets are increasing and thereby lowering the attractiveness of Chinese equities due to the diminishing benefits.

Considering all the above attributes of the Chinese equities, it has been emphasized by BNP (Paribas, 2019) and MSCI (Wei, 2019) for investors to increase their stock allocation of Chinese stocks, as they have become easily accessible and possess significant growth potential. Therefore, this further support the conclusion to international investors to deem the Chinese equities attractive and shift part of their allocation towards this emerging market and exploit its benefits even as they might be somewhat diminishing.

5. Factor Analysis of the Shanghai Stock Exchange

In order to evaluate how investors should implement an investment strategy in the Chinese market using a factor approach, this paper will in this section conduct three interlinked analyses that all examine aspects of a factor investment approach. In the first analysis, the chosen factors will be constructed and analyzed. Hence, it can be shown if the risk factors are present and statistically significant in the Chinese stock market and how they can be used to form investment strategies, as they will indicate risk premiums. The second analysis will construct multiple 5x5 portfolios sorted on size, B/M, profitability and investment, which will enable the paper to examine the factor effects on the Chinese equity market over time. The time series analysis is the third and last factor analysis that aims at evaluating how well the chosen asset pricing models perform in the Chinese market. This analysis combines the factors of the first analysis and the 5x5 portfolios of the second analysis and runs 75 regressions on each of the four chosen models, making a total of 300 regressions, in order to evaluate their performance. By conducting these analyses, the paper will be able to advise international investors on how to form an investment strategy for the Chinese equity market relying on a factor investment approach. An important thing to remember, as previously written, is that this factor analysis only examines the firms listed on the Shanghai Stock Exchange (SSE) and not on the entire Chinese stock market.

5.1. The Risk Factors – Explanatory Variables

In this section, the six chosen factors will be constructed by using the methods described in the methodology section. In short, a China-specific methodology has been adopted while heavily relying on the original procedures put forward by Fama & French. The factors are constructed based on 2x3 portfolios, and these portfolios are the first ones to be examined in this section. The idea behind constructing the factors based on 2x3 portfolios is to mimic the underlying risk factors of size, value, momentum, profitability and investment (Hu, Chen, Shao, & Wang, 2019). The summary statistics of the 2x3 portfolios are presented below.

2x3 Portfolio on Size and B/M - Monthly values

	Mean		Standard Deviation	
	Small	Big	Small	Big
Value	0.91%	0.61%	7.93%	6.92%
Neutral	0.52%	0.61%	8.35%	6.94%
Growth	0.41%	0.52%	8.80%	7.30%
	Minimum value		**Maximum value**	
	Small	Big	Small	Big
Value	-27.04%	-17.78%	23.28%	31.12%
Neutral	-30.18%	-26.53%	21.95%	20.71%
Growth	-32.85%	-26.52%	25.43%	18.32%

2x3 Portfolio on Size and E/P - Monthly values

	Mean		Standard Deviation	
	Small	Big	Small	Big
Value	0.64%	0.57%	8.11%	6.68%
Neutral	0.70%	0.32%	8.27%	6.87%
Growth	0.39%	0.85%	8.56%	7.46%
	Minimum value		**Maximum value**	
	Small	Big	Small	Big
Value	-27.37%	-18.55%	21.46%	29.42%
Neutral	-30.75%	-25.98%	21.59%	16.23%
Growth	-31.09%	-27.04%	24.55%	19.89%

2x3 Portfolio on Size and EBITDA/B - Monthly values

	Mean		Standard Deviation	
	Small	Big	Small	Big
Robust	0.52%	0.65%	7.93%	6.34%
Neutral	0.61%	0.56%	7.85%	7.25%
Weak	0.60%	0.37%	8.97%	8.03%
	Minimum value		**Maximum value**	
	Small	Big	Small	Big
Robust	-29.03%	-18.98%	21.16%	25.89%
Neutral	-28.47%	-24.61%	21.34%	18.88%
Weak	-32.10%	-30.07%	25.24%	22.97%

2x3 Portfolio on Size and INV - Monthly values

	Mean		Standard Deviation	
	Small	Big	Small	Big
Aggresive	0.56%	0.62%	8.58%	7.26%
Neutral	0.61%	0.63%	7.91%	6.48%
Conservative	0.60%	0.52%	8.41%	7.18%
	Minimum value		**Maximum value**	
	Small	Big	Small	Big
Aggresive	-31.39%	-24.08%	25.15%	19.76%
Neutral	-28.40%	-19.92%	19.39%	26.29%
Conservative	-30.42%	-27.23%	21.84%	19.21%

2x3 Portfolio on Size and Past Returns - Monthly values

	Mean		Standard Deviation	
	Small	Big	Small	Big
Past High Return	0.80%	1.11%	8.23%	7.40%
Neutral	0.12%	0.53%	8.13%	6.33%
Past Low Return	1.00%	1.05%	8.35%	7.04%
	Minimum value		**Maximum value**	
	Small	Big	Small	Big
Past High Return	-29.75%	-21.25%	24.45%	35.68%
Neutral	-30.58%	-22.96%	20.77%	28.35%
Past Low Return	-26.93%	-18.73%	21.91%	24.20%

Table 7: Summary Statistics on 2x3 Portfolios

Table 7 shows the mean values of returns, standard deviations, minimum- and maximum returns in a 2x3 format formed on size and either B/M, E/P, EBITDA/B, change in total assets, and past return over the period between July 2012–December 2019, resulting in 90 monthly data points for each of the portfolios. Very briefly, the overall patterns seem to indicate that small companies have higher average returns except for portfolios formed on investment and momentum. However, the small companies also tend to be the more volatile ones with high standard deviations, low minimum returns and high maximum returns. The portfolios sorted on momentum seem to contradict this, as the largest companies have a lower standard deviation and higher maximum returns. Overall, there seems to be a size effect on the SSE, which refers to small companies produce higher returns than big companies (Huang, 2019).

The two 2x3 portfolios formed on size and B/M and E/P that are used to construct two different value factors show certain differences even though their overall patterns are similar. The spread in average monthly returns is higher for small and large value companies sorted on B/M, whereas the spread is larger for small and large growth companies sorted on E/P. Therefore, by combining these two different ways of constructing the value factor, these differences will be more moderate for the final HML factor. The value effect refers to the pattern in which value stocks outperform growth stocks. There seems to be a value effect in the Chinese equity market for the portfolios formed on size and B/M. When sorted on size and E/P, there is only a value effect on the small stocks, as the big growth stocks outperform big value stocks quite substantially. Therefore, the final value factor will have a smaller value effect than if it was solely based on size and B/M.

In addition, the profitability effect suggests that firms with a robust profitability measure outperform firms with low profitability. The data shows there is a profitability effect for big companies but not for small. This indicates a weak (if any) profitability effect for the SSE as a whole. The same goes for the investment effect, that says conservatively investing firms produce higher returns than aggressively investing firms, as the results indicate that it is only the small conservative firms that outperforms the aggressive ones. Turning to the momentum portfolios, they suggest there might be a weak momentum effect for big companies, but not for small companies. The momentum effect states that stocks that have had high returns in the past will continue to outperform stocks that have not done well in the past. Lastly, the minimum and maximum values range from negative returns of more than 30% to positive returns of more than 35%. This suggests there have been some volatile periods in the equity market.

The following table will show summary statistics on how representative the data collection used to calculate the portfolios has been in order to evaluate how the attributes of the stocks examined.

HML (B/M)	Average Market Cap	Average Number of Firms	Market Cap %	Firms %
Small Value	566,606,353,088	89	3.63%	13.78%
Big Value	6,045,250,764,928	104	38.70%	16.21%
Small Neutral	882,416,079,424	141	5.65%	21.88%
Big Neutral	4,017,295,763,328	117	25.72%	18.17%
Small Growth	592,274,468,000	92	3.79%	14.34%
Big Growth	3,518,289,610,240	101	22.52%	15.62%
Total	15,622,133,039,008	643	100%	100%

HML (E/P)	Average Market Cap	Average Number of Firms	Market Cap %	Firms %
Small Value	565,120,538,752	89	3.62%	13.87%
Big Value	6,012,649,884,672	104	38.49%	16.09%
Small Neutral	883,986,993,376	139	5.66%	21.57%
Big Neutral	3,753,933,305,792	119	24.03%	18.48%
Small Growth	592,189,368,384	94	3.79%	14.55%
Big Growth	3,814,252,948,032	99	24.42%	15.43%
Total	15,622,133,039,008	643	100%	100%

EBITEDA/B	Average Market Cap	Average Number of Firms	Market Cap %	Firms %
Small Robust	501,839,719,360	76	3.21%	11.87%
Big Robust	7,696,371,012,160	116	49.27%	18.07%
Small Neutral	811,995,763,200	127	5.20%	19.80%
Big Neutral	4,001,973,341,248	130	25.62%	20.27%
Small Weak	727,461,417,952	118	4.66%	18.32%
Big Weak	1,882,491,785,088	75	12.05%	11.66%
Total	15,622,133,039,008	643	100%	100%

INV	Average Market Cap	Average Number of Firms	Market Cap %	Firms %
Small Aggresive	561,873,140,256	88	3.60%	13.60%
Big Aggresive	3,962,987,938,816	105	25.37%	16.36%
Small Neutral	771,986,802,848	122	4.94%	18.99%
Big Neutral	6,153,798,079,040	136	39.39%	21.08%
Small Conservative	707,436,957,408	112	4.53%	17.41%
Big Conservative	3,464,050,120,640	81	22.17%	12.55%
Total	15,622,133,039,008	643	100%	100%

MOM	Average Market Cap	Average Number of Firms	Market Cap %	Firms %
Small Past High Return	582,507,328,832	95	2.43%	13.73%
Big Past High Return	8,308,543,075,392	101	34.68%	14.69%
Small Neutral	845,960,164,864	169	3.53%	24.52%
Big Neutral	9,053,984,054,528	128	37.80%	18.60%
Small Past Low Return	654,532,948,896	98	2.73%	14.28%
Big Past Low Return	4,509,771,032,320	98	18.83%	14.18%
Total	23,955,298,604,832	688	100%	100%

Table 8: Market Capitalization (in CNY) and Firm Allocation of 2x3 Portfolios

According to table 8, that shows the allocation of average market capitalization and average number of firms of each portfolio in the 2x3 format, an average of 643 firms have been used in the construction of the 2x3 portfolios expect for the portfolios based on MOM that has an average number of firm of 688 due to the slightly different sorting of the stocks. The total number of extracted firms listed on the SSE have ranged from 900 in 2010 to 1538 in 2019, and therefore a big part of the firms have been excluded in the analyses due to missing data points in the Bloomberg system. In addition, the smallest 30% of the entire sample of firms have been excluded from the analysis due to the concept of reverse. Hence, a large number of firms have been removed from the analysis on purpose.

The number of firms are quite evenly distributed between each portfolio, however, due to the three uneven break points in the second sorting of each portfolio, the 'neutral' firms that are in between small and big have been allocated a bigger portion of firms, as the break points for the neutral firms are wider. The number of firms allocated to small and big companies are in the range between 11.6% and 18.3% of the total firms, while fairly consistently being around 13-14%. This suggests that each portfolio is based on about an average of 90 firms for the small and big firms, while the number being more than 100 for the neutral firms. This means that the portfolios is based on a rather extensive data collection that represents the SSE well and valid conclusions can be drawn.

Lastly, an important observation from table 8 is the stunning difference in the allocation of market capitalization. One portfolio of small firms constitutes as little as 2.4%, while another portfolio of big firms make up as much as 49% of the entire market capitalization of the portfolios. In addition, big value firms get a substantially higher percentage of the market capitalization than big growth firms. Therefore, by far most of the capital flowing around the firms listed on the SSE is centered in the big value firms, which could be China’s large SOEs that are listed on the SSE.

The Factor Returns

Panel A: Average, standard deviation and t-statistics for monthly factor returns

	Mkt-Rf	*SMB (B/M)*	*SMB (EBITDA/B)*	*SMB (INV)*	*SMB*	*HML (B/M)*	*HML (EP)*	*HML*	*MOM*	*RMW*	*CMA*
Mean	0.42%	0.04%	0.05%	0.00%	0.03%	0.30%	-0.01%	0.14%	-0.07%	0.10%	-0.03%
Std dev.	6.85%	4.08%	4.12%	4.38%	4.17%	4.28%	3.16%	3.63%	3.84%	2.79%	1.79%
T-stat.	0.58	0.08	0.11	0.01	0.07	0.66	-0.04	0.37	-0.16	0.33	-0.15

Panel B: Correlation between SMB factors

	SMB (B/M)	*SMB (EBITDA/B)*	*SMB (INV)*	*SMB*
SMB (B/M)	1.00	0.97	0.99	0.99
SMB (EBITDA/B)	0.97	1.00	0.98	0.99
SMB (INV)	0.99	0.98	1.00	1.00
SMB	0.99	0.99	1.00	1.00

Panel C: Correlation between HML factors

	HML (B/M)	*HML (E/P)*	*HML*
HML (B/M)	1.00	0.90	0.98
HML (E/P)	0.90	1.00	0.96
HML	0.98	0.96	1.00

Table 9: Summary Statistics on Factors

In panel A of the above table 9, the mean monthly returns, standard deviations and t-statistics of the factors have been shown. The factors have been calculated following the calculations stated in methodology section based on their respective 2x3 portfolios.

The average monthly returns for all the factors are all very low and close to zero except for the market, the HML (B/M), the combined HML and the RMW factors. As the factors are constructed on a long-short method following Fama & French, this indicates that the different effects of most of the factors are not present on the SSE. In other words, since the average mean return of most factors are close to zero or even negative for HML (E/P), MOM and CMA, the evidence says that most of the factor effects do not seem to be present on the SSE during the period examined.

The above interpretation is confirmed by the low t-statistics of all of the factors, which indicates that none of them are statistically different from zero. To be clear, as none of the chosen factors are statistically different from zero, none of the factor are statistically significant on the SSE. However, due to the higher average returns and t-statistics, the market, the HML (B/E), HML and RMW factors seem to have a certain effect on the SSE even though they are not statistically significant. Their respective annualized returns are: 5.16%, 3.66%, 1.69%, 1.21%, which means that investment strategies based on these factors would have an expected profit.

Panel B of table 9 shows the correlation matrix of the four different size (SMB) factors. The SMB factors are all very strong and positively correlated with the lowest correlation of 0.97 between SMB (B/M) and SMB (EBITDA/B). Therefore, the size effect seems to be close to the same across the different ways of sorting on size, as none of them stand out. These results are very similar to the correlation matrix on size that Guo et al. (2017) find.

In panel C of table 9, the correlation between the three HML factors are shown. The correlations show a strong, positive relationship with the lowest value of 0.9 between HML (B/M) and HML (E/P). This suggests that while being strongly positive there still are some differences in the two ways of constructing the HML factor. Therefore, the goal of the HML factor is to capture as much of the value effect of the SSE by combining HML (B/M) and HML (E/P).

For the purpose of the rest of the analyses, only the risk factors used in the analyses will be presented and interpreted in more detail below.

Panel A: Average, standard deviation and t-statistics for monthly factor return

	Mkt-Rf	*SMB*	*HML*	*MOM*	*RMW*	*CMA*
Mean	0.42%	0.03%	0.14%	-0.07%	0.10%	-0.03%
Std dev.	6.85%	4.17%	3.63%	3.84%	2.79%	1.79%
T-stat.	0.58	0.07	0.37	-0.16	0.33	-0.15

Panel B: Correlation between all factors

	Mkt-Rf	*SMB*	*HML*	*Mom*	*RMW*	*CMA*
Mkt-Rf	1.00	0.28	-0.24	-0.03	-0.48	-0.18
SMB	0.28	1.00	-0.69	-0.23	-0.63	-0.07
HML	-0.24	-0.69	1.00	0.20	0.48	0.40
Mom	-0.03	-0.23	0.20	1.00	0.08	0.18
RMW	-0.48	-0.63	0.48	0.08	1.00	-0.03
CMA	-0.18	-0.07	0.40	0.18	-0.03	1.00

Table 10: Summary Statistics and Correlation of Chosen Factors

According to panel A of table 10, the return of the value-weighted market factor of the whole Chinese stock market is higher than the risk-free rate during the period examined. It has an average return of 0.42% per month, which is the largest among all the factors, however, it is also the most volatile with a standard deviation of 6.85%. Such a low return and high volatility imply a low risk aversion on the SSE (Guo, Zhang, Zhang, & Zhang, 2017). Its t-statistic is low and insignificant; however, it is the largest among the factors.

The combined and final SMB factor has a very low monthly average return of just 0.03%; suggesting the there is no size effect on the SSE, as small firms barely outperform large firms. This is also confirmed by the very small t-statistic which is 0.07 standard errors from zero; stating that an investment strategy based on size on the SSE is not statistically profitable (Huang, 2019).

The final HML factor has the second largest monthly average return of 0.14% and with a lower standard deviation than the Mkt-Rf factor. It also has the second highest t-statistic of all; however, it remains statistically insignificant. However, due to the positive mean return, it might be profitable to implement a value strategy on the SSE, as value stocks have outperformed growth stocks over the chosen period. Nevertheless, investor should be careful in implementing such as a strategy due to the low t-statistic that states the value effect is weak.

Regarding the MOM factor, it has the lowest monthly average return of -0.07%; indicating a weak reverse momentum effect on the SSE. The t-statistic of the MOM factor is low, and therefore the MOM factor is statistically indistinguishable from zero.

The RMW factor has a monthly average return of 0.10% and a low standard deviation of just 2.79% for the period. Compared to the other factors, its mean return is relatively high but still insignificant, as it is only 0.33 standard errors from zero. Therefore, an investment strategy relying on the profitability effect might provide a small positive return, but it is not statistically significant, and the effect is in fact weak.

Lastly, the CMA factor also delivers a negative monthly average return of 0.03% with the lowest standard deviation of all the factors. This indicates that there is no investment effect on the SSE and the t-statistic of its returns is -0.15, which makes the negative average return might even suggest there exists a very weak reverse investment effect on the SSE.

Overall, it has been found that none of the factor effects are statistically significant, but the Mkt-Rf, HML and RMW indicate to have the strongest, positive effects. However, all of the effects are in general weak and even slightly reverse for MOM and CMA.

In panel B of table 10, the correlations between the chosen risk factors are shown. The size factor is negatively correlated with HML, MOM, RMW and CMA, while positively correlated with Mkt-Rf. This means that smaller stocks have lower value, lower profitability and lower investment, however, in earlier academic studies, it is argued that intuitively it makes more sense for SMB to also be negatively correlated with Mkt-Rf, as this would suggest that small firms would have higher betas (Guo, Zhang, Zhang, & Zhang, 2017). Furthermore, the positive correlations between HML and RMW and CMA indicate that value firms tend to be highly profitable and low investment, which partially is in accordance with Guo et al. (2017) and the findings of Fama & French who finds value firms tend to be of low profitability and low investment. Lastly, the RMW and CMA are slight negatively correlated; suggesting that profitable firms tend to invest more on the SSE.

However, certain of the above correlations are relatively weak; meaning the interpretations should be considered with care. Huang (2019) also finds a slightly different correlation matrix than Guo et al. (2017), and finds, among other things, a positive relationship between Mkt-Rf and SMB like the findings of this analysis. Huang (2019) further argues that the different findings of the correlation matrix might be due to different sample periods and suggests the Chinese market might be sensitive to the periods examined.

Comparison of Model Performance on Index Returns

Following the procedures of Huang (2019), this analysis tests which factors are crucial in determining Chinese stock returns and which asset pricing model is the most effective. The factor models will in this section be regressed on Shanghai Stock Exchange Composite Index in order to test for the overall effectiveness of the models (Huang, 2019) . Hence, based on the results, the paper can decide which asset pricing models to choose to compare in the later time series analysis, which will go more in depth with the model performance. The following models will be compared in this section: (CAPM) the CAPM by Treynor (1961), Sharpe (1964) and Lintner (1965), (FF3) the Fama & French three-factor model (1993), (Carhart4) the Carhart four-factor model (1997), (FF5) the Fama

& French five-factor model (2015), and (ALL) the Fama & French five-factor model with the momentum factor.

Variables	*CAPM*	*FF3*	*Carhart4*	*FF5*	*ALL*
Mkt-Rf	0.9109***	0.9798***	0.9799***	0.9731***	0.9731***
	(0.0278)	(0.0129)	(0.0129)	(0.0145)	(0.0146)
SMB		-0.1963***	-0.1969***	-0.1974***	-0.1977***
		(0.0283)	(0.0288)	(0.0326)	(0.0334)
HML		0.2770***	0.2773***	0.2975***	0.2975***
		(0.0322)	(0.0324)	(0.0376)	(0.0378)
MOM			-0.0036		-0.0011
			(0.0228)		(0.0233)
RMW				-0.0354	-0.0355
				(0.0441)	(0.0444)
CMA				-0.0579	-0.0575
				(0.0569)	(0.0579)
Constant	0.0018	0.0012	0.0012	0.0012	0.0012
	(0.0019)	(0.0009)	(0.0008)	(0.0008)	(0.0009)
Observations	90	90	90	90	90
Adjusted R^2	0.9232	0.9849	0.9847	0.9848	0.9846

Standard errors in the parentheses. *p<0.1; **p<0.05; ***p<0.01

Table 11: Model Performance on the SSE

Overall, table 11 shows a clear pattern between all the models in that the market, size, and value factors all are statistically significant at the 1% level in determining stock returns on the SSE. On the other hand, none of the additional factors are significant in any of the examined models. With 90 monthly observations, the adjusted R^2 is in general very high and almost all of the variance in the Chinese stock returns is explained.

Starting with the CAPM, table 11 shows that it captures the market risk successfully due to its significant market factor. Its coefficient of determination (R^2) is very high; meaning the proportion of variance of the return on the SSE can be explained by the market factor to a very large extent (Huang, 2019). The constant (intercept/alpha) has a very low value of 0.18%, which is not statistically different form zero; meaning that the CAPM is a good model in determining the returns on the SSE. Compared to the FF3, the FF3 explains more of the variations in the returns of the SSE, as its adjusted R^2 is 0.9849, which means that the FF3 model almost explains all of the variance. Furthermore, the SMB and HML factors are both statistically significant; meaning the model successfully captures the returns related to size and value that the market factor does not. The alpha of the FF3 has decreased and is 0.12%. Accordingly, the SMB and HML factors improves the CAPM model, and therefore the FF3 model is a superior model in determining index returns on the SSE over the period 2012–2019.

The Carhart4 model adds the MOM factor to the FF3, and according to table 11, it has a small, negative coefficient that is not statistically significant in determining the returns on the SSE. Additionally, the R^2 has slightly decreased compared to the FF3; meaning the Carhart4 model explains less of the variance of the returns on the SSE. The constant has not changed, but due to the lower adjusted R^2 and insignificant MOM factor, the FF3 model performs slightly better than the Carhart4 model.

The FF5 model adds RMW and CMA to the FF3 model. The evidence from table 11 shows that none of the RMW and CMA factors are statistically significant, and thereby the model does not successfully capture the returns related to profitability and investment. In terms of the adjusted R^2, the FF5 model performs better than the Carhart4 model by a slight margin; however, the FF3 model also outperforms the FF5 model. The intercepts are the same for all three models, which indicates their performance do not vary greatly, but the additional factors do not increase the explanatory power on the SSE.

Lastly, the FF5 model that includes the MOM factor continues the same pattern, in which only the Mkt-Rf, SMB and HML factors are statistically significant at the 1% level in explaining the stock returns on the SSE. The MOM, RMW and CMA factors are insignificant with relatively low and negative coefficients. Due to the low coefficients of the later added factors, the addition of these factors into the FF3 does not alter the model performance to a great extent, as it does for Huang (2019). The adjusted R^2 is reduced when adding all the factors, and it performs slightly worse than both the FF5, Carhart4 and FF3 models. The intercepts has, however, not changed, which means that the model still describes the returns on the SSE well.

Additionally, the results show positive premiums on the market and value factors, and negative premium on the size, momentum, profitability and investment factors. Most of these premiums are in line with the findings of Huang (2019) who investigates both the SSE and SZSE but finds reverse patterns in size and value.

In conclusion, the Mkt-Rf, SMB and HML factors are the only statistically significant factors in determining the return variance on the SSE. The MOM, RMW and CMA are not significant in any of the models proposed and adding them only decreases the adjusted R^2. Therefore, the FF3 model is the best performing model even as all the models produce an intercept that is insignificant; meaning all the models in general explain the SSE returns very well. This indicates that the traditional asset pricing model of the 1990s is a better fit for the explaining stock returns on the SSE index over the period 2012–2019. With these results in mind, this paper will leave out the FF5 model that includes the MOM factor for the time series analysis, as the evidence suggests this is not a better model in explaining returns on the SSE. In addition, in the time series analysis, the models will explain the anomalies in stock returns, and these will be much more pronounced in the portfolios used as the dependent variables than for the index examined in this section.

Impact and Implications of the factor returns to the foreign investor

Interpreting the findings, the evidence shows crucial implications for international investors looking to invest in equities listed on the SSE using a factor approach. Firstly, as none of the factors are statistically different from zero over the period between 2012-2020, investors cannot be statistically guaranteed to get a return different from zero when implementing an investment strategy based on either of the factors. However, as the average monthly return of the market, HML and RMW factors are relatively positive and high, an investment strategy based on entering long and short positions based on these factors does provide the investor with positive expected returns. In practice this means that the investor would buy long the market, value stocks and stocks with underlying firms that have robust profitability and enter short positions in growth- and weak profitable stocks. Investment strategies based on the rest of the factors might be too risky, as their average monthly returns are even closer to zero, but risk tolerant investors should consider a strategy based on a reverse momentum effect of the stock listed on the SSE. This means the investors would buy the recent loser stocks and short the past winner stocks – such a strategy is also known as a contrarian investment strategy (Bodie, Kane, & Marcus, 2017).

Regarding the asset pricing models on the SSE as an index, investors should rely on the three-factor of Fama & French in determining its returns with all its factors being statistically significant and with a very high level of explanatory power. This also means that, considering the SSE as a value weighted index, the three-factor model is the best asset pricing model in explaining the expected returns of the SSE, as it produces the lowest alpha.

5.2. The Factor Effects – Dependent Variables

The purpose of the second analysis is to examine and dig deeper into the factor effects, which can be analyzed by constructing valued weighted 5x5 portfolios. Three double sorted 5x5 portfolios are constructed based on size and B/M, size and profitability (EBITDA/B), and size and investment (change in total assets). By double sorting on a 5x5 basis, the subsets will produce large spreads in the mentioned variables and thereby making it possible to further analyze the anomalies in returns. The portfolios have been constructed following the methods put forward by Fama & French and can be reviewed in the comprehensive methodology section.

Summary Statistics

Before analyzing the portfolios, the summary statistics of their construction will first be presented in order to examine the representative data of the portfolios.

	Book-to-Market Equity Quantiles					
Panel A	Growth	2	3	4	Value	
	Average Number of Firms					%
Small	22	29	29	27	19	20%
2	23	28	29	29	20	20%
3	27	25	28	25	23	20%
4	28	26	24	21	31	20%
Big	28	22	19	25	34	20%
%	20%	20%	20%	20%	20%	

	EBITDA-to-Book Equity Quantiles					
Panel B	Weak	2	3	4	Robust	
	Average Number of Firms					%
Small	36	29	26	20	17	20%
2	29	30	27	23	20	20%
3	27	25	28	27	21	20%
4	23	26	26	26	27	20%
Big	13	18	22	31	42	20%
%	20%	20%	20%	20%	20%	

	Change in Total Assets Quantiles					
Panel C	Conservative	2	3	4	Aggresive	
	Average Number of Firms					%
Small	34	28	24	21	22	20%
2	29	29	23	23	25	20%
3	25	26	25	25	28	20%
4	23	23	30	26	27	20%
Big	17	23	27	33	26	20%
%	20%	20%	20%	20%	20%	

Size Quantiles

Table 12: Average Allocation of Firms for 5x5 Portfolios

Table 12 shows the average allocation of the firms used in the construction of the value weighted 5x5 portfolios. From both panel A, B and C in table 12, the allocation of firms across size and the respective second variable all add up 20% for each row and column. Therefore, even though the number of firms vary across the portfolios, the firms are all equally distributed across the two variables each portfolio is sorted on.

Each of the 5x5 portfolios is based on an average of 640 firms, as have been shown in the previous analysis, which is the majority of the firms listed on the SSE and the data is thereby representing the SSE well. However, the lowest level of firms for the above subsets is for the big firms with a weak profitability in panel B that only has been allocated 13 firms. Therefore, it might be worth noting that this particular subset is based on a smaller than average amount of firms, and that it might pose implications to reality. However, in general, the average allocation of firms are distributed well among the variables in each panel of table 12.

Panel A

Size Quantiles	Book-to-Market Equity Quantiles					
	Growth	2	3	4	Value	
	Average Market Capitalization					%
Small	107,145,999,552	136,157,290,080	138,788,192,800	124,987,011,296	94,774,352,352	4%
2	158,501,453,824	173,554,291,872	193,359,836,384	199,234,952,288	129,514,312,064	6%
3	278,066,821,888	263,688,616,064	286,335,840,640	244,078,746,304	218,923,528,768	9%
4	471,670,439,232	447,648,278,208	413,640,654,016	370,390,863,104	555,043,307,776	16%
Big	1,713,702,515,840	1,283,751,944,960	1,145,510,746,240	1,796,892,112,384	3,199,110,486,016	65%
%	19%	16%	15%	19%	30%	

Panel B

Size Quantiles	EBITDA-to-Book Equity Quantiles					
	Weak	2	3	4	Robust	
	Average Market Capitalization					%
Small	166,617,100,992	137,099,581,728	124,447,553,728	95,216,490,784	79,260,803,456	4%
2	193,809,852,576	197,261,838,784	179,262,271,904	154,849,234,496	128,428,866,944	6%
3	265,581,165,248	252,692,837,312	281,910,854,336	278,688,290,368	213,327,587,776	9%
4	406,034,941,120	460,747,318,720	453,331,278,656	468,317,946,816	463,963,020,224	16%
Big	603,940,348,288	1,125,923,228,800	1,184,129,004,288	2,354,865,264,384	3,865,561,006,592	65%
%	12%	15%	16%	24%	34%	

Panel C

Size Quantiles	Change in Total Assets Quantiles					
	Conservative	2	3	4	Aggresive	
	Average Market Capitalization					%
Small	162,282,751,680	124,696,286,080	121,298,659,104	99,135,349,216	97,188,668,576	4%
2	198,019,415,104	201,370,594,400	145,764,912,416	151,943,570,496	160,166,382,336	6%
3	241,258,063,808	254,119,591,232	250,611,801,984	257,025,059,712	285,298,733,376	9%
4	403,834,619,520	413,021,704,256	515,269,485,952	442,432,127,680	474,392,220,736	16%
Big	1,390,202,158,848	1,751,567,529,856	1,932,020,933,888	2,382,536,482,304	1,682,254,152,320	65%
%	17%	19%	21%	24%	19%	

Table 13: Allocation of Market Capitalization (CNY) of the 5x5 Portfolios

Table 13 shows the allocation of average market capitalization of each 5x5 portfolio. According to panel A, the 5x5 portfolio formed on size and B/M shows a very clear pattern in the allocation of market capitalization in relation to size. The total of small firms only constitutes a total of 4% of the total market capitalization; meaning in terms of market capitalization the small firms are not representing a large portion of the SSE. Big firms, on the other hand, makes up a total of 65% of average total market capitalization, and thereby representing substantially more than half of the SSE. In fact, the same exact same size patterns can be seen for the two other 5x5 portfolios that are formed on size and profitability/investment found in panel B and C of table 13.

In regard to the B/M variable of panel A, firms with the highest average market capitalization are value firms that constitute 30% of total market capitalization of the firms examined on the SSE.

Growth firms correspond to 19% of total average market capitalization, and in between growth and value firms there is no clear pattern.

Panel B shows a very clear pattern in the allocation of average market capitalization among profitability. The more robust a firm's profitability, the higher is its market capitalization. As it already has been shown that the firms are well distributed among the 5x5 portfolios in table 12, this means that there is a positive relationship between average market capitalization and profitability.

In terms of investments, panel C shows no specific pattern, but the firms with the largest market capitalization are in the third quantile on investment and therefore in between conservative- and aggressive investing firms. There is a weak pattern, however, showing that firms with higher market capitalization tend to invest more aggressively.

5x5 valued weighted portfolios on size and B/M

Full sample period

		Book-to-Market Equity Quantiles				
		Growth	2	3	4	Value
		Average montly excess return				
Size Quantiles	Small	-0.01%	0.18%	0.27%	0.85%	0.69%
	2	0.01%	0.21%	0.18%	0.35%	0.52%
	3	0.08%	-0.26%	0.07%	0.37%	0.75%
	4	0.17%	0.13%	0.04%	0.11%	0.43%
	Big	0.24%	0.04%	0.16%	0.46%	0.71%

Table 14: Excess return on the 5x5 Value Weighted Portfolios on size and B/M

Table 14 shows the average monthly excess returns of the value weighted 5x5 portfolios formed on size and B/M. This section will investigate the effects related to size and value present on the SSE. Starting with the size effect that states small firms performs better than big firms, the results of the SSE are mixed. The B/M columns for growth firms show the exact opposite size effect, which means that the bigger the firm, the larger the return. This is, however, not the case for all the B/M columns. B/M columns 2, 3 and 4 all show that the smaller firms outperform the bigger ones, which is evidence of a size effect on the SSE among these portfolios. Lastly, the value portfolios do not show any clear pattern in terms of size effect. Overall, the evidence shows a weak size effect on the portfolios formed on size and B/M. Additionally, the evidence shows similar results as Fama & French (2015), as the microcap growth portfolio contradicts the size effect in contrasts to the other portfolios.

In terms of value effect, the 5x5 portfolios present a very clear pattern. Value stocks perform much better than growth stocks and the returns are increasing across the B/M columns. The findings are furthermore in accordance with Fama & French (2015) that state the value effects is stronger among small firms, which is also what the evidence suggest on the SSE. For example, the microcap growth firms have an average return of negative 0.01, whereas the corresponding microcap value firms deliver an average return of 0.69%. For comparison, the big growth firms have an average of 0.24%, and the big value firms deliver an average return of 0.71%. Therefore, the difference between the average return is larger for the microcap firms.

In order to dig deeper into the effects on the SSE, a hypothesis could indicate that the effects are time dependent, as indicated for the factor correlation by Huang (2019). Therefore, in the following, the study will divide the full sample period into two in order to investigate if the size and value effects vary over time.

1st half of sample period

	Book-to-Market Equity Quantiles					
	Panel A	Growth	2	3	4	Value
		Average montly excess return				
Size Quantiles	Small	1.19%	1.13%	1.59%	2.03%	1.65%
	2	1.24%	1.07%	1.06%	1.15%	1.14%
	3	1.04%	0.45%	0.97%	1.20%	1.58%
	4	0.51%	0.28%	0.25%	1.02%	1.13%
	Big	-0.70%	-0.37%	0.20%	1.16%	0.89%

2nd half of sample period

	Book-to-Market Equity Quantiles					
	Panel B	Growth	2	3	4	Value
		Average montly excess return				
Size Quantiles	Small	-1.21%	-0.76%	-1.06%	-0.33%	-0.27%
	2	-1.22%	-0.66%	-0.70%	-0.45%	-0.10%
	3	-0.88%	-0.98%	-0.84%	-0.47%	-0.08%
	4	-0.17%	-0.02%	-0.16%	-0.80%	-0.27%
	Big	1.18%	0.44%	0.12%	-0.23%	0.52%

Table 15: 5x5 Portfolios formed on Size and B/M divided into two sample periods

The first half of the sample period starts in July 2012 and ends by the end of March 2016, whereas the second half start in April 2016 and ends by the end of December 2019. Therefore, each half of the sample period is based on average monthly excess returns of slightly less than four years of data.

Beginning the analysis with the first half of the sample period in panel A of table 15, the evidence of both clear size and value effects is striking. In terms of size, the average excess returns decreases substantially with size; meaning the size is evident for all B/M columns, as small firms outperform big ones significantly. In addition, panel A of table 15 also shows a clear value effect. The value portfolios all have higher average returns except one; suggesting the effect is strong. In general, there is a strong increasing trend going across the B/M columns, which is evidence of the value effect.

The portfolios of panel B, that shows the average excess returns of the portfolios for the second half of the sample period, generally have some extreme negative average excess returns across all the portfolios. This suggests that the returns on the SSE generally have been negative during this period, which might have caused the clear size and value effect of the first period to partly vanish out for the full period. In terms of size, there seems to be a reverse size effect during the second half of the sample period. The portfolios containing the big firms are doing relatively well over this period with mostly positive average excess returns. However, the small portfolios are doing much worse with extreme negative returns. With regard to the value effect, value firms have performed less bad than growth firms; meaning the value firms have outperformed growth firms. However, over the B/M columns, the increasing, positive relationship is not as clear as in panel A of table 15. Therefore, the value effect in the second half of the sample period exists but is not as strong.

In conclusion on the 5x5 value weighted portfolios formed on size and B/M showing excess returns, the evidence presents a weak size effect and relatively strong value effect on the SSE over the full sample period. However, the size effect seems to fluctuate throughout the period, as it is very strong in the first half of the period but reverse in the second; making it weak overall. The value effect also differs throughout time but not as extreme as the size effect, and therefore, the overall value effect is strong. Due to these fluctuations, investors need to be careful in blinding relying on the factor effects as their investment strategy. Overall, investors should especially be careful about the size effect, but the evidence provides a rather stable view on the value effect.

5x5 valued weighted portfolios on size and profitability

Full sample period

		EBITDA-to-Book Equity Quantiles				
		Weak	2	3	4	Robust
		Average montly excess return				
Size Quantiles	Small	0.39%	0.32%	0.50%	0.11%	0.35%
	2	0.54%	0.22%	0.05%	0.39%	0.05%
	3	-0.13%	0.35%	0.10%	0.50%	0.04%
	4	0.16%	-0.02%	0.05%	-0.12%	0.59%
	Big	-0.37%	0.27%	0.78%	0.48%	0.41%

Table 16: Excess Returns of 5x5 Portfolios Formed on Size and Profitability

Table 16 shows the average monthly excess returns of the value weighted 5x5 portfolios formed on size and profitability. Regarding the size effect for the full sample period, there seems to be no clear relationship between the average returns of small and big firms. The portfolios with weak profitability do show signs of the size effect; however, the portfolios with robust profitability are dominated by high returns of big firms. Hence, there is no obvious pattern in relation to the size.

The profitability effect states that firms with robust profitability performs better than firms with weak profitability. According to table 16, three of the portfolios containing firms with robust profitability outperform their weak profitable counterpart quite substantially. However, the two last ones are being outperformed by the portfolios with weak profitability. A similar pattern is found in the rest of the columns based on profitability, which means that the evidence is well mixed. Therefore, there seems to be a weak profitability effect, if any, as the robust portfolios on average outperforms the weak ones. In addition, the spread produced by the profitability effect is smaller than the spread produced by the value effect, which is in line with the findings of Guo et al. (2017).

1st half of sample period

	Panel A	Weak	2	3	4	Robust
		EBITDA-to-Book Equity Quantiles				
		Average montly excess return				
Size Quantiles	Small	1.65%	1.47%	1.78%	0.96%	1.19%
	2	1.55%	1.29%	0.75%	1.27%	0.91%
	3	0.79%	1.49%	1.17%	1.05%	0.87%
	4	1.19%	0.58%	0.30%	0.04%	0.74%
	Big	0.33%	0.21%	2.10%	0.52%	-0.07%

2nd half of sample period

	Panel B	Weak	2	3	4	Robust
		EBITDA-to-Book Equity Quantiles				
		Average montly excess return				
Size Quantiles	Small	-0.87%	-0.83%	-0.77%	-0.75%	-0.49%
	2	-0.47%	-0.86%	-0.65%	-0.49%	-0.81%
	3	-1.04%	-0.80%	-0.98%	-0.06%	-0.79%
	4	-0.87%	-0.62%	-0.19%	-0.29%	0.44%
	Big	-1.08%	0.32%	-0.53%	0.45%	0.90%

Table 17: 5x5 Portfolios formed on Size and EBITDA/B divided into two sample periods

Table 17 has divided the full sample period into two in order to examine if the size- and profitability effects vary with time. Panel A of table 17, that shows the average excess returns of the first half of the sample period, presents a strong size effect, as the small portfolios are outperforming the big ones substantially. There is only one big portfolio that beats its smaller counterpart, which is the megacap in the third column on profitability, however, the pattern shows a strong size effect throughout the rest of the portfolios. In terms of the profitability, there seems to be a reverse profitability effect in the first half of the sample period. The portfolios with more robust profitability perform worse than the weaker profitability portfolios, which indicates that the effect is reverse. There are a few cases that goes against this reverse profitability effect, but it is fairly strong.

Regarding the second half of the sample period in panel B of table 17, the average excess returns indicate a reverse size effect for all the five columns except for the first one presenting the weak profitability portfolios. Therefore, in general, the reverse size effect is quite strong especially with the big, robust profitability portfolios performing well during the second half period in which most portfolios experience negative average excess returns. Turning to the profitability patterns of panel B, the evidence is also very clearly showing a profitability effect, as the more robust profitability portfolios typically outperforms the weaker ones. There are, however, a few minor deviations from that effect, but in general it seems to hold and be strong during the second period.

In conclusion, the 5x5 value weighted portfolios based on size and profitability indicate there are no relationship between the sizes of the firms; meaning there is no size effect present over the full sample period. Additionally, the findings suggest a weak profitability effect. Just as with the portfolios formed on size and value, the effects of the SSE are fluctuating over time, and therefore the investor has to be careful when making investments based on the factor effects. In the first half of the sample period, the evidence shows the presence of a strong size effect, but in the second half of the sample period, it has reversed; making it insignificant over the entire period. Moreover, a reverse profitability effect in the first half is fairly strong, whereas there is a normal profitability effect in the second half of the sample period. Due to the amount of negative returns of the portfolios during the second half, it indicates that the big, profitable portfolios outperform other firms substantially during such times. Therefore, the evidence do not show definite investment guidelines to the factor investor. However, the investor should rely on the size effect in times with general positive returns on the SSE, but on the other hand seek to big companies during times with general negative returns. With regard to the profitability effect, the investor should invest in firms with weak profitability when the stock market is performing well and invest in firms with robust profitability when the market is performing poorly.

5x5 valued weighted portfolios on size and investment

Full sample period

		Change in Total Assets Quantiles				
		Conservative	2	3	4	Aggressive
		Average montly excess return				
Size Quantiles	Small	0.49%	0.23%	0.37%	0.41%	0.49%
	2	0.18%	0.39%	0.29%	0.01%	0.23%
	3	0.18%	0.01%	0.50%	0.25%	0.05%
	4	0.49%	-0.06%	0.30%	0.11%	-0.07%
	Big	0.41%	0.53%	0.19%	0.98%	-0.12%

Table 18: Excess Returns of 5x5 Portfolios Formed on Size and Investment

Table 18 shows the average monthly excess returns of the value weighted 5x5 portfolios formed on size and investment for the full sample period. With regard to size, there seems to be no obvious size pattern. With small portfolios outperforming bigger ones in certain columns of table 18, and some big portfolios performing better than smaller ones in others, no definite patterns can be observed.

The investment effect states that conservative firms perform better than aggressively investing firms. That is partly in accordance with table 18; indicating a weak investment pattern. The smallest conservative portfolios perform much like their aggressive counterparts, but the bigger conservative portfolios outperform their aggressive counterparts substantially. However, in between the columns of conservative and aggressive portfolios, the excess returns are well mixed and there are no clear patterns. Taken all together, there seems to be a weak investment effect for the very conservative firms.

1st half of sample period

	Change in Total Assets Quantiles					
	Panel A	Conservative	2	3	4	Aggressive
		Average montly excess return				
Size Quantiles	Small	1.66%	1.04%	1.62%	1.90%	1.83%
	2	1.03%	1.11%	1.27%	0.96%	1.38%
	3	0.98%	0.97%	1.20%	1.17%	1.02%
	4	1.23%	0.27%	0.74%	0.52%	0.30%
	Big	0.24%	0.66%	0.10%	1.06%	-0.21%

2nd half of sample period

	Change in Total Assets Quantiles					
	Panel B	Conservative	2	3	4	Aggressive
		Average montly excess return				
Size Quantiles	Small	-0.68%	-0.58%	-0.87%	-1.08%	-0.85%
	2	-0.67%	-0.33%	-0.69%	-0.94%	-0.91%
	3	-0.62%	-0.96%	-0.19%	-0.67%	-0.92%
	4	-0.25%	-0.39%	-0.15%	-0.30%	-0.44%
	Big	0.58%	0.41%	0.27%	0.90%	-0.04%

Table 19: 5x5 Portfolios formed on Size and Investment divided into two sample periods

In table 19, the full sample period has been divided into two as in accordance with previous 5x5 portfolios. Panel A shows the, mostly positive, excess returns of the first half of the sample period. During this period, the excess returns show a strong size effect, as all the microcap portfolios are significantly outperforming the macrocap portfolios. Regarding the investment effect, panel A does not present evidence of such an effect. In fact, even as the returns are very mixed across the portfolios, there seems to be evidence of a weak reverse investment pattern during this period, as the small aggressively investing portfolios are performing better than their conservative counterpart. However, in conclusion on the investment effect during the first half, it is mostly presented as there is no pattern.

Turning to the second half of the sample period, panel B of table 19 shows the same negative environment as previously seen in the other 5x5 portfolios. It is evident that there is a reverse size effect on the SSE, which has also been found on the previous portfolios during the latter half of the sample period. The reverse size effect is very strong during this period. In addition, regardless of size, the conservative portfolios are all performing better than the aggressive ones; indicating a reasonable investment effect.

In conclusion, the average excess returns of the 5x5 value weighted portfolios based on size and investment shows that the SSE overall do not reflect any size effect and only to a very certain extent a weak investment pattern based on the full sample period. In the first half, however, the evidence shows a strong size effect and no investment pattern, whereas in the second half there is found a reverse size effect and a reasonable investment effect. Taken all together, the evidence also here shows that the effects on the SSE are very time dependent, which results in no definite patterns. It seems the investor needs to take the general performance of the SSE into account in order to know what effects are going to be present.

Impact and implications of the 5x5 portfolios to investors

To an investor examining the SSE using a factor approach, the most important aspect of the investment strategy is to know whether the factor effects are present on the equity market in order to implement a profitable investment strategy. The evidence has shown a number of things in this regard that are crucial for international investors. The most important finding from the analysis is that the factor effects are varying with time. In other words, the data suggests that the factor effects show different patterns on the SSE depending on the general performance of the stock market. Therefore, depending on the time horizon for the individual investor, the current performance on the stock market seems to be an important indicator for the investment strategy, as certain factor effects seem to be more pronounced in times when the stock market is doing well in general.

Based on the evidence from all three 5x5 portfolios, the size effect is in general not existing on the SSE over the entire sample period between July 2012–December 2019. However, this is due to the changing size effect. Dividing the sample period into two, the first half shows strong size effects, whereas the second half shows reverse size effects and thereby neutralizing it over the entire period. The value effect is strong, and the profitability and investment effects are both relatively weak over the entire period. Therefore, over the long haul, investor should especially engage in investing in the value stocks and short growth stocks of the SSE, as such a strategy will deliver expected positive returns. In addition, investing in firms with robust profitability and conservatively investing firms might also enhance the investment strategy, but the investor should keep in mind that these relationships are weak due to the changing performance. During the period when the performance of the general market is poor, the investor should invest in firms that are conservatively investing and with a robust profitability, as the factor effects are more pronounced in this negative return environment. Thus, if the investor believe it is possible to predict the future performance of the stock market, the investor should implement a dynamic investment strategy based on the environment in which the factors are more pronounced.

5.3. Time Series Regressions

The third analysis is the time series analysis, which tests the performance of the models set up in the first analysis on the anomalies in the returns on the SSE. The analysis is conducted as described in the methodology section, which briefly states that the different factor models are regressed on each of the portfolios of the three 5x5 portfolios. As this paper is testing four different asset pricing models, a total of 300 regressions are run in order to test the performance of the models. The models are regressed on each of the portfolios in order to test how well the models explain the average excess returns across the anomalies in the stock returns of the SSE. This will result in evidence either supporting or contradicting the different factors depending on how evident they are in the market. Therefore, the model performance will enhance the conclusions of the two previous analyses and enable the paper to further advise investors on what investment strategies to implement.

Model performance on size-B/M portfolios

If the asset pricing models completely explain the expected returns, the intercepts (alpha) of the regressions will be indistinguishable from zero (Fama & French, 2015). Therefore, in figure 3 below, the alpha, t-statistic on alpha and the adjusted R^2 are shown for each model presented in the typical 5x5 format that shows the statistics for each portfolio. In addition, the number of statistically significant factors of each model is shown on the side, which will assist in explaining whether the different factors are statistically significant in explaining the 5x5 portfolios formed on size and B/M.

Model Performance on size-B/M Portfolios

CAPM

Alpha

	Growth	2	3	4	Value
Small	-0.48%	-0.26%	-0.19%	0.37%	0.22%
2	-0.49%	-0.25%	-0.27%	-0.09%	0.10%
3	-0.40%	-0.72%	-0.40%	-0.09%	0.33%
4	-0.28%	-0.30%	-0.38%	-0.32%	0.01%
Big	-0.14%	-0.37%	-0.23%	0.05%	0.35%

T-test of Alpha

	Growth	2	3	4	Value
Small	-1.00	-0.54	-0.40	0.87	0.56
2	-1.10	-0.53	-0.65	-0.23	0.23
3	-0.91	-1.92	-1.08	-0.24	0.80
4	-0.70	-0.80	-1.03	-0.82	0.01
Big	-0.33	-1.08	-0.52	0.11	0.69

Adjusted R^2

	Growth	2	3	4	Value
Small	0.74	0.72	0.74	0.79	0.81
2	0.79	0.73	0.78	0.78	0.73
3	0.78	0.81	0.82	0.81	0.76
4	0.79	0.79	0.80	0.78	0.75
Big	0.71	0.81	0.70	0.71	0.58

# of significant factors	
Mkt-Rf	25

3 Factor Model

Alpha

	Growth	2	3	4	Value
Small	-0.43%	-0.24%	-0.17%	0.33%	0.12%
2	-0.41%	-0.19%	-0.24%	-0.12%	-0.04%
3	-0.29%	-0.66%	-0.38%	-0.13%	0.19%
4	-0.18%	-0.21%	-0.37%	-0.36%	-0.13%
Big	0.02%	-0.34%	-0.28%	-0.07%	0.16%

T-test of Alpha

	Growth	2	3	4	Value
Small	-1.51	-0.80	-0.66	1.32	0.40
2	-1.59	-0.67	-0.83	-0.40	-0.11
3	-1.16	**-2.70**	-1.32	-0.39	0.56
4	-0.59	-0.75	-1.10	-0.94	-0.34
Big	0.06	-1.03	-0.69	-0.26	0.60

Adjusted R^2

	Growth	2	3	4	Value
Small	0.91	0.89	0.91	0.93	0.89
2	0.93	0.90	0.89	0.88	0.81
3	0.93	0.92	0.89	0.86	0.83
4	0.89	0.89	0.83	0.79	0.81
Big	0.82	0.82	0.75	0.90	0.89

# of significant factors	
Mkt-Rf	25
SMB	24
HML	14

4 Factor Model

Alpha

	Growth	2	3	4	Value
Small	-0.44%	-0.24%	-0.19%	0.32%	0.12%
2	-0.40%	-0.19%	-0.25%	-0.12%	-0.03%
3	-0.28%	-0.67%	-0.38%	-0.12%	0.20%
4	-0.16%	-0.21%	-0.37%	-0.35%	-0.12%
Big	0.03%	-0.34%	-0.27%	-0.08%	0.16%

T-test of Alpha

	Growth	2	3	4	Value
Small	-1.52	-0.79	-0.71	1.30	0.40
2	-1.57	-0.67	-0.83	-0.39	-0.07
3	-1.14	**-2.77**	-1.31	-0.38	0.58
4	-0.55	-0.74	-1.08	-0.91	-0.32
Big	0.08	-1.04	-0.67	-0.31	0.59

Adjusted R^2

	Growth	2	3	4	Value
Small	0.91	0.89	0.92	0.93	0.89
2	0.93	0.90	0.89	0.88	0.82
3	0.93	0.92	0.89	0.86	0.83
4	0.89	0.89	0.82	0.79	0.80
Big	0.82	0.82	0.75	0.90	0.88

# of significant factors	
Mkt-Rf	25
SMB	25
HML	14
MOM	3

5 Factor Model

Alpha

	Growth	2	3	4	Value
Small	-0.44%	-0.21%	-0.16%	0.38%	0.16%
2	-0.43%	-0.16%	-0.20%	-0.10%	0.03%
3	-0.22%	-0.65%	-0.34%	-0.09%	0.25%
4	-0.13%	-0.20%	-0.31%	-0.27%	-0.07%
Big	-0.01%	-0.34%	-0.24%	-0.06%	0.18%

T-test of Alpha

	Growth	2	3	4	Value
Small	-1.51	-0.69	-0.61	1.55	0.53
2	-1.68	-0.58	-0.67	-0.33	0.08
3	-0.93	**-2.61**	-1.20	-0.29	0.73
4	-0.44	-0.74	-0.92	-0.72	-0.19
Big	-0.02	-1.03	-0.59	-0.22	0.65

Adjusted R^2

	Growth	2	3	4	Value
Small	0.91	0.89	0.91	0.93	0.89
2	0.93	0.91	0.89	0.88	0.82
3	0.94	0.92	0.90	0.86	0.84
4	0.89	0.89	0.84	0.81	0.81
Big	0.82	0.82	0.75	0.90	0.88

# of significant factors	
Mkt-Rf	25
SMB	21
HML	14
RMW	5
CMA	2

Figure 3: Alpha, t-stat and Adjusted R^2 for each model on 5x5 size-B/M portfolios. The number of significant factors have been tested at the 5% significance level.

The four models that are being tested are the CAPM, the Fama-French three-factor model, the Carhart four-factor model, and the Fama-French five-factor. The factors constructed by the anomaly portfolios (SMB, HML, RWM and CMA) are the ones designed to explain the average excess returns for the corresponding anomaly 5x5 portfolios (Guo, Zhang, Zhang, & Zhang, 2017). Thus, for the 25 portfolios formed on size-B/M, it is the goal of the SMB and HML factors to explain these anomalies in returns.

Analyzing the specifics of figure 3, the performance of the CAPM firstly shows that the market factor is statistically significant at the 5% significance level for all 25 portfolios sorted on size and B/M. In other words, the market factor is statistically significant in explaining the average excess returns on each of the 25 portfolios. The alphas in absolute values produced by the regressions range from 0.72% to as little as 0.01%. The biggest absolute alpha of 0.72% per month might seem like a large monthly excess return, but it is not statistically different from zero at the 5% significance level, as it has a t-statistic of -1.92; however, it is rather close. On the other hand, the lowest absolute value of an intercept produced by the CAPM is 0.01%, which means that the CAPM almost explains this portfolio perfectly. Accordingly, it has a very small t-statistic; meaning it is not statistically different from zero.

In general, the CAPM performs well across the 25 valued weighted portfolios on size and B/M. It produces certain relatively high (absolute value) intercepts especially for the microcap growth stocks. This has also been a problem for Fama & French (2015), as these portfolios have been deadly to performance of their three-factor model. In this paper, the findings show that the alphas are not statistically different from zero even if they are larger than the average alpha produced. In fact, none of the alphas produced by the CAPM are statically different from zero; suggest the CAPM is a good model in describing average excess returns on the SSE.

In terms of the R^2, the performance shows that the CAPM explains 0.58 and 0.82 of the variances in excess returns of the 25 portfolios. The R^2 of 0.58 is a bit of an outlier, as the R^2 generally are between 0.70-0.80 for most of the portfolios. Therefore, the CAPM performs fairly well in this regard as well but has a critical failure in capturing the variance of the excess returns of the big-value portfolio.

Regarding the Fama-French three-factor model (FF3), the addition of the SMB and HML factors enhances the performance of the CAPM; meaning the FF3 model produces lower alphas in absolute terms for almost all the portfolios. The market factor continues to be statistically significant for all the 25 portfolios, whereas the SMB and HML factors are statistically significant for 24 and 14 portfolios respectively. Therefore, the SMB factor is critical to include, as it successfully captures the anomalies in the excess returns related to size on the SSE. The HML factor also increase the explanatory power of the FF3 model for most of the portfolios, and it is also a powerful addition to the CAPM, as it explains the anomaly in returns related to value well.

The alphas in absolute terms produced by the FF3 model range from as much as 0.66% to 0.02%. The range is slightly smaller than the one produced by the CAPM; indicating a better performance of the FF3. In this regard, the problem with the high t-statistic of the CAPM has been amplified and the 3/2 portfolio is significantly different from zero as the only portfolio. This means that the FF3 model fails to explain the expected return related to this portfolio, which is a big flaw of the model. Furthermore, the FF3 model reduces the problems found in the microcap extreme growth portfolios but do not eliminate them. The two microcap extreme growth portfolios are still both producing absolute alphas of slightly more than 0.40%, and still being not being statically different from zero. Hence, the FF3 model improves these numbers.

Regarding the adjusted R^2 of the FF3, there is clear improvement compared to the CAPM. For the FF3 model, the R^2 is in the range of 0.75–0.93, which is much higher overall. Thus, the FF3 performs better than the CAPM in explaining the average excess returns across the anomaly related to size and value in the stock returns of the SSE even as one of the portfolios is significantly different from zero.

The Carhart four-factor model adds the MOM factor to the FF3 model, and as figure 3 shows, the MOM factor is only statistically significant in explaining three out of the 25 portfolios. These results indicate that the MOM factor does not add much explanatory power to the excess returns on the SSE. Moreover, the market and HML factors have the same number of significant factors as for the FF3 model, which has not been altered by the addition of the MOM factor. On the other hand, the SMB factor is for the Carhart4 model significant in explaining all the 25 portfolios, which is an increase of one, and is a result of adding the MOM factor to the FF3 model.

In terms of the alphas produced by the Carhart4 model, not much have changed compared to the ones produced by the FF3. The model still faces the same problems relating to the microcap extreme growth portfolios, and the 3/2 portfolio is still statistically different from zero. The same is evident for the R^2, which do not differ much from the FF3 model. Therefore, the overall performance of the four-factor model is very similar to the FF3 model. The evidence further suggests that adding the MOM factor does not increase the explanatory power of the model.

Lastly, for the model performance of the 25 portfolios formed on size-B/M, the five-factor model of Fama & French (FF5) performs differently, as it adds the RMW and CMA factors to the original FF3 model. Across the significant factors, the market factor is the only factor that is statistically significant in explaining the excess returns of all the 25 portfolios of the SSE. In this model, the SMB and HML factors are significant in 21 and 14 portfolios respectively, whereas the RMW and CMA only are significant in explaining 5 and 2 portfolios respectively. However, the 25 portfolios are formed on size and B/M; meaning the factors meant to explain the anomaly patterns of these portfolios are the SMB and HML factors.

The performance of the FF5 model indicates that the addition of the RMW and CMA factors have improved the overall performance of the model, as the alphas have been substantially reduced in absolute terms. However, the relatively large alphas produced for the microcap extreme growth portfolios have slightly increased compared to the FF3 and Charhart4 models, and the 3/2 portfolio remains statistically significant different from zero. The intercepts of the other 24 portfolios remain statistically indistinguishable from zero; meaning a very good performance of the model in explaining the excess returns on the SSE. Furthermore, the R^2 have also increased for the FF5, and therefore the FF5 describes more of the variance of excess returns of the SSE. Based on the results on model performance on the size-B/M portfolios, the FF5 model delivers a slightly better performance in terms of the alphas and R^2 of the excess returns of the 25 portfolios.

Model performance on size-EBITDA/B portfolios

In this section, in which the model performance is tested on the 25 portfolios formed on size and profitability (EBITDA/B), the goal of the RMW factor is to capture these anomalies in returns. As for the 25 portfolios formed on size and B/M, figure 4 presents the same regression statistics for each portfolio and for each factor model.

Model Performance on size-EBITDA/B Portfolios

CAPM

Alpha

	Weak	2	3	4	Robust
Small	-0.10%	-0.14%	0.06%	-0.33%	-0.10%
2	0.08%	-0.26%	-0.39%	-0.05%	-0.41%
3	-0.63%	-0.12%	-0.35%	0.05%	-0.38%
4	-0.32%	-0.44%	-0.33%	-0.57%	0.17%
Big	-0.82%	-0.12%	0.30%	0.10%	0.07%

T-test of Alpha

	Weak	2	3	4	Robust
Small	-0.24	-0.33	0.13	-0.68	-0.22
2	0.19	-0.59	-1.11	-0.12	-0.97
3	-1.38	-0.33	-1.08	0.15	-1.18
4	-0.80	-1.38	-0.96	-1.36	0.56
Big	-1.65	-0.29	0.50	0.28	0.14

Adjusted R^2

	Weak	2	3	4	Robust
Small	0.79	0.77	0.75	0.71	0.75
2	0.76	0.78	0.82	0.78	0.78
3	0.78	0.84	0.85	0.81	0.83
4	0.81	0.84	0.79	0.77	0.86
Big	0.71	0.71	0.64	0.76	0.62

# of significant factors	
Mkt-Rf	25

3 Factor Model

Alpha

	Weak	2	3	4	Robust
Small	-0.15%	-0.11%	0.06%	-0.33%	-0.12%
2	0.08%	-0.24%	-0.37%	-0.03%	-0.43%
3	-0.61%	-0.10%	-0.35%	0.08%	-0.41%
4	-0.37%	-0.45%	-0.29%	-0.51%	0.17%
Big	-0.88%	-0.17%	0.17%	0.07%	-0.02%

T-test of Alpha

	Weak	2	3	4	Robust
Small	-0.52	-0.40	0.22	-1.05	-0.35
2	0.24	-0.98	-1.42	-0.11	-1.28
3	-1.58	-0.35	-1.56	0.28	-1.36
4	-1.02	-1.50	-0.99	-1.31	0.62
Big	-1.92	-0.42	0.35	0.19	-0.05

Adjusted R^2

	Weak	2	3	4	Robust
Small	0.91	0.92	0.90	0.88	0.86
2	0.85	0.93	0.90	0.89	0.86
3	0.85	0.90	0.93	0.90	0.86
4	0.84	0.86	0.85	0.80	0.87
Big	0.75	0.75	0.77	0.80	0.81

# of significant factors	
Mkt-Rf	25
SMB	23
HML	6

4 Factor Model

Alpha

	Weak	2	3	4	Robust
Small	-0.16%	-0.11%	0.05%	-0.32%	-0.12%
2	0.08%	-0.23%	-0.36%	-0.04%	-0.42%
3	-0.61%	-0.10%	-0.35%	0.07%	-0.41%
4	-0.36%	-0.45%	-0.29%	-0.50%	0.18%
Big	-0.88%	-0.16%	0.14%	0.07%	-0.02%

T-test of Alpha

	Weak	2	3	4	Robust
Small	-0.57	-0.41	0.20	-1.03	-0.35
2	0.22	-0.96	-1.39	-0.12	-1.26
3	-1.57	-0.34	-1.54	0.27	-1.38
4	-1.00	-1.49	-0.99	-1.29	0.63
Big	-1.90	-0.40	0.30	0.20	-0.05

Adjusted R^2

	Weak	2	3	4	Robust
Small	0.91	0.92	0.90	0.88	0.86
2	0.84	0.93	0.90	0.88	0.86
3	0.85	0.90	0.93	0.89	0.86
4	0.85	0.86	0.85	0.80	0.87
Big	0.75	0.75	0.79	0.80	0.80

# of significant factors	
Mkt-Rf	25
SMB	23
HML	6
MOM	2

5 Factor Model

Alpha

	Weak	2	3	4	Robust
Small	-0.09%	-0.06%	0.06%	-0.34%	-0.12%
2	0.23%	-0.22%	-0.36%	-0.10%	-0.43%
3	-0.44%	-0.03%	-0.35%	0.05%	-0.40%
4	-0.23%	-0.37%	-0.28%	-0.45%	0.13%
Big	-0.70%	-0.08%	0.11%	0.03%	-0.03%

T-test of Alpha

	Weak	2	3	4	Robust
Small	-0.31	-0.22	0.21	-1.08	-0.36
2	0.78	-0.91	-1.37	-0.36	-1.24
3	-1.42	-0.13	-1.54	0.18	-1.33
4	-0.73	-1.30	-0.95	-1.16	0.46
Big	-1.87	-0.20	0.23	0.10	-0.10

Adjusted R^2

	Weak	2	3	4	Robust
Small	0.91	0.92	0.90	0.88	0.86
2	0.89	0.93	0.90	0.89	0.86
3	0.90	0.92	0.93	0.90	0.86
4	0.88	0.87	0.85	0.80	0.88
Big	0.84	0.77	0.77	0.80	0.80

# of significant factors	
Mkt-Rf	25
SMB	21
HML	6
RMW	11
CMA	0

Figure 4: Alpha, t-stat and Adjusted R^2 for each model on 5x5 size-EBITDA/B portfolios. The number of significant factors have been tested at the 5% significance level.

For the performance of the CAPM on the size-profitability formed portfolios, the market factor follows the pattern of the size-B/M portfolios, as it is statistically significant for all portfolios. In other words, the market factor is statistically significant in describing the average excess returns of all the portfolios formed on size-EBITDA/B on the SSE. In terms of the alphas produced by the CAPM, they range in absolute values from 0.82% to 0.05%. There is great variation in the alphas and no clear relationship in this regard. However, the problem with the high alphas for the microcap with weak profitability portfolios does not exists when sorted on size and profitability. On the other hand, the CAPM indicates difficulties in explaining the excess returns of the macrocap portfolios that have weak profitability. Even though certain alphas might be large, all of them produced by the CAPM are not statistically distinguishable from zero; meaning the CAPM is a very good model in describing the average excess returns on the SSE. Lastly, the generated R^2 range between 0.64 and 0.86; confirming the relatively good performance of the CAPM.

Adding the SMB and HML factors to the CAPM, the FF3 model produces 25 significant market factors, 23 significant SMB factors and 6 significant HML factors for the 25 portfolios. This means the market and SMB factors are still extremely relevant in describing average excess returns of the SSE when the portfolios is formed on size and profitability. However, as the HML factor is meant to capture the value effects, it has less significance on these 25 portfolios that instead is meant to be captured by the RMW factor.

In addition, the FF3 model does in general not produce much lower alphas than the CAPM. In fact, the alphas of the FF3 model vary a lot compared to the CAPM, and the FF3 model performs worse for about half of the portfolios while improving the rest. The range of the alphas has been extended for the FF3 model and in absolute terms range from 0.88% to 0.02%. Importantly, all the alphas remain statistically indistinguishable from zero; supporting the evidence of good performance for the FF3 model. In addition, the FF3 model performs much better than the CAPM in describing the variance of average excess returns of the 25 portfolios of the SSE.

From figure 4, the Carhart4 model shows that the MOM factor only is significant in explaining two of the 25 portfolios formed on size and profitability. Being only significant for two portfolios indicates that the MOM factor is not a very useful addition to the FF3 model. Moreover, the market, SMB and HML factors are significant in describing respectively 25, 23 and 6 portfolios, which are the same numbers as for the FF3 model. In terms of the alphas produced by the Carhart4 model, the performance seems to slightly have been improved by addition the MOM factor, as the alphas generally are moderately lower. Therefore, the t-statistics also conclude that all of the alphas are indistinguishable from zero following the same, good performance of the FF3 model. The Carhart4 model also faces the problems with the high alphas of the big/weak portfolios, and do not improve these to a great extent. Lastly, regarding the level of explained variance of the excess returns, the Carhart4 model produces slightly lower R^2 compared to the FF3 model. However, in general the R^2 do not vary much compared to the FF3 model, but the overall evidence suggest that the addition of the MOM factor does not help in improving the general performance of the FF3 model.

The FF5 model is the more interesting, as the 25 portfolios are sorted on size and profitability and the FF5 model is the only model containing the RMW factor. The numbers of significant factors have changed for the FF5 model. Firstly, the market and HML factors are significant in respectively 25 and 6 portfolios, which is in line with the previous cases. The SMB factor has decreased by 2 and is significant in explaining 21 of the portfolios. Importantly, the RMW factor is significant in explaining 11 of the 25 portfolios; meaning it is statistically significant in explaining just less than half of the portfolios formed on size and profitability. Thus, the RWM factor is useful in explaining the anomalies of the excess returns on the SSE. Lastly, the CMA factor is not significant at all in describing these excess returns.

The alphas of the FF5 model show the improvement of adding the RMW factor to the FF3 model. In general, the alphas are remarkably lower, and range between 0.70% and 0.03% in absolute values. The alphas of the macrocap weak profitable portfolios have decreased as well and has thereby reduced the previously large problem. The t-statistics also show that all the alphas are indistinguishable from zero, which further supports the good performance of the model. In terms of R^2, the FF5 model performs better than any of the other models; cementing the superior performance of the model on the portfolios formed on size and profitability.

Model performance on size-INV portfolios

Figure 5 presents the same regression statistics for each of the 25 portfolios formed on size-INV. As for the two previous 5x5 portfolios, the market factor is significant in describing the 25 portfolios formed on size-INV as well for the CAPM.

Model Performance on size-INV Portfolios

CAPM

Alpha	Conservative	2	3	4	Aggressive
Small	0.02%	-0.23%	-0.08%	-0.06%	0.03%
2	-0.25%	-0.06%	-0.15%	-0.45%	-0.24%
3	-0.27%	-0.46%	0.07%	-0.20%	-0.44%
4	0.01%	-0.49%	-0.09%	-0.31%	-0.51%
Big	0.00%	0.18%	-0.18%	0.59%	-0.56%

T-test of Alpha	Conservative	2	3	4	Aggressive
Small	0.03	-0.56	-0.20	-0.12	0.06
2	-0.58	-0.15	-0.48	-1.06	-0.63
3	-0.70	-1.32	0.19	-0.62	-1.11
4	0.04	-1.43	-0.30	-1.02	-1.60
Big	0.00	0.46	-0.43	1.57	-1.28

Adjusted R^2	Conservative	2	3	4	Aggressive	# of significant factors	
Small	0.76	0.79	0.79	0.74	0.74	Mkt-Rf	25
2	0.75	0.78	0.85	0.77	0.82		
3	0.80	0.84	0.78	0.85	0.82		
4	0.81	0.83	0.82	0.85	0.85		
Big	0.71	0.69	0.70	0.76	0.75		

3 Factor Model

Alpha	Conservative	2	3	4	Aggressive
Small	0.00%	-0.21%	-0.10%	-0.06%	0.02%
2	-0.26%	-0.05%	-0.17%	-0.42%	-0.23%
3	-0.27%	-0.48%	0.07%	-0.19%	-0.39%
4	-0.03%	-0.51%	-0.09%	-0.28%	-0.45%
Big	-0.07%	0.07%	-0.28%	0.55%	-0.58%

T-test of Alpha	Conservative	2	3	4	Aggressive
Small	0.00	-0.86	-0.32	-0.20	0.07
2	-0.88	-0.19	-0.67	-1.35	-0.77
3	-0.87	-1.65	0.20	-0.80	-1.32
4	-0.09	-1.53	-0.33	-1.00	-1.67
Big	-0.17	0.22	-0.91	**2.14**	-1.51

Adjusted R^2	Conservative	2	3	4	Aggressive	# of significant factors	
Small	0.93	0.92	0.89	0.89	0.88	Mkt-Rf	25
2	0.89	0.90	0.90	0.88	0.89	SMB	24
3	0.88	0.89	0.83	0.92	0.90	HML	9
4	0.83	0.84	0.85	0.87	0.89		
Big	0.78	0.82	0.83	0.89	0.80		

4 Factor Model

Alpha	Conservative	2	3	4	Aggressive
Small	-0.01%	-0.21%	-0.10%	-0.06%	0.01%
2	-0.25%	-0.05%	-0.17%	-0.43%	-0.22%
3	-0.26%	-0.49%	0.08%	-0.20%	-0.39%
4	-0.02%	-0.50%	-0.09%	-0.28%	-0.45%
Big	-0.07%	0.08%	-0.29%	0.56%	-0.59%

T-test of Alpha	Conservative	2	3	4	Aggressive
Small	-0.03	-0.86	-0.35	-0.18	0.03
2	-0.86	-0.17	-0.65	-1.35	-0.75
3	-0.85	-1.66	0.22	-0.87	-1.32
4	-0.05	-1.51	-0.32	-0.97	-1.65
Big	-0.17	0.25	-0.92	**2.13**	-1.51

Adjusted R^2	Conservative	2	3	4	Aggressive	# of significant factors	
Small	0.93	0.92	0.89	0.89	0.88	Mkt-Rf	25
2	0.89	0.90	0.90	0.88	0.89	SMB	24
3	0.87	0.89	0.83	0.92	0.90	HML	9
4	0.84	0.84	0.85	0.87	0.89	MOM	1
Big	0.78	0.82	0.83	0.89	0.80		

5 Factor Model

Alpha	Conservative	2	3	4	Aggressive
Small	0.03%	-0.17%	-0.08%	-0.02%	0.00%
2	-0.24%	0.00%	-0.15%	-0.41%	-0.22%
3	-0.18%	-0.43%	0.11%	-0.17%	-0.37%
4	0.08%	-0.46%	-0.04%	-0.26%	-0.43%
Big	0.02%	0.09%	-0.28%	0.52%	-0.59%

T-test of Alpha	Conservative	2	3	4	Aggressive
Small	0.12	-0.70	-0.25	-0.05	-0.01
2	-0.81	-0.01	-0.59	-1.28	-0.75
3	-0.62	-1.50	0.31	-0.71	-1.30
4	0.22	-1.39	-0.14	-0.91	-1.57
Big	0.05	0.30	-0.88	**2.01**	-1.63

Adjusted R^2	Conservative	2	3	4	Aggressive	# of significant factors	
Small	0.94	0.92	0.89	0.89	0.88	Mkt-Rf	25
2	0.89	0.91	0.90	0.88	0.90	SMB	21
3	0.89	0.89	0.83	0.92	0.91	HML	7
4	0.85	0.85	0.86	0.87	0.89	RMW	3
Big	0.80	0.85	0.83	0.89	0.83	CMA	7

Figure 5: Alpha, t-stat and Adjusted R^2 for each model on 5x5 size-INV portfolios. The number of significant factors have been tested at the 5% significance level

The alphas produced by the CAPM range from 0.59% to 0.02% in absolute values. The pattern in alphas show problems for the CAPM in explaining the big aggressively investing portfolios that all have relatively high values. However, none of the 25 alphas are statistically different from 0, which means that the CAPM performs well in describing the excess returns of the 25 portfolios formed on size and investment of the SSE. This is also the case when examining the R^2, which in general is quite high and ranging between 0.69 and 0.85.

The addition of the SMB and HML factors seems to be important for the 25 portfolios, as the factors are statistically significant in explaining 24 and 9 portfolios respectively. The alphas of the FF3 model do not follow the line of argument, as some have been reduced but other have increased relative to the CAPM. The performance of most of the conservative investing portfolios have been worsened, whereas the evidence suggests that the alphas of the aggressively investing portfolios have been slightly improved. Therefore, it seems that the FF3 model has trouble in fully explaining the portfolios relating to size and investment. In addition, the FF3 model produces a statistically significantly alpha of the big portfolio in the fourth column of investments, which means that the model fails to explain the excess returns of that portfolio. However, all the other alphas remain statistically indistinguishable from zero, which reinforces the good overall performance of the FF3 model. Lastly, the R^2 indicate that the FF3 model dominates the CAPM due to the substantial increase in R^2s for each of the 25 portfolios.

As in the cases of the two other 5x5 portfolios, adding the MOM factor to the FF3 does not seem crucial in describing the average excess returns of the portfolios formed on size and investment. In this case, the Carhart4 model shows that the MOM factor is only significant in explaining one of the 25 portfolios; showing the limited explanatory power of the factor. The rest of the factors remain unchanged in this regard from the findings of the FF3 model. This also means that the alphas of the Charhart4 model have not changed much from the FF3 model, and it is difficult to tell their performance apart.

The Carhart4 model also produces the same significant alpha as the FF3, while the rest remain indistinguishable from zero. Similar patterns are found for the R^2 of the model, which means it performs much like the FF3 model and that the addition of the MOM factor does not contribute any significance for the size-INV portfolios.

The FF5 model, that includes the RMW and CMA factors, has been constructed to explain the anomalies relating to profitability and investment. The findings of the time series regressions of the FF5 model firstly shows that the market, SMB and HML factor are significant in describing respectively 25, 21 and 7 of the 25 portfolios. The RMW factor is significant in explaining only three of the portfolios, but most importantly, the CMA factor is statistically significant in explaining 7 out of the 25 portfolios. 7 significant slopes of the CMA factor is by far the best it has performed for any of the 5x5 portfolios; however, it is still less than one third of all the portfolios. Therefore, the CMA factor is somewhat significant in explaining the anomalies related to investments, but the market and SMB factor have a much more substantial impact.

The FF5 model performs very well in terms of alphas. The alphas are in general lower than the ones produced by the FF3 and Carhart4 models but have not substantially improved. An interesting observation is that the alpha of the big aggressively investing portfolio is -0.59%, which is the same for the Carhart4 model, but higher (in absolute values) than the alphas produced by the FF3 model and the CAPM. Therefore, this extreme portfolio seems to further enhance the earlier problem identified of the other models. In addition, the big portfolio in the fourth column is also significant for the FF5 model even though it has lowered its alpha. However, the rest of the portfolios remain insignificant. In terms of the R^2 of the FF5 model, the performance has improved and the variance of the average excess returns of the 25 portfolios of the SSE are better explained by the FF5 model. Therefore, the FF5 model shows it is a superior tool in evaluating the performance of the 25 portfolios formed on size and investment of the SSE, as the CMA factor adds a number of significant slopes in the regressions conducted, even though the overall significance of the investment effect is questionable on the SSE.

Overall model performance in time series regressions

In order to test and evaluate how the different asset pricing models capture the cross-section of average excess returns of the three 5x5 portfolios formed on size and either B/M, profitability and investment of the SSE, a number of time series regressions have been performed. This analysis will help investors, who are seeking Chinese equities, in explaining how the combined risk factors explain the cross-section of average returns, and thereby giving them more information on which factors to include in their investment strategy on the SSE.

The evidence shows that all four models examined perform very well in explaining the average excess returns of the SSE. The models explain between 58% and 94% of the cross-variance of expected returns for the size, B/M, profitability and investment portfolios examined. All the models produce only a few significant alphas that are statistically different from zero; indicating an exceptional performance overall. In general, there is a gradual improvement of adding additional factors to the models both in terms of variance explained and reduced alpha. The only exception is for the Carhart four-factor model that performs much like the FF3 model, and therefore the evidence shows that the MOM factor is insignificant in explaining the large spreads in excess returns of the SSE. The FF3 model does in fact perform very well, however, it fails to capture some of the anomalies in average excess return related to profitability and investments. The FF5 model that include the risk factors related to profit and investment produces lower alphas and improves the R^2; meaning that the it is a more well-specified asset pricing model in explaining average excess returns on the SSE even though it is not perfect.

Based on the evidence, international investors are with the proposed asset pricing models able to explain average excess returns on the SSE with mostly statistically insignificant alphas. They should rely on the FF5 model in explaining the cross-section, as this is the superior tool of combined risk factors. As the five-factor model includes all the factors examined except for the MOM factor and outperforms the other models, the evidence supports the importance of these factors to investors for their investment strategy. Hence, investors should in fact consider the market, SMB, HML, RMW and CMA factors for their investment strategies in order to beat the market, as they help lowering the alphas of the model and thereby explain more of the excess returns of the SSE. However, the evidence also showed that the addition of the CMA factor only helps to a limited extent questioning its significance.

6. Discussion and Implications of the Empirical Findings

The extensive analyses of the stocks listed on the Shanghai Stock Exchange have provided various investment suggestions and implications to international investors. In this section, the most important findings of this study will be discussed and compared to previous research on the Chinese equity markets using different methods and time horizons. This will also include the implications of the findings to foreign investors. Lastly, a brief section of theoretical explanations of factor models in general will be discussed and put into context.

Findings of factors

Most importantly from the first analysis on the risk factors is that none of the factors investigated were statistically significant on the SSE. However, the market, HML and RMW factors presented the strongest, positive effects. The SMB factor was very close to zero, and the MOM and CMA showed weak evidence of reverse effects. Academic research have examined the Chinese stock market over different time horizons using different factor definitions. Firstly, Fenghua and Xu (2004) examine the Chinese stock market over the period 1996-2002 and found a strong size effect but a weak value effect. In addition, Grace Xing Hu et al. (2019) examines the traditional size and value factors of Fama-French over the period between 1995-2016, and their results show evidence of a significant size factor and an insignificant value factor. Guo et al. (2017) expands the tests to examine the Fama-French five-factor model and both find a strong value and profitability effects but weak and insignificant size and investment effects. All of the above-mentioned research have focused on the entire Chinese market as a whole and are therefore both examining the combined SSE and SZSE. Considering the work of Huang (2019), who studies the SSE and the SZSE individually between 1994-2016, the author finds the size effect to be significant on both exchanges, but the values effect is insignificant on the SSE while being weak on the SZSE. Furthermore, the evidence shows that the investment factor is negative for the SSE and positive for the SZSE, and the MOM factor is found to be reverse for the Chinese stock market as a whole. However, also this study deviates from that paper, as Huang (2019) uses individual stocks as the dependent variables. This is an untraditional way of conducting the study, and this paper has adopted the traditional way of using portfolios as the dependent variables. All of the outlined past research uses traditional factors in their analyses. However, as explained in the theoretical section, research using China-specific methodology has also been conducted, which is more in line with the nature of this study. Jianan Liu et al. (2019) adopt such a China-specific methodology and examines the period between 2000-2016 for the entire Chinese stock market. They find both the size and value factors are significant on the Chinese market.

The research conducted has examined different ways of constructing the factors over different time horizons, which has led to different results on the factors in the Chinese stock market. It seems odd that the findings of this study show that all the factors are insignificant on the SSE, as this has not been the case of any of the past research examined. However, the evidence of this study also suggests that these factors are insignificant because they change throughout the period examined. Taken all together, there seems to be consensus on a strong size factor on the Chinese stock market as a whole. This is not evident over the whole period examined in this study, but in the first half the sample period the evidence also shows a strong size effect. In general, past research indicates that the value factor is weak, which supports the results of this study, and the past research further suggests it might only be insignificant for the SSE and not in fact for the Chinese market as whole. The profitability factor seems to be present on the Chinse market, but the evidence could indicate it is weak on the SSE, which also supports the findings of this study. However, that should be interpreted with care. Regarding the investment factor, the findings indicate that it is insignificant and maybe even negative on the SSE, which also is in line with the findings of this paper. Not much research has been conducted on the MOM factor, but the research shows it is reverse on the Chinese stock market. The findings of this paper also suggest the MOM factor to be slightly negative but still insignificant.

Therefore, based on the above comparison, the main findings regarding the risk-factors suggest that there are similarities and differences compared to previous research due to this paper only investigates the SSE, but also due to the different factor definitions and time horizons. Moreover, the time horizon used in this paper consists of 90 monthly observations, which is a relatively short period compared to the previously research, and it would therefore be reasonable to expand the amount of data used. In addition, it has also been shown that this time period has been relatively volatile, in which the constructed portfolios in first half had very positive returns and had very negative returns during the second half. Thus, certain factors had opposite effects over the two different halves of the sample period. Extending the period of data examined would be an interesting way to further extend the analysis in order to examine how different the factor effects are on the SSE compared to the entire Chinese stock market, and also how the findings would change if the study was based on more solid time series data.

An important aspect of the factor effects on the SSE is that the analysis of this study clearly shows that they are in fact fluctuating with time. Overall, the findings of the three 5x5 value weighted portfolios also confirm that the size effect is not present on the SSE, the value effect is relative strong, and the profitability and investment effects are both comparatively weak. However, as the effects vary through time and seems to depend on the general performance of the stock market, this can have crucial impacts of the investors returns depending on the investment horizon for the individual investor. Most importantly, the evidence shows that the size and value effects are strong when the stock market is performing positively, whereas the profitability and investment effects are present when the stock market is doing poorly.

Examining the details of the 5x5 portfolios of the SSE, they further show that the value effects is stronger for the portfolios containing small firms, which also is in accordance with the findings of Fama & French (2015) who examine the U.S. stock market. This means that investors will get higher expected returns from implementing a long-short position on the value effect on small firms. In addition, the spread produced by the profitability effect is smaller than the spread produced by the value effect, which is in line with the findings of Guo et al. (2017). In other words, the implication of this finding is that the long-short position investors can enter will have higher expected returns for value stocks than for profitable stocks.

To investors, the evidence of the risk-factors on the SSE and on the Chinese stock market as a whole have provided useful insights for implementing investment strategies even though not all the research have been showing unified results.

Time series regressions

Regarding the model performance of the four asset pricing models tested in the analysis, the findings showed that the models in general had high explanatory power producing almost only alphas indistinguishable from zero. The FF3 model successful captured the spread in excess returns of size and to a large extent value but had certain flaws for the portfolios formed on size and profitability/investment. Adding the momentum factor did not seem to help enhance the performance. However, the FF5 model performed better than the other models, as adding the RMW and CMA factors help explain the excess returns formed on size and profitability/investment. Not much research has investigated the model performance following the Fama-French methodology on the Chinese market, as this study has. Three different studies using both different methods and scopes have performed similar analyses. Liu et al. (2019), who adopts the China-specific methodology, examine the performance of their FF3 model on different anomalies in stock returns. Most importantly, they find that their China-specific FF3 model, that contains the market, SMB and HML factors, is able to explain the anomalies related to value and even profitability. In addition, Grace Xing Hu et al. (2019) examine a classic FF3 model on the Chinese stock market, and find that 20 out of the 25 portfolios formed on size and value had alphas indistinguishable from zero. They further conclude that the market, SMB and HML factors successfully capture the cross-section returns, and they stress the importance of including the SMB and HML factors in explaining the wide variations of returns across the 5x5 portfolios sorted on size and B/M. Lastly, Guo et al. (2017) examines and compares the different models, like this study does, and examines similar 5x5 portfolios. For the 25 portfolios formed on size and B/M, the authors find that the FF3 model performs better than the four- or five-factor counterpart. The four-factor model in their study includes the market, SMB, HML and RMW factors and not the MOM factor. The FF3 model performs very well for the size-B/M portfolios and leaves little space for improvements in terms of the value alphas. Regarding the portfolios formed on size-profitability, in which the authors use ROE as the profitability measure, and on size-investment, the evidence shows the FF3 fails to explain the average returns for these portfolios. It is especially the average returns on the small portfolios that are deadly to the FF3 model for the portfolios formed on size and profitability. The four-factor model improves the performs of the FF3 model, but still faces difficulties with relatively high alphas. For the portfolios formed on size and investment, the four-factor model absorbs more of the average returns and thereby improve the performance.

A point that cannot be stressed enough for the comparison of the findings is that all the research have examined different time periods and used different factor definitions. In general, all the evidence suggests the anomalies related to size and value can well be captured by the FF3 model. The market factor explains the overall pattern of average excess returns for each portfolio and the SMB and HML factors successfully captures the excess returns related to their risk premium. Adding the RMW and CMA factors improves the performance of this study for all the three 5x5 portfolios, however, Guo et al. (2017) find the CMA factor as redundant, and therefore find their four-factor model to be superior. Importantly, none of the asset pricing models are producing consistent alphas of zero; meaning not all the excess returns have been captures by the risk-factors examined. To investors, the evidence supports the risk premiums of the five factors in the FF5 model. Hence, implementing an investment strategy that encompasses these premiums will deliver expected returns that outperform the market. Even as some of the premiums of the factors have been found to be small, and even insignificant, in the previous analyses, the alphas and R^2 of the model performance analyses still supports the evidence of investors to enter the related long/short positions based on the factors.

Why do asset pricing models work?

According to the efficient market hypothesis, securities are priced efficiently so that they reflect the information that is available to investors (Bodie, Kane, & Marcus, 2017). Essentially, this mean that stock prices only would change due to releases of new information regarding the securities. Thus, in theory, no investment strategy of the stocks examined on the SSE should offer an abnormal high return. However, as previous research and this paper have shown, there exists several market anomalies, in which certain stocks have delivered abnormal returns. These anomalies in returns, which are patterns that seem to contradict the efficient market hypothesis, have in this paper been calculated and shown as the risk-factors. As the 'inventors' of the three- and five-factor models, Fama and French have acknowledged that their empirical analysis do not explain why their models work so well in explaining excess returns across stock markets (Munk, 2018). However, as already briefly outlined in the theoretical overview, Fama and French (1998) have suggested that the risk-factors of SMB and HML are related to the premium on financial distress. This is due to the fact that small value stocks usually are firms that have performed poor recently, and therefore are more likely to exhibit financial distress. Therefore, the abnormal returns of the stocks simply are due to the higher risk associated with the specifications of the stocks. The abnormal return is then explained as the related risk premium investors get for taking the additional risk of the specific factor. Fama & French (1993) further argue that these anomalies in returns actually are consistent with the idea of an efficient market, as the expected return is related to the risk, which explains how strategies based on the examined risk factors exist. However, other researchers such as Lakonishok, Sleifer and Vishny (1995) have argued that the anomalies in returns are rather evidence of inefficient markets.

In addition, it is important to realize that risk factors can perform well in certain markets over certain periods, while it can perform poorly in other markets or for other periods of time (Munk, 2018). This has also been shown in this study, in which the three 5x5 portfolios show a huge difference in the factor effects when dividing the sample period into two. The evidence suggested that the performance of the risk factors depends on the general conditions of the stock market with the size and value effects being strong and significant in the first half of the sample period when returns on the SSE were positive. On the other hand, the analysis revealed reverse or weakened effects during times when the stock market generally was doing poorly. As it is difficult, if not impossible, to predict the future conditions of stock markets, investors are facing the question of whether to be exposed to the risk factors constantly over time or trying to invest by timing.

A study by Harvey, Liu and Zhu (2016) states there exists more than 300 factors that have showed significance in explaining the cross section of stock returns in the U.S. As correlation does not imply causation, it can be hard to tell which factors are indeed relevant for describing stock returns without a theoretical explanation. However, the consensus in the academic literature seems to be that at least the six factors studies in this paper are well documented and seem to somehow have a causal role on stock returns.

An interesting aspect of the Chinese stock market is that it is driven largely by individual investors. As explained in the overview of the stock market, about 86% of the trading in the Chinese stock market is done by retail investors who tend to focus on short-term investing and are more likely to be driven by a momentum approach (Paribas, 2019). Having these trends in mind, the findings of this study and the study of Huang (2019) are showing the exact opposite, as the momentum factors have negative premiums. This seems a bit odd, and it means that the evidence suggest that these trends do not apply for the Chinese retail investors. There exists multiple explanations for the momentum factor – both risk- and non-risk based (Moskowitz, 2010). According to Moskowitz (2010) writing for AQR Capital Management, the non-risk-based explanations are related to behavioral finance, which might be more appropriate for a retail-driven market such as the Chinese. 'Herding behavior' might be a reasonable explanation in a stock market driven by retail investors. This theory of the herding effect shortly states that the behavior of investors stems from investors chasing the same returns as other investors (Moskowitz, 2010). However, the findings of both papers goes against this herding behavior of the retail investors on the SSE, as the momentum factors have negative premiums; meaning it is slightly reverse on the SSE.

7. Conclusion

This master's thesis has analyzed the Chinese stock market, which has been narrowed down to the Shanghai Stock Exchange (SSE), using a factor approach from a European investor's perspective who holds a well-balanced equity portfolio primarily containing equities from developed markets.

Through a general analysis, it is found that the Chinese stock market as a whole offers high returns, high risk and low correlation to Western equity markets. To investors, it is being argued that they should increase their allocation of Chinese equities in order to realize these attributes which ultimately will result in higher expected returns and lower overall risk of their portfolios due to diversification benefits. However, the investor should realize that there are important differences between the SSE and SZSE, in which the stocks listed on the latter exchange are more attractive to foreign investors.

The factor analysis is the backbone of this paper, and the findings are the basis for the investor's investment strategy. Most importantly, none of the six factors examined are statistically significant on the SSE during the period 2012-2020. In order words, investors are not statically guaranteed to earn profit on investment strategies by implementing the long-short positions of the market, size, value, momentum, profitability and investment factors and thereby obtain their risk premium. However, as the average returns of the market, value and profitability factors are relatively high and positive, implementing an investment strategy of buying long the market, value- and stocks with robust profitability while entering short positions in growth- and stocks with weak profitability will provide investors with positive expected returns. Additionally, the risk tolerant investor could even consider reverse investment strategies of the momentum and investment factors.

The evidence has further shown that the factor effects depend on the general stock market performance. The size and value factors are strongly present on the SSE when the market is performing well, whereas the profitability and investment effects are the stronger ones during market turbulence. Thus, depending on the investment horizon, risk preference and whether the investor believes it is possible to predict the future performance of the market, the investor should choose to either stay invested in the factors over the long haul based on the above strategy, or implement a dynamic investment strategy that depends on the future market performance.

The performance of the asset pricing models emphasizes the importance of all factors, except for the momentum, in explaining the anomalies of the excess returns on the SSE. It can be concluded that the Fama-French five-factor model performs the best on the SSE, which supports the need of including these five factors into the investor's investment strategy in order to beat the market. However, the impact of the investment factor is questionable, as its patterns are not very strong.

As the final conclusion, depending on the investor's risk aversion and time horizon, the investor should implement Chinese stocks into his portfolio by entering long positions in the market, value- and stocks with robust profitability, combined with entering short positions in growth- and stocks with weak profitability. Additionally, the investor should put emphasis on the changing factor effects depending on the general market performance.

Future Research

Due to the scale, scope and the unfortunate development of the COVID-19 situation, this master's thesis has been subject to several delimitations and limitations. Removing these, even just partially, would therefore enhance the quality of the research conducted and could have the potential to even alter certain conclusions of the study. Most importantly, it would be crucial for foreign investors to do an equivalent study of the firms listed on the SZSE and to do a complete analysis of the combined SSE and SZSE in order to fully understand the differences in microstructure of the Chinese equity markets. In addition, extending the period of time series data in order to analyze if the risk factors are consistent with the results of this paper or whether they are more in line with past research. Lastly, as this paper has focused on adopting a China-specific methodology based on past research, it would be crucial to construct the original Fama-French factors using the same data in order to test whether this China-specific methodology actually improves the quality of the results. Consequently, this will give investors the best advice on factor investing, and their investment strategies can be enhanced.

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