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An Adjusted Factor Model Based on Government Ownership in China's Stock Market

Master thesis Economics (Financial Economics)

Abstract: In this paper, I use the government ownership to build an adjusted factor model for stocks in China's stock market. Two methods are used to build the government ownership factor. The empirical results show that the adjusted five-factor model with government ownership factor improves the FF-3 and Carhart-4 model slightly. Also, the two factors cannot be explained by the factors in FF-3 and Carhart-4 models, separately or together, while these two factors can explain some factors in FF-3 and Carhart-4 models in return. The GRS test gives further evidence that the government ownership factor in China can explain Carhart-4 factors to some extent. Also, the factor models with government ownership factor improve the explanatory power of profitability and investment anomalies. Finally, two robustness checks are taken. This paper shows that the government ownership factor is an effective factor in China's stock market, and the adjusted factor model with government ownership factor improves the explanatory power of the Carhart-4 model.

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1. Introduction

Before Capital Asset Pricing Model (CAPM) was proposed in 1960s, people did not have a clear understanding of how risk affects a company's cost of capital, and thus how it affects the expected return of the asset. The introduction of CAPM makes clear that the expected excess return is determined by the combination of expected excess return of the market portfolio with the exposure of the asset to market risks, where the market portfolio is also called the market factor. This simple relationship opened the curtain for subsequent studies on a large number of factor models. People find that the return of the asset is not determined by a single market factor, but also is affected by other factors at the same time. Based on CAPM, Fama and French first proposed the multi-factor model in 1993. This model considers the fact that value and small-cap stocks outperform markets on a regular basis, and then they expand on the capital asset pricing model by adding size risk and value risk factors to the market risk factors. Unitl now, the three-factor model is perhaps the most famous factor model and Eugene Fama and Kenneth French won the Nobel Prize in economics for their work. As the first-generation multi-factor model, although the Fama-French three-factor model is sufficiently groundbreaking, it has limited applicability, and has many unexplainable anomalies. Among the many anomalies, the most significant is probably the cross-sectional momentum anomaly. It is first proposed by Jegadeesh and Titman (1993). Inspired by their work, in an attempt to capture the momentum effect, Carhart (1997) add a cross-sectional momentum factor into the Fama-French three-factor model, and thus propose the Carhart four-factor model. Factor models are important to understand asset pricing. Because of their importance, many empirical studies investigate the effectiveness of different factor models in an attempt to find the best model. Most previous studies consider mature stock markets like the United States. But the explanatory power of the asset pricing model varies with stock markets and countries that they are in. One cannot simply use a US best performing model in other stock markets or countries.

Being the world’s second-largest stock market after the United State, China's stock market is still an emerging market. It has political and economic environments quite different from those in the US and other developed economies. One significant difference lies in the fact that the vast majority of China's listed companies are state-owned enterprises. China's economic transition in the past 30 years is considered to be a process through measures such as regional decentralization, the development of non-state-owned enterprises, financial reforms, and market reforms under the dual-track system. Therefore, in the background of China's economic transition, studying the motivations of Chinese corporate behavior and decision-making needs to take into account the important institutional feature of government ownership. In China, The differences between state-owned enterprises and private enterprises are generally shown in that: (1) private enterprises face discrimination in obtaining bank loan financing and capital market equity financing, which means private enterprises have stronger financing constraints; (2) State-owned enterprises have assumed many social responsibilities of the government. Compared with private enterprises, state-owned enterprises face much less competitive pressure; (3) Based on equity control and state-owned enterprise executives' administrative level and appointment mechanism, the government's influence on state-owned enterprises are much stronger than that of private enterprises, that is, state-owned enterprises are subject to a greater degree of government intervention.

As is indicated in the property rights theory, the different property structure of the enterprise determines the different corporate governance structure, thus affecting principal-agent relationship and incentive mechanism, which is ultimately reflected in the return of the stock. Therefore, the government ownership factor should be considered, especially when it comes to finding a factor model with good explanatory power in China.

In this paper, I add this new factor, government ownership, to develop an adjusted factor model in China. Two methods are used to build the government ownership (OWNERSHIP) factor. First, at the beginning of each month from January 2005 to December 2020, the samples are separated into two portfolios, SOEs or non-SOEs, and the OWNERSHIP_1 factor is the difference in return between the SOEs and non-SOEs portfolios. Secondly, due to the short selling constraints in China's stock market, a more practical approach to build the government ownership factor is to use only returns of the non-SOEs, which gives OWNERSHIP_2 factor. The main questions that should be answered in this study is as follows:

Does the adjusted factor model with government ownership factor have more explanatory power than FF-3 model and Carhart-4 model?

To answer the questions mentioned above, proper measurements for model performance should be taken. According to the previous literature, three methods are used in this paper: 1) Pricing FF-3 and Carhart-4 factors. The first step of proposing a new factor and evaluating its effectiveness is to examine whether it can explain the factors in FF-3 and Carhart-4 models without being explained by these factors. The ability of the OWNERSHIP factor to price FF-3/Carhart-4 factors, and whether the OWNERSHIP factor can be explained by FF-3/Carhart-4 factors are tested. 2) Gibbons-Ross-Shanken test. In the first step, the explanatory power of OWNERSHIP factor on FF-3/Carhart-4 factors are tested in several regressions separately.

GRS test is implemented then for the hypothesis that all the alphas — the intercept term in the regression of OWNERSHIP factor on each of the factors in FF-3/Carhart-4 — are jointly zero. 3) The explanatory power on anomalies. A factor model is often judged by its ability not only to price another model's factors but also to explain return anomalies. The anomalies' explanation ability for my five-factor model with government ownership factor versus CAPM, FF-3 ,and Carhart-4 factor models are then tested.

The results of this study show that the OWNERSHIP factor contains new information that FF-3/Carhart-4 factors do not capture, as all the risk-adjusted alphas in the regressions of FF-3/Carhart-4 models to price OWNERSHIP_1 and OWNERSHIP_2 factors are significantly larger than zero. At the same time, the OWNERSHIP_1 factor is able to interpret MKT and UMD factor in FF3/Carhart-4 model, while OWNERSHIP_2 factor is able to interpret SMB HML and UMD factor, separately. The GRS test gives further evidence that alphas in all the regressions of OWNERSHIP_2 factor to price each FF-3/Carhart-4 factor are jointly insignificant, which indicates that the government ownership factor—when using only returns of the non-SOEs—in China can explain FF-3/Carhart-4 factors. When it comes to the explanatory power of factor models on anomalies, my five-factor model with OWNERSHIP_1 or OWNERSHIP_2 improves the explanatory power of profitability (ANO_ROE) and investment (ANO_GROW) anomalies.

Moreover, two robustness checks are taken. Firstly, one of the firm specific characteristics, market capitalization, is considered when forming the government ownership factor, and six value-weighted portfolios (SOE/B, SOE/M, SOE/S, non-SOE/B, non-SOE/M, non-SOE/S) are used to build OWNERSHIP_3 and OWNERSHIP_4 factors. The explanatory power of OWNERSHIP_3 and OWNERSHIP_4 factors to interpret FF-3 and Carhart-4 factors are quite similar to OWNERSHIP_1 and OWNERSHIP_2, but with no improvement of explanatory power to the anomalies. Secondly, the Fama-French five-factor model is implemented as another benchmark for model comparison. It is found that OWNERSHIP_1 or OWNERSHIP_2 factors can only explain CMA factor in FF-5 model, and the FF-5 with OWNERSHIP_1 or OWNERSHIP_2 model improves the explanatory power of profitability (ANO_ROE) and investment (ANO_GROW) anomalies. All the results discussed above show that government ownership factor is an effective factor in China's stock market, and the adjusted factor model with government ownership factor has more explanatory power than FF-3 or Carhart-4 models in China.

This paper extends the previous literature on factor models by adding one more factor, the government ownership factor, to the four-factor model of Carhart, which can reflect the unique characteristic in China's stock market, and is thus an asset pricing model better applicable in China. The remainder of the paper proceeds as follows: Chapter 2 sorts out the relevant literature. Chapter 3 discusses data sources and the performance measure of factor models. Chapter 4 gives empirical illustration of the explanatory power of government ownership factor and the adjusted factor model. Chapter 5 checks the robustness of main empirical findings. Chapter 6 summarizes the conclusions.

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2. Literature overview

This chapter starts with backtracking the origin of factor models. Then the theories behind the different factor models such as CAPM, FF-3, and Carhart-4 model are discovered. Afterwards, the government ownership factor and research on factor models in China is introduced. Thus, two main hypotheses in this paper are put forward.

2.1 The origin of factor models

The research on factor models can be traced back to the 1930s. Graham and Dodd (1934) first put forward the value premium. Then in the 1960s, Capital Asset Pricing Model (CAPM) has been proposed, which provides a quantitative analytic tool for the study of factors. The main goal of the research on factors becomes proposing a better asset pricing model. From this perspective, CAPM can be thought of as a single factor model where the market factor is the only pricing factor.

After that, the effect of cheap stocks and the effect of small market capitalization has been discovered, both of which are anomalies that CAPM cannot explain. Faced with the increasing number of anomalies, people can no longer ignore the systemic risks that cannot be explained by a single market factor. Based on CAPM, Fama and French first proposed the multi-factor model in 1993. In that paper, two factors, HML and SMB, which represent the effect of cheap stocks and small market capitalization, respectively, are added to the market factor to form a three-factor model. Today, the Fama-French three-factor model has long been the first choice for empirical asset pricing research in the global stock markets, and many multi-factor models, which based on FF-3 model, are widely applied in empirical asset pricing researches.

Academics have now unearthed more than 400 factors (including pricing factors and anomaly factors). However, most of the factors are just the product of data snooping. Academia's fanaticism and impetuous attitude towards factor-digging has caused many scholars to be wary. In addition to a great deal of research on asset pricing, scholars have also studied various statistical methods to test anomalies and factors, or to compare multi-factor models. Besides, with the rapid development of machine learning in recent years, more and more researchers have applied such methods to the test of factor models.

2.2 CAPM model

Markowitz proposed the portfolio theory in 1952, which is regarded as a milestone of modern portfolio theory. Besides, Sharpe (1964) and Lintner (1965) developed the CAPM one after another. The CAPM is the simplest single factor model, which points out that the expected excess return rate of assets is determined by the expected excess return rate of market portfolio and the exposure of assets to market risks, where the market portfolio is also known as the market factor. After CAPM was proposed, a lot of work has been done to test it. Black et. al. (1972), Fama and Macbeth (1973) empirically proved the effectiveness of CAPM by using the data in US before 1969.

When it comes to the testing of CAPM, the method in Fama and Macbeth's paper is used, which avoids the influence of cross-sectional correlation of random perturbation term of return rate, obtains more convincing results and rejects CAPM model. The Fama-Macbeth method is thus spread more widely afterwards and becomes the most important statistical method in the research on factors now. Based on it, Ross (1976) proposed the famous Arbitrage Pricing Theory (APT), which further extends the CAPM and builds the foundation for multi-factor models.

2.3 Fama-French three-factor Model

Since the findings of many other factors to affect stock return, CAPM has been questioned a lot. Banz (1981) finds that the size of the company (market value) is an important factor to explain the stock return, and return of the stocks with small market value is much higher in average than that calculated by the CAPM, while the reverse is true for the stocks with large market value. Besides, Stattman (1980) and Rosenberg et al.(1985) have observed the correlation between book-to-market ratio(BM) and the stock return.

Fama and French (1993) integrated a variety of previously proposed anomalies and extended the CAPM into a famous Fama-French three-factor model (FF-3 model) later, which states that the excess return portfolio is explained by three asset pricing factors.i.e., CAPM's market factor, size (SMB) factor, and book-to-market (HML) factor.The FF-3 model can be expressed in the following:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \varepsilon_{it}$$

As the first proposed multi-factor model, the FF-3 has been tested a lot. Davis et al. (2000) uses data from 1927 to test the three-factor model; Fama and French (1998,2008) uses the data of other countries, and uses a three-factor model to investigate the anomalies that could not be explained by CAPM. In addition, Fama and French (1996) also tries to explain SMB and HML factors from the perspective of risk, and inferring that they are related to the financial distress risk of listed companies.

2.4 Carhart four-factor Model

Even though FF-3 model is a pioneering multi-factor model and tons of studies have show that FF-3 model can explain the cross section of stock returns well, there are still many anomalies that cannot be explained by this model.

Among the many anomalies, the most significant one is the cross-sectional momentum anomaly. It is first proposed by Jegadeesh and Titman (1993). In their paper, they define the current point as the t month, then they use the total return over the 11-month period from t-12 to t-1 month to rank all the stocks, and select the stocks with the highest total return to build the winner portfolio (Winner), and the ones with the lowest total return as the Loser portfolio (Loser). They find that longing the stocks in Winner group and shorting the ones in Loser group could generate significant excess returns. The reason why Jegadeesh and Titman (1993) deliberately avoid the recent month is that they observe the phenomenon of short-term reversal in the market. In order not to disturb the short-term reverse rotation in the medium-term momentum, they specifically exclude the recent month from the calculation of momentum. So the 11 months between t-12 and t-1 are used instead of the last 12 months.

Inspired by Jegadeesh and Titman (1993), in an attempt to capture the momentum effect, Carhart (1997) add a cross-sectional momentum factor (denoted as UMD) into the FF-3 model. and thus propose the Carhart four-factor model (Carhart-4 model). The momentum factor represents the tendency of firms with negative past returns to earn negative future returns, and for firms with positive past returns to earn positive future returns. The Carhart-4 model can be expressed in the following equation:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \beta_{4i}UMD_t + \varepsilon_{it}$$

Since then, subsequent studies find evidence that four-factor model of Carhart is better than the Fama-French three-factor model in explaining the variation of excess return of stock portfolio. After that, the impact of profitability (Novy-Marx, 2013) and capital investment (Aharoni et al., 2013) on earnings are then proposed one after another.

2.5 The government ownership factor

According to the ownership attribute of equity, all the shares of listed companies in China are divided into state-owned shares, legal person shares, public shares and foreign capital shares according to the investment subjects. State-owned enterprises (SOEs) have been playing an important role in the economic growth in China, such as being the key instruments in implementing government strategic plans. Vast majority of China's listed companies are restructured from the former SOEs. Usually, state-owned shares and legal person shares are rarely circulated or transferred, thus most of China's listed companies are still directly or indirectly controlled by the government now.

As is indicated in the property rights theory, the different property structure of the enterprise determines the different corporate governance structure, thus affecting principal-agent relationship and incentive mechanism, which is ultimately reflected in the return of the stock. However, the relationship between government ownership and stock return still appear ambiguous. On one hand, as the controlling shareholder of SOEs is the government, managers of SOEs can be induced to pursue political objectives, for example, maintaining a high level of employment and promoting regional development by locating production in politically desirable rather than maximize corporate profits, resulting in the expropriation of minority shareholders (e.g. Dewenter and Malatesta, 2001; Megginson and Netter, 2001; Lee and Wang 2017). In the empirical studies, Ben-Nasr et al. (2012) prove the negative relationship between state ownership and firm-level stock price variation, i.e. stock price informativeness, by using a sample of privatized firms from 41 countries between 1980 and 2012. Besides, the relation between state ownership and stock price informativeness depends on political institutions. In particular, the adverse effects of state ownership on stock price informativeness are more pronounced in countries with lower political rights. In studies relying on China, Xie et al. (2019) also find that the residual of state ownership after the reform of non-tradable shares in China is negatively related to stock return volatility. Further, the volatility-mitigating effect is more prevalent in firms in which the government has greater influence on corporate decisions. However, the volatility-mitigating effect is temporary, lasting up to three years after state shares become fully tradable. On the other hand, state-ownership sometime is perceived as a favorable signal of firm valuation. Du et al. (2016) find state-ownership has a positive and significant impact on Chinese acquirers' returns in cross-border mergers and acquisitions.

Moreover, it is widely accepted that government serves as implicit and explicit guarantor on loans issued to SOEs (Faccio, 2010; Song et. al., 2011) and lots of empirical studies have been proved the positive relationship between default risk and future stock returns. (Vassalou and Xing 2004; Campbell et. al., 2008). By applying a structural model to estimate firm-level default risk in China for the sample period from 2003 to 2015, Liu et al. (2019a) found the evidence that in China, default risk is positively related with expected stock returns and state ownership significantly determine the extent of the return predictability of default risk. However, Huang and Wu (2015) demonstrated that whether in the short term or in the long term, the average excess return and cumulative average excess return rate of state-owned listed companies are lower than those of non-state-owned listed companies, and the longer the time is, the greater the difference will be.

Therefore, the first hypotheses in this paper is thus as follows:

H1: *The government ownership factor plays an important role in explaining stock returns in China's stock market.*

2.6 Research on Factor models in China

The application of factor models also has been extensively studied in China. Drew et al. (2002) took stocks listed in Shanghai Stock Exchange to verify the applicability of the FF-3 model. They find that the book-to-market ratio effect did not hold in the Shanghai stock market while the combination of market factor and size factor can produce positive excess returns. Fan and Wang (2003) use the Fama-Macbeth regression method and factor mimicking portfolio to investigate the application of FF-3 model in China, and confirmed the significant size effect, book-to-market ratio effect, as well as price-earnings ratio effect. However, the results also showed that these effects cannot be fully explained by the FF-3 model, while the four-factor model with the P/E factor has more explanatory power. Wu and Xu (2004) take all listed companies in China's stock market from February 1995 to June 2002 as a sample to compare CAPM and FF-3 model, and the results show that FF-3 model can better explain the stock return. Liu (2010)'s study also found that the explanatory power of the FF-3 model on cross-sectional returns was improved after the Non-tradable Shares Reform in China.

In general, most of the empirical studies on the applicability of the FF-3 model in China have different results, which may be due to the difference in the time span of the sample data or the research market, or the difference in the way of data grouping and processing, or the difference in the setting of the model. However, most studies have confirmed the existence of size and book-to-market effect in China's stock market. Besides FF-3 model, other scholars, like Zhao et al. (2016), also empirically study the performance of the Fama-French five-factor model (FF-5 model) in China's stock market, and find that the performance of the FF-5 model was inferior to the FF-3 model. By analyzing the momentum effect and reversal effect of stock prices, Ouyang and Li (2016) construct an applicable four-factor model, based on Carhart model, to the China's stock market and find that the four-factor model with 6-month lag momentum factor has higher explanatory ability compared to the FF-3 model and CAPM model. In addition, the four-factor model is more effectively applicable.

Even though the previous researches have confirmed that the factor models more or less have explanatory power for China's stock market, whether the explanatory power is sufficient and whether the explanatory power can be improved has not yet been answered. After 30 years of development, China's stock market has grown into the world's second-largest stock market. However, as an emerging market, China still has political and economic environments quite different from those in the US and other developed countries. We still need to modify the existing models by taking account into the special situation of China to explore a more applicable asset pricing model for China. Therefore, the second hypotheses in this paper is thus as follows:

H2: *The adjusted factor model with government ownership factor has more explanatory power than FF-3 model and Carhart-4 model.*

3. Methodology

The methodology chapter contains the illustration of data source and samples used in this study. Then, the construction of SMB, HML, UMD in FF-3 and Carhart-4 model is introduced, following the government ownership factor . Also, the anomaly portfolios and three model performance measures are being discussed. Last but not least, two robustness checks are implemented.

3.1 Data source and samples

China's domestic stock market data that is required in this study comes from the China Stock Market & Accounting Research Database (CSMAR). It is an database drawn on the professional standards of authoritative databases such as CRSP, COMPUSTAT, TAQ, and THOMSON. CSMAR combines China's actual national conditions to develop a research-based accurate database in the economic and financial field.

To construct the firm-level variables, which include data on returns, trading, and financial statements, I start by getting these monthly data from January 1 2005 to December 31 2020. I focus on the post-2005 period for two reasons. The first reason is the Non-tradable Shares Reform happened in 2004, which is closely related to government ownership in China. State-owned enterprises were successfully transformed into joint stock companies and two stock exchanges were established in the early 1990s. At the same time, a split share structure was created and nearly two-thirds of the shares cannot be traded, most of them are state-owned shares and legal person shares. In order to meet the needs of advancing the reform and development of state-owned enterprises, an exploratory attempt initiated by the State Council to allow trading state-owned shares began in January 31st 2004, which is so called as the Non-tradable Shares Reform.

The second reason for beginning our sample in 2005 is to ensure sufficient numbers of observations,as CSMAR only has data on company ownership after 2003. The sample of stocks I use in this study includes all stocks listed in Shanghai Stock Exchange and Shenzhen Stock Exchange, except (i) New stocks (less than 12 months after listing), risk warning stocks, stocks to be delisted, and stocks with negative net asset. (ii) Non-tradable stocks including suspended stocks and stocks at price limit.

3.2 Fama-French-Carhart four factors

3.2.1 SMB, HML factors

The FF-3 model can be expressed in the following:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \varepsilon_{it}$$

In order to construct value and size factors, Fama and French (1993) select two company indicators, BM and market capitalization, and used them to conduct a 2×3 independent double ranking. In the ranking, the median market capitalization of companies listed on the New York Stock Exchange (NYSE) is taken as the boundary, and the companies listed in NYSE, Nasdaq and the American Stock Exchange (NYSE) are divided into Small and Big groups. Similarly, the listed companies in these three exchanges are divided into three groups by taking the 30% and 70% quantile of NYSE listed companies as the boundary: the companies with BM higher than 70% quantile are in high group, the companies with BM lower than 30% quantile are in low group, and the companies with BM from 30% to 70% quantile are in middle group. After the above classification, all stocks are divided into 6 groups (2×3=6) according to market capitalization and book-to-market ratio, which are recorded as S/H, S/M, S/L, B/H, B/M and B/L as shown in Figure 1.

		BM		
		High	Middle	Low
Market Capitalization	Small	S/H	S/M	S/L
	Big	B/H	B/M	B/L

Figure 1: Double sorting with respect to market capitalization and BM.

Finally, Fama and French (1993) construct six portfolios weighted by market capitalization for the returns on stocks in each group, and then the equations to determine value and size factors are as follows:

$$SMB = \frac{1}{3}(S/H + S/M + S/L) - \frac{1}{3}(B/H + B/M + B/L)$$

$$HML = \frac{1}{2}(S/H + B/H) - \frac{1}{2}(S/L + B/L)$$

3.2.2 UMD factor

The four-factor model of Carhart(1997) can be expressed in the following equation:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \beta_{4i}UMD_t + \varepsilon_{it}$$

To construct the momentum factor, Carhart (1997) uses all the stocks of NYSE, NASDAQ and AMEX. At the end of each month, all stocks are sorted according to the total return of 11 months from t-12 to t-1, and the momentum factor is constructed by equally weighted longing the top 30% and shorting the bottom 30% stocks.

3.3 OWNERSHIP factor

Two methods are used to build the government ownership (OWNERSHIP) factor.

Firstly, at the beginning of each month, I simply separate the samples into two portfolios, SOEs or non-SOEs, and calculate the return in each portfolio. The two portfolios are annually re-balanced on April according to the status of government ownership of each stock. The OWNERSHIP factor is the difference in return between the SOEs and non-SOEs:

$$OWNERSHIP\_1 = non\_SOEs - SOEs$$

Secondly, we use only returns of the non-SOEs to build the other OWNERSHIP factor. The reasons are as follows: 1) For a long time, China's stock market lacked a short selling mechanism. On March 31, 2010, China's stock market officially launched a pilot program for margin trading and securities lending. On February 28, 2013, the refinancing business was officially implemented. However, in practice, due to the low lending interest rate and the high cost of borrowing securities, investors still often face the situation of lacking securities available. For the vast majority of investors, long-only factor portfolios are the most realistic path to capture the benefits of factors. 2) Huij et. al. (2014) and Blitz (2020) argue that the short side of the FF-3 factors, which are built from long/short portfolios, offer no additional value once controlling for the long side, since the factor exposure of the short side is fully subsumed by the long side. A long-only approach seems to be the preferred alternative in most scenarios after accounting for practical issues such as benchmark restrictions, implementation costs and factor decay. 3) Usually, long-short portfolio is made of a continuous factor which captures not only the out-performance of stocks in the top group but also the under-performance of stocks in the bottom group. But the OWNERSHIP factor in this paper is a dummy variable, where non-Soes alone may also capture some systematic risk caused by government ownership. As a result, a more practical approach is to use only returns of the non-SOEs, which is:

$$OWNERSHIP\_2 = non\_SOEs$$

3.4 Anomaly portfolios

Moreover, a factor model is judged by its ability to explain return anomalies. After the factor model is selected, if there is a part of the expected return rate of the long-short portfolio, which is constructed according to a certain firm characteristic, that cannot be explained by the factor model, and this part is systematically different from zero, then there is a return anomaly to the factor model.

The study of anomaly is also popular in academic research. In the past 30 years, researchers have "digged" hundreds of anomalies in the US stock market. Hou et al. (2020) spent a lot of effort to replicate 452 anomalies in US. Liu et al. (2019b) replicated 9 anomalies in China's stock market using 14 indicators.

For example, people often rank stocks based on a company's financial indicators or volume and price indicators, and then build a long and short hedging portfolio according to the ranking. Putting the portfolio as an asset to be explained by a factor model, If its α_i is significantly greater than zero, then the portfolio is called an anomaly, and the indicator that constructs the portfolio is called an anomaly variable.

3.5 Model performance measures

3.5.1 Pricing FF-3 and Carhart-4 factors

The central theme of asset pricing literature is that the risk premium should depend on a security's market beta or other measure(s) of systematic risk. In a classic test of the CAPM, Black, Jensen and Scholes (1972) examines the intercepts in time-series regressions of excess test-portfolio returns on market excess returns. Given the CAPM's implication that the market portfolio is efficient, these intercepts or "alphas" (α) should be zero. That is, an insignificant α is a necessary (though not sufficient) condition that the asset pricing model fully explains the portfolio returns, while a significant α indicates that the portfolio return contains extra information beyond the considered factors.

Like other asset pricing model analyses based on alphas (Liu et. al., 2019; Ahmed et. al., 2019, Andrei et. al., 2019; Barillas and Shanken, 2018), an alternative approach to comparing asset pricing models involves a competition in pricing standard factor returns, such as the three factors in the FF-3 model. Barillas and Shanken (2018) denotes that to examine the performance of a multifactor model should consider the extent to which the model does in pricing a set of portfolio returns, and whether the model can interpret the factors in other models. Therefore, the first step of proposing a new factor and evaluating its effectiveness is to examine whether it can explain the factors in FF-3 and Carhart-4 models.

3.5.2 Gibbons-Ross-Shanken test

In the first step, the explanatory power of OWNERSHIP factor on FF-3/Carhart-4 factors are tested in several regressions separately. What if some of the alphas — the intercept term in the regression of OWNERSHIP factor on each of the factors in FF-3/Carhart-4 — are insignificant while others not?

For the time series regression model, Michael Gibbons, Stephen Ross and Jay Shanken proposed the GRS test, a method to test whether the joint intercept terms (α_i)are zero. Assume that there are N assets and K factors in the multifactor model to be tested. Let $\widehat{\alpha} = [\widehat{\alpha}_1, \widehat{\alpha}_2, \cdots, \widehat{\alpha}_N]'$ represent the pricing error vector of all N assets, $\hat{\epsilon}_t = [\hat{\epsilon}_{1t}, \hat{\epsilon}_{2t}, \cdots, \hat{\epsilon}_{Nt}]'$ represent the residual vector of N assets that cannot be explained by the multifactor model, and $\hat{\lambda}_t = [\hat{\lambda}_{1t}, \hat{\lambda}_{2t}, \cdots, \hat{\lambda}_{Kt}]'$ represent the return vector of K factors. Then, they construct the following test statistics, called GRS test statistic, satisfying the F-distribution with T-N-K and N degrees of freedom:

$$\frac{T-N-K}{N}(1 + E[\lambda_t]'\widehat{\Sigma}_\lambda^{-1}E[\lambda_t])^{-1}\widehat{\boldsymbol{\alpha}}'\widehat{\Sigma}^{-1}\widehat{\boldsymbol{\alpha}},$$

$$\text{With } \widehat{\Sigma}_\lambda = \frac{1}{T}\sum_{t=1}^{T}[\lambda_t - E[\lambda_t]][\lambda_t - E[\lambda_t]]',$$

$$\widehat{\Sigma} = \frac{1}{T}\sum_{t=1}^{T}\hat{\epsilon}_t\hat{\epsilon}_t'$$

After constructing the test statistic, use the F distribution to calculate its p-value to decide whether to accept or reject the null hypothesis. There are two advantages to use GRS test. First, its F-statistic is the statistic of finite sample, that is, GRS test gives the joint distribution that these pricing errors should satisfy under the given sample size, thus the test is highly accurate. When the sample size tends to infinity, the joint distribution will tend to the χ^2 distribution asymptotically while χ^2 distribution in finite samples is not reliable, which highlights the advantage of GRS test. Secondly, GRS test has a very high test effectiveness. But, it should be noted that once there is a correlation or heteroscedasticity between ϵ_{it}, the standard OLS error formula is wrong and the test statistic mentioned above are also problematic. In such cases, more powerful econometric tools, such as the generalized moment estimation, can be used for testing. Nevertheless, the GRS test is still a very popular and preferred method to test and compare multifactor models.

Moreover, there is another form of GRS test statistic:

$$\frac{T-N-K}{N} = \left[\frac{\sqrt{1+\hat{\theta}_{N+K}^2}}{\sqrt{1+\hat{\theta}_k^2}}\right]^2,$$

where $\hat{\theta}_{N+k}$ represents the Sharpe ratio of portfolio consisting of all N assets and K factors with the maximum ex post Sharpe ratio, and $\hat{\theta}_k$ is the Sharpe ratio of the portfolio consisting of all K factors with the maximum ex post Sharpe ratio. In this way, GRS test statistic can be intuitively understood as: after adding N assets in addition to K factors, whether the maximum Sharpe ratio that can be obtained is significantly higher than the maximum Sharpe ratio realized only by K factors. If the Sharpe ratio is significantly increased, it means that the factor model have not fully price these N assets.

3.5.3 Factor model explanations of anomalies

If an asset can obtain significant excess returns that cannot be explained by the factor model, then the asset is called an anomaly. An anomaly asset is constructed as follows: (1) Choose a potential financial indicator, and use it as an anomaly variable; (2) According to the value of the anomaly variable, the stocks are sorted on the cross-section. Then, the anomaly investment portfolio is constructed, and the time series of the return rate is obtained. (3) Test whether the rate of return can be explained by a factor model.

I explore the anomalies' explanation ability for my five-factor model versus CAPM, FF-3 ,and Carhart-4 factor models. A set of anomalies in China that are reported in the literature are compiled in our study. In this paper, I compile here 6 categories of anomalies:

(1) Value (ANO_VALUE). Book-to-market ratio (BM) is used. Book equity equals total shareholder equity minus the book value of preferred stocks. A stock's BM is the ratio of book equity to the product of last month-end's close price and total shares.

(2) Profitability (ANO_ROE). Return-on-equity (ROE) is used. The value of ROE equals the ratio of a firm's earnings to book equity.

(3) Investment (ANO_GROW). As in Fama and French (2015), a firm's investment is measured by its annual asset growth rate. Specifically, a firm's asset growth equals total assets in the most recent annual report divided by total assets in the previous annual report.

(4) Volatility (ANO_VOL). One-month volatility is used. A firm's one-month volatility is calculated as the standard deviation of daily returns over the past 20 trading days.

(5) Size (ANO_SIZE). The stock's market capitalization is used. It is computed as the

previous month's closing price times total A shares outstanding.

(6) Momentum (ANO_MOM). The stock's cumulative return over the past 12 months is used.

For every anomaly except reversal, we sort the stock universe each month using the most recent month-end measures and then hold the resulting portfolios for one month. For all anomalies, value-weighted portfolios of stocks within the top and bottom deciles are formed using the most recent monthend market capitalization as weights.

3.6 Robustness checks

3.6.1 the alternatives of government ownership factors

The market capitalization is considered. Referring to the procedure used by Fama and French (1993), I separate all stocks into three groups by ranking the market capitalization in each stock: top 30% (big, B), middle 40% (middle, M), and bottom 30% (small, S). I also break that universe into two groups according to their government ownership: SOEs or non-SOEs. We then use the intersections of those groups to form value-weighted portfolios for the six resulting size-ownership combinations: Thus, the six value-weighted portfolios (SOE/B, SOE/M, SOE/S, non-SOE/B, non-SOE/M, non-SOE/S). The OWNERSHIP factor is thus:

$$OWNERSHIP\_3 = \frac{1}{3}（\mathrm{non\_SOE/B} + \mathrm{non\_SOE/M} + \mathrm{non\_SOE/S}) - \frac{1}{3}（\mathrm{SOE/B} + \mathrm{SOE/B} + \mathrm{SOE/B})$$

$$OWNERSHIP\_4 = \frac{1}{3}（\mathrm{non\_SOE/B} + \mathrm{non\_SOE/M} + \mathrm{non\_SOE/S})$$

The former two government ownership factors, $OWNERSHIP\_1$ and $OWNERSHIP\_2$ are used in empirical illustration, and the later two $OWNERSHIP\_3$ and $OWNERSHIP\_4$ are used as robustness checks.

3.6.2 Fama and French five factor model as benchmark

On the basis of the FF-3, Fama and French (2015) added two factors of profit and investment, and proposed a new five-factor model (FF-5),which can be expressed in the following equation:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \beta_{4i}RMW_t + \beta_{5i}CMA_t + \varepsilon_{it}$$

This model starts from the dividend discount model and uses the results of Miller and Modigliani (1961) to derive that the return of the stock is positively correlated with its expected earnings and negatively correlated with its expected investment expenditure. In practice, the research on how to construct factors around expected earnings and expected investment expenditure can be traced back to Fama and French (2006). This paper specifically examines the relationship between the expected profit and investment expenditure and stock return. In the calculation of expected earnings and expected investment, Fama and French (2006) tested both naive estimates using historical data as expectations and regression analysis forecasting methods and choose the former one finally(2015).

When constructing the factors, similar to Fama and French (1993), for newly added profit and investment factors, Fama and French (2015) use ROE, the rate of change of total assets in the past year and market capitalization in a 2×3 double ranking. Taking the 30% and 70% quantile of ROE of listed companies in NYSE as the bounds, the listed companies on NYSE, NASDAQ and AMEX are classified as robust (ROE above 70% quantile) and neutral (ROE between 30% and 70% quantile) and weak (ROE below 30%) .Then, these three groups and market value were ranked independently to get six portfolios S/R, S/N, S/W, B/R, B/N and B/W. For the profit factor, as expected profit and expected return rate are positively correlated, the difference of return rate between the stable group (S/R and B/R) and the weak group (S/W and B/W) is used to construct the profit factor (RMW):

$$\mathrm{RMW} = \frac{1}{2}\ (\mathrm{S/R} + \mathrm{B/R}) - \frac{1}{2}\ (\mathrm{S/W} + \mathrm{B/W})$$

		ROE		
		Robust	Netural	Weak
Market Capitalization	Small	S/R	S/N	S/W
	Big	B/R	B/N	B/W

Figure 2: Double sorting with respect to market capitalization and ROE.

For investment factor, the companies are classified as aggressive, neutral and conservative group based on the change rate of total assets of listed companies in NYSE by taking 30% and 70% quantiles as the bounds. Then, they used these three groups and market capitalization in a 2×3 double ranking, and obtained six portfolios respectively: S/A, S/N, S/C, B/A, B/N and B/C. Similarly, the difference between the return rate of the conservative group (S/C and B/C) and the aggressive group (S/A and B/A) is used to construct the investment factor(CMA):

$$\mathrm{CMA} = \frac{1}{2}\left(\mathrm{S/C} + \mathrm{B/C}\right) - \frac{1}{2}\left(\mathrm{S/A} + \mathrm{B/A}\right)$$

Rate of Change of Total Assets

Market Capitalization		Aggressive	Netural	Conservative
	Small	S/A	S/N	S/C
	Big	B/A	B/N	B/C

Figure 3: Double sorting with respect to market capitalization and growth rate of total assets.

For size factor, different from the Fama-French three-factor model, in the Fama-French five-factor model, the small and big size group were obtained by double ranking respectively BM, ROE and rate of change of total assets and market value. Specifically, the size factor in FF-5 is constructed as followings:

$$\mathrm{SMB} = \frac{1}{3}\left(\mathrm{SMB_{BM}} + \mathrm{SMB_{ROE}} + \mathrm{SMB_{INV}}\right),$$

in which,

$$\mathrm{SMB_{BM}} = \frac{1}{3}\left(\mathrm{S/H} + \mathrm{S/M} + \mathrm{S/L}\right) - \frac{1}{3}\left(\mathrm{B/H} + \mathrm{B/M} + \mathrm{B/L}\right),$$

$$\mathrm{SMB_{ROE}} = \frac{1}{3}\left(\mathrm{S/R} + \mathrm{S/N} + \mathrm{S/W}\right) - \frac{1}{3}\left(\mathrm{B/R} + \mathrm{B/N} + \mathrm{B/W}\right),$$

$$\mathrm{SMB_{INV}} = \frac{1}{3}\left(\mathrm{S/C} + \mathrm{S/N} + \mathrm{S/A}\right) - \frac{1}{3}\left(\mathrm{B/C} + \mathrm{B/N} + \mathrm{B/A}\right)$$

4. Results

Three methods are used into compare asset pricing models, including 1) Explanatory power between factors. 2) Gibbons-Ross-Shanken test. 3) Factor model explanations of anomalies. The empirical results are shown in this chapter.

4.1 Summary Description

Table 1 presents the summary statistics of all the factors used in this paper, including monthly average rate of return, standard deviation, minimum rate of return, maximum rate of return, skewness, kurtosis, and the number of observations. During the period from 1/2005 to 12/2020, the OWNERSHIP_1 portfolio produces a mean monthly return of 1.23% and a monthly standard deviation of 4.72%. Meanwhile, the OWNERSHIP_2 portfolio produces a mean monthly return of 3.23% and a monthly standard deviation of 9.72%, which has the highest monthly average rate of return among all the factors. The kurtosis of all the factors are bigger than 3, presenting an obvious peak and fat tail phenomenon usually appear in financial time-series returns.

	Mean	Std. Dev.	min	max	skewness	kurtosis	N
ownership_1	.0123	.0472	-.2149	.2373	.348	9.4185	192
ownership_2	.0323	.0975	-.2643	.3408	.1725	3.9044	192
mkt	.0128	.0805	-.2496	.2879	-.1921	4.2565	192
smb	.0059	.0531	-.217	.1945	-.1694	4.6486	192
hml	-.0003	.0411	-.176	.193	.1011	6.521	192
umd	-.0005	.0409	-.1307	.126	-.1307	4.0325	192
ano_value	.0163	.0896	-.2764	.3001	-.0844	4.1748	192
ano_roe	.0185	.0853	-.2822	.2971	-.3274	4.2581	192
ano_vol	.0145	.0853	-.2744	.2982	-.053	4.5827	192
ano_size	.016	.1016	-.283	.3836	.1264	4.1509	192
ano_mom	.015	.0929	-.2958	.3276	-.2298	4.5098	192
ano_grow	.0175	.0915	-.2716	.3301	-.1457	4.114	192

Table 1: Summary statistics of all the factors used in this paper.

This table reports the monthly average rate of return, standard deviation, minimum rate of return, maximum rate of return, skewness, kurtosis, and the number of observations for two government ownership factors OWNERSHIP_1 and OWNERSHIP_2, four factors MKT, SMB, HML, UMD in FF-3 and Carhart-4 model, six anomaly variables ANO_VALUE, ANO_ROE, ANO_VOL, ANO_SIZE, ANO_MOM, ANO_GROW from China's stock market which are reported in the literature. The sample period is January 2005 through December 2020.

The correlations of the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns with the Fama and French three factors (MKT, HML, SMB) and the Carhart momentum factor (UMD) are shown in Table 2. The OWNERSHIP_1 and OWNERSHIP_2 portfolio returns are strongly positively correlated with the MKT, SMB factor returns and strongly negatively correlated with the HML factor returns. However, the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns are not significantly correlated with the UMD factor return. Moreover, Table 3 shows the correlations of the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns with all the anomaly factor returns (ANO_VALUE, ANO_ROE, ANO_VOL, ANO_SIZE, ANO_MOM, ANO_GROW). As is shown in Table 3, the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns are strongly positively correlated with all the anomaly factor returns.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) ownership_1	1.0000					
(2) ownership_2	0.5325***	1.0000				
(3) mkt	0.2071***	0.9205***	1.0000			
(4) smb	0.7315***	0.3882***	0.1496**	1.0000		
(5) hml	-0.5414***	-0.2151***	0.0424	-0.3331***	1.0000	
(6) umd	0.0578	-0.0185	-0.0694	-0.2399***	-0.2858***	1.0000

Table 2: The correlations of the government ownership factor with four factors in FF-3 and Carhart-4 model.

*This table reports all the pairwise correlation coefficients of the OWNERSHIP_1 and OWNERSHIP_2 with ANO_VALUE, ANO_ROE, ANO_VOL, ANO_SIZE, ANO_MOM, ANO_GROW. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

Variables	(1)	(2)	(7)	(8)	(9)	(10)	(11)	(12)
(1) ownership_1	1.0000							
(2) ownership_2	0.5325***	1.0000						
(7) ano_value	0.1237*	0.8571***	1.0000					
(8) ano_roe	0.3571***	0.9260***	0.8998***	1.0000				
(9) ano_vol	0.1475**	0.8793***	0.9710***	0.9051***	1.0000			
(10) ano_size	0.3911***	0.9325***	0.9189***	0.9130***	0.9209***	1.0000		
(11) ano_mom	0.2635***	0.8993***	0.8983***	0.9465***	0.9101***	0.8985***	1.0000	
(12) ano_grow	0.2852***	0.9226***	0.9380***	0.9618***	0.9453***	0.9405***	0.9656***	1.0000

Table 3: The correlations of the government ownership factor with six anomaly factors.

*This table reports all the pairwise correlation coefficients of the OWNERSHIP_1 and OWNERSHIP_2 with MKT, HML, SMB, and UMD factors in FF-3 and Carhart-4 model. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

4.2 Pricing FF-3 and Carhart-4 factors

The first step is to test whether the adjusted five-factor model with government ownership factor has additional explanatory power in China's stock market beyond FF-3 or Carhart-4 model. Therefore, I regress the excess return of each stock on FF-3 model, Carhart-4 model, and two adjusted five-factor model — Carhart-4 with OWNERSHIP_1 and Carhart-4 with OWNERSHIP_2 — respectively. The average alpha, average absolute t-statistic, and percentage of absolute t-statistic larger than 2 are reported in Table 4. As is indicated in the alpha-based analyse framework (Liu et. al., 2019; Ahmed et. al., 2019, Andrei et. al., 2019; Barillas and Shanken, 2018) , a significant alpha means that there is extra information content which cannot be fully explained by factors in factor model. Column (1) and (2) of Table 4 show that the average alpha of FF-3 and Carhart-4 model is -0.71% and 0.26%, respectively, with an average absolute t-statistic of 0.9049 and 0.8341. Among the 3580 regressions, the percentage of absolute t-statistic larger than 2 is 8.99% and 6.02%, respectively. When OWNERSHIP factor is included in the Carhart-4 model, as is shown in column (3) and (4), the average absolute t-statistic drops to 0.7686 and 0.7544. The percentage of absolute t-statistic larger than 2 also declines to 5.08% and 4.49%. The results show that the adjusted five-factor model with government ownership factor improves the FF-3 and Carhart-4 model slightly.

	(1) FF-3	(2) Carhart-4	(3) Carhart-4 + OWNERSHIP_1	(4) Carhart-4 + OWNERSHIP_2
Average alpha	-0.0071	0.0026	0.0017	0.0011
Average |t-value|	0.9049	0.8341	0.7686	0.7544
Pct of |t-value|>2	8.99%	6.02%	5.08%	4.49%
No. of regressions	3580	3580	3580	3580

Table 4: The regressions of excess return of each stock on FF-3, Carhart-4, Carhart-4 + OWNERSHIP_1, and Carhart-4 + OWNERSHIP_2.

*This table reports the The average alpha, average absolute t-statistic, and percentage of absolute t-statistic larger than 2. For each stock in China's stock market, a regression of excess return on FF-3, Carhart-4, Carhart-4 + OWNERSHIP_1, and Carhart-4 + OWNERSHIP_2 is implemented, respectively. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

In Table 5 and Table 6, I regress the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns on the Fama and French three factors and the Carhart momentum factor, respectively. Columns (1) to (4) in Table 5 and Table 6 show that, while these factors are significantly correlated with the government ownership factor, none of these factors is able to fully explain the returns of the OWNERSHIP_1 and OWNERSHIP_2 portfolio. This can be seen from the significant risk-adjusted alphas in all regressions, ranging between 0.85% and 3.23% per month with a Newey and West (1987) t-statistic adjusted for six autocorrelation lags. Regressing the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns on FF-3 model (column 5 in Table 5 and Table 6) indicates that the OWNERSHIP_1 and OWNERSHIP_2 portfolio has a risk-adjusted alpha of 0.81% and 1.62%, with a Newey and West t-statistic of 4.61 and 8.81, respectively. Also, the regression on Carhart-4 model (column 6 in Table 5 and Table 6) indicates a risk-adjusted alpha of 0.79% and 1.6%, , with a Newey and West t-statistic of 4.43 and 8.44, respectively. We also notice the strong positive sensitivity of the OWNERSHIP_1 and OWNERSHIP_2 portfolio to the MKT and SMB factors, and the strong negative sensitivity to the HML factor.

The returns of the OWNERSHIP_1 and OWNERSHIP_2 portfolio, therefore, are not fully explained by exposure to the MKT, HML, SMB, or UMD factors.

	(1) **ownership_1**	**(2)** **ownership_1**	**(3)** **ownership_1**	**(4)** **ownership_1**	**(5)** **ownership_1**	**(6)** **ownership_1**
mkt	.1215***				.0779**	.0775***
	(2.8249)				(2.4947)	(2.6254)
smb		.6503***			.5294***	.5761***
		(8.369)			(9.1457)	(9.1189)
hml			-.6228***		-.4011***	-.3351***
			(-3.672)		(-5.5974)	(-4.3079)
umd				.0668		.1609***
				(.433)		(2.9441)
intercept	.0107***	.0085***	.0121***	.0123***	.0081***	.0079***
	(3.35)	(3.6646)	(3.9831)	(3.5478)	(4.6117)	(4.4315)
Observations	192	192	192	192	192	192

Table 5: The regression of OWNERSHIP_1 on FF-3 and Carhart-4 factors.

*This table reports the slope coefficients from the regression of OWNERSHIP_1 on MKT, SMB, HML, and UMD in FF-3 and Carhart-4 factors. The columns labeled (1), (2), (3), and (4) present results for univariate specifications using only MKT, HML, SMB, and UMD, respectively, as the independent variable.The column labeled (6) and (7) present results from the multivariate specification using all FF-3 factors and Carhart-4 factors, respectively, as independent variables. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

	(1) ownership_2	(2) ownership_2	(3) ownership_2	(4) ownership_2	(5) ownership_2	(6) ownership_2
mkt	1.1149***				1.0902***	1.09***
	(33.8284)				(48.7044)	(48.965)
smb		.7121***			.349***	.3798***
		(3.6573)			(7.849)	(7.3083)
hml			-.5107*		-.4509***	-.4073***
			(-1.6914)		(-8.2297)	(-6.1486)
umd				-.0442		.1062**
				(-.2297)		(2.073)
intercept	.018***	.0281***	.0322***	.0323***	.0162***	.016***
	(6.0317)	(3.0395)	(3.4379)	(3.5033)	(8.812)	(8.4433)
Observations	192	192	192	192	192	192

Table 6: The regression of OWNERSHIP_2 on FF-3 and Carhart-4 factors.

*This table reports the slope coefficients from the regression of OWNERSHIP_2 on MKT, SMB, HML, and UMD in FF-3 and Carhart-4 factors. The columns labeled (1), (2), (3), and (4) present results for univariate specifications using only MKT, HML, SMB, and UMD, respectively, as the independent variable.The column labeled (6) and (7) present results from the multivariate specification using all FF-3 factors and Carhart-4 factors, respectively, as independent variables. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

Table 7 and Table 8 presents the results of regressions of the Fama and French three factors and the Carhart momentum factor on the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns. Although in Table 5 and Table 6, the alpha of the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns remains strongly economically and statistically significant, and is thus unexplained by any of FF-3 and Carhart-4 factors (separately or together), Table 7 and Table 8 indicates that, some of the alphas from regressing the FF-3 and Carhart-4 factors on the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns become statistically insignificant.

In Table 7, the two alpha of MKT and UMD are insignificant (with a t-statistic of 0.99 and -0.38, respectively) and the two alpha of SMB and HML are weakly economically significant (with a t-statistic of -1.78 and 2.18, respectively). In Table 8, with the exception of MKT factor, all the other alphas from regressions on the OWNERSHIP_2 portfolio returns become strongly insignificant (with a t-statistic ranging from -0.25 to 1.02).

We take the results of Tables 5 to Table 8 as evidence for the explanatory power of the government ownership factor. Table 7 and Table 8 shows that the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns are able to price some factors in FF-3 and Carhart-4 model, while not the other way around.

	(1) mkt	(2) smb	(3) hml	(4) umd
ownership_1	.3529**	.823***	-.4707***	.0501
	(1.9905)	(11.1928)	(-3.2426)	(.448)
intercept	.0085	-.0042*	.0055**	-.0011
	(.9856)	(-1.7845)	(2.1787)	(-.3768)
Observations	192	192	192	192

Table 7: The regression of FF-3 and Carhart-4 factors on OWNERSHIP_1.

*This table reports the slope coefficients from the regression of MKT, SMB, HML, and UMD on OWNERSHIP_1. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

	(1) mkt	(2) smb	(3) hml	(4) umd
ownership_2	.76***	.2116***	-.0906	-.0078
	(17.6777)	(4.2301)	(-1.596)	(-.2286)
intercept	-.0117***	-.0009	.0027	-.0003
	(-4.7597)	(-.2523)	(1.0175)	(-.0971)
Observations	192	192	192	192

Table 8: The regression of FF-3 and Carhart-4 factors on OWNERSHIP_2.

*This table reports the slope coefficients from the regression of MKT, SMB, HML, and UMD on OWNERSHIP_2. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

4.3 The GRS Test

The Gibbons-Ross-Shanken (GRS) test is what finance calls a statistical F-test for the hypothesis that all the alphas (from a set of time-series regressions) are zero. Each alpha is the intercept term in a time-series regression of factor portfolio returns on other factors. GRS test is often applied to compare the performance of factor models.

Table 9 and Table 10 computes the GRS mean alpha and the F-statistic of whether a given model produces zero alphas for the factors of the other model. In Table 9, the OWNERSHIP_1 alpha for the non-market factors in Carhart-4 produces a GRS mean alpha of 0.88%, with a F-statistic of 18.63. Whereas the Carhart-4 alphas for the OWNERSHIP_1 factor produce a GRS mean alpha of 0.01%, with a F-statistic of 2.64. Also in Table 10, the OWNERSHIP_2 alpha for the non-market factors in Carhart-4 produces a GRS mean alpha of 2.83%, with a F-statistic of 18.56. Whereas the Carhart-4 alphas for the OWNERSHIP_2 factor produce a GRS mean alpha of 0.05%, with a F-statistic of 0.26.

As is shown in Table 9 and Table 10, the Carhart-4 alphas for the OWNERSHIP_1 or OWNERSHIP_2 factors are either weakly significant, with an F-statistic of 2.64, or statistically insignificant, with an F-statistic of 0.26, which indicates that the government ownership factor in China can explain Carhart-4 factors, while not the other way around. The GRS test gives further evidence that a factor model with government ownership factor can improve the traditional Carhart-4 model in China.

	ownership_1	**smb, hml, umd**
ownership_1	-	.0001*
	-	(2.6407)
smb, hml, umd	.0088***	-
	(18.6305)	-

Table 9: The GRS test of OWNERSHIP_1 and Carhart-4 to explain each other's factors

*This table computes the GRS mean alpha and the F-statistic (presented in parentheses) of whether a given model produces zero alphas for the factors of the other model. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

	ownership_2	**smb, hml, umd**
ownership_2	-	.0005
	-	(.2614)
smb, hml, umd	.0283***	-
	(18.5633)	-

Table 10: The GRS test of OWNERSHIP_2 and Carhart-4 to explain each other's factors

*This table computes the GRS mean alpha and the F-statistic (presented in parentheses) of whether a given model produces zero alphas for the factors of the other model. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

4.4 Explanatory power of factor model with government ownership on anomalies

In this paper, I test 6 categories of anomalies revealed in the previous literature: value, profitability, investment, volatility, size ,and momentum. The literature documenting Chinese anomalies is rather heterogeneous with respect to sample periods, data sources, and choice of bench-marking model as is discussed in Liu et. al. (2019b). My first step is to reexamine all of the anomalies using our data and sample period. the Fama and French three factor model and the Carhart four factor model are used to classify all the anomalies as being significant or not.

The results reveal significant anomalies in three categories including value, profitability, and investment, as is shown in Column (1) and Column (2) in Table 11. The profitability anomaly produces strongly significant alpha, while the value and investment anomaly produces weakly significant alphas. The estimated monthly alphas for them are 0.54%, 0.24% and 0.31% in FF-3 model, and 0.52%, 0.25% and 0.29% in Carhart-4 model, with a t-statistic ranging from 1.67 to 3.13. Also unlike the US stock market, when I rely on post-2005 data and the method of sample selecting I discussed earlier in Chapter three, I find no evidence of volatility, size, and momentum anomaly in China.

Column (3) and Column (4) of Table 11 reports Carhart four-factor model with OWNERSHIP_1 or OWNERSHIP_2 alphas and t-statistics of alpha for the three anomalies that survive the FF-3 and Carhart-4 model. The factor model with government ownership improves the explanatory power of profitability and investment anomalies. The monthly alphas of ANO_ROE in Carhart-4 with OWNERSHIP_1 or OWNERSHIP_2 model is 0.37% and 0.36%, respectively. The t-statistics of alpha reduce from 3.13 in FF-3 and 3.07 in Carhart-4 to 2.17 in Carhart-4 with OWNERSHIP_1 and 1.67 in Carhart-4 with OWNERSHIP_2. Moreover, the monthly alphas of ANO_GROW in the adjusted factor model are 0.3% or less, with a t-statistic no higher than 1.48. In general, the Carhart-4 with OWNERSHIP_1 or OWNERSHIP_2 model do 'explain' some of the anomalies with not only insignificant t-statistics but also fairly small estimated alphas.

Anomaly	**Coefficients of alpha**			
	(1)	**(2)**	**(3)**	**(4)**
	FF-3	**Carhart-4**	**Carhart-4 +OWNERSHIP_1**	**Carhart-4 +OWNERSHIP_2**
ano_value	.0024*	.0025*	.0039**	.0049**
ano_roe	.0054***	.0052***	.0037**	.0036*
ano_grow	.0031*	.0029*	0.0026	.003
ano_vol	0.0013	0.0014	-	-
ano_size	-0.0019	-0.0018	-	-
ano_mom	0.0011	0.0006	-	-
	(T-statistic of alpha)			
ano_value	(1.6745)	(1.8699)	(2.3751)	(2.5376)
ano_roe	(3.1322)	(3.0666)	(2.1695)	(1.6675)
ano_grow	(1.8302)	(1.7776)	(1.4818)	(1.348)
ano_vol	(1.0884)	(1.2513)	-	-
ano_size	(-1.3762)	(-1.349)	-	-
ano_mom	(.4967)	(.3535)	-	-

Table 11: The alphas of FF-3, Carhart-4, Carhart-4+OWNERSHIP_1, and Carhart-4+OWNERSHIP_2 model for anomalies

This table reports alphas and t-statistics of alpha for each of anomaly variables. Coefficients of alpha are shown in the upper panel of this table, while T-statistics presented in parentheses are shown in the lower panel.

*The columns labeled (1) and (2) present results for FF-3 and Carhart-4 model, respectively. Three anomalies in the sample, including ANO_VALUE, ANO_ROE, and ANO_GROW, are discovered then. The columns labeled (3) and (4) present results for Carhart-4+OWNERSHIP_1, and Carhart-4+OWNERSHIP_2 model, respectively. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

5. Robustness Checks

This chapter checks the robustness of my main empirical findings. Two robustness checks will be executed. Firstly, one of the firm specific characteristics, market capitalization, is considered when forming the government ownership factor, and I use $OWNERSHIP\_3$ and $OWNERSHIP\_4$ as alternatives of $OWNERSHIP\_1$ and $OWNERSHIP\_2$, which is discussed earlier. Secondly, I add Fama and French five factor model as another benchmark for model comparison.

5.1 The alternatives of government ownership factors

In Table 12, I regress the OWNERSHIP_3 and OWNERSHIP_4 portfolio returns, as alternatives to OWNERSHIP_1 and OWNERSHIP_1, on FF-3 and Carhart-4 factors. As a result, all the risk-adjusted alphas are statistically significant, with a Newey and West t-statistic ranging from 2.25 to 5.57. The returns of the OWNERSHIP_3 and OWNERSHIP_4 portfolio, therefore, are not explained by the MKT, HML, SMB, or UMD factors, which is quite similar as is indicated in Table 4 and Table.

	(1) ownership_3	(2) ownership_3	(3) ownership_3	(4) ownership_3	(5) ownership_3	(6) ownership_3
mkt	.0464**				.0367	.0363*
	(2.1074)				(1.6055)	(1.6733)
smb		.2832***			.1795***	.2249***
		(3.6646)			(4.489)	(5.2533)
hml			-.445***		-.3707***	-.3066***
			(-4.6241)		(-5.8434)	(-4.6278)
umd				.1693**		.1564***
				(2.1035)		(3.3617)
intercept	.0088***	.0078***	.0093***	.0095***	.0078***	.0076***
	(4.1498)	(4.5496)	(4.5928)	(4.0784)	(5.0579)	(4.847)
Observations	192	192	192	192	192	192
	ownership_4	**ownership_4**	**ownership_4**	**ownership_4**	**ownership_4**	**ownership_4**
mkt	1.1132***				1.0515***	1.0515***
	(22.508)				(54.0674)	(54.1947)
smb		1.0324***			.7027***	.7113***
		(5.6701)			(20.3949)	(19.5492)
hml			-.5707		-.3552***	-.343***
			(-1.6279)		(-6.7693)	(-6.1417)
umd				-.2373		.0297
				(-1.1886)		(.7962)
intercept	.0115***	.0196**	.0256***	.0256***	.008***	.008***
	(3.3661)	(2.2501)	(2.7566)	(2.8504)	(5.5715)	(5.4789)
Observations	192	192	192	192	192	192

Table 12: The regression of OWNERSHIP_3 and OWNERSHIP_4 on FF-3 and Carhart-4 factors.

This table reports the slope coefficients from the regression of OWNERSHIP_3 (the upper panel) and OWNERSHIP_4 (the lower panel) on MKT, SMB, HML, and UMD in FF-3 and Carhart-4 factors, respectively.

*The columns labeled (1), (2), (3), and (4) present results for univariate specifications using only MKT, HML, SMB, and UMD, respectively, as the independent variable.The column labeled (6) and (7) present results from the multivariate specification using all FF-3 factors and Carhart-4 factors, respectively, as independent variables. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

Table 13 shows the explanatory power of OWNERSHIP_3 and OWNERSHIP_4 on FF-3 and Carhart-4 factors. In the upper panel of Table 13, the alpha of SMB becomes insignificant with a t-statistic of -0.81, comparing to that in Table 6 with a t-statistic of -1.78. In the lower panel of Table 13, the alpha of MKT becomes weakly significant with a t-statistic of -1.67, comparing to that in Table 6 with a t-statistic of -4.76. Therefore, the OWNERSHIP_3 and OWNERSHIP_4 portfolio returns are able to price other factors in FF-3 and Carhart-4 model, which have slightly better explanatory power than OWNERSHIP_1 and OWNERSHIP_2 factors.

	(1) mkt	(2) smb	(3) hml	(4) umd
ownership_3	.3374*	.8984***	-.843***	.3179**
	(1.9032)	(7.6061)	(-6.6437)	(2.2595)
intercept	.0096	-.0026	.0077***	-.0035
	(1.1531)	(-.814)	(2.832)	(-1.2464)
Observations	192	192	192	192
	mkt	**smb**	**hml**	**umd**
ownership_4	.702***	.2838***	-.0937	-.0386
	(14.9367)	(7.9273)	(-1.5263)	(-1.1476)
intercept	-.0053*	-.0014	.0022	.0005
	(-1.6719)	(-.3776)	(.7954)	(.169)
Observations	192	192	192	192

Table 13: The regression of FF-3 and Carhart-4 factors on OWNERSHIP_3 and OWNERSHIP_4.

*This table reports the slope coefficients from the regression of MKT, SMB, HML, and UMD on OWNERSHIP_3 (the upper panel) and OWNERSHIP_4 (the lower panel), respectively. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

The GRS mean alphas and F-statistics using OWNERSHIP_3 (the upper panel) or OWNERSHIP_4 (the lower panel) in Table 14 indicate a quite similar pattern to Table 9 and Table 10. As a result, the GRS test shows that OWNERSHIP_3 or OWNERSHIP_4 factor in China can explain Carhart-4 factors, while not the other way around.

	ownership_3	**smb, hml, umd**
ownership_3	-	.0005**
	-	3.6414
smb, hml, umd	.0081***	-

	(27.7558)	-
	ownership_4	**smb, hml, umd**
ownership_4	-	.0004
	-	(.7008)
smb, hml, umd	.0198***	-
	(10.0249)	-

Table 14: The GRS test of OWNERSHIP_3/OWNERSHIP_4 and Carhart-4 to explain each other's factors

*This table computes the GRS mean alpha using OWNERSHIP_3 (the upper panel) or OWNERSHIP_4 (the lower panel) and the F-statistic (presented in parentheses) of whether a given model produces zero alphas for the factors of the other model. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

Table 15 reports Carhart four factor model with OWNERSHIP_3 or OWNERSHIP_4 alphas and t-statistics of alpha for the three anomalies that survive the FF-3 and Carhart-4 model. All the alphas are statistically significant with a t-statistic ranging from 2.10 to 3.12. In general, the Carhart-4 with OWNERSHIP_3 or OWNERSHIP_4 model has no improvement of explanatory power to the anomalies, comparing to the Carhart-4 with OWNERSHIP_1 or OWNERSHIP_2 model.

Anomaly	**Coefficients of alpha**	
	(3) **Carhart-4 +OWNERSHIP_3**	**(4)** **Carhart-4 +OWNERSHIP_4**
ano_value	.0042**	.0038**
ano_roe	.0054***	.0049***
ano_grow	.0039**	.0043**
	(T-statistic of alpha)	
ano_value	(2.4568)	(2.0985)
ano_roe	(3.1247)	(2.733)
ano_grow	(2.2161)	(2.2608)

Table 15: The alphas of Carhart-4+OWNERSHIP_3, and Carhart-4+OWNERSHIP_4 model for anomalies

*This table reports alphas and t-statistics of alpha for each of anomaly variables. Coefficients of alpha are shown in the upper panel of this table, while T-statistics presented in parentheses are shown in the lower panel. Three anomalies in the sample, including ANO_VALUE, ANO_ROE, and ANO_GROW, are discovered. The columns labeled (1) and (2) present results for Carhart-4+OWNERSHIP_3, and Carhart-4+OWNERSHIP_4 model, respectively. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

5.2 Fama-French five-factor model as benchmark

In Table 16, the regression of OWNERSHIP_1 and OWNERSHIP_2 portfolio returns on Fama-French five factors model is presented. As a result, both of the risk-adjusted alphas are statistically significant, with a Newey and West t-statistic of 3.98 and 8.07, respectively. Showing that the OWNERSHIP_1 and OWNERSHIP_2 portfolio are not explained by the FF-5 model.

	(1) ownership_1	(1) ownership_2
mkt	.0732**	1.0885***
	(2.143)	(51.0922)
smb	.6225***	.4141***
	(7.3822)	(5.9224)
hml	-.2646***	-.363***
	(-3.12)	(-4.3856)
rmw	.0021	.014
	(.0168)	(.1436)
cma	-.3409**	-.2134
	(-2.0298)	(-1.5496)
intercept	.0067***	.0152***
	(3.9772)	(8.0723)
Observations	192	192

Table 16: The regression of OWNERSHIP_1 and OWNERSHIP_2 on FF-5.

*This table reports the slope coefficients from the regression of OWNERSHIP_1 (column (1)) and OWNERSHIP_2 (column (2)) on MKT, SMB, HML, RMW and CMA in FF-5, respectively. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

Table 17 shows the explanatory power of OWNERSHIP_1 and OWNERSHIP_2 on RMW and CMA factors in FF-5 model. As a result, the alpha of CMA factor becomes insignificant with a t-statistic of -1.34 and -1.54, respectively, while the alpha of RMW factor is significant. The GRS test of OWNERSHIP_1/OWNERSHIP_2 and FF-5 to explain each other ' s factors in Table 18 gives further evidence that, all the alphas are not jointly

	(1) rmw	(2) cma
ownership_1	-.3601***	-.0129
	(-6.1828)	(-.2018)
intercept	.0063***	-.0025
	(3.4036)	(-1.3362)
Observations	192	192
	rmw	**cma**
ownership_2	-.1666***	.0035
	(-6.063)	(.1493)
intercept	.0072***	-.0028
	(3.5138)	(-1.5358)
Observations	192	192

significantly different from zero, indicating less improvement than the FF-5 model.

Table 17: The regression of RMW and CMA in FF-5 on OWNERSHIP_1 and OWNERSHIP_2.

*This table reports the slope coefficients from the regression of RMW and CMA on OWNERSHIP_1 (the upper panel) and OWNERSHIP_2 (the lower panel), respectively. T-statistics, adjusted following Newey and West (1987) using six lags, are presented in parentheses. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

	ownership_1	**smb, hml, rmw, cma**
ownership_1	-	.0013**
	-	(4.7751)
smb, hml, rmw, cma	.0078***	-
	(13.4431)	-
	ownership_2	**smb, hml, rmw, cma**
ownership_2	-	.0015***
	-	(5.9803)
smb, hml, rmw, cma	.0316***	-
	(26.2192)	-

Table 18: The GRS test of OWNERSHIP_1/OWNERSHIP_2 and FF-5 to explain each other's factors

*This table computes the GRS mean alpha using OWNERSHIP_1 (the upper panel) or OWNERSHIP_2 (the lower panel) and the F-statistic (presented in parentheses) of whether a given model produces zero alphas for the factors of the other model. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

Table 19 reports FF-5 model with OWNERSHIP_1 or OWNERSHIP_2 alphas and t-statistics of alpha for the three anomalies that survive the FF-3 and Carhart-4 model. The factor model with government ownership improves the explanatory power of profitability (ANO_ROE) and investment (ANO_GROW) anomalies. The monthly alphas of ANO_ROE in FF-5 with OWNERSHIP_1 or OWNERSHIP_2 model is 0.25% and 0.22%, respectively. The t-statistics of alpha reduce from 2.19 in FF-5 to 1.38 in FF-5 with OWNERSHIP_1 and 0.95 in FF-5 with OWNERSHIP_2.

Anomaly	**Coefficients of alpha**		
	(1)	**(2)**	**(3)**
	FF-5	**FF5 +OWNERSHIP_1**	**FF5+OWNERSHIP_2**
ano_value	.0032**	.0045***	.0058***
ano_roe	.0039**	.0025	.0022

ano_grow	.0026	.0022	.0023
		(T-statistic of alpha)	
ano_value	(2.3049)	(2.6913)	(2.7152)
ano_roe	(2.1909)	(1.377)	(.9516)
ano_grow	(1.4348)	(1.1718)	(1.0124)

Table 19: The alphas of FF-5, FF5+OWNERSHIP_1, and FF5+OWNERSHIP_2 model for anomalies

*This table reports alphas and t-statistics of alpha for each of anomaly variables. Coefficients of alpha are shown in the upper panel of this table, while T-statistics presented in parentheses are shown in the lower panel. Three anomalies in the sample, including ANO_VALUE, ANO_ROE, and ANO_GROW, are discovered. The columns labeled (1), (2), and (3) present results for FF-5, FF5+OWNERSHIP_1, and FF5+OWNERSHIP_2 model, respectively. *** p<.01, ** p<.05, * p<.1. The sample period is January 2005 through December 2020.*

6. Conclusion and Discussion

6.1 Conclusion

Being the world's second-largest stock market after the United State, China's stock market is still an emerging market, which has political and economic environments quite different from those in the US and other developed economies. This paper aims to construct an asset pricing model by adding one more factor, the government ownership factor, in the traditional factor model, and thus exams the effectiveness of the adjusted factor model based on government ownership in China's stock market

Two methods are used to build the government ownership (OWNERSHIP) factor. Firstly, at the beginning of each month from January 2005 to December 2020, the sample stocks are separated into two portfolios, SOEs or non-SOEs, and the OWNERSHIP_1 factor is the difference in return between the SOEs and non-SOEs portfolios. Secondly, due to the short selling constraints in China's stock market, a more practical approach to build the government ownership factor is to use only returns of the non-SOEs directly, which gives OWNERSHIP_2 factor.

To begin with, I test whether the adjusted five-factor model with government ownership factor has additional explanatory power in China's stock market beyond FF-3 or Carhart-4 model. When OWNERSHIP factor is included in the Carhart-4 model, the average absolute t-statistic drops to 0.7686 and 0.7544. The percentage of absolute t-statistic larger than 2 also declines to 5.08% and 4.49%. The results show that the adjusted five-factor model with government ownership factor improves the FF-3 and Carhart-4 model slightly. The regression results of the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns on FF-3 and Carhart-4 factors show that all the risk-adjusted alphas are significantly different from zero, with a t-statistics ranging from 3.04 to 8.81, which means none of these factors is able to explain the returns of the OWNERSHIP_1 and OWNERSHIP_2 portfolio, separately or together. At the same time, the OWNERSHIP_1 and OWNERSHIP_2 portfolio returns are able to price some of the factors in FF-3 and Carhart-4 model. The two alpha of MKT and UMD on OWNERSHIP_1 are insignificant, with a t-statistic of 0.99 and -0.38, respectively. Also, with the exception of MKT factor, all the other alphas from regressions on the OWNERSHIP_2 portfolio return become strongly insignificant, with a t-statistic ranging from -0.25 to 1.02.

The GRS test gives further evidence that the Carhart-4 alphas for the OWNERSHIP_1 or OWNERSHIP_2 factor are either weakly significant, with an F-statistic of 2.64, or statistically insignificant, with an F-statistic of 0.26, which indicates that the government ownership factor—when using only returns of the non-SOEs—in China can explain FF-

3/Carhart-4 factors.

Moreover, the tests of explanatory power on anomalies show that, the factor models with government ownership OWNERSHIP_1 or OWNERSHIP_2 improve the explanatory power of profitability (ANO_ROE) and investment (ANO_GROW) anomalies. The monthly alphas of ANO_ROE in Carhart-4 with OWNERSHIP_1 or OWNERSHIP_2 model is 0.37% and 0.36%, respectively. The t-statistics of alpha reduce from 3.13 in FF-3 and 3.07 in Carhart-4 to 2.17 in Carhart-4 with OWNERSHIP_1 and 1.67 in Carhart-4 with OWNERSHIP_2. Also, the monthly alphas of ANO_GROW in the adjusted factor model are 0.3% or less, with a t-statistic no higher than 1.48.

Last but not least, two robustness checks are taken. Firstly, one of the firm specific characteristics, market capitalization, is considered when forming the government ownership factor, and six value-weighted portfolios (SOE/B, SOE/M, SOE/S, non-SOE/B, non-SOE/M, non-SOE/S) are used to build OWNERSHIP_3 and OWNERSHIP_4 factors. The explanatory power of OWNERSHIP_3 and OWNERSHIP_4 factors to interpret FF-3 and Carhart-4 factors are quite similar to OWNERSHIP_1 and OWNERSHIP_2, but with no improvement of explanatory power to the anomalies. Secondly, the Fama-French five-factor model is implemented as another benchmark for model comparison. It is found that OWNERSHIP_1 or OWNERSHIP_2 factor can only explain CMA factor, and the FF-5 with OWNERSHIP_1 or OWNERSHIP_2 model improves the explanatory power of profitability (ANO_ROE) and investment (ANO_GROW) anomalies. All the results discussed above show that the government ownership factor is an effective factor in China's stock market, and the adjusted factor model with government ownership factor has more explanatory power than CAPM model and FF-3 model.

In conclusion, the empirical analysis in this paper proves that government ownership factor is an effective factor in China's stock market, and the adjusted factor model with government ownership factor is better applicable than Carhart-4 model in China.

6.2 Discussion

The government ownership factor proposed in this paper improves the FF3 and Carhart4 models, but there are still some shortcomings in additional explanatory power beyond other factors and the explanatory power of anomalies.

First of all, even though this article has tried four methods to construct the government ownership factor, it may still not be perfect. For example, this paper strictly follows the definition of state-owned enterprises in CSMAR database. However, we define all enterprises with a proportion of less than 30% government-controlled shares as non-state-owned enterprises in the following research. Secondly, there are only 6 anomaly variables included in the my model while nearly 500 anomaly variables have been unearthed in the previous literature. Thus, the government ownership factor proposed in this article needs more tests by adding more variables. Thirdly, the improvement of the factor model in this article is mainly based on the FF3 and Carhart4 factor models. However, in recent years, the development of factor model is rapid. In particular, more and more scholars have begun to pay attention to the applicability of factor models in China. In the future, the validity of the government ownership factor proposed in this article can be tested based on these Chinese factor models. Finally, considering the situation of China's stock market, this paper conducts research based on monthly data since 2014. Compared with traditional factor model research, the sample period is a little bit too short. In the future, I may try to use a longer sample period or to examine the effectiveness of this factor model in different periods.

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