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Evidence to Support Multifactor Asset Pricing Models: The Case of The Istanbul Stock Exchange

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Abstract

The objective of this study is to test, instead of the single factor CAPM, the power of three factor, four factor and five factor models to explain stock returns for the Istanbul Stock Exchange (ISE). The test results of all models in the ISE indicate that the models are applicable. During the period covering July 1992-June 2011 it is consequently established that, in addition to the market risk, size, book to market ratio, momentum and liquidity factors also constitute significant risk factors that affect the expected stock returns in the ISE and that the risk premiums belonging to these five factors are priced by the market.

Keywords: Fama and French Three Factor Model, Four-Factor Pricing Model, Five Factor Pricing Model, Asset Pricing, Emerging Markets

JEL Cod: G11, G12

1. Introduction

The validity of asset pricing models bears vital importance for individual and institutional investors planning to invest in securities. As it is known, the most widely known and used asset pricing model in capital markets is CAPM (Capital Asset Pricing Model) as developed by Sharpe (1964), Lintner (1965) and Mossin (1966), which represents a balance model that prices a certain asset relying on certain assumptions with consideration of the relation between the risk and the expected return.

During the 1970's, CAPM was widely advocated owing to the facilities it provided such as its provision for measuring risks with a single variable. In parallel with the developing capital markets during the 1980's and 1990's however, controversies appeared as to the adequacy of CAPM to explain the stock returns. Nevertheless, many researchers show that the anomalies they detected could not be foreseen by the model. Examples to these are size anomaly by Banz (1981), Reinganum (1981), Keim (1983); Book to Market effect by Stattman (1980), Rosenberg, Reid and Lanstein (1985), Chan, Hamao, and Lakonishok (1991); Price-Earning effect by Basu (1983); and Momentum effect by Jegadeesh and Titman (1993).

The fact that no non-market factor (size, book to market ratio, momentum, liquidity, etc…) other than market risk is included in CAPM, indicates that excessive returns created by such variables, which are thought to lead anomalies, cannot be foreseen by the model either. Focus switched towards multifactor models for capital markets as CAPM fell insufficient to explain stock returns. These models present evidence that company specific characteristics are usually very successful in explaining horizontal-section stock returns. The purpose of this study is to test the power of the three factor, four factor and five factor models, which attract intensive attention in international markets, to explain asset prices in the Istanbul Stock Exchange (ISE). It is believed that testing alternative asset pricing models will fill an important gap for the Turkish capital market. This study further represents an initial work for the ISE that tests the five factor asset pricing model, which is created by adding liquidity as a risk factor to the four factor model. In addition, it is considered that the study bears importance in that it shows whether small company premium, value premium, momentum and liquidity premium are priced in the ISE as far as the investors are concerned.

2. Literature Review

As CAPM fell insufficient to explain security prices, various studies were conducted on multifactor models in capital markets and alternative asset pricing models were suggested to remedy the deficiencies of CAPM.

Fama and French suggest a multifactor model to explain expected stock returns in the studies they conducted in 1993 and 1996. In the three factor model by Fama and French, the R_m-R_f, SMB and HML risk factors affect the expected return of stocks.

Fama-French (1993, 1996) predicted this model for the below equation:

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f)] + s_i E(SMB) + h_i E(HML) + \varepsilon_i$$

The beta coefficients mentioned in the equation represent sensitivity coefficients that express the slope of the multiple regressions that is made between $E(R_i) - R_f$ and R_m-R_f, SMB and HML. Here, SMB covers the size risk factor on the returns and HML covers the B/M ratio risk factor in the returns.

The validity of the three factor model proposed by Fama and French (1993, 1996) was supported by the studies conducted in many markets. Griffin (2003) tested the three factor model for Japan, England and Canada for the period of 1981-1995 and found the power of the model significant for explaining the change in of cross-section stock returns. Lam (2002) reached findings that support the three factor model in the study he conducted during the period of 1980-1997 for 100 companies that were traded in the Hong-Kong stock exchange. Ajili (2003) tested the three factor model for the French market during the July 1976 – June 2001 period and the characteristic model of Daniel-Titman (1997). It was established that power of 6 portfolios, which were determined as dependent variables, to explain the expected returns was 90,5% on average. Cao, Leggio and Schniederjans (2005), included within the model 367 stocks that were quoted in the Shanghai Stock Exchange (SHSE) during the period of 01 December 1999 - 31 December 2002. The focus of the study is to compare the explanatoriness of CAPM and the Fama – French three factor model with the artificial neural network model and linear models. The result showed that the composed linear models produced much mode significant results compared to the artificial neural networks. Iqbal and Brooks (2007) compared two asset pricing models (CAPM and Fama and French three factor) in Pakistan's Karachi Stock Exchange (KSE). They applied GARCH and EGARCH as the method and used the daily, weekly and monthly data. The study used 89 stocks that were traded in the Karachi Stock Exchange (KSE) during the period of 09 March 1999 – 08 March 2005. The KSE-100 index was used as the market index. It was concluded that the risk factors in the Fama and French three factor model were more significant than the CAPM. In the meanwhile, the authors recommend using daily data instead of monthly data. In their study conducted for the Australian market, O'Brien, Brailsford and Gaunt (2008) took 1982-2006 as the sampling period and compared CAPM with the three factor model. It was concluded that the three-factor model represented a very successful model for explaining the change in returns and that it explained nearly 70% of the changes in returns.

3. The Four-Factor Model

The four factor model represents an asset pricing model developed by Carhart (1997) owing to the fact that the three factor model of Fama-French (1993, 1996) could not explain the momentum effect presented by Jegadeesh-Titman (1993).

During a study by Jegadeesh and Titman (1993), the portfolios created using a strategy, which is based on the assumption that within a period of 3-12 months (short-term), the stocks that made gains (led to losses) in the past will make gains (lead to losses) in the future, obtained abnormal returns of 1% in each consecutive year. When the literature is examined, it is seen that very small number of studies paid regard to the power of adding the momentum factor to SMB and HML factors of Fama and French (WML-winners minus losers) in explaining stock returns. (Carhart 1997, Jegadeesh 2000, Liew and Vassalou 2000, Kim and Kim 2003, L'Her;

Masmoudi; Suret 2004, Bello 2007, Carmichael and Coën 2008, Lam; Li; So 2009; Unlu, 2012).

The four factor model was first tested by Carhart (1997). Carhart (1997) created the four factor model by augmenting the momentum factor of Jegadeesh and Titman (1993) to the three factor model of Fama-French. The four factor model is tested as follows (Carhart, 1997: 61):

$$r_{iT} = \alpha_{iT} + b_{iT}RMRF + s_{iT}SMB + h_{iT}HML + p_{iT}PR1YR + \varepsilon_i$$

The thing involved here is the return of the RMRF; NYSE, AMEX and NASDAQ indexes on the one month Treasury bill. These are SMB and HML Fama-French factors. On the other hand, PR1YR represents the difference between the highest 30% returns 11 months ago and the lowest 30% returns 11 months ago. As a conclusion, Carhart (1997) suggests that the four factor model can be used in explaining stock returns.

Liew and Vassalou (2000) examined the relation between the macroeconomic risk factors and the profitability of SMB, HML, WML transaction strategies for 10 developed markets comprised of Australia Canada, France, Germany Italy, Japan, the Netherlands, Switzerland, England and the USA. Whereas this study represents an evidence for the WML factor, the findings obtained are not as strong as the SMB and HML factors. By using monthly data, L'Her, Masmoudi and Suret (2004) looked into the power of four factors, which are R_m-R_f, SMB, HML and WML, to explain stock returns during the period of 1960 – 2001 for the Canadian equity market. It was concluded that the four-factor model was valid for the Canadian Market. Naceur and Chaibi (2007) researched into the best asset pricing model in the Tunisian Stock Exchange (TSE) for calculating the capital cost. The result of the study, the four factor model of Carhart (1997) was the best model to estimate the capital cost for the TSE. Lam, Li and So (2009) examined the power of the four factor model, which was created by adding the momentum factor to the three factor model of Fama-French, in explaining the change in stock returns concerning the Hong Kong market. The study concluded that the coefficients of the four factor model are significant; alpha coefficients are not significantly different from zero and thus showed that the model is applicable. Unlu (2012) tested the four factor model in the ISE for the period of July 1992 – June 2008 and the results showed that the four factor model was significant for the ISE.

4. The Five Factor Model

The liquidity of a stock means that it can easily be purchased and sold rapidly on lower costs in the secondary market.

Pastor and Stambaugh (2003) added the liquidity factor to the four factor model in their studies for the NYSE, AMEX, and NASDAQ stocks and tested the five factor model. Amihud (2002) was used as the liquidity measurement method. The study concluded that liquidity represented an important risk factor. On the other hand, Chan and Faff (2005) added the liquidity factor as the four factor to the three factor model for the Australian market. The study, which used turnover rate as the liquidity measurement, determined that the liquidity

factor was priced by the market. In their studies, Nguyen and Tribhuvan (2009) added the liquidity factor to the three factor model and examined the role of liquidity in stock pricing. In the study where the NYSE and AMEX stocks were used, it was established that liquidity could be used as an important systematic risk factor.

5. Data Structure and Method

The study took July 1992 – June 2011 as the sample period and used monthly data. Data on stock returns, index closing and balance sheets was obtained from the ISE and Treasury bill rates was obtained from the official website of the Turkey Undersecretariat of Treasury. Stock transaction amounts and the number of stocks were taken from Datastream. The financial ratios in the study were calculated from the 31 December 1991 and 31 December 2010 end-year balance sheet data of the companies. Presuming that the company profits arrived to the investor before the balance sheets were declared, results in look ahead bias. The returns were calculated for the 01 July 1992 – 30 June 2011 period in order to prevent this (Fama and French 1993, 1996). The ISE-100 index was used as the index return. The annual compound reference Treasury bill rates was converted into monthly values and used as risk-free interest rate in the study. The portfolios were created using the Fama and French (1993, 1996) methodology and factors of size and B/M ratio were used as criteria. Firm size was measured by market capitalization or market value of equity. The B/M ratio is calculated by dividing the per-stock book value into the stock's market price.

The portfolios were created in the June of each t year and the balance sheet data in the t-1 year's December were paired with the stock returns in the t year's June. As the firm size was calculated as of the month of June, the B/M ratio was calculated by dividing the book value in the t-1 year's December into the market value in the t-1 year's December.

The returns for the three factor model, four factor model and the five factor model are monthly, and on the other hand, 6 pcs portfolios were created according to the B/M ratio and these were used as dependent variable in the models. 2 pcs (small and large) portfolios were determined for the size effect and 3 pcs (low, medium and high) portfolios were determined for the B/M effect. A total of 6 intersection portfolios were created for the size effect and the B/M ratio effect (Low = 30%, Medium = 40%, High = 30%) and (SMB and HML) were used for the calculation of (S/L, S/M, S/H, B/L, B/M, B/H) risk factors.

The portfolios created were calculated in a manner to cover the period between each t year's July until each t+1 year's June and they were revised in the June of each year.

In order to enable the calculation of the momentum factor, the stocks were sequenced as the t year's July and t-1 year's June and their performances between the months of t-2 and t-12 were taken into consideration (Fama and French, 2007, L'Her; Masmoudi; Suret, 2004, Lam; Li; So, 2009). The stocks were divided into two groups according to their size measurements, which are S (small) for 50% and B (big) again for 50%. Later, 6 pcs equally weighted portfolios were created, representing namely the 70% portion with the best return (momentum) labeled as W (winner), the average 40% labeled as N (Neutral) and the lowest 30% portion labeled as L (loser), and these were used for the calculation of the "WML" risk

factor.

"Turnover Ratio" was used the liquidity criterion as similar to Chan and Faff (2005) and Eckbo and Norli (2005). The turnover ratio is found by using the monthly transaction amount and the number of stock certificates present in the market. That is to say, the turnover ratio of a stock was calculated by dividing the monthly transaction amount into the number of stock present in the market. 6 pcs equally-weight portfolios were created in order to calculate the liquidity risk factor.

Five pcs risk factors were determined in order to explain the stock returns. These are the risk factors of R_m-R_f (the difference between the market return and the risk-free interest ratio), SMB (the difference between the return of the portfolio that is composed of the small stocks with low market values and the portfolio that is composed of large stocks with high market values), HML (the difference between the return of the portfolio that is composed of the stocks with high B/M ratio and the return of the portfolio that is composed of the stocks with low B/M ratio) and WML (the difference between the return of the winner stocks portfolio and the return of the loser stocks portfolio) and LMH (the difference between return on the two portfolios with low turnover and return on the two portfolios with high turnover)

($E(R_m) - R_f$) represents the market premium and it is the return of the market over the risk-free interest ratio. SMB represents the size premium, HML represents the value premium, WML represents the earning premium and LMH represents liquidity premium.

The returns of the 6 portfolios, which were created according to size and B/M ratio, on the risk-free interest ratio were used as dependent variables in time series regressions. The following regression models were created in order to estimate the stock returns:

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f)] + s_i E(SMB) + h_i E(HML) + \varepsilon_i \quad (1)$$

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f)] + s_i E(SMB) + h_i E(HML) + w_i E(WML) + \varepsilon_i \quad (2)$$

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f)] + s_i E(SMB) + h_i E(HML) + w_i E(WML) + l_i E(LMI) + \varepsilon_i \quad (3)$$

The beta coefficients mentioned in the equation represent sensitivity coefficients that express the slope of the multiple regressions that is made between $E(R_i) - R_f$ and R_m-R_f, SMB, HML, WML, LMH.

As it is known, if the alpha value reached in the asset pricing models is significantly different from zero, this means that there is a pricing error in the models and there is a factor or are factors that cannot be explained by the models (Black; Jensen; Scholes 1972, Fama and French, 1993).

The F (GRS) test of Gibbons, Ross and Shanken (1989) is usually recommended during studies in order to determine whether the alpha value is significantly different from zero (Fama and French 1996, Campel; Lo; Mckinlay 1997, Gregory; Tharyan; Huang 2009).

The GRS test statistic is;

$$J = \frac{(T-N-k)}{N}(1+\mu_k' \Omega^{-1}\mu_k)^{-1}\hat{\alpha}'\hat{\Sigma}^{-1}\hat{\alpha} \rightarrow F_{N,T-N-K}$$

✓ *H_0 = All α_i coefficients obtained from multiple factor models are equivalent to zero ($\alpha_i = 0$).*

✓ *H_1 Not all α_i coefficients obtained from multiple factor models are equivalent to zero ($\alpha_i \neq 0$).*

✓ *The acceptance of the zero hypothesis will also show that the multi-factor asset pricing models, which constitute the basic purpose of the study, can be used for the ISE to explain the stock prices* (Fama and French 1996).

6. Findings

The regression results pertaining to the three factor asset pricing model have been given in Table 1.

Table 1. Three factor regression of montly excess returns: from July 1992 to June 2011

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f] + s_i E(SMB) + h_i E(HML) + \varepsilon$$

R_i-R_f	α	B	s	h	Ad.R^2	DW	F
SL	-0,003	0,694	0,618	-0,191	0,726	2,05	76,18
	(-0,355)	(13,803)*	(5,434)*	(-2,415)**			[0,000]
SM	-0,016	0,612	-0,618	-0,869	0,811	2,11	124,53
	(-0,658)	(10,642)*	(-4,755)*	(-9,610)*			[0,000]
SH	-0,009	0,759	0,388	0,235	0,719	2,12	73,75
	(0,273)	(14,848)*	(3,369)*	(2,936)*			[0,000]
BL	-0,013	0,733	-0,648	-0,887	0,868	2,09	187,65
	(-0,455)	(14,077)*	(-5,505)*	(-10,840)*			[0,000]
BM	-0,015	0,747	0,406	-0,030	0,737	2,22	80,562
	(-0,751)	(14,929)*	(3,591)*	(-0,385)			[0,000]
BH	-0,006	0,669	-0,418	0,685	0,763	2,19	88,03
	(-0,766)	(13,786)*	(-3,810)*	(8,983)*			[0,000]

GRS-F Test: 0,955 [0,432]

The p value are in parentheses ***, **,* show significance at the 10, 5, and 1% levels, respectively. Probability values of GRS-F test are in brackets.

When Table 1 is examined, the F values and probability values of all models, which were

created according to the regression results of the Fama-French's three factor model, show that the established models are meaningful. It is seen that not the entirety of the alpha values is different from zero. In addition, the GRS F test result's being 0,655 and that the probability value's being 0,432 mean that the zero hypothesis is accepted, in other words that the three factor model is valid for the ISE.

Table 2. Four factor regression of montly excess returns: from July 1992 to June 2011

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f)] + s_i E(SMB) + h_i E(HML) + w_i E(WML) + \varepsilon_i$$

R_i-R_f	α	β	s	h	w	Ad.R^2	DW	F
SL	0,006	0,677	0,558	-0,283	-0,271	0,748	2,15	64,105
	(0,754)	(13,915)*	(5,018)*	(-3,434)*	(-2,844)*			[0,000]
SM	-0,009	0,600	-0,659	-0,931	-0,183	0,817	2,11	95,87
	(-0,923)	(10,457)*	(-5,021)*	(-9,554)*	(-1,690)***			[0,000]
SH	-0,000	0,741	0,332	0,148	-0,259	0,736	2,22	101,14
	(-0,043)	(14,920)*	(2,923)*	(1,760)***	(-2,627)*			[0,000]
BL	-0,007	0,723	-0,681	-0,937	-0,150	0,869	2,12	143,71
	(-0,791)	(13,877)*	(-5,718)*	(-10,606)*	(-1,455)			[0,000]
BM	-0,004	0,728	0,340	-0,131	-0,300	0,764	2,23	69,50
	(-0,786)	(15,201)*	(3,111)*	(-1,614)	(-3,154)*			[0,000]
BH	-0,000	0,659	-0,455	0,630	-0,166	0,760	2,15	68,38
	(-0,048)	(13,624)*	(-4,116)*	(7,677)*	(-1,731)***			[0,000]

GRS F Test: 1,103 [0,295]

The p value are in parentheses ***, **,* show significance at the 10, 5, and 1% levels, respectively. Probability values of GRS-F test are in brackets.

When regression results of the four factor model are examined, the F values and probability values of all models show that the established models are significant. Not the entirety of the alpha values is different from zero. It was established that the GRS F test result is 1,103 and the probability value is 0,295. This result means that the zero hypothesis is not rejected, meaning that the four factor model is also valid for the ISE.

Table 3. Five factor regression of montly excess returns: from July 1992 to June 2011

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_m) - R_f] + s_i E(SMB) + h_i E(HML) + w_i E(WML) + l_i E(LMI) + \varepsilon_i$$

R_i-R_f	α	β	s	h	w	l	Ad.R^2	DW	F
SL	0,006	0,346	0,589	-0,285	-0,264	0,332	0,753	2,17	52,83
	(0,724)	(1,748)*	(5,271)*	(-3,495)*	(-2,758)*	(-1,728)***			[0,000]
SM	-0,010	0,096	-0,593	-0,935	-0,162	0,700	0,833	2,10	86,08
	(-1,036)	(12,405)*	(-4,670)*	(-10,665)*	(-1,486)***	(3,001)*			[0,000]
SH	-0,001	0,145	0,387	0,144	-0,240	0,598	0,761	2,26	55,24
	(-0,112)	(17,365)*	(3,522)*	(1,792)***	(-2,546)*	(2,958)*			[0,000]
BL	-0,008	0,096	-0,622	-0,942	-0,131	2,970	0,881	2,21	127,37
	(-0,895)	(10,774)*	(-5,390)*	(-11,155)*	(-1,823)***	(1,059)			[0,000]
BM	-0,004	0,167	0,393	-0,135	-0,282	0,563	0,782	2,12	62,28
	(-0,573)	(11,243)*	(3,694)*	(-1,734)***	(-3,094)*	(2,883)*			[0,000]
BH	-0,000	0,296	-0,421	0,627	-0,155	0,363	0,766	2,02	56,84
	(-0,090)	(12,235)*	(-3,803)*	(7,749)*	(-1,741)***	(1,790)***			[0,000]

GRS F Test: 0,512 [0,725]

The p value are in parentheses ***, **,* show significance at the 10, 5, and 1% levels, respectively. Probability values of GRS-F test are in brackets.

The examination of Table 3 established that just like the three factor and four factor models, F values and probability values of the established models were significant for the regression results yielded by the five factor model and that not the entirety of their alpha values was different from zero. The GRS F test result was found to be 0,512 and the probability value was found to be 0,725. This result shows that the five factor model can be used in explaining securities' returns in the ISE.

When the regression results are examined, it is seen that the R square vales of the three factor and four factor models are close to each other. The addition of the liquidity factor to the four factor model has meaningfully increased the R square value. It is seen that the coefficients of the Rm-Rf, SMB, HML, WML and LMH, which constitute systematic risk factors, are meaningful in almost all models.

The regression findings revealed the finding that the portfolio of the companies with small market value (SL and SH) has a positive SMB slope whereas the portfolio of the companies with large market value (BL and BH) has a negative SMB slope. This finding points to the effect of company size. Furthermore, the fact that the portfolio of the companies with high B/M ratio (SL and SH) has a positive HML slope and the portfolio of the companies with low B/M ratio (BL and BH) has a negative HML slope points to the presence of the value effect. The obtained results are consistent with the findings of Fama and French (1996). It was nevertheless determined that all WML slopes are negative and all LMH slopes are positive. This results shows that the WML and the LMH factors are not related with the firm size or

the B/M ratio.

7. Conclusion

The purpose of the study is to test the alternative asset pricing models for the ISE. This paper aims to fulfill this gap and contributes to empirical literature on this subject. The obtained findings point to the existence of the size and value effects for the ISE. It is also determined that the factors of momentum and liquidity should be preferred during the creation of asset pricing models.

It is consequentially established that the three factor, four factor and five factor models are valid in the ISE, and that in addition to the market risk, factors of firm size, B/M ratio, momentum and liquidity also constitute significant risk factors that affects stock returns and that the risk premiums belonging to these five factors are priced by the market.

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