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Asset pricing in China’s stock markets: Yes, there is a logic.

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
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Bachelor of Arts with Honors

Economics

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Abstract

By Shuohao Zhang

China’s stock market, since its inception, has been one of the most important emerging market. Its rapid growth and evolving maturity attract a considerable number of international investors and financial institutions. Public media usually describes the nascent Chinese stock market as chaotic, unpredictable and irrational. Such depictions even become part of the common sense for those who follow the financial markets. Consequently, whether or not that the Chinese stock market is truly irrational has been a topic of great interest both for the academic researchers and for industry practitioners. Some studies have examined the validity of the application of asset pricing mechanism in Chinese domestic markets including Shang Hai Stock Exchange (SHSE) and Shen Zheng Stock Exchange (SZSE). However, few studies thoroughly investigate asset pricing theories in Chinese domestic stock markets with the most recent and comprehensive data. This paper studies the asset pricing mechanism in China with a primary objective to identify risk factors that can explain the cross-sectional variation in average stock returns. The results of this paper suggest that market risk, size and book-to-market ratio are significant in pricing securities in Chinese domestic stock markets. The finding that market risk is priced deviates from some studies that document that market risk is not statistically significant in capturing variation in stock returns, yet is consistent with the classic Capital Asset Pricing Model (CAPM) which uses market risk (market excess return) to explain excess return of securities. This paper also implements a lottery factor account for the potential behavior of irrational Chinese investors to chase for lottery-like assets (assets with high payoffs but low probability to achieve such high payoffs). The results show that there is no significant lottery-chasing behavior observed in the Chinese domestic stock markets. Overall, equity securities in Chinese domestic markets are well-priced and the rationality of asset pricing theories in China exists.

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1. Introduction

A central topic in financial economics and asset pricing field is the study of factors that determine the cross-section of average stock returns. In the classic Capital Asset Pricing Model (CAPM), an important variable to explain individual stock returns is the covariance between individual stock performance and market benchmark portfolio performance (Market betas). Many of the early studies focus on the such covariance between stock returns and the market benchmark returns. The work of Sharpe (1964) and Linter (1965) is among the earliest studies that examine the relationship between the cross-section of average stock returns and explanatory risk factors. Sharpe (1964) and Linter (1965) show that the market betas contain little information about the cross-section of expected stock returns on common stocks in the U.S markets. Same results are found in the study of Breeden (1979) about the intertemporal asset pricing model. Fama and French (1992a) further research on the role of market portfolio returns in predicting stock returns and incorporate factors that seem to have no special standing in the classic asset pricing settings. These factors include firm size, price/earnings ratio, leverage and book-to-market equity. Accord with Sharpe (1964) and Linter (1965), Fama and French (1992a) show that the market betas have little explanatory power on the cross-section of stock returns in the U.S market when used alone. On the other hand, used alone, firm size, price/earnings ratio, leverage, and book-to-market equity all have significant explanatory power. In combinations, the work of Fama and French (1992a, 1996) displays that firm size and book-to-market equity appear to digest the used-alone explanatory power of leverage and price/earnings ratio. Hence, Fama and French (1992a, 1996) further concludes that firm size and book-to-market equity have apparent and reliable power in explaining the cross-section of average stock returns in the U.S market. Fama and French (1992a, 1996) also suggest that market risk plays an important role in pricing stock returns when used in combination with size and book-to-market equity.

There is a significant growth of interest in applying asset pricing models to developed or emerging markets. Since their inception, Chinese domestic stock markets such as Shang Hai Stock Exchange (SHSE) and Shen Zheng Stock Exchange (SZSE) are long considered as volatile and unpredictable. A widespread perception is that a significant number of investors in Chinese domestic equity markets are irrational due to the immaturity of Chinese domestic stock markets, insufficient involvement of organized institutional investors, and the lack of training on financial theories for majority of individual investors. Hence, the price pattern for many Chinese domestic stocks appears to be volatile and not to follow risk-based asset pricing mechanisms. As the nascent Chinese stock market develops rapidly, studies that focus on testing empirical asset pricing factor models in Chinese domestic stock market emerge. Changyun Wang (2004) documents that the effects of market risk, firm size and book-to-market equity in the Chinese domestic market from 1994 to 2006 are highly similar to those in the U.S market, that is, small stocks outperform big stocks, value stock outperform growth stock, and market risk is not priced. The finding that the asset pricing mechanism in Chinese domestic stock markets is not inconsistent with rational risk-factor asset pricing models receives empirical support from Cheol S. Eun and Wei Huang (2007), whose study also argues that firm size and book-to-market ratio are systematically related to the cross-section of average stock returns while the market risk (market beta) is not found to be associated with variations of stock returns.

Although the previous research proves that a certain level of rationality exists in Chinese domestic equity markets, the finding that the market risk is not priced appears to deviate from the classic CAPM theory, which prices excess returns of equities according to market risk measured by the excess return of the market benchmark portfolio. Furthermore, the methodology used by Changyun Wang (2004) and Cheol S. Eun (2007) is firm-level cross-section regressions rather than the portfolio-level time-series regressions implemented by Fama and French (1996). In addition, most of these studies focus on examining Chinese domestic stock markets in early years such as 1990s and 2000s. Since these research, Chinese financial markets and Chinese financial database have advanced remarkably, although far from being mature. With the introduction of active institutional investors and a growing education on financial theories for individual investors, Chinese domestic equity markets begin to behave more rationally than it does before. However, irrationality is still significant. An important reason that Chinese domestic stock markets have been reported to be chaotic and insufficient is the strong preference of investors to chase lottery-like assets, assets that achieve a large payoff but are risky (the probability of achieving such a large payoff is low). Turan G. Bali (2011) uses the maximum daily return of stocks during the previous month as a new factor to examine the effect of lottery-chasing behavior on the cross-section of average stock returns. He shows that extreme positive returns are significant in the cross-sectional pricing of average stock returns in the U.S market. Motivated by these literature, this paper adds to the literature by providing a thorough analysis on the validity of risk-factor asset pricing models that incorporate Fama and French (1996) three factors and a lottery factor to account for the lottery-chasing effect in Chinese domestic stock markets. The data used for this study more comprehensive and recent, covering all A-shares traded from 1997 to 2016.

This paper proceeds with an overview of Chinese stock markets and an introduction to the sample and methodology used in the analysis with detailed explanations of how risk-factor variables are constructed from the raw data. This paper then examines how different combinations of risk factors capture the cross-sectional variation of average stock returns, and if the lottery factor is statistically significant in pricing stock returns in Chinese domestic stock markets.

2. Chinese Stock Markets Overview

China has two domestic stock exchanges: the Shanghai Stock Exchange (SHSE), initiated in 1990, and the Shenzhen Stock Exchange (SZSE), initiated in 1991. China's stock markets develop rapidly and the total market capitalization exceeds that of Hong Kong starting from 2001. By December 2016, there were 2359 listed companies (1183 on SHSE and 1275 on SZSE). The total market capitalization was $27 billion and $16 billion for SHSE and SZSE respectively.

The structure of Chinese domestic stock markets is very different from that of the U.S stock market. The first distinctive feature in Chinese domestic stock markets is that listed companies are mostly state-owned and the restriction from the government is tight. Since most listed firms are restructured state-owned enterprises, in order for the government to have control over state-owned assets, shares of a company, in usual case, is divided into legal-entity shares, state shares and tradable shares. Only tradable shares are allowed to be traded on public exchanges while state shares and legal-entity shares cannot be traded. As a result, the number of tradeable shares on the marketplace is limited and tradable shares on average account for around 40% of total shares outstanding of a firm.

Tradable shares are further split into A-shares and B-shares. A-shares are designed to be exclusively traded by Chinese citizens and institutions. On the other hand, B-shares are held exclusively by overseas investors. Typically, A-shares are the subjects to be studied for the research on Chinese domestic stock markets. Both A-shares and B-shares are qualified for voting right and cash flow dividend. The size of B-share market is relatively small compared to that of A-share market. By December 2016, there were 52 B-shares and 1131 A-shares listed on SHSE. 1230 A-shares were listed on SZSE while only 45 B-shares were listed. Since B-share market is generally illiquid and has a much smaller size, it can be excluded from the study when behaviors of Chinese domestic stocks are examined.

Second significant feature of Chinese domestic stock markets is that the trading mechanism is employed with additional regulations. Short-selling is strictly prohibited by the government. Daily fluctuation limits are set for tradable stocks to avoid extraordinary volatile price movements. This means the price of a stock can neither increase over a certain percentage nor can it decrease over a certain percentage in one day. Usually, the stock price of the current day cannot fluctuate over 5% to 10% of the closing price of the previous day.

Third feature is investors' highly speculative investing behaviors. The speculative atmosphere of Chinese stock markets has been attested by a few media reports and surveys. According to Cheol S. Eun (2007), the *Financial Times* (July 11, 1997) reports that interviewees desired to gain quickly and often held shares for less than one month. The report indicates that investment decisions were driven by little piece of information from newspaper, television and friends. Investors who focused on long-term value investing were scarce in the stock market in China. Chinese domestic stock markets also provided few tools for investors to diversify portfolios. In 1990s, bank savings, treasury bonds and common stocks were the only investment instruments. Neither institutionmanaged funds nor derivatives on equity or fixed-income were offered. Mutual funds were not available until November 1997, when the government passed the *Provisional Measures of the Administration of Securities Investment Funds.* Institutional investors played a limited role in the Chinese domestic markets. However, as Chinese domestic markets evolve and regulations improve, institutional investors are becoming active players and enrich the market with well-organized investment behaviors. Nevertheless, the number of individual investors who seek short-term speculative profits still seems to be large.

3. Sample and Methodology

3.1 Sample

This paper analyzes a sample consisting of all publicly traded A-shares on the SHSE and SZSE from January 1997 to December 2016. Data is obtained from the Chinese Stock Market and Accounting Research Database (CSMAR). The interval is chosen since very few companies were listed before 1997. There were 13, 32, 94, 161, and 270 firms in total listed by the end of 1991, 1992, 1993, 1994, 1995, and 1996 respectively. As mentioned above, B-shares are excluded from the sample since the B-share market is small and illiquid. Plus, B-shares are only offered to overseas investors while domestic investors are subjects of interest in this paper. Following the screening process of Fama and French (1992a, 1996) and Changyun Wang (2004), firms that are financial institutions, investment companies, funds or real estate companies are removed from the sample. Following Fama and French (1992a, 1996), firms that do not have available accounting data such as book value of equity are eliminated from the sample as well. The cleaning process yields 240 monthly data points with an average of 2295 stocks per month. Each individual firm has monthly return data, book value data, monthly maximum daily return data and market capitalization data. Following Fama and French (1992a, 1996), the book value of a firm in year *t* is measured in the December of year *t – 1*. In this paper, book value of a company is computed as total assets minus total liability and net intangibles. Table 1 represents summary statistics of the raw data. Market capitalization is the market value at the end of each month and is reported in thousands of RMB. Book-to-market ratio in each month is the ratio of book value of equity to market value of equity. Monthly market returns are equal-weighted average returns on the two market indexes (SHSE and SZSE) with dividend reinvested. The largest overall monthly return (calculated as equal-weighted average of returns on the composite index of two exchanges) is 0.37 in May 2015, and the lowest is – 0.28 in January 2016 (when Chinese stock markets were in great turmoil). The gaps between book-to-market ratios are high. For example, in 2004, the maximum BM ratio is 79.62 and the minimum is 0.002.

Table 1: Summary Statistics

Summary	Market Capitalization			Book-to-Market Ratio			Market Return		
Year	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1997	98840	26943906	704174	0.10	14.28	0.93	-0.10	0.20	0.02
1998	106260	24823519	747555	0.06	16.82	0.95	-0.12	0.12	0.01
1999	103642	29492654	852645	0.02	17.63	0.95	-0.06	0.32	0.02
2000	175740	1346123	21579503	0.0003.8	22.02	0.67	-0.04	0.14	0.05
2001	234117	22596484	1397133	0.0018	29.83	0.69	-0.13	0.08	-0.02
2002	176135	1182724	21704174	0.003	32.56	0.93	-0.12	0.12	-0.02
2003	137838	18632130	1134846	0.002	79.62	1.17	-0.07	0.10	-0.01
2004	60268	23088670	1067931	0.003	17.38	1.28	-0.13	0.10	-0.01
2005	33876	21284730	807553	0.00006	22.35	1.86	-0.12	0.16	-0.01
2006	72541	1257789	77038141	0.001	18.47	1.37	-0.03	0.27	0.06
2007	166561	4341669	295709781	0.002	15.35	0.56	-0.15	0.34	0.11
2008	95304	3559127	253680223	0.004	22.13	0.81	-0.26	0.19	-0.07
2009	180445	4862811	985200290	0.0006	15.28	0.60	-0.15752	0.22	0.09
2010	266160	6670338	820185527	0.0006	6.44	0.50	-0.09	0.12	0.01
2011	40628	6063435	629298358	0.001	37.57	0.65	-0.15	0.08	-0.04
2012	165780	4666005	542595298	0.0001	11.91	0.88	-0.11	0.18	0.01
2013	192100	5040854	517594131	0.00009	11.21	0.77	-0.14	0.16	0.02
2014	273750	6323091	602057551	0.00007	11.81	0.56	-0.05	0.15	0.04
2015	392100	10954861	775929101	0.00007	9.46	0.36	-0.16	0.37	0.08
2016	296916	9824909	516967541	0.00002	36.72	0.42	-0.29	0.20	-0.0009

3.2 Methodology

3.2.1 Explanatory variables

Fama and French (1992) expands the classic CAPM model into a three-factor model that contains size and book-to-market equity other than the market excess return to explain cross-sectional stock returns in the U.S market. They document that size and book-to-market equity are related to economic fundamentals.

Theoretically, firms that have high BE/ME are firms that have a low stock price relative to book value, which means they are undervalued by the market compared to their balance sheet data. These stocks are preferred by value investors since they are value stocks which are traded cheaply in the market. Firms that have high BE/ME are expected to have relatively low earnings on assets compared to those are more valued by the market (firms that have low BE/ME). Fama and French (1992a) document that firms with low BM ratios persistently generate high earnings while low earnings are measured for firms with high BM ratios. Therefore, a high BE/ME ratio implies a higher probability that the underlying company involves in financially distressing situation, and represents a higher risk for investing.

According to Fama and French (1992a), size is also closely related to profitability. Small firms usually have low earnings on assets compared to big firms, and Fama and French (1992a) show that small firms can suffer from prolonged earning depressions. The fact that small firms demonstrate weaker ability to rehabilitate earning power implies that size is a common risk factor associated with pricing of equities. As excess returns are associated with excess risk, these intuitions might explain the phenomena that small stocks tend to outperform big smalls, and value stocks tend to outperform growth stocks. Studies of Fama and French (1992a,1996) indicate that size and book-to-market are statistically significant risk factors in pricing stock returns. If risk-factor asset pricing models are rational in Chinese domestic stock markets, same results regarding the impact of size and book-to-market on cross-sectional variation of average stock returns should be observed in Chinese markets as well.

Following Fama and French (1992a, 1996), six portfolios here are formed to mimic the risk factors in returns related to size and book-to-market equity. In the December of each year *t* from 1996 to 2016, all A-share stocks listed on SHSE and SZSE are ranked on size. The median size of companies listed on SHSE and SZSE is used to split stocks into two groups, Small and Big. Small group contains companies whose market capitalization is below median market capitalization of all public traded A-share stocks in the sample, and Big group contains those whose market capitalization is above the median level. Stocks are also broken into three groups based on their book-to-market ratios. Breakpoints are 30 percentile and 70 percentile. Hence, in the December of each year *t*, stocks are grouped into Low (bottom 30%), Medium (middle 40%), and High (top 30%) of the ranked BE/ME values. The reason that firms are sorted into three groups by BE/ME but only two groups by size is that Fama and French (1992a) present evidence that book-to-market equity has a stronger explanatory power on stock returns than size does.

The six portfolios are constructed from the intersections of the two ME and the three BE/ME groups, that is, Small/High, Small/Medium, Small/Low, Big/High, Big/Medium, Big/Low. For example, Small/Low portfolio contains stocks that are both in the Small group and in the Low group. This means the stocks are below median market size and are in bottom 30% of book-to-market equity of all stocks according to data of the December in year *t*. After portfolios are formed, monthly equal-weighted returns are calculated from the January of year $t + 1$ to December of year $t + 1$. The portfolios are reformed at the December of year $t + 1$.

A size factor SMB (Small minus Big) that is designated to mimic risk factor in returns related to size is constructed as the difference between the simple average returns on the three small size portfolios (Small/Low, Small/Medium, Small/High) and the simple average returns on the three big size portfolios (Big/Low, Big/Medium, Big/High) in each month. The computed SMB values are essentially difference between returns on small stocks and returns on big stocks with approximately the same book-to-market equity. Hence, SMB factor mimics the risk factor related to size and is free of the impact of book-to-market equity.

A factor that accounts for the risk associated with the book-to-market equity is constructed in a similar way. The factor HML (High minus Low) is the difference between the simple average returns on the two high book-to-market equity portfolios (Small/High, Big/High) and the simple average returns on the two low book-to-market equity portfolios (Small/Low, Big/Low) in each month. The computed HML values are essentially difference between returns on value stocks and returns on growth stocks with approximately the same size. Thus, the difference should capture the different performance between stocks with high book-to-market equity and stocks with low book-to-market equity, and should be free of the influence of the size factor.

To further elaborate on how SMB and HML factors are built, here January 1997 is taken as an example. First, firms are sorted into six portfolios (Small/High, Small/Medium, Small/Low, Big/High, Big/Medium, Big/Low) based on the market data and balance sheet data of December 1996. In 1997, the SMB factor in each month is calculated as the difference between the simple average of equal-weighted monthly returns on the Small/High, Small/Medium, and Small/Low portfolios and that of equal-weighted monthly returns on the Big/High, Big/Medium, and Big/Low portfolios. The HML factor in each month is computed as the difference between the simple average of equal-weighted monthly returns on the Small/High and Big/High portfolios and that of equal-weighted monthly returns on the Small/Low and Big/Low portfolios. Stocks are re-sorted at the end of 1997. This means the six portfolios are re-constructed based on the data of December 1997, and the same calculations are performed for SMB and HML in 1998. The process is repeated for the rest of the years in the sample.

Another factor is monthly market excess return, which is measured as market return minus risk-free rate. This factor is designed to represent the risk related to the general market and economic outlook.

The final new factor Lot (lottery) added to the model is the factor to mimic the risk associated with chasing lottery-like assets. Following the approach of Bali (2009), at the end of each month, stocks are sorted based on their maximum daily return. The lottery factor is computed as the difference between the equal-weighted returns on the portfolio that consist of stocks with highest 10% maximum daily return in the previous month and that of the portfolio that consist of stocks with lowest 10% maximum daily return in the previous month. For example, based on the maximum daily returns in December 1996, two portfolios are formed, a portfolio contains stocks with highest 10% maximum daily return and a portfolio contains stocks with lowest 10% maximum daily return. These two portfolios are used to compute the lottery factor in January 1997, which is the difference between the equal-weighted returns on the two portfolios. The same process is repeated every month.

3.2.2 The response variable——cross-section of average stock returns

Following Fama and French (1996), 25 portfolios are formed on size and book-to-market equity to compute cross-section of average stock returns. The formation methodology is similar to that is used to compute SMB and HML. In the December of each year *t*, all stocks in the sample are sorted based on the balance sheet data and market data. 25 portfolios are constructed from the intersection of the five size quantiles and five book-to-market quantiles. Excess equal-weighted returns (equal-weighted returns minus the risk-free rate) on the 25 portfolios are calculated in each month as dependent variables. Again, portfolios are re-formed in the December of each year, and are held in the entire next year.

3.2.3 Statistical methods

Time-series regressions are applied on the 25 portfolios in this paper. Table 2 presents the summary statistics of risk factors. The average premium per unit of market beta ($RM - RF$) is -0.09% per month. The average SMB, which measures the average premium on returns related to the size factor, is 1.21% per month, that is large in statistical and practical sense. The average HML, which measures the average premium on returns related to the book-to-market equity, is 1.19% per month, which is also large. The average Lot is 0.69% per month, that is the average premium on returns for lottery-chasing behavior. Table 3 presents the correlation matrix of risk factors.

Table 2: Factor Summary Statistics

Summary	Mean	Standard Deviation	t-statistics
RM-RF	-0.008532	0.101493	-6.4436
SMB	0.01210	0.03718922	24.937
HML	0.011191	0.03796168	22.596
Lot	-0.006876	0.03801515	-13.863

Table 3: Correlation Matrix

Correlation	RM-RF	SMB	HML	Lot
RM-RF	1.00			
SMB	0.26	1.00		
HML	0.29	0.07	1.00	
Lot	0.36	0.14	0.14	1.00

Based on the study of Fama and French (1996), SMB, and HML should be expected to capture the strong cross-sectional variation in average stock returns as their average premium on returns are high. Choel S.Eun (2007), and Changyun Wang (2004) all document that the market excess return, measured by RM – RF, is not significant in explaining the cross-sectional variation in average stock returns in the Chinese domestic markets. In next sections, this paper performs asset pricing tests using Fama and French three-factor model, that is, portfolio-level variations in average stock returns are explained by the market excess return, SMB factor and HML factor. The primary focus is to test if risk factors proposed by Fama and French (1996), which explain a significant proportion of cross-sectional variation in average stock returns in the U.S market, could also capture variation in stock returns in Chinese domestic stock markets. Next, the lottery factor is added into the model to explain stock returns. If the lottery factor is statistically meaningful in explaining the cross-section of average stock returns, it potentially implies that investors' preference for lottery-like assets is significant. Finally, the lottery effect is regressed on common risk factors RM – RF, SMB, and HML. The purpose of this regression is to test if these three risk factors have already absorbed the information presented by the lottery effect.

4. Results

4.1 Two-factor regression

Since Choel S.Eun (2007) and Changyun Wang (2004) document the insignificance of market excess return in explaining cross-sectional average stock returns in China. First, a two-factor time series regression which only uses the size factor and book-to-market factor as explanatory variables is performed on 25 portfolios. The model is summarized as the following:

$$R(t) - RF(t) = a + sSMB(t) + hHML(t) + e(t)$$

The results are presented in Table 4. In table 4, S indicates the size quantile and H indicates the book-to-market equity quantile. For example, S1H2 means the portfolio that consists of stocks that are in bottom 20% based on size and in 20% – 40% interval based on book-to-market equity. The average intercept is about -0.15. The intercepts generated by the two-factor regression are large from the practical perspective and they are statistically significant in most of the regressions, meaning that there is information that is not explained by SMB and HML. Intercepts are similar in size, which supports the conclusion in Fama and French (1992a, 1996) that size and book-to-market equity capture different average returns across stocks. However, overall, the large and statistically significant intercepts say that SMB and HML, when used alone, do not explain the average premium of stock returns very well.

Table 4: Two-factor Regressions

Portfolio	a : intercept	s : SMB	h : HML	R^2
S1H1	-0.02**	1.29***	0.2	0.23
	(0.01)	(0.25)	(0.25)	
S1H2	-0.02*	0.84**	0.62*	0.18
	(0.01)	(0.27)	(0.26)	
S1H3	-0.02*	0.56*	0.86***	0.18
	(0.011)	(0.27)	(0.26)	
S1H4	-0.02**	0.38	1.14***	0.21
	(0.01)	(0.26)	(0.25)	
S1H5	-0.02**	0.27	1.22***	0.23
	(0.01)	(0.25)	(0.24)	
S2H1	-0.02***	1.02***	0.28	0.16
	(0.01)	(0.26)	(0.26)	
S2H2	-0.02**	0.64*	0.62*	0.14
	(0.01)	(0.26)	(0.26)	
S2H3	-0.02**	0.35	0.88***	0.15
	(0.01)	(0.25)	(0.25)	
S2H4	-0.02**	0.23	1.00***	0.16
	(0.01)	(0.25)	(0.24)	
S2H5	-0.03**	0.11	1.21***	0.20
	(0.01)	(0.24)	(0.24)	
S3H1	-0.02**	0.53*	0.32	0.07
	(0.01)	(0.26)	(0.25)	
S3H2	-0.02**	0.36	0.58*	0.09
	(0.01)	(0.26)	(0.25)	
S3H3	-0.02**	0.31	0.64*	0.09
	(0.01)	(0.25)	(0.25)	
S3H4	-0.02***	0.23	0.82***	0.12
	(0.01)	(0.24)	(0.24)	
S3H5	-0.01**	0.01	1.00***	0.12
	(0.01)	(0.25)	(0.24)	
S4H1	-0.02**	0.20	0.30	0.02
	(0.01)	(0.26)	(0.25)	
S4H2	-0.02**	0.13	0.58*	0.05
	(0.01)	(0.26)	(0.25)	
S4H3	-0.02**	0.06	0.52*	0.04
	(0.01)	(0.25)	(0.25)	
S4H4	-0.02**	-0.08	0.76**	0.06
	(0.01)	(0.25)	(0.25)	
S4H5	-0.02***	-0.14	0.80***	0.07
	(0.01)	(0.04)	(0.23)	
S5H1	-0.02**	-0.23	0.18	0.05
	(0.01)	(0.25)	(0.25)	

S5H2	-0.02**	-0.25	0.35	0.01
	(0.01)	(0.25)	(0.24)	
S5H3	-0.02**	-0.21	0.34	0.02
	(0.01)	(0.24)	(0.24)	
S5H4	-0.02**	-0.24	0.48	0.01
	(0.01)	(0.24)	(0.24)	
S5H5	-0.02**	-0.28	0.50*	0.01
	(0.01)	(0.24)	(0.24)	

4.2 Three-factor regression

Time-series regressions are performed on the 25 portfolios formed on size and book-to-market equity. The market excess return, SMB factor, HML factor are explanatory variables. The excess return of the 25 portfolios is the dependent variable to be explained. The model is summarized as following:

$$R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB + hHML + e(t)$$

Table 5 reports the results of time-series regressions. Compared to the two-factor regressions, adding market excess return as an explanatory variable pushes the large intercepts observed in the two-factor regressions close to 0. The average intercept is close to 0.001, and intercepts in many portfolios are very close to 0. Only 7 out of 25 intercepts in the three-factor regressions differ from 0 by more than 0.002. All the intercepts are not statistically significant except for S3H4 and S4H5, implying that the three-factor model absorbs information regarding the variation in cross-sectional stock returns well. The market excess return, in all cases, is statistically significant. This result is inconsistent with findings of Choel S.Eun (2007) and Changyun Wang (2004), but is reliable from the statistical and practical perspective. The slopes on RM – RF in all regressions on 25 portfolios are very close to 1, which is consistent with the results of Fama and French (1996), who also find that slopes on RM – RF are close to 1 for the three-factor regressions performed on data of the U.S stock markets. Although deviate from the studies of Choel S.Eun (2007) and Changyun Wang (2004), who also apply asset pricing tests on Chinese domestic stock markets, these results are in line with those of Fama and French (1996) and show that the market excess return plays a crucial role in explaining why average stock returns are above the risk-free rate. The importance of market risk factor in pricing stock returns can also be seen in the improved R-squared in three-factor regressions compared to two-factor regressions. The average adjusted R-squared in three-factor regressions is roughly 0.93 while the adjusted R-squared scores in the two-factor regressions are generally low. The high average adjusted R-squared in three-factor regressions justify the remarkable ability of RM – RF, SMB and HML to capture the cross-sectional variation in average stock returns in Chinese domestic markets.

Consistent with Fama and French (1996), Choel S.Eun (2007) and Changyun Wang(2004), the results confirm the explanatory power of size and book-to-market equity on cross-sectional stock returns. The fact that intercepts are close across 25 portfolios formed on size and book-to-market equity supports the conclusion that size and book-to-market factors explain variation in average stock returns well. In most cases, SMB and HML are statistically significant in pricing average stock returns. This makes sense from the practical perspective as small size and high book-to-market equity all can potentially imply a larger probability that a company involves in financially distressing status. The slopes on SMB are positive for small-sized portfolios and start to drop when size is increasing. This confirms the argument of Fama and French (1996) that small stocks are more variable than big stocks. The slopes on HML are usually negative and are big in absolute values for stocks with low book-to-market equity. As book-to-market equity increases, slopes on HML tend to approach 0. Hence, HML seems to increase the volatility of low book-to-market equity stock returns.

Table 5: Three-factor Regressions

Portfolio	a : intercept	b : RM-RF	s : SMB	h : HML	R^2
S1H1	-0.002	0.99***	1.04***	-0.42***	0.91
	(0.002)	(0.02)	(0.09)	(0.09)	
S1H2	0.001	1.06***	0.57***	-0.12***	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	
S1H3	0.003.	1.07***	0.29***	0.13*	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	
S1H4	0.000	1.04***	0.11*	0.42***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S1H5	-0.002	1.00***	0.02	0.52***	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	
S2H1	-0.003.	1.05***	0.75***	-0.46***	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	
S2H2	0.002	1.06***	0.37***	-0.12*	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S2H3	0.000	1.02***	0.09.	0.16**	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	
S2H4	0.000	1.01***	-0.03	0.28***	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	
S2H5	-0.003	0.99***	-0.14*	0.52***	0.96
	(0.002)	(0.02)	(0.06)	(0.06)	
S3H1	-0.002	1.04***	0.26***	-0.41***	0.95
	(0.001)	(0.02)	(0.06)	(0.06)	
S3H2	-0.002	1.03***	0.10	-0.14*	0.94
	(0.002)	(0.02)	(0.06)	(0.07)	
S3H3	-0.002	1.03***	0.015	-0.076	0.96
	(0.002)	(0.01)	(0.05)	(0.05)	
S3H4	-0.003*	0.98***	-0.02	-0.12*	0.96
	(0.002)	(0.01)	(0.05)	(0.05)	
S3H5	-0.001	1.00***	-0.25***	0.30***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S4H1	-0.001	1.04***	-0.07	-0.43***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S4H2	-0.003.	1.04***	-0.14**	-0.15**	0.95
	(0.002)	(0.01)	(0.05)	(0.05)	
S4H3	0.000	1.02***	-0.20**	-0.17**	0.95
	(0.001)	(0.02)	(0.06)	(0.06)	
S4H4	-0.003	0.99***	-0.34***	0.07	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	
S4H5	-0.005*	0.92***	-0.38***	0.16.	0.89
	(0.002)	(0.02)	(0.08)	(0.08)	
S5H1	0.000	1.01***	-0.48***	-0.53***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	

S5H2	0.000	0.99***	-0.50***	-0.34***	0.93
	(0.002)	(0.02)	(0.06)	(0.06)	
S5H3	0.000	0.95***	-0.44***	-0.31***	0.91
	(0.002)	(0.02)	(0.07)	(0.07)	
S5H4	0.000	0.95***	-0.48***	-0.17.	0.84
	(0.002)	(0.03)	(0.10)	(0.10)	
S5H5	-0.002	0.87***	-0.50***	-0.11	0.76
	(0.003)	(0.03)	(0.12)	(0.12)	

4.3 Lottery-factor regression

Fama and French (1996) three factors and the lottery factor

$$R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB + hHML + lLot + e(t)$$

The model is extended from the three-factor model through the addition of the lottery factor. Table 6 reports the regression results on 25 portfolios. The strong explanatory power of the three factors, RM – RF, SMB and HML, persist in the lottery-factor regression. However, the lottery factor is not found to be statistically significant except for the S1H2 portfolio (portfolio that consists of stocks that are in bottom 20% based on size and in 20% – 40% interval based on book-to-market equity). This means that the factor that mimics the risk associated with chasing lottery-like assets is not significant in pricing stock returns. In addition, little improvement on adjusted R-square scores are observed after adding the lottery-factor. Unlike the research of Bail (2011), which documents the presence of the significance of lottery-chasing behavior in the U.S stock markets, the premium of investing lottery-like assets appears to play a limited role in explaining cross-section of average stock returns in the Chinese domestic stock markets.

Table 6: Three-factor and Lottery Factor Regressions

Portfolio	a : intercept	b : RM-RF	s : SMB	h : HML	l : Lot	R^2
S1H1	-0.002	0.99***	1.04***	-0.42***	-0.010	0.91
	(0.002)	(0.03)	(0.09)	(0.09)	0.06	
S1H2	0.002	1.05***	0.56***	-0.12	0.11*	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S1H3	0.003*	1.06***	0.28***	0.13*	0.07	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S1H4	0.000	1.03***	0.11*	0.42***	0.09.	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S1H5	-0.002	0.99***	0.02	0.52***	0.02	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	0.04	
S2H1	-0.003.	1.05***	0.75***	-0.46***	0.02	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S2H2	0.002	1.05***	0.36***	-0.12*	0.07	0.96
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S2H3	0.000	1.02***	0.08	0.16**	0.05	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	0.04	
S2H4	0.000	1.02***	-0.03	0.28***	-0.04	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	0.04	
S2H5	-0.003	1.00***	-0.13*	0.52***	-0.08	0.96
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S3H1	-0.003.	1.05***	0.27***	-0.41***	-0.09.	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S3H2	-0.002	1.03***	0.10	-0.14*	-0.01	0.94
	(0.002)	(0.02)	(0.06)	(0.07)	0.05	
S3H3	0.000	1.02***	0.06	-0.076	0.01	0.96
	(0.002)	(0.02)	(0.06)	(0.05)	0.04	
S3H4	-0.003*	0.98***	-0.02	0.12*	0.01	0.96
	(0.002)	(0.02)	(0.05)	(0.05)	0.04	
S3H5	-0.002	1.00***	-0.25***	0.30***	-0.03	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S4H1	-0.001	1.04***	-0.07	-0.43***	0.01	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S4H2	-0.002.	1.04***	-0.14*	-0.15**	0.00	0.96
	(0.002)	(0.02)	(0.05)	(0.05)	0.04	
S4H3	0.000	1.02***	-0.20**	-0.17**	0.00	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S4H4	-0.003	0.99***	-0.33***	0.07	-0.02	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S4H5	-0.005*	0.93***	-0.38***	0.15.	-0.05	0.89
	(0.002)	(0.02)	(0.08)	(0.08)	0.06	
S5H1	0.001	1.01***	-0.49***	-0.53***	0.02	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	

S5H2	0.000	0.99***	-0.50***	-0.34***	0.03	0.93
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S5H3	0.000	0.95***	-0.45***	-0.31***	-0.02	0.91
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S5H4	0.000	0.94***	-0.48***	-0.17.	-0.1	0.84
	(0.002)	(0.03)	(0.10)	(0.10)		
S5H5	-0.003	0.90***	-0.50***	-0.11	-0.15	0.76
	(0.003)	(0.03)	(0.12)	(0.12)	0.09	

4.4 Further exploration on the lottery effect

$$Lot \ = \ a + b[RM(t) - RF(t)] + sSMB + hHML + e(t)$$

Table 6 summarizes the result statistics of the regression which has the lottery factor regressed on RM – RF, SMB and HML. The objective of this regression is to explore if the three risk factors have already contained the information that the lottery factor has. The result indicates that market excess return is statistically significant in explaining the lottery factor. Nevertheless, the statistically significant intercept means that the three factors do not completely reflect the behavior of chasing lottery-like assets. SMB and HML are also not directly related to the lottery effect and the R-squared is small. Hence, the three factors do not fully capture the information presented by the lottery factor.

Table 7: Lottery Regression

Lottery	a : intercept	b : RM-RF	s : SMB	h : HML	R^2
Lot	-0.006*	0.14***	1.04	0.04	0.13
	(0.002)	(0.02)	(0.09)	(0.09)	

4.5 Diagnostics

Following Fama and French (1996), studentized residual test and Cook's distance test are performed. Test results and associated t-statistics indicate that the regression results are robust. Results are not presented here, but are available upon request.

5. Conclusion

Chinese stock market is one of the fastest growing emerging markets in the world, and is very likely to continue to grow in the future. As the Chinese stock market has attracted countless domestic investors and international investors, a considerable interest to understand how equity is priced in China emerges. Since a variety of media reports, surveys and papers point out that irrationality exists in Chinese domestic stock markets, it is reasonable to examine these claims with scientific methods. Although some systematic studies investigate asset pricing models in Chinese domestic markets, the time period covered by most of these studies is not recent, and cannot reflect the growing maturity of the stock market in China.

This paper then studies the asset pricing mechanism in Chinese domestic stock markets with an attempt to identify risk measures which can capture cross-sectional variation in average stock returns. In addition to the three common risk factors, which are market risk, size and book-to-market ratio, proposed by Fama and French (1996), this paper examines the role of lottery-chasing behavior in pricing cross-sectional variation in average stock returns.

Noteworthy results are obtained using stock data which contains all listed A-shares both on SHSE and SZSE from 1997 to 2016. First, empirical asset pricing models work very well in explaining cross-sectional variation in average stock returns. Most of the variance can be captured by market risk, size and book-to-market factors. The combination of these three factors has a remarkable performance in pricing securities in Chinese domestic markets, considering that Chinese investors have been long depicted as short-term speculators who pay little attention to the operating conditions of the underlying companies. In general, asset pricing has a logic in the stock market in China and the claim that the speculative atmosphere has caused the asset pricing theories to fail to work in China does not receive scientific support.

Second, inconsistent with what Choel S.Eun (2007) and Changyun Wang (2004) document, results show that market risk is well-priced in China, However, the results are accord with the classic CAMP theory, which lists market risk as a vital factor in explaining excess return of the securities. One potential explanation is that Choel S.Eun (2007) and Changyun (2004) Wang uses data of a time interval in which Chinese domestic stock markets were still nascent, had few institutional investors and had many imperfections. Changyun Wang (2004) uses data from 1994 to 2000, and Choel S.Eun (2007) works with data from 1991 to 2004. The stock market in China was opened in 1991, and very few companies were listed in several years within its inception, as discussed in the introduction sections. Therefore, the market at that time might not respond well to the common risk factors that are meaningful in the asset pricing theories due to market imperfections and the great number of irrational individual investors. The Chinese stock market is evolving, and when more recent data which covers stocks from 1997 to 2016 is used in this paper, the market risk is found to be significant in pricing equity in China. In addition, the data source in this paper is different from many other studies. For example, data from the Chinese Stock Market and Accounting Research Database is used in this paper while the study of Choel S.Eun (2007) uses data from *Taiwan Economic Journal*. Different data sources might also have contributed to the discrepancies in the results. Overall, the market risk is discovered to play a crucial role in asset pricing in China, and this finding is consistent with the classic asset pricing theories.

Finally, due to the irrationality of Chinese individual investors reported in many studies, it is reasonable to expect that Chinese investors have a preference towards lottery-like payoffs which can grant investors abnormally high returns. A lottery factor is constructed from the difference between companies with the highest previous return and the lowest previous return to mimic the risk associated with chasing lottery-like securities. However, this factor is not found to be very helpful in explaining the cross-sectional variation in average stock returns. Further analysis shows that market risk, size and book-to-market do not fully capture the information contained in the lottery factor. These results show that there is no substantial evidence which supports that notable lottery-chasing behavior exists in the stock market in China.

Despite the tests of the risk-based factor models in Chinese stock markets in this paper, there is a large space for asset pricing study in Chinese stock markets. For example, in this paper, lottery-chasing behavior is examined, and is not found to be significant in pricing stock return in China. However, no effort is taken to classify the lottery effect or to break down the specific risks associated with lottery-chasing such as takeovers, earnings announcement, media broadcast. Given the robustness of the results in this paper, the risk-based asset pricing models are proved to have logic in Chinese stock markets. Hence, this paper presents the future research space to explore additional common risk factors that can capture the variation in stock returns in Chinese domestic markets.

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1. Introduction

A central topic in financial economics and asset pricing field is the study of factors that determine the cross-section of average stock returns. In the classic Capital Asset Pricing Model (CAPM), an important variable to explain individual stock returns is the covariance between individual stock performance and market benchmark portfolio performance (Market betas). Many of the early studies focus on the such covariance between stock returns and the market benchmark returns. The work of Sharpe (1964) and Linter (1965) is among the earliest studies that examine the relationship between the cross-section of average stock returns and explanatory risk factors. Sharpe (1964) and Linter (1965) show that the market betas contain little information about the cross-section of expected stock returns on common stocks in the U.S markets. Same results are found in the study of Breeden (1979) about the intertemporal asset pricing model. Fama and French (1992a) further research on the role of market portfolio returns in predicting stock returns and incorporate factors that seem to have no special standing in the classic asset pricing settings. These factors include firm size, price/earnings ratio, leverage and book-to-market equity. Accord with Sharpe (1964) and Linter (1965), Fama and French (1992a) show that the market betas have little explanatory power on the cross-section of stock returns in the U.S market when used alone. On the other hand, used alone, firm size, price/earnings ratio, leverage, and book-to-market equity all have significant explanatory power. In combinations, the work of Fama and French (1992a, 1996) displays that firm size and book-to-market equity appear to digest the used-alone explanatory power of leverage and price/earnings ratio. Hence, Fama and French (1992a, 1996) further concludes that firm size and book-to-market equity have apparent and reliable power in explaining the cross-section of average stock returns in the U.S market. Fama and French (1992a, 1996) also suggest that market risk plays an important role in pricing stock returns when used in combination with size and book-to-market equity.

There is a significant growth of interest in applying asset pricing models to developed or emerging markets. Since their inception, Chinese domestic stock markets such as Shang Hai Stock Exchange (SHSE) and Shen Zheng Stock Exchange (SZSE) are long considered as volatile and unpredictable. A widespread perception is that a significant number of investors in Chinese domestic equity markets are irrational due to the immaturity of Chinese domestic stock markets, insufficient involvement of organized institutional investors, and the lack of training on financial theories for majority of individual investors. Hence, the price pattern for many Chinese domestic stocks appears to be volatile and not to follow risk-based asset pricing mechanisms. As the nascent Chinese stock market develops rapidly, studies that focus on testing empirical asset pricing factor models in Chinese domestic stock market emerge. Changyun Wang (2004) documents that the effects of market risk, firm size and book-to-market equity in the Chinese domestic market from 1994 to 2006 are highly similar to those in the U.S market, that is, small stocks outperform big stocks, value stock outperform growth stock, and market risk is not priced. The finding that the asset pricing mechanism in Chinese domestic stock markets is not inconsistent with rational risk-factor asset pricing models receives empirical support from Cheol S. Eun and Wei Huang (2007), whose study also argues that firm size and book-to-market ratio are systematically related to the cross-section of average stock returns while the market risk (market beta) is not found to be associated with variations of stock returns.

Although the previous research proves that a certain level of rationality exists in Chinese domestic equity markets, the finding that the market risk is not priced appears to deviate from the classic CAPM theory, which prices excess returns of equities according to market risk measured by the excess return of the market benchmark portfolio. Furthermore, the methodology used by Changyun Wang (2004) and Cheol S. Eun (2007) is firm-level cross-section regressions rather than the portfolio-level time-series regressions implemented by Fama and French (1996). In addition, most of these studies focus on examining Chinese domestic stock markets in early years such as 1990s and 2000s. Since these research, Chinese financial markets and Chinese financial database have advanced remarkably, although far from being mature. With the introduction of active institutional investors and a growing education on financial theories for individual investors, Chinese domestic equity markets begin to behave more rationally than it does before. However, irrationality is still significant. An important reason that Chinese domestic stock markets have been reported to be chaotic and insufficient is the strong preference of investors to chase lottery-like assets, assets that achieve a large payoff but are risky (the probability of achieving such a large payoff is low). Turan G. Bali (2011) uses the maximum daily return of stocks during the previous month as a new factor to examine the effect of lottery-chasing behavior on the cross-section of average stock returns. He shows that extreme positive returns are significant in the cross-sectional pricing of average stock returns in the U.S market. Motivated by these literature, this paper adds to the literature by providing a thorough analysis on the validity of risk-factor asset pricing models that incorporate Fama and French (1996) three factors and a lottery factor to account for the lottery-chasing effect in Chinese domestic stock markets. The data used for this study more comprehensive and recent, covering all A-shares traded from 1997 to 2016.

This paper proceeds with an overview of Chinese stock markets and an introduction to the sample and methodology used in the analysis with detailed explanations of how risk-factor variables are constructed from the raw data. This paper then examines how different combinations of risk factors capture the cross-sectional variation of average stock returns, and if the lottery factor is statistically significant in pricing stock returns in Chinese domestic stock markets.

2. Chinese Stock Markets Overview

China has two domestic stock exchanges: the Shanghai Stock Exchange (SHSE), initiated in 1990, and the Shenzhen Stock Exchange (SZSE), initiated in 1991. China's stock markets develop rapidly and the total market capitalization exceeds that of Hong Kong starting from 2001. By December 2016, there were 2359 listed companies (1183 on SHSE and 1275 on SZSE). The total market capitalization was $27 billion and $16 billion for SHSE and SZSE respectively.

The structure of Chinese domestic stock markets is very different from that of the U.S stock market. The first distinctive feature in Chinese domestic stock markets is that listed companies are mostly state-owned and the restriction from the government is tight. Since most listed firms are restructured state-owned enterprises, in order for the government to have control over state-owned assets, shares of a company, in usual case, is divided into legal-entity shares, state shares and tradable shares. Only tradable shares are allowed to be traded on public exchanges while state shares and legal-entity shares cannot be traded. As a result, the number of tradeable shares on the marketplace is limited and tradable shares on average account for around 40% of total shares outstanding of a firm.

Tradable shares are further split into A-shares and B-shares. A-shares are designed to be exclusively traded by Chinese citizens and institutions. On the other hand, B-shares are held exclusively by overseas investors. Typically, A-shares are the subjects to be studied for the research on Chinese domestic stock markets. Both A-shares and B-shares are qualified for voting right and cash flow dividend. The size of B-share market is relatively small compared to that of A-share market. By December 2016, there were 52 B-shares and 1131 A-shares listed on SHSE. 1230 A-shares were listed on SZSE while only 45 B-shares were listed. Since B-share market is generally illiquid and has a much smaller size, it can be excluded from the study when behaviors of Chinese domestic stocks are examined.

Second significant feature of Chinese domestic stock markets is that the trading mechanism is employed with additional regulations. Short-selling is strictly prohibited by the government. Daily fluctuation limits are set for tradable stocks to avoid extraordinary volatile price movements. This means the price of a stock can neither increase over a certain percentage nor can it decrease over a certain percentage in one day. Usually, the stock price of the current day cannot fluctuate over 5% to 10% of the closing price of the previous day.

Third feature is investors' highly speculative investing behaviors. The speculative atmosphere of Chinese stock markets has been attested by a few media reports and surveys. According to Cheol S. Eun (2007), the *Financial Times* (July 11, 1997) reports that interviewees desired to gain quickly and often held shares for less than one month. The report indicates that investment decisions were driven by little piece of information from newspaper, television and friends. Investors who focused on long-term value investing were scarce in the stock market in China. Chinese domestic stock markets also provided few tools for investors to diversify portfolios. In 1990s, bank savings, treasury bonds and common stocks were the only investment instruments. Neither institutionmanaged funds nor derivatives on equity or fixed-income were offered. Mutual funds were not available until November 1997, when the government passed the *Provisional Measures of the Administration of Securities Investment Funds.* Institutional investors played a limited role in the Chinese domestic markets. However, as Chinese domestic markets evolve and regulations improve, institutional investors are becoming active players and enrich the market with well-organized investment behaviors. Nevertheless, the number of individual investors who seek short-term speculative profits still seems to be large.

3. Sample and Methodology

3.1 Sample

This paper analyzes a sample consisting of all publicly traded A-shares on the SHSE and SZSE from January 1997 to December 2016. Data is obtained from the Chinese Stock Market and Accounting Research Database (CSMAR). The interval is chosen since very few companies were listed before 1997. There were 13, 32, 94, 161, and 270 firms in total listed by the end of 1991, 1992, 1993, 1994, 1995, and 1996 respectively. As mentioned above, B-shares are excluded from the sample since the B-share market is small and illiquid. Plus, B-shares are only offered to overseas investors while domestic investors are subjects of interest in this paper. Following the screening process of Fama and French (1992a, 1996) and Changyun Wang (2004), firms that are financial institutions, investment companies, funds or real estate companies are removed from the sample. Following Fama and French (1992a, 1996), firms that do not have available accounting data such as book value of equity are eliminated from the sample as well. The cleaning process yields 240 monthly data points with an average of 2295 stocks per month. Each individual firm has monthly return data, book value data, monthly maximum daily return data and market capitalization data. Following Fama and French (1992a, 1996), the book value of a firm in year *t* is measured in the December of year *t – 1*. In this paper, book value of a company is computed as total assets minus total liability and net intangibles. Table 1 represents summary statistics of the raw data. Market capitalization is the market value at the end of each month and is reported in thousands of RMB. Book-to-market ratio in each month is the ratio of book value of equity to market value of equity. Monthly market returns are equal-weighted average returns on the two market indexes (SHSE and SZSE) with dividend reinvested. The largest overall monthly return (calculated as equal-weighted average of returns on the composite index of two exchanges) is 0.37 in May 2015, and the lowest is – 0.28 in January 2016 (when Chinese stock markets were in great turmoil). The gaps between book-to-market ratios are high. For example, in 2004, the maximum BM ratio is 79.62 and the minimum is 0.002.

Table 1: Summary Statistics

Summary	Market Capitalization			Book-to-Market Ratio			Market Return		
Year	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1997	98840	26943906	704174	0.10	14.28	0.93	-0.10	0.20	0.02
1998	106260	24823519	747555	0.06	16.82	0.95	-0.12	0.12	0.01
1999	103642	29492654	852645	0.02	17.63	0.95	-0.06	0.32	0.02
2000	175740	1346123	21579503	0.0003.8	22.02	0.67	-0.04	0.14	0.05
2001	234117	22596484	1397133	0.0018	29.83	0.69	-0.13	0.08	-0.02
2002	176135	1182724	21704174	0.003	32.56	0.93	-0.12	0.12	-0.02
2003	137838	18632130	1134846	0.002	79.62	1.17	-0.07	0.10	-0.01
2004	60268	23088670	1067931	0.003	17.38	1.28	-0.13	0.10	-0.01
2005	33876	21284730	807553	0.00006	22.35	1.86	-0.12	0.16	-0.01
2006	72541	1257789	77038141	0.001	18.47	1.37	-0.03	0.27	0.06
2007	166561	4341669	295709781	0.002	15.35	0.56	-0.15	0.34	0.11
2008	95304	3559127	253680223	0.004	22.13	0.81	-0.26	0.19	-0.07
2009	180445	4862811	985200290	0.0006	15.28	0.60	-0.15752	0.22	0.09
2010	266160	6670338	820185527	0.0006	6.44	0.50	-0.09	0.12	0.01
2011	40628	6063435	629298358	0.001	37.57	0.65	-0.15	0.08	-0.04
2012	165780	4666005	542595298	0.0001	11.91	0.88	-0.11	0.18	0.01
2013	192100	5040854	517594131	0.00009	11.21	0.77	-0.14	0.16	0.02
2014	273750	6323091	602057551	0.00007	11.81	0.56	-0.05	0.15	0.04
2015	392100	10954861	775929101	0.00007	9.46	0.36	-0.16	0.37	0.08
2016	296916	9824909	516967541	0.00002	36.72	0.42	-0.29	0.20	-0.0009

3.2 Methodology

3.2.1 Explanatory variables

Fama and French (1992) expands the classic CAPM model into a three-factor model that contains size and book-to-market equity other than the market excess return to explain cross-sectional stock returns in the U.S market. They document that size and book-to-market equity are related to economic fundamentals.

Theoretically, firms that have high BE/ME are firms that have a low stock price relative to book value, which means they are undervalued by the market compared to their balance sheet data. These stocks are preferred by value investors since they are value stocks which are traded cheaply in the market. Firms that have high BE/ME are expected to have relatively low earnings on assets compared to those are more valued by the market (firms that have low BE/ME). Fama and French (1992a) document that firms with low BM ratios persistently generate high earnings while low earnings are measured for firms with high BM ratios. Therefore, a high BE/ME ratio implies a higher probability that the underlying company involves in financially distressing situation, and represents a higher risk for investing.

According to Fama and French (1992a), size is also closely related to profitability. Small firms usually have low earnings on assets compared to big firms, and Fama and French (1992a) show that small firms can suffer from prolonged earning depressions. The fact that small firms demonstrate weaker ability to rehabilitate earning power implies that size is a common risk factor associated with pricing of equities. As excess returns are associated with excess risk, these intuitions might explain the phenomena that small stocks tend to outperform big smalls, and value stocks tend to outperform growth stocks. Studies of Fama and French (1992a,1996) indicate that size and book-to-market are statistically significant risk factors in pricing stock returns. If risk-factor asset pricing models are rational in Chinese domestic stock markets, same results regarding the impact of size and book-to-market on cross-sectional variation of average stock returns should be observed in Chinese markets as well.

Following Fama and French (1992a, 1996), six portfolios here are formed to mimic the risk factors in returns related to size and book-to-market equity. In the December of each year *t* from 1996 to 2016, all A-share stocks listed on SHSE and SZSE are ranked on size. The median size of companies listed on SHSE and SZSE is used to split stocks into two groups, Small and Big. Small group contains companies whose market capitalization is below median market capitalization of all public traded A-share stocks in the sample, and Big group contains those whose market capitalization is above the median level. Stocks are also broken into three groups based on their book-to-market ratios. Breakpoints are 30 percentile and 70 percentile. Hence, in the December of each year *t*, stocks are grouped into Low (bottom 30%), Medium (middle 40%), and High (top 30%) of the ranked BE/ME values. The reason that firms are sorted into three groups by BE/ME but only two groups by size is that Fama and French (1992a) present evidence that book-to-market equity has a stronger explanatory power on stock returns than size does.

The six portfolios are constructed from the intersections of the two ME and the three BE/ME groups, that is, Small/High, Small/Medium, Small/Low, Big/High, Big/Medium, Big/Low. For example, Small/Low portfolio contains stocks that are both in the Small group and in the Low group. This means the stocks are below median market size and are in bottom 30% of book-to-market equity of all stocks according to data of the December in year *t*. After portfolios are formed, monthly equal-weighted returns are calculated from the January of year $t + 1$ to December of year $t + 1$. The portfolios are reformed at the December of year $t + 1$.

A size factor SMB (Small minus Big) that is designated to mimic risk factor in returns related to size is constructed as the difference between the simple average returns on the three small size portfolios (Small/Low, Small/Medium, Small/High) and the simple average returns on the three big size portfolios (Big/Low, Big/Medium, Big/High) in each month. The computed SMB values are essentially difference between returns on small stocks and returns on big stocks with approximately the same book-to-market equity. Hence, SMB factor mimics the risk factor related to size and is free of the impact of book-to-market equity.

A factor that accounts for the risk associated with the book-to-market equity is constructed in a similar way. The factor HML (High minus Low) is the difference between the simple average returns on the two high book-to-market equity portfolios (Small/High, Big/High) and the simple average returns on the two low book-to-market equity portfolios (Small/Low, Big/Low) in each month. The computed HML values are essentially difference between returns on value stocks and returns on growth stocks with approximately the same size. Thus, the difference should capture the different performance between stocks with high book-to-market equity and stocks with low book-to-market equity, and should be free of the influence of the size factor.

To further elaborate on how SMB and HML factors are built, here January 1997 is taken as an example. First, firms are sorted into six portfolios (Small/High, Small/Medium, Small/Low, Big/High, Big/Medium, Big/Low) based on the market data and balance sheet data of December 1996. In 1997, the SMB factor in each month is calculated as the difference between the simple average of equal-weighted monthly returns on the Small/High, Small/Medium, and Small/Low portfolios and that of equal-weighted monthly returns on the Big/High, Big/Medium, and Big/Low portfolios. The HML factor in each month is computed as the difference between the simple average of equal-weighted monthly returns on the Small/High and Big/High portfolios and that of equal-weighted monthly returns on the Small/Low and Big/Low portfolios. Stocks are re-sorted at the end of 1997. This means the six portfolios are re-constructed based on the data of December 1997, and the same calculations are performed for SMB and HML in 1998. The process is repeated for the rest of the years in the sample.

Another factor is monthly market excess return, which is measured as market return minus risk-free rate. This factor is designed to represent the risk related to the general market and economic outlook.

The final new factor Lot (lottery) added to the model is the factor to mimic the risk associated with chasing lottery-like assets. Following the approach of Bali (2009), at the end of each month, stocks are sorted based on their maximum daily return. The lottery factor is computed as the difference between the equal-weighted returns on the portfolio that consist of stocks with highest 10% maximum daily return in the previous month and that of the portfolio that consist of stocks with lowest 10% maximum daily return in the previous month. For example, based on the maximum daily returns in December 1996, two portfolios are formed, a portfolio contains stocks with highest 10% maximum daily return and a portfolio contains stocks with lowest 10% maximum daily return. These two portfolios are used to compute the lottery factor in January 1997, which is the difference between the equal-weighted returns on the two portfolios. The same process is repeated every month.

3.2.2 The response variable——cross-section of average stock returns

Following Fama and French (1996), 25 portfolios are formed on size and book-to-market equity to compute cross-section of average stock returns. The formation methodology is similar to that is used to compute SMB and HML. In the December of each year *t*, all stocks in the sample are sorted based on the balance sheet data and market data. 25 portfolios are constructed from the intersection of the five size quantiles and five book-to-market quantiles. Excess equal-weighted returns (equal-weighted returns minus the risk-free rate) on the 25 portfolios are calculated in each month as dependent variables. Again, portfolios are re-formed in the December of each year, and are held in the entire next year.

3.2.3 Statistical methods

Time-series regressions are applied on the 25 portfolios in this paper. Table 2 presents the summary statistics of risk factors. The average premium per unit of market beta ($RM - RF$) is -0.09% per month. The average SMB, which measures the average premium on returns related to the size factor, is 1.21% per month, that is large in statistical and practical sense. The average HML, which measures the average premium on returns related to the book-to-market equity, is 1.19% per month, which is also large. The average Lot is 0.69% per month, that is the average premium on returns for lottery-chasing behavior. Table 3 presents the correlation matrix of risk factors.

Table 2: Factor Summary Statistics

Summary	Mean	Standard Deviation	t-statistics
RM-RF	-0.008532	0.101493	-6.4436
SMB	0.01210	0.03718922	24.937
HML	0.011191	0.03796168	22.596
Lot	-0.006876	0.03801515	-13.863

Table 3: Correlation Matrix

Correlation	RM-RF	SMB	HML	Lot
RM-RF	1.00			
SMB	0.26	1.00		
HML	0.29	0.07	1.00	
Lot	0.36	0.14	0.14	1.00

Based on the study of Fama and French (1996), SMB, and HML should be expected to capture the strong cross-sectional variation in average stock returns as their average premium on returns are high. Choel S.Eun (2007), and Changyun Wang (2004) all document that the market excess return, measured by RM – RF, is not significant in explaining the cross-sectional variation in average stock returns in the Chinese domestic markets. In next sections, this paper performs asset pricing tests using Fama and French three-factor model, that is, portfolio-level variations in average stock returns are explained by the market excess return, SMB factor and HML factor. The primary focus is to test if risk factors proposed by Fama and French (1996), which explain a significant proportion of cross-sectional variation in average stock returns in the U.S market, could also capture variation in stock returns in Chinese domestic stock markets. Next, the lottery factor is added into the model to explain stock returns. If the lottery factor is statistically meaningful in explaining the cross-section of average stock returns, it potentially implies that investors' preference for lottery-like assets is significant. Finally, the lottery effect is regressed on common risk factors RM – RF, SMB, and HML. The purpose of this regression is to test if these three risk factors have already absorbed the information presented by the lottery effect.

4. Results

4.1 Two-factor regression

Since Choel S.Eun (2007) and Changyun Wang (2004) document the insignificance of market excess return in explaining cross-sectional average stock returns in China. First, a two-factor time series regression which only uses the size factor and book-to-market factor as explanatory variables is performed on 25 portfolios. The model is summarized as the following:

$$R(t) - RF(t) = a + sSMB(t) + hHML(t) + e(t)$$

The results are presented in Table 4. In table 4, S indicates the size quantile and H indicates the book-to-market equity quantile. For example, S1H2 means the portfolio that consists of stocks that are in bottom 20% based on size and in 20% – 40% interval based on book-to-market equity. The average intercept is about -0.15. The intercepts generated by the two-factor regression are large from the practical perspective and they are statistically significant in most of the regressions, meaning that there is information that is not explained by SMB and HML. Intercepts are similar in size, which supports the conclusion in Fama and French (1992a, 1996) that size and book-to-market equity capture different average returns across stocks. However, overall, the large and statistically significant intercepts say that SMB and HML, when used alone, do not explain the average premium of stock returns very well.

Table 4: Two-factor Regressions

Portfolio	a : intercept	s : SMB	h : HML	R^2
S1H1	-0.02**	1.29***	0.2	0.23
	(0.01)	(0.25)	(0.25)	
S1H2	-0.02*	0.84**	0.62*	0.18
	(0.01)	(0.27)	(0.26)	
S1H3	-0.02*	0.56*	0.86***	0.18
	(0.011)	(0.27)	(0.26)	
S1H4	-0.02**	0.38	1.14***	0.21
	(0.01)	(0.26)	(0.25)	
S1H5	-0.02**	0.27	1.22***	0.23
	(0.01)	(0.25)	(0.24)	
S2H1	-0.02***	1.02***	0.28	0.16
	(0.01)	(0.26)	(0.26)	
S2H2	-0.02**	0.64*	0.62*	0.14
	(0.01)	(0.26)	(0.26)	
S2H3	-0.02**	0.35	0.88***	0.15
	(0.01)	(0.25)	(0.25)	
S2H4	-0.02**	0.23	1.00***	0.16
	(0.01)	(0.25)	(0.24)	
S2H5	-0.03**	0.11	1.21***	0.20
	(0.01)	(0.24)	(0.24)	
S3H1	-0.02**	0.53*	0.32	0.07
	(0.01)	(0.26)	(0.25)	
S3H2	-0.02**	0.36	0.58*	0.09
	(0.01)	(0.26)	(0.25)	
S3H3	-0.02**	0.31	0.64*	0.09
	(0.01)	(0.25)	(0.25)	
S3H4	-0.02***	0.23	0.82***	0.12
	(0.01)	(0.24)	(0.24)	
S3H5	-0.01**	0.01	1.00***	0.12
	(0.01)	(0.25)	(0.24)	
S4H1	-0.02**	0.20	0.30	0.02
	(0.01)	(0.26)	(0.25)	
S4H2	-0.02**	0.13	0.58*	0.05
	(0.01)	(0.26)	(0.25)	
S4H3	-0.02**	0.06	0.52*	0.04
	(0.01)	(0.25)	(0.25)	
S4H4	-0.02**	-0.08	0.76**	0.06
	(0.01)	(0.25)	(0.25)	
S4H5	-0.02***	-0.14	0.80***	0.07
	(0.01)	(0.04)	(0.23)	
S5H1	-0.02**	-0.23	0.18	0.05
	(0.01)	(0.25)	(0.25)	

S5H2	-0.02**	-0.25	0.35	0.01
	(0.01)	(0.25)	(0.24)	
S5H3	-0.02**	-0.21	0.34	0.02
	(0.01)	(0.24)	(0.24)	
S5H4	-0.02**	-0.24	0.48	0.01
	(0.01)	(0.24)	(0.24)	
S5H5	-0.02**	-0.28	0.50*	0.01
	(0.01)	(0.24)	(0.24)	

4.2 Three-factor regression

Time-series regressions are performed on the 25 portfolios formed on size and book-to-market equity. The market excess return, SMB factor, HML factor are explanatory variables. The excess return of the 25 portfolios is the dependent variable to be explained. The model is summarized as following:

$$R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB + hHML + e(t)$$

Table 5 reports the results of time-series regressions. Compared to the two-factor regressions, adding market excess return as an explanatory variable pushes the large intercepts observed in the two-factor regressions close to 0. The average intercept is close to 0.001, and intercepts in many portfolios are very close to 0. Only 7 out of 25 intercepts in the three-factor regressions differ from 0 by more than 0.002. All the intercepts are not statistically significant except for S3H4 and S4H5, implying that the three-factor model absorbs information regarding the variation in cross-sectional stock returns well. The market excess return, in all cases, is statistically significant. This result is inconsistent with findings of Choel S.Eun (2007) and Changyun Wang (2004), but is reliable from the statistical and practical perspective. The slopes on RM – RF in all regressions on 25 portfolios are very close to 1, which is consistent with the results of Fama and French (1996), who also find that slopes on RM – RF are close to 1 for the three-factor regressions performed on data of the U.S stock markets. Although deviate from the studies of Choel S.Eun (2007) and Changyun Wang (2004), who also apply asset pricing tests on Chinese domestic stock markets, these results are in line with those of Fama and French (1996) and show that the market excess return plays a crucial role in explaining why average stock returns are above the risk-free rate. The importance of market risk factor in pricing stock returns can also be seen in the improved R-squared in three-factor regressions compared to two-factor regressions. The average adjusted R-squared in three-factor regressions is roughly 0.93 while the adjusted R-squared scores in the two-factor regressions are generally low. The high average adjusted R-squared in three-factor regressions justify the remarkable ability of RM – RF, SMB and HML to capture the cross-sectional variation in average stock returns in Chinese domestic markets.

Consistent with Fama and French (1996), Choel S.Eun (2007) and Changyun Wang(2004), the results confirm the explanatory power of size and book-to-market equity on cross-sectional stock returns. The fact that intercepts are close across 25 portfolios formed on size and book-to-market equity supports the conclusion that size and book-to-market factors explain variation in average stock returns well. In most cases, SMB and HML are statistically significant in pricing average stock returns. This makes sense from the practical perspective as small size and high book-to-market equity all can potentially imply a larger probability that a company involves in financially distressing status. The slopes on SMB are positive for small-sized portfolios and start to drop when size is increasing. This confirms the argument of Fama and French (1996) that small stocks are more variable than big stocks. The slopes on HML are usually negative and are big in absolute values for stocks with low book-to-market equity. As book-to-market equity increases, slopes on HML tend to approach 0. Hence, HML seems to increase the volatility of low book-to-market equity stock returns.

Table 5: Three-factor Regressions

Portfolio	a : intercept	b : RM-RF	s : SMB	h : HML	R^2
S1H1	-0.002	0.99***	1.04***	-0.42***	0.91
	(0.002)	(0.02)	(0.09)	(0.09)	
S1H2	0.001	1.06***	0.57***	-0.12***	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	
S1H3	0.003.	1.07***	0.29***	0.13*	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	
S1H4	0.000	1.04***	0.11*	0.42***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S1H5	-0.002	1.00***	0.02	0.52***	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	
S2H1	-0.003.	1.05***	0.75***	-0.46***	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	
S2H2	0.002	1.06***	0.37***	-0.12*	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S2H3	0.000	1.02***	0.09.	0.16**	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	
S2H4	0.000	1.01***	-0.03	0.28***	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	
S2H5	-0.003	0.99***	-0.14*	0.52***	0.96
	(0.002)	(0.02)	(0.06)	(0.06)	
S3H1	-0.002	1.04***	0.26***	-0.41***	0.95
	(0.001)	(0.02)	(0.06)	(0.06)	
S3H2	-0.002	1.03***	0.10	-0.14*	0.94
	(0.002)	(0.02)	(0.06)	(0.07)	
S3H3	-0.002	1.03***	0.015	-0.076	0.96
	(0.002)	(0.01)	(0.05)	(0.05)	
S3H4	-0.003*	0.98***	-0.02	-0.12*	0.96
	(0.002)	(0.01)	(0.05)	(0.05)	
S3H5	-0.001	1.00***	-0.25***	0.30***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S4H1	-0.001	1.04***	-0.07	-0.43***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	
S4H2	-0.003.	1.04***	-0.14**	-0.15**	0.95
	(0.002)	(0.01)	(0.05)	(0.05)	
S4H3	0.000	1.02***	-0.20**	-0.17**	0.95
	(0.001)	(0.02)	(0.06)	(0.06)	
S4H4	-0.003	0.99***	-0.34***	0.07	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	
S4H5	-0.005*	0.92***	-0.38***	0.16.	0.89
	(0.002)	(0.02)	(0.08)	(0.08)	
S5H1	0.000	1.01***	-0.48***	-0.53***	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	

S5H2	0.000	0.99***	-0.50***	-0.34***	0.93
	(0.002)	(0.02)	(0.06)	(0.06)	
S5H3	0.000	0.95***	-0.44***	-0.31***	0.91
	(0.002)	(0.02)	(0.07)	(0.07)	
S5H4	0.000	0.95***	-0.48***	-0.17.	0.84
	(0.002)	(0.03)	(0.10)	(0.10)	
S5H5	-0.002	0.87***	-0.50***	-0.11	0.76
	(0.003)	(0.03)	(0.12)	(0.12)	

4.3 Lottery-factor regression

Fama and French (1996) three factors and the lottery factor

$$R(t) - RF(t) = a + b[RM(t) - RF(t)] + sSMB + hHML + lLot + e(t)$$

The model is extended from the three-factor model through the addition of the lottery factor. Table 6 reports the regression results on 25 portfolios. The strong explanatory power of the three factors, RM – RF, SMB and HML, persist in the lottery-factor regression. However, the lottery factor is not found to be statistically significant except for the S1H2 portfolio (portfolio that consists of stocks that are in bottom 20% based on size and in 20% – 40% interval based on book-to-market equity). This means that the factor that mimics the risk associated with chasing lottery-like assets is not significant in pricing stock returns. In addition, little improvement on adjusted R-square scores are observed after adding the lottery-factor. Unlike the research of Bail (2011), which documents the presence of the significance of lottery-chasing behavior in the U.S stock markets, the premium of investing lottery-like assets appears to play a limited role in explaining cross-section of average stock returns in the Chinese domestic stock markets.

Table 6: Three-factor and Lottery Factor Regressions

Portfolio	a : intercept	b : RM-RF	s : SMB	h : HML	l : Lot	R^2
S1H1	-0.002	0.99***	1.04***	-0.42***	-0.010	0.91
	(0.002)	(0.03)	(0.09)	(0.09)	0.06	
S1H2	0.002	1.05***	0.56***	-0.12	0.11*	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S1H3	0.003*	1.06***	0.28***	0.13*	0.07	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S1H4	0.000	1.03***	0.11*	0.42***	0.09.	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S1H5	-0.002	0.99***	0.02	0.52***	0.02	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	0.04	
S2H1	-0.003.	1.05***	0.75***	-0.46***	0.02	0.94
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S2H2	0.002	1.05***	0.36***	-0.12*	0.07	0.96
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S2H3	0.000	1.02***	0.08	0.16**	0.05	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	0.04	
S2H4	0.000	1.02***	-0.03	0.28***	-0.04	0.97
	(0.001)	(0.01)	(0.05)	(0.05)	0.04	
S2H5	-0.003	1.00***	-0.13*	0.52***	-0.08	0.96
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S3H1	-0.003.	1.05***	0.27***	-0.41***	-0.09.	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S3H2	-0.002	1.03***	0.10	-0.14*	-0.01	0.94
	(0.002)	(0.02)	(0.06)	(0.07)	0.05	
S3H3	0.000	1.02***	0.06	-0.076	0.01	0.96
	(0.002)	(0.02)	(0.06)	(0.05)	0.04	
S3H4	-0.003*	0.98***	-0.02	0.12*	0.01	0.96
	(0.002)	(0.02)	(0.05)	(0.05)	0.04	
S3H5	-0.002	1.00***	-0.25***	0.30***	-0.03	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S4H1	-0.001	1.04***	-0.07	-0.43***	0.01	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S4H2	-0.002.	1.04***	-0.14*	-0.15**	0.00	0.96
	(0.002)	(0.02)	(0.05)	(0.05)	0.04	
S4H3	0.000	1.02***	-0.20**	-0.17**	0.00	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	
S4H4	-0.003	0.99***	-0.33***	0.07	-0.02	0.94
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S4H5	-0.005*	0.93***	-0.38***	0.15.	-0.05	0.89
	(0.002)	(0.02)	(0.08)	(0.08)	0.06	
S5H1	0.001	1.01***	-0.49***	-0.53***	0.02	0.95
	(0.002)	(0.02)	(0.06)	(0.06)	0.04	

S5H2	0.000	0.99***	-0.50***	-0.34***	0.03	0.93
	(0.002)	(0.02)	(0.06)	(0.06)	0.05	
S5H3	0.000	0.95***	-0.45***	-0.31***	-0.02	0.91
	(0.002)	(0.02)	(0.07)	(0.07)	0.05	
S5H4	0.000	0.94***	-0.48***	-0.17.	-0.1	0.84
	(0.002)	(0.03)	(0.10)	(0.10)		
S5H5	-0.003	0.90***	-0.50***	-0.11	-0.15	0.76
	(0.003)	(0.03)	(0.12)	(0.12)	0.09	

4.4 Further exploration on the lottery effect

$$Lot = a + b[RM(t) - RF(t)] + sSMB + hHML + e(t)$$

Table 6 summarizes the result statistics of the regression which has the lottery factor regressed on RM – RF, SMB and HML. The objective of this regression is to explore if the three risk factors have already contained the information that the lottery factor has. The result indicates that market excess return is statistically significant in explaining the lottery factor. Nevertheless, the statistically significant intercept means that the three factors do not completely reflect the behavior of chasing lottery-like assets. SMB and HML are also not directly related to the lottery effect and the R-squared is small. Hence, the three factors do not fully capture the information presented by the lottery factor.

Table 7: Lottery Regression

Lottery	a : intercept	b : RM-RF	s : SMB	h : HML	R^2
Lot	-0.006*	0.14***	1.04	0.04	0.13
	(0.002)	(0.02)	(0.09)	(0.09)	

4.5 Diagnostics

Following Fama and French (1996), studentized residual test and Cook's distance test are performed. Test results and associated t-statistics indicate that the regression results are robust. Results are not presented here, but are available upon request.

5. Conclusion

Chinese stock market is one of the fastest growing emerging markets in the world, and is very likely to continue to grow in the future. As the Chinese stock market has attracted countless domestic investors and international investors, a considerable interest to understand how equity is priced in China emerges. Since a variety of media reports, surveys and papers point out that irrationality exists in Chinese domestic stock markets, it is reasonable to examine these claims with scientific methods. Although some systematic studies investigate asset pricing models in Chinese domestic markets, the time period covered by most of these studies is not recent, and cannot reflect the growing maturity of the stock market in China.

This paper then studies the asset pricing mechanism in Chinese domestic stock markets with an attempt to identify risk measures which can capture cross-sectional variation in average stock returns. In addition to the three common risk factors, which are market risk, size and book-to-market ratio, proposed by Fama and French (1996), this paper examines the role of lottery-chasing behavior in pricing cross-sectional variation in average stock returns.

Noteworthy results are obtained using stock data which contains all listed A-shares both on SHSE and SZSE from 1997 to 2016. First, empirical asset pricing models work very well in explaining cross-sectional variation in average stock returns. Most of the variance can be captured by market risk, size and book-to-market factors. The combination of these three factors has a remarkable performance in pricing securities in Chinese domestic markets, considering that Chinese investors have been long depicted as short-term speculators who pay little attention to the operating conditions of the underlying companies. In general, asset pricing has a logic in the stock market in China and the claim that the speculative atmosphere has caused the asset pricing theories to fail to work in China does not receive scientific support.

Second, inconsistent with what Choel S.Eun (2007) and Changyun Wang (2004) document, results show that market risk is well-priced in China, However, the results are accord with the classic CAMP theory, which lists market risk as a vital factor in explaining excess return of the securities. One potential explanation is that Choel S.Eun (2007) and Changyun (2004) Wang uses data of a time interval in which Chinese domestic stock markets were still nascent, had few institutional investors and had many imperfections. Changyun Wang (2004) uses data from 1994 to 2000, and Choel S.Eun (2007) works with data from 1991 to 2004. The stock market in China was opened in 1991, and very few companies were listed in several years within its inception, as discussed in the introduction sections. Therefore, the market at that time might not respond well to the common risk factors that are meaningful in the asset pricing theories due to market imperfections and the great number of irrational individual investors. The Chinese stock market is evolving, and when more recent data which covers stocks from 1997 to 2016 is used in this paper, the market risk is found to be significant in pricing equity in China. In addition, the data source in this paper is different from many other studies. For example, data from the Chinese Stock Market and Accounting Research Database is used in this paper while the study of Choel S.Eun (2007) uses data from *Taiwan Economic Journal*. Different data sources might also have contributed to the discrepancies in the results. Overall, the market risk is discovered to play a crucial role in asset pricing in China, and this finding is consistent with the classic asset pricing theories.

Finally, due to the irrationality of Chinese individual investors reported in many studies, it is reasonable to expect that Chinese investors have a preference towards lottery-like payoffs which can grant investors abnormally high returns. A lottery factor is constructed from the difference between companies with the highest previous return and the lowest previous return to mimic the risk associated with chasing lottery-like securities. However, this factor is not found to be very helpful in explaining the cross-sectional variation in average stock returns. Further analysis shows that market risk, size and book-to-market do not fully capture the information contained in the lottery factor. These results show that there is no substantial evidence which supports that notable lottery-chasing behavior exists in the stock market in China.

Despite the tests of the risk-based factor models in Chinese stock markets in this paper, there is a large space for asset pricing study in Chinese stock markets. For example, in this paper, lottery-chasing behavior is examined, and is not found to be significant in pricing stock return in China. However, no effort is taken to classify the lottery effect or to break down the specific risks associated with lottery-chasing such as takeovers, earnings announcement, media broadcast. Given the robustness of the results in this paper, the risk-based asset pricing models are proved to have logic in Chinese stock markets. Hence, this paper presents the future research space to explore additional common risk factors that can capture the variation in stock returns in Chinese domestic markets.

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