Does the alternative three-factor model explain momentum anomaly better in G12 countries?

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ABSTRACT

This study constructs the newly developed alternative three-factor model (Chen, Novy-Marx, and Zhang 2010) and applies it on G12 countries to examine whether it can explain the momentum anomaly in international equity market. This paper demonstrates that the alternative model is able to explain momentum abnormal returns better than the well-known Fama-French model. Although the alphas from the alternative model remain significant, the magnitudes are smaller than those obtained from the Fama-French model. This observation is persistent across countries. Results suggest that the alternative model has more explanatory power than the Fama-French model.

Keywords: momentum anomaly, Fama-French model, alternative 3-factor model, G12 countries

INTRODUCTION

Equity market anomalies are empirical relations between average returns and firm characteristics that cannot be explained by standard asset pricing models, such as Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965) and factor models (Fama and French, 1993; and Carhart, 1997). One of the prominent anomalies is the positive relation between stock returns and momentum. Jagadeesh and Titman (1993) demonstrate that stocks that perform well in recent months continue to earn higher average returns in future months than stocks that perform poorly. This return pattern cannot be explained by traditional asset pricing model, including the highly influential Fama-French model. Since the discovery of the momentum anomaly, it has been studied extensively among academics. Many studies have attempted to provide explanations of the existence of the momentum anomaly. It has been suggested that anomalies indicate either market inefficiency or inadequacies in the underlying asset-pricing model. A large number of studies provide new or additional risk factors to provide better explanations of the momentum anomaly (Pastor and Stambaugh, 2003, Hoberg and Welch, 2009, Cremers et al., 2010, Hirshleifer and Jiang, 2010, Hirshleifer et al., 2011, Novy-Marx, 2010, Fama and French, 2011, and Hou et al., 2011 among others). In recent years, Chen et al. (2010) proposed an alternative three-factor model based on q-theory. They report that the alternative model is able to outperform Fama-French model in U.S. market when examining several well-known equity anomalies, including momentum. This study extends the alternative model to international market. This paper constructs the alternative model for G12 countries to examine if the superior performance is a local manifestation or a global phenomenon.

This study begins by examining abnormal returns of zero-cost portfolios formed on momentum strategy. All stocks in each country are first divided into five quintiles based on the ranking of past six-month returns. Momentum strategy takes long positions of stocks in the quintile with the highest past returns and takes short positions of stocks in the quintile with the lowest past returns. This zero-cost trading strategy produces significant abnormal monthly returns for 12 out of 13 G12 countries (except for Japan). To test if these abnormal returns can be explained by some well-known risk factors, calendar-time factor regression is applied with Fama-French three-factor model plus the momentum factor (Fama and French, 1992, 1993, Carhart, 1997). Fama-French regression results indicate that significant abnormal returns from zero-cost strategies still exist after controlling for size and value risk factors. In other words, Fama-French model cannot explain momentum anomaly in G12 countries.

This paper then examines if the alternative model has a higher explanatory power in explaining momentum anomaly. The investment and return on asset (ROA) factors are constructed for each country following the method in Chen et al. (2010). The same calendar-time regression is conducted with the Fama-French model. Results suggest that alphas from the alternative model remain significant in most countries. It indicates that the alternative model cannot drive away abnormal returns. However, the magnitude of alphas dramatically decreased compares to the Fama-French model. The results are persistent for all countries except for Japan (Japan is the only country that does not have momentum abnormal returns during sample period) and Italy.

To test if these results are driven by firm size, 25 size-momentum portfolios are formed to control for size effect. First, all stocks are ranked into quintiles in each country based on ranking of size and momentum anomaly, independently. Second, 25 portfolios are formed based on the interactions of size quintiles and momentum quintiles. Finally, calendar-time factor regression is performed using both the Fama-French and alternative model on momentum

abnormal returns in each size quintiles. Test results show that the superior explanatory power of the alternative model is present in each size quintile and it is persistent across countries.

Overall, this study provides strong evidence that the alternative model can better explain abnormal returns associated with momentum anomaly. Although it is not powerful enough to drive away abnormal returns, it is able to significantly reduce the magnitude of these abnormal returns. This study suggests that the alternative three-factor model should be considered in studies of momentum anomaly in international market.

LITERATURE REVIEW

Since the influential study of Jagadeesh and Titman (1993), momentum anomaly has been one of the most extensively studied stock return patterns in the literature. Momentum anomaly has been examined for its persistence over time (Jagadeesh and Titman, 2001) and existence across countries (Rouwenhorst, 1998). Many studies try to identify factors that may contribute to its existence, such as earning momentum (Chan, Jagadeesh, Lakonishok, 1996), investor cognitive biases (Daniel, et al., 1998), analyst coverage (Hong, Lim, and Stein, 2000), and past trading volume (Lee and Swaminathan, 2000). Griffin et al. (2003) study momentum investing in global markets. They report that momentum profits are more persistent and pervasive in European and North American markets, but less evident in Asian markets, including Japan.

Among studies examining the existence of momentum anomaly, there is strong evidence that the highly-influential Fama-French model is not able to explain variations in momentum returns. A large number of studies are devoted to the search for additional risk factors that can explain anomalies. For example, Pastor and Stambaugh (2003) propose a market-wide liquidity measure and show that this liquidity measure accounts for half of the profit from a momentum strategy. Hoberg and Welch (2009) show that risk factors and test portfolios can be formed by optimizing objective functions instead of by sorting stocks. Cremers et al. (2010) suggest that significant alphas obtained from the Fama-Frech model primarily arise due to the disproportional weights on small value stocks and on CRSP value-weighted market index. They test alternative ways to construct risk factors and propose alternative models constructed from other tradable benchmark indices and report improved results. Hirshleifer and Jiang (2010) propose a financing-based misevaluation factor model. They present evidence that their model captures co-movement in returns beyond that in some standard multifactor models. Hirshleifer et al. (2011) find that innovative efficiency is a strong positive predictor of stock returns. Hou et al. (2011) study stock return patterns around the world and find that momentum and cash flow-to-price captures significant time series variation in global stock returns.

In a recent study, Chen, Novy-Marx, and Zhang (2010) motivate an alternative three-factor model from *q*-theory, and show that the new three-factor model is able to explain many return patterns in the U.S. markets that the Fama-French model is unable to. Because of its superior performance in explaining many anomalies, this alternative model has attracted a lot of attention and has been applied in several published studies (Ammann et al., 2012, Walkshausl and Lobe, 2011, Stambaugh et al. 2011, Da et al., 2012, among others). This new factor model consists of the market factor, an investment factor, and a return-on-asset factor. The motivation behind this alternative model is that firms will invest more when their profitability is high and the cost of capital is low. Therefore, after controlling for profitability, investment-to-asset should be a negative predictor of expected returns; and controlling for investment, profitability should be a positive predictor of expected returns. The authors provide strong evidence that the new

three-factor model reduces the magnitude of abnormal returns of various well-known anomalies, often to insignificance.

DATA AND METHODOLOGY

This study uses monthly returns, stock prices, and number of shares outstanding from 1989 through 2009 for firms in G12 countries from Thomson Financial's DataStream database. All variables are expressed in U.S. dollar. The analysis is restricted to common-ordinary stocks trading in the companies' home market. To identify common-ordinary stocks, this paper applies Griffin, Kelly and Nardari (2010) multi-stage screening method to eliminate preferred stocks, warrants, units or investment trusts, duplicates, ADRs or cross-listings, and other non-common equity from the sample. Detailed description of the filtering process can be found in Griffin et al. (2010).

Momentum portfolios are constructed using the "6/1/6" convention. At the beginning of each month *t*, momentum is computed as the past 6-month cumulative returns from month *t-2* to *t-7*, skipping month *t-1*. At the beginning of each month, all stocks in each country are ranked in ascending order based on momentum. All stocks are divided into quintiles based on momentum rankings. Stocks in the first quintile are assigned to the losers portfolio and those in the fifth quintile to the winners portfolio. These equal-weighted portfolios are held for 6 months. To increase the power of the tests, overlapping portfolios are constructed. For example, the winners portfolio is an overlapping portfolio that consists of winners portfolios in the previous 6 months, and the return on the portfolio is the simple average of returns of these six portfolios. The zero-cost portfolio is the winners-minus-losers portfolio, i.e, taking long positions in winners stocks and short positions in losers stocks.

To test if these anomalies can be explained by risk factors, portfolio risk-adjusted returns are computed using two factor models: the domestic Fama-French four-factor model (Fama and French, 1992, 1993) and the alternative three-factor model (Chen, Novy-Mark, and Zhang, 2010). Fama-French four-factor model refers to the Fama-French three-factor model plus the momentum factor. If abnormal returns of zero-cost portfolios can be explained by risk factors, an insignificant alpha should be observed. CAPM model is not used in this study because CAPM assumes constant systemic risk over time. This is not true, especially when portfolios are frequently adjusted. One single market index is not sufficient to capture return variations of a portfolio (Gruber, 1996; Grinblatt and Titman, 1989; and Ferreira, Miguel, and Ramos, 2006).

Fama and French (1992, 1993) propose a three-factor model to improve CAPM pricing errors by adding size and book-to-market risk factors. Carhart (1997) demonstrates that a momentum factor (Jegadeesh and Titman, 1993) should be included in the model. The four-factor model is given by:

$$R_{it} = \alpha_i + \beta_{0i} RM_t + \beta_{1i} SMB_t + \beta_{2i} HML_t + \beta_{3i} MOM_t + \varepsilon_{it} \quad (1)$$

where RM_t is market monthly return in U.S. dollar in excess of the one-month U.S. Treasury bill rate in month *t*. RM_t is computed using value-weighted average returns in U.S. dollar of all stocks in each country in each month. The conventional method in Fama and French's studies (1992, 1993) is used to construct size (*SMB*) and book-to-market (*HML*) factors. *SMB* is the average return on small-capitalization portfolios minus the average return on large-capitalization portfolios; *HML* is the difference in returns between portfolios with high book-to-market stocks

and portfolios with low book-to-market stocks. Monthly benchmark factors for each individual country are constructed using all stocks included in the Datastream/Worldscope database.

Momentum (MOM) factor for month *t* is computed using six value-weighted portfolios formed at the end of month *t-1*. These six portfolios are formed on the intersections of two portfolios formed on size and three portfolios formed on prior six-month (escaping the most recent month) cumulative returns. The median market equity at month *t-1* in each country is used as the breakpoint for size portfolios. The 30th and 70th percentiles of prior cumulative returns in each country as breakpoints for the prior return portfolios. The bottom 30% is classified as the losers portfolio, the middle 40% as medium, and the top 30% as the winners portfolio. MOM factor is computed as the monthly average return on the two winners portfolios minus the monthly average return on the two losers portfolios:

$$MOM = (Small\ Winnners + Big\ Winners - Small\ Losers - Big\ Losers)/2 \quad (2)$$

An alternative three-factor model is developed by Chen, Novy-Marx, and Zhang (2010) based on *q*-theory. The new model includes a market factor, an investment factor, and a return-on-asset factor. They demonstrate that this alternative model can explain many documented anomalies that cannot be explained by the Fama-French model in U.S. equity market. This alternative model is applied in this study to test whether abnormal returns are driven by the market, investment, and return-on-asset factors. The alternative three-factor model is given by:

$$R_{it} = \alpha_i + \beta_{0i} RM_t + \beta_{1i} r_{INV,t} + \beta_{2i} r_{ROA,t} + \varepsilon_{it} \quad (3)$$

where RM_t is stock return in U.S. dollar in excess of the one-month U.S. Treasury bill rate in month *t*. r_{INV} is the low-minus-high investment factor, and r_{ROA} is the high-minus-low ROA factor. The factor construction method in Chen, Novy-Marx, and Zhang (2010) is used. Investment factor, r_{INV}, is constructed from a two-by-three sort on size and Investment-to-Asset (IA) in a similar way as in Fama and French (1992, 1993). IA is measured as the annual change in gross property, plant, and equipment plus the annual change in inventory divided by lagged total assets in June of each year *t*. All stocks from the same market are broken into three IA groups based on breakpoints for the low 30%, medium 40%, and high 30% of ranked values. The median market equity in each country is used to split all stocks into two groups. Six portfolios on the intersections of two size and three IA groups are formed. Monthly value-weighted returns on these six portfolios are calculated from July of year *t* to June of *t+1*, and the portfolios are rebalanced in June of year *t+1*. Investment factor is the difference (low-minus-high IA) between the simple average of returns of the two low-IA portfolios and the simple average of returns of the two high-IA portfolios in each month.

$$r_{INV} = (Small\ Low + Big\ Low - Small\ High - Big\ High)/2 \quad (4)$$

ROA factor, r_{ROA} is constructed in the same way as r_{INV}. ROA factor is the monthly difference (high-minus-low ROA) between the simple average of returns on the two high-ROA portfolios and the simple average of returns on the two low-ROA portfolios.

$$r_{ROA} = (Small\ High + Big\ High - Small\ Low - Big\ Low)/2 \quad (5)$$

RESULTS

Table 1 reports average momentum abnormal monthly returns of the zero-cost strategy and corresponding *p* values for individual country. As shown in Table 1, momentum anomaly is a global phenomenon. 12 out of the 13 G12 countries (except for Japan) exhibit significant abnormal returns, which range from 1.02% in Belgium to 0.47% in Canada. These results are consistent to momentum return patterns reported in international markets (Griffin et al. 2003). In this table, the percentages of market size to total stock value of the world for each country is also reported. These G12 countries consist of 84.37% of total world market value. It suggests that the sample size is large and representative for the global market.

The average risk factors for both Fama-French model and the alternative model are summarized in Table 2. Monthly averages and standard deviations for market excess return RM, size risk factor SMB, value risk factor HML, and momentum factor MOM are reported. For comparison, Table 2 also reports averages and standard deviations for investment factor IA and ROA factor. As shown in this table, these risk factors vary dramatically within a country as evidenced by high standard deviations, and across countries. For example, SMB ranges from -0.48% in Germany to 0.35% in Australia. IA and ROA factors have more in-country variations than SMB and HML factors.

IA factors in Table 2 indicate that average monthly returns are positive in most countries for investors holding stocks with low investment-to-asset ratios and shorting stocks with high investment-to-asset ratios. In order to examine if IA factor captures stock return variations different from CAPM and Fama-French model, regression analyses are applied. Regression results are reported in Table 3. The same analysis is conducted for ROA factors, and results are present in Table 4. Both Table 3 and Table 4 present consistent evidence. IA and ROA factors capture stock return variations that are not captured by traditional valuation models. Alphas from both CAPM and Fama-French model remain significant for many of the G12 countries. For example, IA factors are not explained by CAPM model for Canada, Japan, Netherlands, Spain, Sweden, U.K. and U.S. at 10% significance level. It is not explained by Fama-French model for Australia, Canada, U.K, and U.S. ROA factors are not explained by CAPM model for Belgium, Canada, France, Germany, Sweden, and U.S, while not explained by the Fama-French model for Australia, Belgium, Canada, France, Germany, Netherlands, Sweden, and U.S. These results provide evidence that IA and ROA factors capture stock return variations differently from both CAPM and Fama-French model.

Table 5 reports comparisons of risk adjusted momentum returns between Fama-French model and the alternative model, which are the main results of this study. All stocks in each country are divided into quintiles according to the ranking of momentum. Five portfolios are formed monthly using the "6/1/6" convention.

Table 5 presents alphas for losers, winners, and winners-minus-losers (W-L) portfolios and the corresponding *p* values. There are several interesting observations in Table 5. First, 12 out of 13 G12 countries (except for Japan) have significant alphas. Stocks in U.S. market exhibit the largest momentum abnormal returns (1.701% from Fama-French model and 1.504% from the alternative model), while Canada has the lowest abnormal returns (0.641% from Fama-French model and 0.287% from the alternative model). Second, comparing to Table 1, Table 5 shows that abnormal monthly returns from the zero-cost trading strategy are not explained by either Fama-French or the alternative model, since all abnormal returns remain after adjusting for different risk factors. However, although the W-L alphas from the alternative model are still

significant, they are smaller in magnitude than those from the Fama-French model for most of the countries. The last column in Table 5 reports the reduction in alpha values in percentage. Except for Japan (no significant alphas observed) and Italy (small increase in alpha 5.95%), the biggest drop is from Canada (-55.23%), while the smallest drop is from Australia (-7.36%).

Momentum has been reported to be persistent across world, except for Asian countries, such as Japan and China (Griffin et al. 2003). These results are consistent with previous findings. Results in Table 5 demonstrate that the higher explanatory power for the alternative three-factor model is evident for most of the G12 countries. G12 countries represent 84.37% of global market capitalization. This finding provides strong support for the alternative model in global equity market. Although it is not powerful to drive away abnormal returns, the alternative model outperforms the traditional Fama-French model in reducing the magnitude of alphas.

Despite strong evidence in Table 5, it is possible that these results are driven by some factors other than momentum itself. Size effect is the most likely potential factor. To control for potential size effect, 25 size and momentum portfolios are formed (Jegadeesh and Titman, 1993). Regression analyses are conducted using both Fama-French and the alternative model. As shown in Table 6, after controlling for potential size effect, abnormal returns still exist for most of the size groups in both models for each country. F-statistics F_{GRS} (Gibbons, Ross, and Shanken, 1989) and their p-values show that the joint tests of alphas of all portfolios being zero are rejected for both models.

Table 6 also compares alphas between Fama-French model and the alternative model. Similar to the results in Table 5, almost all alphas from each size group decrease in magnitude after using the alternative model. The percentages of reduction range from -4.39% (medium size group in Germany) to -70.72% (big size group in France), without considering Japan. There are few positive percentages in the last column, which indicate an increase in alpha value for the alternative model. However, the reduction of alpha values is an overwhelming common observation in Table 6, which suggests that additional explanatory power of the alternative model is not a result caused by size effect.

CONCLUSION

This paper investigates whether the newly developed alternative three-factor model has additional explanatory power in explaining momentum anomaly. By forming a zero-cost trading strategy, this study demonstrates the existence of momentum abnormal returns in 12 out of 13 G12 countries. These abnormal returns cannot be explained by the Fama-French model. The results are consistent with current literature. A significant reduction in alpha values is documented for almost all countries when the alternative three-factor model is applied. This paper provides further evidence that the higher explanatory power is not driven by size effect across countries. Although this study provides strong evidence to support the alternative three-factor model, it is not comprehensive. For instance, it does not consider transaction costs in portfolio returns. The analyses do not address potential effects from other well-known anomalies, such as asset growth, value, etc. either. These issues may be considered in futures studies. Overall, this study suggests that the new alternative model need to be considered when study momentum in global market.

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APPENDIX

Table 1. Monthly Abnormal Returns of Momentum Investing for Individual Country

This table reports average monthly abnormal returns of momentum investing using zero-cost trading strategy and the corresponding p values for the G12 countries. The percentages of stock market size of each country to the global market are also reported. The sample period is from 1989 to 2009.

COUNTRY	W-L	p	Market Size (%)
AUSTRALIA	0.884	0.000	1.259%
BELGIUM	1.040	0.000	0.242%
CANADA	0.469	0.020	2.365%
FRANCE	0.815	0.000	2.818%
GERMANY	0.932	0.000	2.958%
ITALY	0.844	0.000	1.368%
JAPAN	0.033	0.885	29.854%
NETHERLANDS	0.953	0.000	1.221%
SPAIN	0.865	0.016	1.594%
SWEDEN	0.709	0.010	0.460%
SWITZERLAND	0.742	0.000	0.487%
UNITED KINGDOM	0.835	0.000	8.666%
UNITED STATES	1.036	0.000	31.078%

Table 2. Average Monthly Factor Returns

This table reports average monthly returns of risk factors in the Fama-French model and the alternative three-factor model. RM is the market return calculated as a value-weighted return of all stocks in a country.

Nation	RM		SMB		HML		MOM		IA		ROA	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
AUSTRALIA	1.10	4.87	0.35	3.62	0.58	2.85	0.46	4.39	0.06	4.77	-0.05	5.01
BELGIUM	0.60	3.91	-0.23	3.31	0.65	3.20	0.90	4.05	-0.05	5.12	0.50	3.55
CANADA	1.61	6.41	0.53	3.96	0.22	4.50	-0.01	5.73	-0.14	5.04	0.28	5.95
FRANCE	0.94	4.29	-0.13	3.31	0.66	3.13	0.81	3.95	-0.02	3.25	0.26	3.17
GERMANY	1.03	5.15	-0.48	3.58	0.71	2.99	1.02	6.73	0.06	3.53	0.16	3.09
ITALY	0.68	5.51	-0.28	3.44	0.75	3.19	0.87	4.58	-0.10	3.48	0.17	3.08
JAPAN	0.07	8.12	-0.04	3.70	0.49	2.42	0.15	6.43	0.56	4.40	-0.06	2.79
NETHERLANDS	1.16	5.08	-0.33	3.32	0.69	3.89	0.78	5.27	0.38	3.82	0.13	3.38
SPAIN	1.12	5.28	-0.31	3.67	0.65	3.57	0.89	5.74	0.31	4.23	-0.06	3.60
SWEDEN	1.06	5.63	-0.12	4.42	0.48	5.35	0.70	5.67	0.70	6.34	0.41	5.20
SWITZERLAND	1.79	14.30	-0.34	3.78	0.52	3.30	0.22	9.94	0.02	3.75	0.39	3.73
UNITED KINGDOM	0.30	3.01	0.02	5.65	0.99	8.28	0.74	7.20	0.30	2.10	0.14	2.65
UNITED STATES	0.51	4.61	0.13	3.18	0.38	3.19	0.65	5.73	0.74	17.85	1.00	17.68

Table 3. Properties of Investment Factor Using CAPM and Fama-French Model

This table presents regression results of the monthly return of investment factor using CAPM and the Fama-French model. Alpha, coefficients of market, size, and value factors, corresponding p values, and R-Square are reported for each country.

Nation	Market Model			Four Factor Model				
	Alpha	RM	R-Square	Alpha	RM	SMB	HML	R-Square
AUSTRALIA	0.186	-0.112	0.013	0.044	-0.07	-0.11	0.213	0.041
	(0.573)	(0.093)		(0.089)	(0.308)	(0.233)	(0.078)	
BELGIUM	0.027	-0.112	0.007	0.035	-0.12	-0.023	-0.012	0.007
	(0.94)	(0.228)		(0.925)	(0.24)	(0.841)	(0.919)	
CANADA	0.423	-0.408	0.131	0.236	-0.351	0.112	0.22	0.172
	(0.021)	(0.001)		(0.048)	(0.001)	(0.169)	(0.004)	
FRANCE	-0.059	0.036	0.002	-0.082	0.039	-0.008	0.028	0.003
	(0.796)	(0.51)		(0.734)	(0.522)	(0.918)	(0.699)	
GERMANY	0.309	-0.217	0.091	0.281	-0.162	0.17	0.075	0.115
	(0.19)	(0.001)		(0.241)	(0.003)	(0.021)	(0.326)	
ITALY	-0.139	0.046	0.005	-0.257	0.038	0.241	0.235	0.110
	(0.562)	(0.296)		(0.271)	(0.418)	(0.001)	(0.002)	
JAPAN	0.561	0.033	0.004	0.204	0.075	0.026	0.685	0.135
	(0.062)	(0.384)		(0.479)	(0.039)	(0.749)	(0.001)	
NETHERLANDS	0.444	-0.054	0.005	0.313	-0.069	-0.146	0.14	0.052
	(0.097)	(0.29)		(0.241)	(0.178)	(0.069)	(0.04)	
SPAIN	0.539	-0.188	0.051	0.455	-0.197	-0.059	0.135	0.067
	(0.063)	(0.001)		(0.12)	(0.001)	(0.454)	(0.09)	
SWEDEN	0.830	-0.109	0.009	0.646	-0.05	-0.027	0.228	0.044
	(0.06)	(0.166)		(0.143)	(0.554)	(0.796)	(0.009)	
SWITZERLAND	0.035	-0.010	0.001	-0.03	-0.009	0.082	0.152	0.020
	(0.891)	(0.578)		(0.911)	(0.62)	(0.252)	(0.059)	
UNITED KINGDOM	0.322	-0.056	0.006	0.26	-0.065	-0.059	0.07	0.058
	(0.026)	(0.254)		(0.068)	(0.181)	(0.051)	(0.001)	
UNITED STATES	0.209	-0.676	0.095	0.179	-0.085	0.0664	0.537	0.281
	(0.000)	(0.000)		(0.000)	(0.055)	(0.020)	(0.011)	

Table 4. Properties of ROA Factor Using CAPM and Fama-French Model

This table presents regression results of monthly returns of ROA factor using CAPM and the Fama-French model. Alpha, coefficients of market, size, and value factors, corresponding p values, and R-Square are reported for each country.

Country	Market Model			Four Factor Model				
	Alpha	RM	R-Square	Alpha	RM	SMB	HML	R-Square
AUSTRALIA	0.264	-0.277	0.073	0.182	-0.219	-0.276	0.175	0.132
	(0.434)	(0.001)		(0.596)	(0.002)	(0.004)	(0.146)	
BELGIUM	0.745	-0.358	0.143	0.875	-0.276	0.186	-0.221	0.221
	(0.002)	(0.001)		(0.001)	(0.001)	(0.009)	(0.002)	
CANADA	1.127	-0.619	0.217	1.007	-0.437	-0.327	0.332	0.325
	(0.003)	(0.001)		(0.005)	(0.001)	(0.001)	(0.001)	
FRANCE	0.476	-0.206	0.069	0.754	-0.239	0.08	-0.354	0.206
	(0.029)	(0.001)		(0.001)	(0.001)	(0.206)	(0.001)	
GERMANY	0.382	-0.195	0.094	0.439	-0.227	-0.108	-0.103	0.113
	(0.065)	(0.001)		(0.038)	(0.001)	(0.093)	(0.125)	
ITALY	0.189	-0.023	0.002	0.256	-0.011	-0.078	-0.121	0.025
	(0.375)	(0.575)		(0.237)	(0.815)	(0.212)	(0.082)	
JAPAN	-0.047	-0.159	0.204	-0.004	-0.165	-0.205	-0.104	0.276
	(0.784)	(0.001)		(0.985)	(0.001)	(0.001)	(0.141)	
NETHERLANDS	0.353	-0.181	0.075	0.41	-0.172	0.094	-0.054	0.090
	(0.122)	(0.001)		(0.078)	(0.001)	(0.178)	(0.362)	
SPAIN	0.228	-0.234	0.109	0.285	-0.243	-0.055	-0.1	0.121
	(0.339)	(0.001)		(0.238)	(0.001)	(0.396)	(0.127)	
SWEDEN	0.675	-0.223	0.055	0.772	-0.296	-0.527	-0.024	0.242
	(0.056)	(0.001)		(0.017)	(0.001)	(0.001)	(0.71)	
SWITZERLAND	0.401	-0.007	0.001	0.394	-0.002	0.258	0.142	0.065
	(0.118)	(0.713)		(0.12)	(0.908)	(0.001)	(0.069)	
UNITED KINGDOM	0.143	-0.023	0.001	0.193	-0.024	-0.057	-0.042	0.053
	(0.432)	(0.718)		(0.283)	(0.695)	(0.136)	(0.105)	
UNITED STATES	1.534	-0.777	0.033	1.079	-0.804	-0.505	-0.206	0.286
	(0.000)	(0.03)		(0,000)	(0.065)	0	(0.704)	

Table 5. Comparison of Alphas of Both the Fama-French and the Alternative Model

This table presents alpha values for Losers, Winners, and Winners-minus-Losers (W-L) portfolios using both the Fama-French and the alternative model. Average monthly alphas over the testing period (1989-2009), its corresponding t-values, and reductions (%) in alpha values of W-L portfolio after using the alternative model compared to those obtained from the Fama-French model are reported.

Country	Loser	Winner	W-L	Loser	Winner	W-L	Reduction in Alpha (%)
	Fama-French Alphas			Alternative Alphas			
AUSTRALIA	-0.902	0.105	1.006	-1.109	-0.178	0.932	-7.36%
	(-2.77)	(0.402)	(3.785)	(-4.279)	(-0.795)	(3.453)	
BELGIUM	-0.645	0.498	1.143	-0.427	0.48	0.906	-20.73%
	(-3.013)	(3.507)	(4.768)	(-2.067)	(3.206)	(3.988)	
CANADA	-1.11	-0.469	0.641	-0.385	-0.099	0.287	-55.23%
	(-3.881)	(-2.03)	(2.515)	(-1.114)	(-0.348)	(1.136)	
FRANCE	-1.205	-0.061	1.144	-0.594	0.075	0.669	-41.52%
	(-4.869)	(-0.495)	(4.364)	(-2.461)	(0.442)	(3.195)	
GERMANY	-1.271	-0.028	1.243	-0.911	0.107	1.017	-18.18%
	(-3.315)	(-0.143)	(3.8)	(-2.655)	(0.524)	(3.603)	
ITALY	-0.782	-0.043	0.739	-0.764	0.019	0.783	5.95%
	(-2.978)	(-0.323)	(2.381)	(-2.921)	(0.112)	(2.644)	
JAPAN	0.3	-0.135	-0.435	-0.047	-0.214	-0.168	-61.38%
	(0.96)	(-0.488)	(-1.578)	(-0.116)	(-0.668)	(-0.586)	
NETHERLANDS	-0.943	0.115	1.057	-0.78	0.087	0.866	-18.07%
	(-2.888)	(0.537)	(3.318)	(-2.282)	(0.37)	(2.801)	
SPAIN	-1.159	-0.224	0.935	-0.875	-0.134	0.742	-20.64%
	(-4.552)	(-1.546)	(2.948)	(-3.084)	(-0.712)	(2.346)	
SWEDEN	-1.393	-0.5	0.893	-0.97	-0.195	0.775	-13.21%
	(-4.204)	(-2.851)	(2.344)	(-3.144)	(-0.855)	(2.142)	
SWITZERLAND	0.01	0.783	0.773	0.174	0.841	0.668	-13.58%
	(0.025)	(2.818)	(2.947)	(0.523)	(3.077)	(2.867)	
UNITED KINGDOM	-0.592	0.459	1.051	-0.41	0.465	0.875	-16.75%
	(-2.058)	(2.628)	(4.63)	(-1.463)	(2.46)	(3.927)	
UNITED STATES	-1.168	0.533	1.701	-1.191	0.314	1.504	-11.58%
	(-2.376)	(1.768)	(4.513)	(-2.594)	(1.44)	(3.816)	

Table 6. Comparison of Alphas of 25 Size-Momentum Portfolios

25 size-momentum portfolios are constructed based on the interactions of the quintiles ranked on size and momentum, independently. This table presents monthly alphas for Losers, Winners, and Winners-minus-Losers portfolio for each size group and the corresponding t-values. The reductions (%) in alpha values of W-L portfolio after using the alternative model compared to those obtained from the Fama-French model are reported in the last column. Joint test of all alphas (F_{GRS}) in the 25 portfolios to be zero is also reported.

Country		Loser	Winner	W-L	FGRS (p)	Loser	Winner	W-L	FGRS (p)	Reduction of alpha (%)
		Panel A: Fama-French alphas				Panel B: The new three-factor alphas				
	Small	1.346	1.501	0.155		0.809	0.897	0.088		-43.23%
		(2.606)	(3.093)	(0.49)		(1.965)	(2.158)	(0.271)		
AUSTRALIA	3	-1.834	-0.248	1.587	10.893	-2.036	-0.587	1.449	10.182	-8.70%
		(-4.972)	(-0.848)	(5.101)	(0)	(-6.754)	(-2.346)	(4.558)	(0.001)	
	Big	-1.207	-0.614	0.593		-0.989	-0.563	0.427		-27.99%
		(-4.197)	(-3.568)	(1.606)		(-3.391)	(-3.125)	(1.126)		
	Small	-0.255	1.496	1.75		-0.077	1.509	1.586		-9.37%
		(-0.767)	(4.084)	(3.962)		(-0.224)	(3.985)	(3.603)		
BELGIUM	3	-0.745	0.327	1.072	3.117	-0.672	0.287	0.958	2.998	-10.63%
		(-3.244)	(1.94)	(4.115)	(0.001)	(-2.761)	(1.57)	(3.726)	(0.001)	
	Big	-0.774	-0.151	0.624		-0.378	-0.137	0.241		-61.38%
		(-2.477)	(-0.878)	(1.626)		(-1.254)	(-0.79)	(0.645)		
	Small	1.938	1.31	-0.628		2.685	1.759	-0.927		47.61%
		(5.036)	(3.423)	(-2.578)		(5.452)	(3.936)	(-3.606)		
CANADA	3	-2.053	-1.342	0.712	19.126	-1.213	-0.806	0.408	17.345	-42.70%
		(-6.612)	(-4.841)	(2.703)	(0.001)	(-3.034)	(-2.335)	(1.526)	(0)	
	Big	-2.21	-0.74	1.471		-1.814	-0.792	1.022		-30.52%
		(-5.541)	(-4.122)	(2.977)		(-4.769)	(-4.308)	(2.123)		
	Small	-0.787	0.196	0.983		-0.094	0.455	0.548		-44.25%
		(-2.979)	(1.024)	(3.484)		(-0.276)	(1.886)	(2.032)		
FRANCE	3	-1.311	0.147	1.458	4	-0.685	0.245	0.929	3.777	-36.28%
		(-4.144)	(0.931)	(4.398)	(0.001)	(-2.167)	(1.142)	(3.35)	(0.001)	
	Big	-1.131	-0.342	0.789		-0.709	-0.478	0.231		-70.72%
		(-4.012)	(-2.158)	(2.344)		(-3.23)	(-3.031)	(0.811)		
	Small	-0.773	0.407	1.179		-0.341	0.583	0.923		-21.71%
		(-2.148)	(1.572)	(3.336)		(-0.92)	(2.072)	(2.817)		
GERMANY	3	-1.886	-0.223	1.663	2.568	-1.669	-0.079	1.59	3.113	-4.39%
		(-4.411)	(-0.982)	(4.67)	(0.001)	(-4.074)	(-0.325)	(4.841)	(0.001)	
	Big	-0.835	-0.268	0.568		-0.347	-0.13	0.218		-61.62%
		(-1.907)	(-1.253)	(1.237)		(-0.871)	(-0.597)	(0.515)		
	Small	-0.602	0.513	1.115		-0.529	0.612	1.141		2.33%
		(-1.8)	(2.042)	(2.772)		(-1.43)	(2.119)	(2.896)		
ITALY	3	-0.863	-0.286	0.578	3.549	-0.877	-0.191	0.686	3.718	18.69%
		(-2.93)	(-1.812)	(1.711)	(0.001)	(-2.845)	(-0.927)	(2.097)	(0.001)	
	Big	-0.651	-0.288	0.363		-0.575	-0.267	0.309		-14.88%
		(-1.957)	(-1.902)	(0.871)		(-1.867)	(-1.798)	(0.792)		
	Small	0.555	0.029	-0.527		0.299	0.039	-0.26		-50.66%
		(1.761)	(0.1)	(-2.066)		(0.638)	(0.1)	(-0.947)		
JAPAN	3	0.137	-0.316	-0.453	1.366	-0.277	-0.424	-0.148	1.605	-67.33%
		(0.373)	(-1.021)	(-1.535)	(0.672)	(-0.582)	(-1.148)	(-0.474)	(0.042)	

	Big	0.218	-0.182	-0.399		-0.039	-0.3	-0.262		-34.34%
		(0.693)	(-0.511)	(-0.845)		(-0.121)	(-0.857)	(-0.575)		
	Small	-1.396	0.061	1.456		-1.222	0.087	1.308		-10.16%
		(-2.907)	(0.158)	(2.61)		(-2.378)	(0.212)	(2.363)		
	3	-1.219	0.512	1.73	3.147	-0.974	0.477	1.451	2.721	-16.13%
NETHER-LANDS		(-2.999)	(2.004)	(4.094)	(0.002)	(-2.276)	(1.673)	(3.511)	(0.001)	
	Big	-0.719	-0.298	0.422		-0.609	-0.358	0.251		-40.52%
		(-2.067)	(-1.149)	(1.046)		(-1.818)	(-1.375)	(0.635)		
	Small	-1.12	0.301	1.421		-0.686	0.551	1.237		-12.95%
		(-3.064)	(1.035)	(3.26)		(-1.619)	(1.556)	(2.886)		
SPAIN	3	-1.221	-0.136	1.085	4.852	-0.918	-0.01	0.908	4.637	-16.31%
		(-3.902)	(-0.65)	(2.977)	(0.001)	(-2.71)	(-0.037)	(2.454)	(0.001)	
	Big	-1.103	-0.435	0.669		-0.872	-0.516	0.357		-46.64%
		(-2.805)	(-2.149)	(1.341)		(-2.232)	(-2.527)	(0.709)		
	Small	-1.203	-0.71	0.494		-0.602	-0.156	0.447		-9.51%
		(-2.916)	(-2.167)	(1.124)		(-1.332)	(-0.386)	(1.012)		
SWEDEN	3	-1.947	-0.581	1.367	4.148	-1.344	-0.281	1.064	3.513	-22.17%
		(-4.759)	(-2.659)	(2.953)	(0.001)	(-3.502)	(-1.035)	(2.481)	(0.001)	
	Big	-0.794	-0.448	0.346		-0.806	-0.391	0.416		20.23%
		(-1.855)	(-2.343)	(0.629)		(-2.022)	(-2.013)	(0.787)		
	Small	-0.3	1.004	1.304		-0.247	1.069	1.316		0.92%
		(-0.81)	(3.112)	(3.682)		(-0.673)	(3.279)	(3.79)		
	3	0.012	0.947	0.936	2.587	0.213	1.002	0.789	2.666	-15.71%
SWITZER-LAND		(0.028)	(2.959)	(3.04)	(0.001)	(0.564)	(3.133)	(2.792)	(0.001)	
	Big	0.23	0.39	0.16		0.411	0.445	0.035		-78.13%
		(0.587)	(1.272)	(0.479)		(1.173)	(1.408)	(0.116)		
	Small	-0.395	0.673	1.068		-0.32	0.605	0.924		-13.48%
		(-1.467)	(3.287)	(4.543)		(-1.115)	(2.501)	(3.975)		
	3	-0.743	0.453	1.195	5.072	-0.587	0.438	1.024	5.238	-14.31%
UNITED KINGDOM		(-2.272)	(2.373)	(4.957)	(0.001)	(-1.78)	(2.011)	(4.354)	(0.001)	
	Big	-0.45	0.205	0.655		-0.082	0.303	0.384		-41.37%
		(-1.51)	(1.197)	(2.1)		(-0.277)	(1.789)	(1.234)		
	Small	-0.223	0.749	0.971		-0.382	0.544	0.926		-4.63%
		(-0.317)	(1.55)	(2.99)		(-0.551)	(1.209)	(2.705)		
	3	-1.632	0.63	2.262	5.853	-1.699	0.299	1.997	4.871	-11.72%
UNITED STATES		(-2.846)	(1.707)	(4.977)	(0.001)	(-3.358)	(1.197)	(2.228)	(0.001)	
	Big	-1.092	0.184	1.276		-0.769	0.224	0.993		-22.18%
		(-1.801)	(0.953)	(1.993)		(-1.212)	(1.117)	(1.473)		