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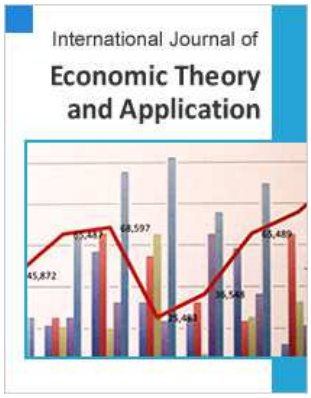

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How Multi-factor with Exchange Rate Volatility Affects Equity Premium: Case from Chinese Stock Market

Yajie Wang[1, *], Elias C. Grivoyannis[2], Hui Li[1]

[1]School of Management, Harbin Institute of Technology, Nangang District, Harbin, P.R. of China
[2]Department of Economics, Yeshiva University, New York, *USA*

Email address
yajiew@126.com (Yajie Wang), grivoyan@yu.edu (E. C. Grivoyannis)

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Abstract
RMB exchange rate is increasing volatile and its influence on Chinese stock market is more and more strongly. In this paper, volatility of RMB exchange rate as another factor is implanted into the traditional Fama-French three-factor model to build an improved asset-pricing model. And this paper evaluates each factor's influence on stock risk premium using data of A-share listed companies in China from 2008 to 2012. The results show that market factor, scale factor and volatility factor of RMB exchange rate, all have strong explanatory power on equity risk premium and the risk of the three factors is also priced. The risk represented by the exchange rate volatility factor is the exchange rate exposure faced by Chinese stock market. This finding provides some actual evidence for the fact that exchange rate fluctuation has a noticeable impact on Chinese stock market.

1. Introduction

The capital asset pricing model (CAPM) points out that the size of the market risk premium is an important factor deciding expected returns of securities, namely, risk premium of securities can be embodied in the product of the market risk premium and coefficient β. CAPM as a quantitative model of asset risk is recognized by economic circles and is considered to be the foundation of the follow-up study, opening up a new era of financial empirical research. However, due to its strict hypothesis and omitting some risk factors, empirical explanation of CAPM model is not ideal. To make up for the imperfection, there emerge many modified academic studies of CAPM, the larger influence of which is three-factor model put forward by Fama and French, the model analyzes equity risk premium of CAPM model in detail, introducing scale factor (SMB) and Book-to-Market ratio factor (HML), furthermore, the model has proved its better explanation than CAPM model by the empirical test of the stock market. A number of studies subsequently discuss the factors affecting equity risk premium on the basis of this model. At the same time, research methods employed in the three factors model have also been widely referenced by follow-up studies.

The researches of domestic scholars in China using F-F three-factor model mainly focus on the following two aspects. On the one hand, there are some discussions about the three factors itself, for example, testing whether three factors have any influence to China stock market. Because of the different time and sample selection, domestic scholars have different studying results. Some studies confirm that the three-factor model has its good

applicability in China's stock market. Du Juntao, Zhou Xiaohua and Yang Xiutai (2003) study new shares listed on the Shanghai Stock Exchange in 1996 using three-factor model and find their long-term performance are explained well; Zhu Baoxian (2002) compares Book-to-Market ratio with scale using the data of listed companies in 1995-1997 and draws the conclusion that Book-to-Market ratio has more explanatory power to rate of stock returns; Wu Shinong, Xu Nianhang (2004) and Yang Xin (2003) further conclude that there exists significant effects of HML and SMB in China's stock market. However, other studies have gotten the opposite conclusions, namely, F-F three-factor model doesn't explain market risk premium of the Chinese stock unless it is improved. Fan Longzhen and Wang Haitao (2003) find that F-F three-factor model cannot fully explain the anomalous earnings of the listed companies, but introducing a p/e ratio factor in F-F three factor model can well explain the problem; Su Baotong (2004) suggests adding tradable share factor may make the model has good fitting effect.

On the other hand, there are some studies using the F-F three-factor model combined with the characteristic variables of listed companies to examine their influence to stock returns. Yang Jianwei and Jiang Fu (2004) study multi-factor model containing HML, SMB, market factor and tradable share factor, demonstrate that HML and tradable shares have especially significant effect to stock yield. Wang Yin and Zhu Yingzi (2011) embed several characteristics of listed companies and a few macroeconomic variables to constructs a model including eight factors. Pan Li (2011) obtains the conclusions that market average rate of returns, market value of stock and p/e ratio result in the change of China's stock market returns.

Existing literature of the equity risk premium using F-F three-factor model in China concentrate on investigation of companies' characteristic variables besides the standard three factors, but few of them introduce macroeconomic factors into the three-factor model, especially, introducing the volatility factor of exchange rate. Eugene F.Fama and Kenneth R. French(2015) point out that some abnormal factors will produce problem to three factor model and it is available to improve the model by introducing potential factors.

As for this paper, why is exchange rate fluctuations introduced to the three-factor model? We can present two considerations as follows. In the first place, the influence of macroeconomic situations to the stock market cannot be underestimated, as a macroeconomic factor, exchange rate may reflect the performance of domestic financial markets in context of the open economy; also, it reflects the monetary authority's policy intentions. In the second place, the recent fluctuations on RMB exchange rate are on growing, which means the exchange rate is also affected by changing market environment. Production and business activities of listed companies have become increasingly open and international; exchange rate fluctuations will have a direct or indirect impact on the profits of the enterprises having import and export needs, and ultimately affect their returns on equity. Therefore, the impacts of exchange rate fluctuations on the stock premium show their dual-level meaning, this is to say, the volatility not only embodies the changes in economic fundamentals but also relates to the enterprises' ongoing operations.

Since the RMB exchange rate reform in July 2005, value of the RMB exchange rate has appeared two-way fluctuations of continuous appreciation of RMB exchange rate and its successive volatility. Simultaneously, there has experienced larger price changes in Chinese stock market and the equity returns have floated over time as well. In the increasingly open environment of Chinese financial market, whether the RMB exchange rate fluctuation will affect the stock price and equity returns and if so, what magnitude is the influence? It is particularly essential to measure accurately the effect of exchange rate volatility to stock returns.

The main contribution of this paper is reflected in three aspects. First, we calculate the exchange rate volatility factor based on the monthly data, incorporating it into F-F three-factor model as another factor and then analyze the role of the exchange rate fluctuation and co-movement effects on the equity premium when combining with other multiple factors. Second, this paper selected all A-shares listed in both Shanghai and Shenzhen markets to analyze comprehensively, and we can show the whole picture of China's stock market using these data which obtain the real empirical evidence of China as an emerging country for the F-F three-factor model. Third, this paper enhances two-dimension empirical tests including time series data and cross-sectional data, in which, one is we confirm how and to what extent exchange rate fluctuations have an impact on the equity premium, another is we analyze whether the exchange rate is a risk factor and how it is priced. This paper improves the FF three-factor model to study the influence of the exchange rate to the equity risk premium, furthermore, to explore the role of the exchange rate volatility to the stock risk pricing.

The remainder of this paper is structured as follows. Section 2 elaborates the relative literatures that reveal and analyze the theoretical source of exchange rate impacts on equity premium. Section 3 introduces RMB exchange rate volatility factor to the model to construct asset portfolio; Section 4 gives specific time series empirical analysis. Section 5 further analyzes how the exchange rate factor is the priced as a risk factor by cross-sector analysis. Section 6 concludes.

2. Relative Theoretical Background

Initial studies on the relationship between exchange rate exposure and equity premium are derived from the exchange rate determination theory. These models introduce the indirect role of asset pricing on exchange rate determination. Dornbusch(1980) explains that changes of the current account is an important determinant of the exchange rate. In fact, the current account at last plays its role via its net asset position in the asset markets, thereby generating intertemporally effects so that asset prices will affect the exchange rate. On the other

hand, Changes in exchange rates may lead to changes in a company output, thereby affecting the company's value that exhibits its stock price changes as well as the overall trade balance of the economy. Stulz (1987) analyzes the reasons for the nominal exchange rate deviates from the actual exchange rate and notes that the existence of the nominal exchange rate possible overshooting. When referring to price of non-tradable goods play a crucial part in the exchange rate level, he implies that risky assets and their pricing are indispensable to exchange rate dynamics.

A different opinion with Dornbusch(1980) and Stulz(1987)is that exchange rate links to the stock price though the capital account. It can be divided into monetary model and asset model. In term of the monetary model, the exchange rate is also regarded as an asset price, while the price of assets will be affected by the expected rate of return, so the real exchange rate will be affected by its expected changes. The portfolio model is that if the domestic stock prices are going up, investors will be attracted to invest in the domestic financial market, resulting in a rise of national currency value. The rise of exchange rate is expected to mirror the changes in financial asset prices.

Another research perspective focuses on the financial asset pricing so as to explore the relationship between exchange rate and stock price. Bruno H.Solnik (1974) proposes a new international capital markets equilibrium model, this model is based on the capital asset pricing model (CAPM) of Sharpe-Lintner-Mossin and is so-called international capital asset pricing model. The model describes links between exchange rate risk and the risk of financial assets in two aspects. One is the risk premium of any kind of securities in one countries will become the component of international systemic risks. Another is the expected variation of interest rates in two countries depend on the covariance of exchange rate exposure, and the forward rate is a biased estimate of future exchange rate, which implies exchange rate risk play a crucial role in the risk premium of the portfolio.

In addition, from a firm level, Michael Adler and Bernard Dumas(1984) define the currency risk exposure and design how to measure the exchange rate exposure using single linear regression, he further regards the regressive coefficient as the amount of exchange rate exposure, which is a single comprehensive measure the sensitivity of the whole firm and can further affect the market returns of the firm. By analogy, this univariate regressive model embodies the economic meaning of the market risk of a security, in which, riskiness of a security is measured as a coefficient β in the regression of the security returns. Pritamani, M.D., Shome, D.K. and Singal, V.(2004)discuss the firm-specific exchange rate exposure and propose the that total exposure of a firm is exchange rate and also provide univariate regression. Dominguez, K.M.E. and Tesar, L.L. (2006) examine the relations between exchange rate movement and firm value and find that firm's value is affected by the specific change of exchange rate and suggest that firm should adjust their behavior and hedge the exchange rate risk.

Some empirical analyses show that a number of factors will affect the stock price and returns on equity, where exchange rate fluctuations are a very obvious and cannot be ignored. Zakri Bello (2013) examines the relations between exchange rate and stock price for the four trade partners the United States, China, Britain, the EU, Japan and other countries and finds there are positive or negative influence of currencies to the US stock market, concluding that exchange rate movements have a certain influence on the stock market, but different direction, meanwhile, there are also differences among certain industries and sectors. Other researches uncover similar effects in different aspects such as the papers of Aggarwal (1981), Soenen and Hennigar (1988), Solnik (1987), Mao and Kao (1990), Benita and Lautertach (2004) and Huchet-Bourdon and Korinek (2011). Besides, other empirical tests of country-specific and firm-specific including Lucie Samson (2013), Apergis, N., Artikis, P. and Sorrosa, J. (2011), Bartrama, S. M., Bodnar, G.M.(2012), Ahmadi,R., Rezayi, M. and Zakeri,M. (2012), Koutmos ,G. and Martin,A.D. (2003) Chow, E. H., Lee, W.Y. and Solt, M.E.(1997)verify the impacts of exchange rate risk factor on stock returns are non-linear and diversifiable in different periods.

In summary, scholars in different periods have made many efforts on exploring how exchange rate influences equity premium and achieved rich theoretical and empirical results, which represent good enlightenments for our in-depth study on China financial market. Eugene F. Fama and Kenneth R. French (2015) expand the three-factor model by introducing other two factors of corporate profits and investment pattern and also provide a guide for academic field, where the extension will improve the model along with continuously research.

3. Multi-Factor Model with RMB Exchange Rate Volatility

3.1. FF Three-Factor Model

Fama and French (1993) argue if other factors are constant, the great changes of β will not produce volatility of stock returns. On the contrary, other risk factors such as SMB and HML affect the formation of asset prices. Its expression is:

$$r_p - r_f = \alpha + \beta_m (r_m - r_f) + \beta_{smb} SMB + \beta_{hml} HML + \varepsilon \quad (1)$$

Where, r_p is the stock return, r_m is the market average return rate, r_f shows the risk-free rate, $r_p - r_f$ is the risk premium of stock returns, $r_m - r_f$ is the market risk premium. There are three factors such as market premium, scale (SMB) and Book-to-Market ratio (HML) deciding risk premium of assets return, so the formula (1) is known as the standard three factor model. The SMB factor is a measure of SIZE effect while HML factor is a measure of BM effect. The SIZE effect refers to the larger is the company scale, the smaller is the return rate; BM effect refers to the greater is the

Book-to-Market ratio of the listed companies, the higher is the return rate. The coefficient of various factors is β and also named as factor loading to depict the sensitivity of these three factors.

3.2. Four-factor Model Embedding Exchange Rate Volatility

Although FF three-factor model well explains the cause of the equity risk premium, RMB exchange rate, however, has not been identified as the influence factors of equity risk premium. For studying the effect of exchange rate on the equity risk premium, we take the equity risk premium as the dependent variable, the exchange rate volatility as the fourth factor, combined with three factors mentioned above as the independent variable to construct linear regression model, it can be obtained:

$$r_p - r_f = \alpha + \beta_m(r_m - r_f) + \beta_{smb}SMB + \beta_{hml}HML + \beta_\sigma\sigma + \varepsilon \quad (2)$$

Where, r_p is stock return rate, r_f represents the risk-free return rate, r_m is the market return rate, SMB and HML show scale factor and Book-to-Market ratio factor, σ is the exchange rate volatility. Thus the equity risk premium is affected by four factors. Newly introduced factor σ represents the exchange rate risk factors involved in the pricing of stock risk premium.

4. Methodology

4.1. Data and Sample

4.1.1. Indicators

The primary data of this paper includes three aspects: return rate of each listed company; market value of listed companies; year-end closing price; returns per share; Risk-free rate and RMB real exchange rate volatility. This paper selected above indicators from all the A-share listed companies in SSE and SZSE of China with the time span from July of 2008 to March of 2012, while, the data of market value, year-end closing price, returns per share released by the annual reports of listed companies, the rest of the data is choosing the monthly data. The listed company data is from RESSET database; data of RMB effective exchange rate is from the official website of BIS.

4.1.2. Data Filtering

The first step is choosing the period span of data. some changes take place every year in the stock market in China, so every year is as a research period. Following the approach of Fama and French (1993), time division is from July of t year to June of $t+1$ year as a year, in accordance with the market value and Book-to-Market ratio in the end of the t year as indicators to group. Therefore some listed companies with broken data have to be eliminated. The second step is the filtering indicators. BM value is an important indicator of listed companies, so its negative value and zero value must be removed. The last one is the dispose of abnormal value. When a listed company appeared continuous too high or too low returns (i.e., extreme value returns), which will produce great influence on whole stock market returns, they must also be removed. The samples of listed companies are shown in table 1.

Table 1. *Statistics of Total Samples.*

year	1	2	3	4	total
Time span	2008.7-2009.6	2009.7-2010.6	2010.7-2011.6	2011.7-2012.3	45 months
Primary data	1400	1414	1702	1948	6464
Qualified data	1332	1250	1600	1887	6069

4.2. Structuring Stock Portfolios

The study object of this paper is all A-share of China, so the research method is to construct equity portfolio of two-dimensional group for the all listed companies samples. The reasons are as follows: firstly, the listed companies are so large that it is more insignificant to analyze the return of individual stocks than to construct stock portfolio to investigate. Secondly, study on stock portfolio may stand out the common features of Chinese stock market returns and screen non-systematic risk to the effects of stock returns. Thirdly, returns of portfolio has smaller residual error than individual stocks, their average returns is statistically more credible than specific stocks, furthermore, the portfolio data can improve regressing precision.

4.2.1. Two-Dimensional Grouping

Referring to the method of Fama and French (1993), two-dimension groups are divided with the SIZE and BM values as indexes through constructing a portfolio. In this paper, according to the value of SIZE and BM, from small to big, all samples produce 1, 2, 3, 4, 5 portfolios respectively and also overlap 5 * 5 = 25 portfolio. Namely, S1B1, S2B1, S3B1,... S5B1, S1B2, S2B2,... S5B2,... S1B5, S2B5,... S5B5, etc. Portfolio S1B1 shows the smallest in SIZE and BM, while S5B5 represents the largest in SIZE and BM.

4.2.2. Grouping in Groups

Because the value of SIZE and BM for each stock change dramatically with time, the structure of the portfolio must be renewed annually, Moreover, because the numbers of sample are different yearly, leading to the change of numbers of listed companies in every portfolio. This paper uses the method of grouping in group to build portfolios to avoid the greater difference among each portfolio, using SIZE and BM value released at the end of the year as the group index. The listed companies are first ordered from small to large according to different BM value then being quintile; next, above portfolios can be further ordered in term of different SIZE value, likewise quintile. No matter how change the number is, or even, some listed companies change from one portfolio to another, this method ensures to maintain the strict rules that index value of each group is ordered from small to large, each portfolio in quantity is as close or equivalent as possible to

obtain available average rate of return, thereby, ensures the consistency and representativeness of the number of portfolio. After Two-dimensional grouping, the paper solved weighted average returns in each portfolio in term of market value of stock-specific as weights, which are regarded as return rate of this portfolio. At last, time series of return rate of 25 portfolios are gotten.

4.3. Regression Model

This paper embodied the two regression of the portfolio. The first stage is the time series linear regression, with equity risk premium to be an explained variable and the four factors as the independent variables, such as the formula (2). It can be obtained a regression equation for each stock portfolio according to the above formula, recording the regression coefficient of each factor (i.e. the factor loading). This time series regression is used to test whether the four factors do any influences on equity risk premium. The second stage is the cross-section regression based on the results of above time series regression, in which, equity risk premium to be an explained variable are regressed again with the factor loading in the first stage as independent variables. If they are showed to have significant impacts on equity risk premium, they are the risk factors determining the equity risk premium. The regression model of the second stage is defined as:

$$r_p - r_f = \alpha + \sum_{i=1}^{n} \beta_i \lambda_i + \mu \tag{3}$$

Where β_i shows the regressing coefficient of i factor in the first stage, namely, the factor loading of i factor; λ_i is the regression coefficient in second stage using to explain the pricing of the risk factors.

5. Empirical Results and Analysis

5.1. Parameters Determination

Here, it further needs to determine the calculation method of each variable in the model.

5.1.1. Risk Premium of Monthly Return Rate ($r_p - r_f$)

Average return rate of each portfolio r_p can be calculated through weighted averaging return rate of each listed company within the portfolios, here, the weighs derive from SIZE factor. Namely,

$$r_p = \sum_{i=1}^{n} r_i \frac{SIZE_i}{\sum_{i=1}^{n} SIZE_i} \tag{4}$$

n is the total numbers of listed companies within a portfolio, r_i is average return rate monthly of i listed company, $SIZE_i$ says the size of the corresponding market value., This paper uses the three-month deposit interest rate, by converting continuous compound rate into a month to form the risk-free rate r_f. Risk premium of the portfolio can be gotten by average return rate minus the risk-free rate. Eventually, we can obtain the time series of risk premium of 25 portfolios with 45 month-spans.

5.1.2. Market Premium Factor ($r_m - r_f$)

The time series of market premium factor can be obtained through the market return minus the corresponding risk-free rate respectively, for the market return rate , in term of CAPM model, it is called return rate of "Market portfolio". However, in the empirical research, with reference to current literature, the market index returns is alternative for market portfolio returns.

r_m can be calculated by monthly return rate of all sample listed companies setting a-share market value as weights ,the result is as follows:

$$r_m = \sum_{i=1}^{n} r_i \frac{SIZE_i}{\sum_{i=1}^{n} SIZE_i} \tag{5}$$

Where n says he total number of listed companies in the sample, $SIZE_i$ is market value of stock i, r_i is return rat e of stock i.

5.1.3. Building of SMB Factor and HML Factor

The independent variables the regression are selected into two categories: one is they can get simple processing, such as monthly risk-free rate and exchange rate volatility factor; another is they are constructed through the existing data, such as SMB factor and HML factor.

As for the building of the SMB factor and HML factor, it is adopted by grouping then calculating the weighted difference. Because SMB factor and HML factor reflect respectively influences of SIZE value and BM value on stock returns, when analyzing the effect of one factor alone we need to weed out another one.

All listed companies are divided into small (S) and large (B) groups according to the SIZE values, and each group are then divided into low (L), medium (M), high (H) groups according to BM values, in this way ,we can get six groups such as SL, SM, SH, BL, BM, BH. After grouping every time, weighted average monthly returns are calculated using the ratio(size of each listed company /size of the portfolio) as weights, at last, each portfolio produces monthly return rate. In the sample period, return rate of 45 months can be gotten. For each six group, SMB and HML factors can be computed according to the formula (5) :

$$SMB = \frac{1}{3}[(r_{SL} - r_{BL}) + (r_{SM} - r_{BM}) + (r_{SH} - r_{BH})]$$

$$HML = \frac{1}{2}[(r_{SH} - r_{SL}) + (r_{BH} - r_{BL})] \quad (6)$$

5.1.4. Exchange Rate Volatility Factor

In this paper, the exchange rate volatility factor is calculated according to the monthly data of RMB real effective exchange rate. RMB real effective exchange rate not only considers the all the relative changes of bilateral nominal exchange rate, but also eliminate the impact of price changes on itself value, compared with other methods measuring the RMB exchange rate, this way can synthetically reflect external value and relative purchasing power of domestic currency. Through the calculation, we can get 45 months time series data of RMB exchange rate volatility.

$$\sigma_t = \frac{e_t - e_{t-1}}{e_{t-1}} \quad (7)$$

e_t is t period of RMB real exchange rate, which is the monthly RMB real effective exchange rate on average.

5.2. Time Series Regression and Result Analysis

5.2.1. Regressing Results of the Introducing Exchange Rate Volatility

Using the formula (2)to do time series regression, this paper reports the results of each portfolio in table 2. The last line tells the frequency of a factor passing the significant test in 25 regressions. Adjust R^2 in last column shows its maximum of 0.938, with a average of 0.866, and removing extreme value 0.578 of S5B2, the goodness-of-fit of other portfolios change range from 0.738 to 0.938, which means that the 25 portfolios have been able to achieve a better fitting effect in the first stage of the linear regression as a whole.

5.2.2. Effects of Standard Three Factors

In 25 time series regression, the coefficient of market premium factor is statistically significant, SMB is significant in 22, and exchange rate volatility factor is significant in 15. By contrast, HML is significant only in 4. This suggests that the market premium factor has very strong explanation power for the stock risk premium of all portfolios, all Chinese listed companies undertake the market risk, and it is quite consistent with the theoretical conclusion. SMB factor is also shown as a stronger effect, and the HML factor's influence is very small. From the empirical results in this paper, in the current stage of China's stock market, HML factors cannot serve as a powerful explanatory variable to explain the equity risk premium.

Table 2. *Coefficients of factors in time series regressions.*

	Rm-Rf	SMB	HML	R^2	Adjusted R^2
S1B1	1.155*	1.159*	-0.177	-0.671*	0.868
S1B2	1.030*	1.606*	-0.129	-0.132	0.857
S1B3	1.214*	1.491*	0.397	-0.462*	0.860
S1B4	1.049*	1.502*	0.363	0.499*	0.915
S1B5	0.982*	1.345*	0.249	0.323*	0.914
S2B1	1.174*	1.046*	0.015	-0.341*	0.909
S2B2	1.242*	1.753*	-0.061	0.662*	0.893
S2B3	0.961*	1.405*	0.229	0.308	0.877
S2B4	0.957*	1.182*	0.349*	-0.217	0.908
S2B5	0.967*	1.052*	-0.138	0.666*	0.906
S3B1	0.864*	1.062*	-0.055	0.503*	0.891
S3B2	1.115*	0.944*	-0.657*	0.403*	0.880
S3B3	0.937*	1.330*	0.124	-0.124	0.868
S3B4	1.016*	1.230*	-0.811	0.128	0.934
S3B5	0.939*	0.495*	-0.338	0.673*	0.893
S4B1	1.016*	1.211*	-0.167	0.747*	0.902
S4B2	1.041*	1.347*	-0.150	0.520*	0.874
S4B3	1.161*	1.047*	-0.021	0.485*	0.867
S4B4	1.124*	0.320*	-0.494*	-0.316*	0.898
S4B5	0.869*	0.463*	-0.226	0.445*	0.938
S5B1	1.190*	0.182	-0.779*	0.084	0.823
S5B2	0.6246*	0.810*	0.064	0.311	0.578
S5B3	0.891*	0.145	-0.235	0.234	0.738
S5B4	0.8294*	-0.39	-0.695	-0.232	0.781
S5B5	0.961*	-0.259*	-0.287	-0.242	0.892
Frequency	25	22	4	15	

(Mark * represents significant level in 10%).

5.2.3. Effects of RMB Exchange Rate Volatility Factor to Equity Risk Premium

The performance of RMB exchange rate volatility is far better than the HML factor. First of all, the coefficient the exchange rate volatility factor passed significant test for 15 times, while HML factor just has 4 times to pass the test, suggesting that exchange rate volatility factor has stronger effects on stock risk premium. Second, the goodness of fit of the linear regression improved to some extent after incorporating the exchange rate volatility factor. This paper then use adjusted R^2 and AIC value as testing indexes to compare the regression results. The bigger Adjust R^2 value is , the greater the better fitting effect is; AIC value diminishes when regressing results show the better fitting effects.

Table 3 shows that adjust R^2 gets improved 20 times after introducing the exchange rate volatility factor. Exchange rate volatility factor is another influencing factor in the modified three-factor model. Similarly, AIC rule also shows that 23 portfolios improve their regressing results after introducing RMB exchange rate volatility factor.

In short, the RMB exchange rate has become indispensable factor to influence stock returns, also the factor model introducing exchange rate volatility factor are better able to explain the risk premium of stock returns. According to the empirical analysis of this paper, it is obvious that we can conclude that the suitable factors to explain China's a-share stock risk premium are mainly the market factor, SMB factor and exchange rate volatility factor.

Table 3. *Regression results comparison before and after incorporating RMB exchange rate volatility.*

	Adjusted β_i (before)	Adjuste β_i (after)	AIC (before)	AIC (after)
S1B1	0.863	0.868	-3.390	-3.470

	Adjusted β_i (before)	Adjuste β_i (after)	AIC (before)	AIC (after)
S1B2	0.852	0.857	-3.119	-3.190
S1B3	0.852	0.860	-3.257	-3.230
S1B4	0.912	0.915	-3.757	-3.750
S1B5	0.913	0.914	-3.713	-3.730
S2B1	0.907	0.909	-3.930	-3.980
S2B2	0.891	0.893	-3.730	-3.770
S2B3	0.876	0.877	-3.570	-3.590
S2B4	0.906	0.908	-3.900	-3.940
S2B5	0.904	0.906	-3.690	-3.730
S3B1	0.887	0.891	-3.350	-3.420
S3B2	0.881	0.880	-3.690	-3.710
S3B3	0.873	0.868	-3.520	-3.507
S3B4	0.933	0.934	-4.180	-4.220
S3B5	0.897	0.893	-3.650	-3.656
S4B1	0.901	0.902	-3.768	-3.817
S4B2	0.872	0.874	-3.387	-3.430
S4B3	0.894	0.867	-3.896	-3.940
S4B4	0.898	0.898	-3.906	-3.920
S4B5	0.938	0.938	-4.088	-4.104
S5B1	0.816	0.823	-2.986	-3.065
S5B2	0.560	0.578	-2.870	-2.956
S5B3	0.731	0.738	-3.043	-3.155
S5B4	0.777	0.781	-3.470	-3.509
S5B5	0.891	0.892	-3.957	-4.002
Frenqucy	Increased times	20	Decreased times	23

5.3. Regressions of Cross-Section

5.3.1. The role of Cross-Section Regression

Above discussion shows that the specific three factors will affect stock returns risk premium, but what reason did cause such effect? It needs further discussion.

Daniel and Titman (1997) considered if the rate of return and factor loading were positively correlated, this factor's influence on the rate of return is relative to risk. On the other hand, if the rate of return is not affected by the change of the factor loading, it has nothing to do with any risk.

In fact, if the coefficient of some factors directly results in the changes of portfolios in the average risk premium, they indicate these factors' influence on the returns represent the risk, that is to say the risk is priced. So we need to examine the relationship between load factor and portfolio risk premium, this can be done through the second stage named cross-section regression.

5.3.2. The results and Risk Analysis

We do the second stage regression using the average risk premium in each portfolio as explained variable, the factor loading out of the first stage as independent variables, simultaneously, excluding the factor loading of HML factor, choosing the coefficients of other three factors in 15 portfolios are significant statistically as samples, the results are shown in table 4.

Table 4 exhibits the coefficient and goodness of fit in the second stage regression.. Regressing results of 1-3 show the risk premium of portfolios are affected by the three factors respectively, the regressing result 4 is that risk premium of portfolios are affected by two factors including market premium and SMB factors. At last, regressing result 5 reflects the three factor loadings after adding exchange rate volatility factor are passed the test of significance. This shows that the risks represented by the three factors are priced. The results conform to the asset pricing theory of "rational pricing school", which says abnormal returns derived from the high risks and the price of these abnormal returns are the price of risks. Any investment strategy can not earn additional profits without undertaking any risk in the efficient markets. In comparison, we can see that goodness-of-fit of regressing results 4 and 5 improve from 0.33 to 0.485 after introducing RMB exchange rate volatility, thus it can be concluded that the factor loading of exchange rate volatility, to a great extent, explains the pricing of risk premium.

Table 4. *Coefficients of each factor in Cross-section regressions.*

	Rm-Rf	SMB	β_i	Adjusted β_i
1	0.012*			0.272
2		0.011*		0.223
3			0.006*	0.135
4	0.007*	0.005*		0.330
5	0.006*	0.007*	0.005*	0.485

"*" means to pass the test of 10% significant level

Cross-section regression results in the second stage disclose some information of the risk behind the four factors. The coefficients express the size of the risk. In the regression results 5, the risk price of the market factor is 0.006, the risk price of scale factor is 0.007, relatively, and the risk price of the exchange rate factor is 0.005. The size of the risk price depicts a factor loading β_i influencing the degree of the equity risk premium, namely, one unit change of β_i correspondingly produces the changing range in the value of equity risk premium. The greater the risk price is, the greater the load factor's influence on the equity risk premium is.

6. Discussion and Conclusions

This paper firstly introduces RMB exchange rate volatility to the standard three-factor model, and uncovers the exchange rate volatility factor becomes a noticeable factor of explaining China's a-share risk premium. Meanwhile, market factor and scale factor in modified three-factor model relatively reflect China's A-share risk premium. However, Book-to-Market ration is weak. So, Exchange rate volatility factor, market factor and scale factor, is composed of new three factors to explain the return risk premium and further formed a new three-factor model.

This paper further examines above three significant factors in the second stage regression and finds all the three factors passed the test of significance, which shows that the factor loadings of the three factors have important influence on stock returns risk premium, also, the risk represented by the three factors is priced. And factor loading of RMB exchange rate volatility has a strong influence on stock returns risk premium, indicating that exchange rate risk represented by exchange rate volatility factor has an important influence on Chinese stock market. In this paper, empirical research results show that the exchange rate volatility factor is not only a

characteristic factors of listed companies, but also as a kind of risk incorporated into the pricing factors for stock returns, the size of exchange rate volatility factor loading β_σ can represent its influencing degree of exchange rate risk, the greater β_σ is, the larger is it is affected by exchange rate fluctuations.

This paper also implies that the exchange rate volatility factor undertakes the exchange rate risk in China's stock market and this situation needs to draw the attentions of the all sectors of society. For listed companies, they can measure their own exchange rate volatility factor loading β_σ , determining the size of exchange rate risk. Listed companies with a higher β_σ may notice during the period of volatility of RMB exchange rate leading to shocks of their stock returns. For academics, it is necessary to pay more attention to explore the related theories of exchange rate impact on the stock returns. For policymakers and regulators, they may raise their awareness to guard against exchange rate risk of Chinese stock market.

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