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Feasibility of the Alternative Three-Factor Model on the TSE

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Abstract: This study aims at examining and comparing the Fama-French three factor model with the Fama-French four factor model based on using the asset growth factor which has been added to the Fama-French model of 1993 and proposed by Cooper *et al.* [1] and Yao *et a.l* [2]. The research population includes all the companies listed at Tehran Stock Exchange (TSE) between the years, 2000 up to 2009. The companies are supposed to be of the specifications determined by the research population. The findings of the research indicate that although the three factor model is applicable to Tehran Stock Exchange, the four factor model is of relative superiority. It also has a roughly greater strength in explicating the dispersion of the stock returns.

Key words: Fama-French Three Factor Model · Asset Growth Factor · Tehran Stock Exchange (TSE)

INTRODUCTION

For over twenty years, detecting the determinants of disperse cross-sectional performance of stocks has been one of the most rapidly expanding areas in the asset pricing literature. The popularity of this branch of modern finance is at least twofold. First, numerous patterns in average stock returns, i.e. the dependencies between stock characteristics and stock returns, have been documented since the early eighties and the research in this field still continues. Second, a failure of the empirical tests on the Capital Asset Pricing Model (CAPM) questioned the importance of mean-variance based beta factor as a unique risk measure and intensified the debate about the multidimensional character of risk [3].

Asset pricing models are of crucial importance to both financial economists and investment practitioners [4]. According to the textbook of asset pricing theory, investors are only rewarded for bearing aggregate risk and, consequently, idiosyncratic volatility should not be priced in the cross section of stock returns [5]. Despite its theoretical appeal, the CAPM of Sharpe [6] and Lintner [7] fail to explain the cross-section of stock returns. Motivated by the CAPM anomalies of the size effect of Banz [8] and the value-growth effect of Stattman [9], Fama and French [10] propose a three-factor model that augments the CAPM with the size and book-to-market-equity factors [4]. This model states that, in addition to the market index, the expected stock returns also depend on the size of a company measured by its market capitalization as well as its book-to-market ratio [11]. In general, there are several factors that affect the stock returns and many researchers have examined the factors and effects. This study provides empirical evidences from effects of the alternative three-factor Model on the TSE. The structure of the research is as follows: Section 2 presents Literature Review, section 3 discusses the Research Methodology, section 4 describes the Research Variables and Hypotheses, section 5 represents Testing of Hypotheses and finally section 6 refers to the Discussions and Conclusion.

Literature Review: There is a large body of literature examining the association between stock characteristics and the cross-section of stock returns in international markets [12]. Risk in the context of rational equity markets and the expected return is solely determined by the underlying risk. Consequently, substantial effort has been made to identify factors that capture risk. These factors have been identified based on the existing theories, such

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as the beta form the Capital Asset Pricing Model (CAPM) [13]. The traditional Capital Asset Pricing Model (CAPM) developed by Sharpe [6], Linter [7] and Black [14] states that (a) expected returns on stocks are positively related to their risk (market betas) and (b) market betas are the only risk factor to explain the cross-sectional variation of expected returns [15]. The single-period capital asset pricing model (henceforth CAPM) postulates a simple liner relationship between the expected return and the market risk of a security.

While the results of direct tests have been inconclusive, recent evidence suggests the existence of additional factors which are relevant for asset pricing. The smaller firms have had higher risk adjusted returns, on average, than larger firms [8]. Roll [16] conjectures that the size effect may be a statistical artifact of improperly measured risk. Scholes and Williams [17] point out that non-synchronous trading of securities imparts a downward bias to the estimated beta when the underlying security trades infrequently. Dimson [18] also argues that trading infrequency biases beta estimates and predicts a downward bias for infrequently traded shares and an upward bias for frequently traded shares [19]. Initially, most finance researchers agree that simple value strategies based on such ratios as book-to-market, earnings-to-price and cash flow-to-price have produced superior returns over a long period of time. Interpreting these superior returns, however, has been more controversial [20]. As quoted by Pinfold *et al* [21], Bryant and Eleswarapu [22] and Vos and Pepper [23] established the presence of the book-to-market effect in New Zealand. Both studies found a positive relationship between book-to-market and returns.

Fama and French [24] defined two easily measured variables, size and book-to-market equity, combined to capture the cross-sectional variation in average stock returns associated with market â, size, leverage, book-to-market equity and earnings-price rations. Moreover, when the tests allow for variation in â that is unrelated to size, the relation between market â and average return is flat, even when â is the only explanatory variable. The three stock-market factors: an overall market factor and factors related to firm size and book-to-market equity and the two bond-market factors seem to explain average returns on stocks and bonds [10].

A study undertaken by Malin and Veeraraghavan [25] found evidence of a small firm effect in France and Germany and a big firm effect in the United Kingdom. Findings showed that investors who hold small stocks generate superior returns than investors who hold big stocks with the exception of investors in the UK market. Senthilkumar [15], has highlighted that small firms have, to a certain extent, higher average return than large firms in selected Indian markets, the market-to-book variables seem to have a consistently stronger role in average returns.

However, Novak and Petr [13] showed none of the variation in market returns (beta), the market value of equity (size), the ratio of the market value of equity to the book value of equity and short-term historical stock returns (momentum) is clearly significant for explaining stock returns on the Stockholm Stock Exchange, which casts doubt on their use as universal risk factors in various corporate governance contexts. Silvestri and Veltri [26] have investigated if the Fama and French three-factor model was able to explain the variations in stock returns in Italian market. Findings of the study provided evidence that the size factor was related with stock returns for the Italian investors, while they did not find evidence of a relation between book-to-market ratio and stock returns. Lieksnis [11] investigated feasibility of the Fama-French three-factor asset pricing model for explaining cross-sectional returns of stocks listed in the Baltic stock exchanges. Findings of this study confirmed the validity and economic significance of the three-factor model for the Baltic stock market.

Chen and Zhang [27] offered a new factor model consisting of the market factor, a low-minus high investment factor and a high-minus-low *ROA* factor. The model's performance is fairly remarkable. In this study, the model's performance, combined with its economic intuition based on *q*-theory, suggests that it can be used to obtain expected return estimates in practice. An interesting study by Fan and Yu [28] constructed the new alternative three-factor model developed by Chen, Novy-Marx and Zhang [29] to explain the momentum anomaly in international equity market. Findings demonstrated that the alternative model is able to explain momentum abnormal return better than the well-known Fama-French model.

Asset growth rates are strong predictors of future abnormal returns. Asset growth retains its forecasting ability even on large capitalization stocks [1]. Yao *et al* [2] believe that there is negative relation between asset growth and subsequent stock returns. Such relation is weaker in markets where firms' asset growth rates are more homogeneous and persistent and in markets where firms rely more on bank financing for growth. On the other hand, corporate governance, investor protection and legal origin do not influence the magnitude of the asset growth

effect in Asian markets. In addition, Gray and Johnson [12] provide evidences that the asset-growth effect also exists in the Australian equity market. Of particular interest, it is present amongst the largest Australian stocks.

MATERIALS AND METHODS

This study aims at examining and comparing the Fama-French three factor model with the Fama-French four factor model based on using the asset growth factor which has been added to the Fama-French model of 1993 and proposed by Cooper *et al* [1] and Yao *et al* [2]. These models have been introduced to explicate the stock out in Tehran Stock Exchange.

The Research Variables: Asset growth is calculated for every stock for which two consecutive years of data are available for total assets [12] The asset Growth Rate of the company has been computed based on the following formula for the concerned year:

$$\text{ASSETG}(T) = \frac{\text{TotalAssets}(t)\text{-Total Assets}(t\text{-}1)}{\text{Total Assets}(t\text{-}1)}$$

ASSETG(T) : Percentage of Asset Growth References
Total Assets (t) : Total Asset Growths in year t
Total Assets (t-t)T: Total Asset Growths in year t-1

Firm's asset growth rate (AG) for year t is defined as the percentage change in total assets from fiscal year t-1 to fiscal year t [2].

The dependent variable used in this project represents $R_{p,t}$-$R_{f,t}$ where $R_{p,t}$ is the expected return of the portfolio which is monthly computed and $R_{f,t}$is considered as the rate of riskless return and equal to the interest rate ratified in the contribution papers with the government guarantee in terms of Table 1.

Research Hypotheses: The above-mentioned project consists of the two hypotheses as follows:

- The first hypothesis: The size of the company, the ratio of the inventory value to the market value and risk-taking have a correlation with the stock returns of the companies registered by Tehran Stock Exchange.
- The second hypothesis: The asset growth of the company, its size, the ratio of the market value to the book value and the market risk-taking reveal a correlation with the stock returns of the companies affiliated to Tehran Stock Exchange.

Sample and Statistical Population:

A: The statistical population of the study is comprised of all companies which are registered in Tehran Stock Exchange. They ought to have the following Particulars:

- They are required to be active in Tehran Stock Exchange from 2000 to 20009,
- Their financial year should be alike (resulting in 12.29 each year and the end of their fiscal year takes place roughly on March 15th).
- There should be the data of their financial statements in the files of Tehran Stock Exchange a year before their entrance to the model,
- There should have been transacted a year before their entrance to the model.

All companies which were in possession of the said specifications were selected to be the statistical population of the research. (It is necessary to explain that the while statistical population took part in the research, so no sampling was carried out).Finally, the research population was formed according to the following table with regard to all aspects.

B: The research period involves a decade stating from 2000 and ending in 2009. (a period of 10 years or 120 months).

Portfolio Construction: To examine the presented model and hypotheses, the independent variables (SMB¡ HML¡ AGfactor and R_{mt}-R_{ft}) have been calculated and carried out at the three steps as follows:

At the first step, the portfolios were prepared based on the control of the two variables: the size and the ratio of book value to the market value with regard to Fama and French [10] method. For the purpose of designing the portfolios, companies were divided into small and large groups after they had been arranged in terms of the size and by the use of the median. In pursuance of this objective, the companies were divided into three groups based on the ratio of inventory value to the market value; therefore, they were ranked from high to low on the basis

Table 1: Interest rate ratified in the governmental bond 'Sukuk' with years separated

Years	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rate/Percentage	19	17	17	17	17	15.5	15.5	15.5	15.5	15.5

Table 2: Yearly Reports of the statistical population

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of companies	183	183	200	220	244	251	226	237	239	232

Table 3: Portfolio of interaction between values

	B/M		
Firm Size	High	Middle	Low
Small Stock	Small-High	Small- Middle	Small- Low
Big Stock	Big- High	Big- Middle	Big- Low

Table 4: Formation of portfolio portfolios resulted from values

	B/M		
Firm Size	High	Middle	Low
Small Stock	AssetG(+2)	AssetG(+2)	AssetG(+2)
	AssetG(+1)	AssetG(+1)	AssetG(+1)
	AssetG(-1)	AssetG(-1)	AssetG(-1)
Big Stock	AssetG(+2)	AssetG(+2)	AssetG(+2)
	AssetG(+1)	AssetG(+1)	AssetG(+1)
	AssetG(-1)	AssetG(-1)	AssetG(-1)

Table 5: Table for the description statistics of the variables

Description	RP-RF	RM-RF	SMB	HML	AGfactor
Mean	1.102134	2.519917	-1.052750	-3.623000	2.038000
Median	-0.440000	2.170000	-0.465000	-2.685000	2.120000
Maximum	160.6200	36.51000	13.51000	8.720000	31.95000
Minimum	-33.15000	-10.95000	-32.41000	-21.17000	-17.86000
Standard Deviation	8.849091	6.038348	5.042078	4.610652	5.553889
Shrewdness	5.492231	1.671969	-1.790708	-0.882054	1.033528
Elongation	75.51629	10.40530	14.15268	4.758486	10.11540
Mass of the sample	2160	2160	2160	2160	2160

Table 6: The results of the regression equation

R-squared	0.189970	Mean dependent var	1.102134
Adjusted R-squared	0.182396	S.D. dependent var	8.849091
S.E. of regression	8.001475	Sum squared resid	136946.5
F-statistic	25.08221	Durbin-Watson stat	1.892188
Prob(F-statistic)	0.000000		

Table 7: Unweighted Statistics

R-squared	0.189970	Mean dependent var	1.102134
Sum squared resid	136946.5	Durbin-Watson stat	1.892188

Table 8: Results obtained from the regression equation of the first hypothesis:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.054913	0.225948	-0.243032	0.8080
SMB	0.515995	0.064713	7.973641	0.0000
HML	0.144327	0.047708	3.025227	0.0025
RMRF	0.882235	0.057527	15.33610	0.0000

Table 9: Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.202395	Mean dependent var	1.102134
Adjusted R-squared	0.194560	S.D. dependent var	8.849091
S.E. of regression	7.941730	Akaike info criterion	6.992272
Sum squared resid	134846.0	Schwarz criterion	7.050102
Log likelihood	-7529.654	Hannan-Quinn criter.	7.013424
F-statistic	25.83448	Durbin-Watson stat	1.889484
Prob(F-statistic)	0.000000		

Table 10: Table of Regression Analysis and Coefficients for the second Hypothesis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.041245	0.222850	0.185078	0.8532
HML	0.095323	0.047684	1.999045	0.0457
SMB	0.480350	0.063946	7.511851	0.0000
AGFAC	-0.196476	0.034046	-5.770948	0.0000
RMRF	0.917630	0.056911	16.12408	0.0000

of the same variable. 30 percent of the high group 40 percent of the mid group and 30 percent of the low group were chosen as the companies holding the high, middle and low ratios of the inventory value to the market value successively. It is worth mentioning that Fama and French model [10] has been used to classify the companies in terms of the size; as the large group for 90 percent high category and the small and very small group for 3 percent and 7 percent low category. The next step concerned with the calculation of the two factors, that is to say, the size (SMB) and the ratio of the inventory value to the market value. As it was pointed earlier, six portfolios of the interaction between the two factors of size and the ratio of inventory value to the market value were prepared and described by the Table 3 Later on the above said factors were computed.

At the second step, the preparation of the portfolios was based on the total sum of the asset growth. This step like the previous one was carried out in two sections. In the first section, the companies were classified into three groups in terms of their total sum of the asset growth. To do so, the companies which had negative sum of asset growth were shaped into one group while the rest of the companies with the positive sum of the asset growth were divided into high and low groups by means of the median.

In the second section the preparation of portfolios was based on the different classes of the asset growth. This kind of classification was done, as described by the Table 4, while the two factors of size and the ratio of the inventory value to the market value were controlled. Accordingly, eighteen portfolios were formed. Later on, after the formation of the portfolios, the factor of the asset growth was calculated.

The Factor of the Asset Growth: The asset growth factor consists of the difference between monthly return mean of the six portfolios which have the higher asset growth (+2) and the monthly return mean of the six portfolios which have the negative asset growth (-1):

$$\text{AGfactor} = \frac{1}{6}\left(\text{AGfactor of six porfolios}(+2)\right) - \frac{1}{6}\left(\text{AGfactor of six porfolios}(-1)\right)$$

Descriptive Statistics of the Research: Descriptive Statistics pertaining to the Independent and Dependant variables are according to the following table:

Testing of Hypotheses:

Hypothesis 1: The company size, the ratio of inventory value to the market value and the market risk-taking are correlated with the stock returns of the companies accepted by Tehran Stock Exchange. The survey of the correlation is based on the following equation:

$$R_{p,t} - R_{f,t} = \propto_p + ß_{p.MRP}\left(R_{m.t} - R_{f.t}\right) + ß_{p.MRB}\, SMB_t + ß_{p.MRL} HML_t + e_{p.t}$$

The null and its opposite Hypotheses are as follows:

H_0: The company size: the ratio of the market value to the inventory value and the market risk-taking are not correlated with the stock returns of the companies registered by Tehran Stock Exchange.

H_1: The company size, the ratio of the market risk-taking has a correlation with the stock returns of the companies affiliated to Tehran Stock Exchange. The following table displays the results of the regression equation:

With regard to the significance of the test described in the above table (sig<0.05), the null hypothesis based on the lack of correlation between the company size, the proportion of the market value to the inventory value and the market value to the stock returns of the companies registered in Tehran Stock Exchange is refuted; the correlation between the variables is proved. According to the results obtained from the tables, the coefficients of the estimated equation are as follows:

Estimated equation:

$$R_p = C(1) + C(2) \times R_m + C(3) \times SMB + C(4) \times HML + [CX=F]$$

Replaced (substituted) coefficients:

$$R_p = R_f - 0.054913123243 + 0.882235432112 \times R_m - R_f + 515995445243 \times SMB + 0.14326665343 \times HML + [CX=F]$$

The equation indicates that the variable of the stock returns pertaining to the companies registered by Tehran Stock Exchange changes 0.88 in lieu of one unit of variation in the market factor, 0.52 in return for one unit of variation in the size and 0.14 in recognition of one unit of variation in the ratio of the market value to the inventory value. In other words, the effect of the Fama-French three factor model on the stock returns of the companies registered by Tehran Stock Exchange is significant and positive. Based on the amount of the obtained correlation coefficient, the regression equation accounts for 19% variation between the independent variable and the dependant variable; the residue (81%) pertains to the factors which are not included in the equation.

Hypothesis 2: The asset growth of the company, the company size, the ratio of the market value to inventory value and the market risk-taking are correlated with the stock returns of the companies registered by Tehran Stock Exchange. The null hypothesis and its opposite one are as follows:

H_0: The asset increase of the company, the company size, the ratio of the market value to the inventory value and the market risk-taking are not correlated with the stock returns of the companies affiliated to Tehran Stock Exchange.

H_1: The asset growth of the company, the company size, the ratio of the market value to the inventory value and the market risk-taking have a correlation with the stock return of the companies registered by Tehran Stock Exchange.

The survey of the correlation is based on the following equation:

$$R_{p,t} - R_{f,t} = \propto_p + ß_{p.MRP}\left(R_{m.t} - R_{f.t}\right) + ß_{p.MRB}\ SMB_t + ß_{p.MRL} HML_t + ß_{p.AG}\ AGfactor_t + e_{p.t}$$

The results of the regression analysis for the second hypothesis have been presented in the following table. It contains the data relevant to the statistic of significant level F, the correlation coefficient and the amounts of regression coefficients. The results of testing the fixed effects are presented for the panel data in the rest of the table:

Since the criterion for the refutation and confirmation of the null hypothesis is the significant level of sig<0.05, the regression equation becomes valid in accordance with the above table and the accuracy of the regression presuppositions. Therefore, the null hypothesis based on the lack of correlation between the asset growth of the company, its size the ratio of the market value to the inventory value and the market risk-taking and the stock returns of the companies registered by Tehran Stock Exchange is refuted while the correlation between the variables is proved and confirmed with regard to the extracted results from the table, the coefficients (indexes) of the equation

According to the results obtained from the tables, the coefficients of the estimated equation are as follows:

Estimated equation:

$R_p - R_p = C(1) + C(2)* R_m + C(3)*SMB + C(4)*HML + C(5)*AGfactor + [CX=F]$

Replaced (Substituted) Coefficients:

$R_p - R_f = 0.0412447113504 + 0.917629785414 *R_m + 0.480349876759 * SMB + 0.0953228534654 * HML - 0.196475962376 * Agfactor + [CX=F]$

The equation indicates that the variable of the stock returns of the companies registered in the stock exchange tends to change 0.91 in lieu of one unit of variation in Rm-Rf, 0.48 in exchange for one unit of variation in SMB, 0.09 in return for one unit of variation in HML and -0.19 in lieu of one unit of variation in AG factor. The effects of the variation on the stock returns of the registered, companies are positive and significant except that the AG factor variable has a negative and significant correlation. On the basis of the amount of the obtained correlation coefficient the regression equation explains 20% of the variations between the independent variable and the dependent variable, whereas, the residue of 80% is related to the factors which are not calculated b the equation.

A Comparison of the Results: The results obtained in this research in comparison to a number of similar enquiries are as follows:

- Market Factor: the obtained results for the market factor correspond to the results of the investigations mode by Sharp [17], Lintner [11], Fama-French [24], Bagherzude [30], Ghaemi and Tusi [31] and Mojtahedzade and Taremi [32].
- Size Factor: the obtained results for the size factor agree with the research findings of Mojtahedzade and Taremi [32] and Ghaemi and Tusi [31] who have reported a positive correlation. Meanwhile they do not match with the research findings of Benz [8], Keim [19], Fama-French [23] Drew, Naughton and Veeraraghavan [33] and Jahromi and Neshvadian [34] who have reported a negative correlation between the company size and the sock return.
- Factor of the Ratio of Inventory Value to the Market Value: The results produced for the ratio of the market value to the inventory value are in conformity with those of Statman [9], Rosenberg, Read and Lanstin [35], Fama-French [32] and Jahromi and Neshvadian [34].
- Asset Growth Factor: The results of this research with regard to the asset growth factor, which is the main research question here, conform to the research findings of Cooper, Gulen and Schill [1], Yao, Yu, Zhang and Chen [2] and Gary and Jonhson [12]. There is also a negative correlation between the asset growth factor and the stock returns in Tehran Stock Exchange.

CONCLUSION

To attain an efficient made for the prediction of the stock returns in Tehran Stock Exchange, this research attempts to appraise the power of the Fama-French model of 1993 in comparison to the four factor model which was obtained by the addition of the asset growth model to the Fama-French three factor model (Yao, Yu, Zhang and Chen 2011). The findings of the research indicate that although the three factor model is applicable to Tehran Stock Exchange, the four factor model is of relative superiority. It also has a roughly greater strength in explicating the dispersion of the stock returns. Of course, with due care given to the amounts of obtained correlation coefficient, it is clear that the presented variables are still unable to account for the variations of the stock returns in Tehran Stock Exchange; therefore; it

is necessary to introduce other variables to the model so as to be representative of other factors of the risks. The four factor model can be applied directly in managing portfolios, appraising the funding function of return determination and predicting and spending the capital. Thus, the experimentation with other variables which have the potential to be in the model is left to the prospective investigation.

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