IN THE CONTEXT OF THE ISE COMPARISON OF FAMA-FRENCH'S 3 FACTOR MODEL AND CARHART'S 4 FACTOR MODEL 1996 – 2009

Turan ÖNDEŞ(*)
Selçuk BALI(**)

Özet: Sermaye varlıkları fiyatlandırma modeli (SVFM) ikinci momentin ötesinde (çarpıklık ve basıklık) çeşitlilik göstermeyen riski tamamen kapsamaz ve bu nedenle ampirik başarısızlıkla sonuçlanır. Fama-French pazarsal olmayan risk faktörlerinin fiyatlandırıldığını savunur ve pazar faktörüne ek olarak bir hacim faktörü, SMB, ve bir değer faktörünü, HML, içeren üç-faktörlü bir model önerir. Fama-French'in faktörlerine ilave olarak Carhar'ın modeli tbir momentum faktörünü içermektedir. Bu çalışmada, IMKB'de portföy fazlası getirilerin çeşitliliği üzerinde çarpıklık etkisini araştıracağız. Çarpıklık faktörünü içeren çok faktörlü modeller Carhart'ın 4 Faktör Modeli ve Fama-French'in 3 Faktörlü Model ile çeşitli portföy gruplamaları için kesitsel ve zaman serileri analizi ile karşılaştırılmıştır. Betimleyici istatistikler hacim portföyleri için ortalama getiri fazlası ve koşulsuz standartlaştırılmış çarpıklık arasında beklenen önemli işlemlerin varlığını gösterir.
Anahtar Kelimeler: SVFM, Fama–French modeli, Carhart modeli,Çarpıklık, İMKB

Abstract: The capital asset pricing model (CAPM) does not completely capture non-diversifiable risk beyond the second co-moment (co-skewness and co-kurtosis), and thus, results in its empirical failures. Fama-French argue that nonmarket risk factors are priced and propose a three-factor model that includes a size factor, SMB, and a value factor, HML, in addition to the market factor. The Carhart's model that includes a momentum factor, WML, in addition to the Fama-French's factors. In this study, we investigate the impact of coskewness on the variation of portfolio excess returns in ISE. Multifactor models including the coskewness factor are compared to Carhart's 4 Factor Model and Fama-French 3 factor model through cross-sectional and time series analyses for various portfolio groupings. Descriptive statistics indicate the existence of expected significant trade-off between average excess returns and unconditional standardized coskewness for size portfolios.
Key Words: CAMP, Fama–French's model, Carhart's model,Co-skewness, ISE

I. Introduction

Previous empirical research on financial markets finds evidence against the classical capital asset pricing model (CAPM) of Sharpe (1964: 425-442), Lintner (1965: 13-37) and Mossin (1966: 768-783). Asset returns are characterized by skewness and significant leptokurtosis providing evidence against the normality assumption. Furthermore, additional factors such as size and value, which are called Fama-French factors in the literature, have been shown to be significant determinants of excess returns in financial markets.

(*) Prof. Dr. Atatürk Üniversitesi İİBF İşletme Bölümü
(**) Dr. Ordu Üniversitesi Meslek Yüksekokulu

Previous empirical literature on emerging financial markets takes these issues into consideration and analyses the importance of Fama-French factors as well as higher comoments.

This article uses data from the Istanbul Stock Exchange (ISE) and adds to the existing literature on emerging markets in three dimensions. First, when compared to previous studies on ISE, we use an extended data set and include all stocks that are listed in ISE during 1996-2009. Second, this article is an attempt at understanding the relative importance of coskewness in explaining the variation of excess returns in ISE. We initially estimate a traditional CAPM and then examine the incremental effect of Fama-French factors as well as coskewness on the variation of portfolio excess returns. Third, in contrast to previous studies on ISE, we perform the multivariate test of Gibbons et al. (1989: 1121-1152) to investigate whether CAPM is sufficient to explain the expected returns or multifactor models adding small minus big (SMB), high minus low (HML) and/or coskewness to the market factor would remove any pricing bias captured by the intercept term. The multivariate test investigates whether the pricing biases are jointly equal to zero; furthermore, it reveals whether the market portfolio or a linear combination of factor portfolios lies on the minimum variance boundary. We also run cross-sectional regressions following Fama-MacBeth (1973: 607-636) as well as full information maximum likelihood (FIML) method to uncover the incremental power of coskewness over CAPM and Fama-French factors.

Our estimations indicate the presence of a significant relationship between average excess returns and coskewness in ISE, especially for size and industry portfolios. We argue that coskewness is able to account for the size premium, i.e. small market capitalization stocks have higher returns than big ones. While a two-factor model incorporating coskewness has more explanatory power than the traditional CAPM in cross-sectional regressions, that power diminishes as we include Fama-French factors.

II. Fama-French's 3 Factor Model

A factor model that expands on the CAPM by adding size and value factors in addition to the market risk factor in CAPM. This model considers the fact that value and small cap stocks outperform markets on a regular basis. By including these two additional factors, the model adjusts for the outperformance tendency, which is thought to make it a better tool for evaluating manager performance.

The three factor model is motivated by the empirical finding that size and the ratio of book to market equity have consistent and significant explanatory power for US stock returns at the very least (Fama and French, 1992:427-465 and 1993: 3-56). The Fama–French three factor model is

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

where SMB and HML capture the size and book to market effects, respectively. SMB and HML are factor mimicking hedge portfolios constructed from stock returns. Details on how these factors are constructed can be found in Fama and French (1993: 3-56). This model performs very well empirically and is capable of explaining many of the anomalies that the CAPM is not capable of explaining, such as the overreaction effect (Fama and French, 1996: 55-84). One possible objection to the model is that it is an empirically driven one designed to capture anomalies such as the size effect that the CAPM is incapable of explaining. Fama and French (1995: 131-155), however, argue that the premia associated with SMB and HML are consistent with a multi factor version of Merton's ICAPM (1973: 867-887). Brennan, Wang, and Xia (2004, 1743-1775) argue that to interpret significant risk factors in the light of the ICAPM, the factors must not just be correlated with returns but should be innovations in the state variables that predict future returns innovations. The evidence in Liew and Vassalou (2000: 221-245) that size and book to market predict economic growth (GDP) suggests that SMB and HML might indeed be proxies for the hedge portfolio in Merton's ICAPM.

III. Carhart's 4 Factor Model

The Carhart's model (1997: 57-82) appears to improve upon the Fama-French model in terms of reducing mean absolute pricing errors of mutual fund returns. By now the Fama-French and Carhart models have become quite popular and have been widely used for estimating costs of capital, computing optimal asset allocations and measuring performance evaluations. The lack of theoretical grounds for the Fama-French and Carhart's momentum factor-mimicking portfolios to be cross-sectionally priced risk factors has spawned a lot of research aimed at either identifying the economic reasons for these portfolios to be priced factors or discrediting the validity of the two multi-factor models on statistical grounds and risk-return relation mis-specifications. Fama and French (1993: 3-56, 1996: 55-84) suggest that the book-to-market factor may be a proxy for a systematic factor related to distressed firms. Chung, Johnson and Schill (2006: 923-940) find that the explanatory power of the book-to-market and size factors decreases or disappears as higher-order co-moments of stock returns with the market factor are added as additional risk factors. Lakonishok, Shleifer and Vishny (1994: 1541-1578) propose that the book-to-market effect is related to a cognitive bias on behalf of investors that arises as they extrapolate firms' future earnings and growth potential from past values. Alternatively, Kothari, Shanken and Sloan (1995:185-224) point out a data-related selection bias associated with the COMPUSTAT dataset that might be driving the results of Fama and French (1993: 3-56). Yet, Cohen and Polk (1995) and Davis (1994: 1579-1585) attempt to fix the bias in the data and still find the presence of a book-to-market effect. Daniel and Titman (1997: 1-33), on the other hand, argue that the size and book-to-market factors are picking up co-movements of stock returns that are related to stocks characteristics instead of some pervasive risk factors. More recently, Petkova (2006: 581-632) finds that the Fama-French factors are correlated with innovations in instrumental variables that predict the return and volatility of a wide market index. Furthermore, Petkova and Zhang (2005: 187-202) show that the empirically documented value premium is justified in a rational asset pricing framework by timevarying conditional betas of value and growth stocks over the business cycle. Finally, Moskowitz (2003: 417-457) finds that the size premium is related to volatility and covariances while no such relation is present for the book-to-market and the momentum premium.

IV. ISE's Structure

The ISE was established on December 26, 1985, where currently stocks, government bonds, treasury bills, private sector bonds, repo-reverse repo transactions, exchange traded funds, Eurobonds and warrants are traded. Trading in the ISE takes place via members.

The Istanbul Stock Exchange (ISE) (Turkish: İstanbul Menkul Kıymetler Borsası, İMKB) is the only corporation in Turkey for securities exchange established to provide trading in equities, bonds and bills, revenue-sharing certificates, private sector bonds, foreign securities and real estate certificates as well as international securities. The ISE was founded as an autonomous, professional organization in early 1986. It is situated in a modern building complex in the quarter of İstinye, on the European side of Istanbul, since May 15, 1995. The Chairman and Chief Executive Officer of the ISE is Hüseyin Erkan who was appointed by the government on November 2, 2007.

ISE is home to 320 national companies. Trading hours are 09:30-12:30 for the first session and 14:00-17:30 for the second session, on workdays. All ISE members are incorporated banks and brokerage houses.

ISE price indices are computed and published throughout the trading session while the return indices are calculated and published at the close of the session only. The indices are: ISE National-All Shares Index, ISE National-30, ISE National-50, ISE National-100, Sector and sub-sector indices, ISE Second National Market Index, ISE New Economy Market Index and ISE Investment Trusts Index. The ISE National-100 Index contains both the ISE National-50 and ISE National-30 Index and is used as a main indicator of the national market.

The ISE Stock Market operates in five market segments: National Market, Collective Products Market, Second National Market, New Economy Market, and Watchlist Companies Market. The average daily trading volume in the ISE Stock Market stood at US$ 1.99 billion (TL 2.96 billion), while the market capitalization of the 317 companies traded on the ISE amounted to US$ 226.29 billion (TL 347.36 billion) as of end-February 2010.

Bonds and Bills Market, on the other hand, operates in two market segments: Outright Purchases and Sales Market, and Repo / Reverse Repo Market. The average daily trading volume of the Bonds and Bills Market was US$ 10.3 billion (TL 15.3 billion) as of end-February 2010. In the ISE Foreign Securities Market, listed Turkish Sovereign Eurobonds are traded. Emerging Companies Market is intended as an intermediate market for enterprises that have a growth potential and seek to supply funding in the capital markets.

Disclosure of financial statements, material events, insider information and other notifications by the ISE traded companies and ISE member brokerage houses are made through the Public Disclosure Platform http://www.kap.gov.tr, which is an electronic data collection and dissemination system through which electronically signed notifications required by the capital markets and the ISE regulations are disclosed in a secure environment.

V. Data and Methodology

The sample analyzed in this dissertation includes all the firms that are listed on the ISE during the 1996–2009 period. Financial firms are excluded since characteristically high debt-to-equity ratios of such firms do not necessarily indicate financial distress, and hence, may distort our analysis. Holdings are excluded, as the stocks of such companies resemble more a mini-portfolio than a single security. Firms with more than one type of share quoted on the stock market are also taken out of the sample since a high correlation among returns to these securities is expected. Finally, firms that miss the required data for analysis are also excluded.

A. Data Sources

For each firm under study, three sets of data are needed. Data on monthly stock prices and number of shares outstanding on the initial public offering (IPO) date are obtained from databases maintained by the ISE. Data on required accounting figures, on the other hand, are compiled from the database of financial statements of the ISE firms published on the official web site of the ISE (www.imkb.gov.tr).

Our data base consists of monthly returns adjusted for dividends and splits of 318 stocks traded in ISE from July 1996 to December 2009. Stock return data is obtained from ISE and IBS Yazılım. IBS Yazılım, which provides all necessary data for basis analysis in ISE, is an independent investment research . Book-to-market ratios and market values of stocks are obtained from ISE and HSBC (The HongKong ve Shangai Banking Corporation) database, respectively. We use the daily average of the overnight interbank rate as the risk-free rate obtained from the Central Bank of Republic of Turkey.

Shares of investment trusts, real estate investment trusts, illiquid stocks, stocks with negative book value and other stocks having less than 36 observations are excluded from the sample. After exclusions, the remaining 194 stocks cover approximately 84% of the market in terms of market capitalization. We form the market portfolio by calculating the value-weighted index of all stocks.

We use data from July 1996 to June 1999 (36 months) to run time series regressions and estimate betas from a Fama-MacBeth (1973: 607-636) procedure and to form coskewness hedge portfolios. The empirical testing period is from July 1996 to December 2009.

B. Methodology

Table 1 presents some descriptive statistics of three portfolio groups, as subsequently defined. Panel A presents value-weighted industry portfolios. We exclude portfolios which include less than 10 stocks; as a result, we have 10 industry portfolios. Panel B presents 10 portfolios with 1-month holding period sorted in ascending order with respect to market value. Panel C presents 16 Fama-French portfolios that are sorted on size and book-to-market value. At the end of each month, stocks are sorted in ascending order with respect to market capitalization and classified into four size groups. Next, in each size group, stocks are ranked again in ascending order according to their book-to-market ratios and divided into four further subgroups. For example, portfolio 1-1 consists of stocks with the lowest market value and lowest book-to-market ratio.

Table 1: *Descriptive Statistics*

Panel A: Industry Portfolios

Industry	Standardized unconditional skewness	Standardized unconditional coskewness	Average excess return	β to $(R_m - R_f)$	Standard deviation	β to $(R_m - R_f)^2$	β to SKS
Food, Beverage and Tobacco	2.014**	0.331**	0.010	0.704**	0.146	0.142	0.496**
Textile and Leather	1.158**	-0.513**	0.020	0.864**	0.168	-0.227*	0.342**
Paper, Printing and Publishing	1.331**	-0.897**	0.024	0.999**	0.199	-0.516**	0.897**
Chemicals, Rubber and Plastics	1.621**	0.352**	0.002	0.890**	0.166	0.114	-0.258**
Nonmetallic Mineral Products	1.065**	-0.415**	0.017	0.756**	0.139	-0.144	0.272**
Basic Metal Industries	0.569**	-0.823**	0.014	0.866**	0.162	-0.318**	-0.16
Fabricated Metal, Machinery and Equipment	0.887**	-0.566**	0.022	1.056**	0.193	-0.214**	0.267*
Banks and Special Finance Corporations	1.629**	0.220	0.015	1.092**	0.194	0.059	-0.045

Table 1: *Descriptive Statistics (Contine)*

Insurance, Leasing and Factoring	0.820**	-0.773**	0.027	0.985**	0.179	-0.286**	-0.13
Holding and Investment Companies	0.937**	-0.533**	0.009	1.043**	0.189	-0.161*	0.055
Correlation with Average Excess Return	-0.452	-0.718	1.000	0.297	0.355	-0.741	0.4

Panel B: Size Portfolios

Lowest: 1	0.704**	-0.629**	0.026	0.836**	0.167	-0.332**	0.560**
2	0.433*	-0.886**	0.015	0.808**	0.155	-0.403**	0.295
3	0.713**	-0.685**	0.013	0.893**	0.166	-0.289**	0.305*
4	0.806**	-0.715**	0.008	0.899**	0.167	-0.294**	0.245
5	1.114**	-0.444**	0.014	0.924**	0.169	-0.181	0.066
6	0.674**	-0.953**	0.010	0.943**	0.169	-0.329**	0.118
7	1.280**	-0.356**	0.009	0.934**	0.167	-0.113	0.055
8	1.355**	-0.446**	0.001	0.875**	0.154	-0.123	0.141
9	1.139**	-0.738**	0.009	0.969**	0.169	-0.170**	0.212**
Highest: 10	1.474**	-0.115	-0.001	0.995**	0.172	-0.012	-0.035
Correlation with average excess return	-0.703	-0.477	1.000	-0.607	0.047	-0.72	0.806

Panel C: Fama-French Portfolios Sorted With Respect to Size and Book-to-Market Ratio

Size	Book-to-Market Value	Standardized Unconditional Skewness	Standardized Unconditional Coskewness	Average Excess Return	β to $(R_m - R_f)$	Standard deviation	β to $(R_m - R_f)^2$
1	1	0.266	-1.023**	-0.001	0.744**	0.159	-0.459**
	2	0.600**	-0.706**	0.023	0.874**	0.182	-0.340**
	3	1.103**	-0.351**	0.021	0.913**	0.187	-0.165
	4	0.568**	-0.543**	0.030	0.868**	0.187	-0.292*
2	1	0.465*	-0.941**	0.005	0.744**	0.175	-0.554**
	2	0.450*	-1.036**	0.007	0.885**	0.178	-0.436**
	3	1.254**	-0.305*	0.021	0.937**	0.188	-0.134
	4	2.106**	0.401**	0.022	1.089**	0.211	0.166
3	1	1.245**	-0.322*	0.002	0.834**	0.167	-0.124
	2	0.750**	-0.899**	-0.005	0.902**	0.174	-0.297**
	3	1.499**	-0.138	0.012	0.952**	0.180	-0.04
	4	0.517**	-1.176**	0.014	0.922**	0.183	-0.475**
4	1	1.433**	0.058	-0.007	0.907**	0.168	0.013
	2	1.510**	0.164	-0.003	1.028**	0.188	0.03
	3	1.920**	0.384**	0.008	1.034**	0.190	0.082
	4	0.887**	-1.019**	0.015	1.073**	0.200	-0.293**

***, **, * Significant at the 1,5 and 10 percent levels, respectively

VI. Findings and Comparison

A. Fama-French's 3 Factor Model

Bekaert *et al*. (1998: 47-61), has identified skewness in the empirical distribution of various stock market indices in emerging markets as an empirical regularity. Hence, the standard mean-variance analysis on which CAPM is based breaks down. Based on Bekaert *et al*. (1998: 47-61) investors in emerging markets should also keep track of asset skewness as well as coskewness, i.e. how an asset contributes to the skewness of the market portfolio.

Applied research analysing the effect of coskewness on excess returns in emerging markets can be divided into two groups. The first group consists of studies that use excess returns of various emerging market as the dependent variable and the excess return of a world version of a market portfolio such as Morgan Stanley Capital International (MSCI) index, as the independent variable. The second group, on the other hand, consists of studies where data on individual stock returns are used and portfolios are formed according to different kinds of strategies. Alternative asset pricing models are then tested using these portfolios. Harvey (2000: 32-49) falls into the first group and focuses on emerging market indices rather than portfolios within each market. Lin and Wang (2003: 1877-1887) on the other hand examine the characteristics of different portfolios in Taiwanese stock market. Similarly, Hung (2004) uses data from 20 international stock markets to form size, momentum and country portfolios and analyses the impact of coskewness. Our study is similar to Lin and Wang (2003: 1877-1887) and investigates whether coskewness has a significant role in explaining portfolio returns in ISE. Accordingly, in each panel in Table 1, we report three different measures of coskewness and cross-sectional correlations between those measures and average excess returns.

First, following Harvey and Siddique (2000: 1263-1295), for each individual stock or portfolio, we calculate the first measure of coskewness, also referred to as the standardized unconditional coskewness or the direct measure, which is defined as

$$\hat{\beta}_{SKD,i} = \frac{E\left[\varepsilon_{Mt}^2 . \varepsilon_{it}\right]}{E\left[\varepsilon_{Mt}^2\right]\sqrt{E\left[\varepsilon_{it}^2\right]}} \quad (2)$$

ε_{it} is the residual from regressing the excess return of the *i*th asset on a constant and contemporaneous market excess return. ε_{Mt} is the difference of market excess return from its mean value. $\hat{\beta}_{SKD,i}$ accounts for the contribution of *i*th asset to the skewness of the market portfolio. A negative coskewness implies that the asset decreases the skewness of the market portfolio; hence, it should have a higher expected return for risk-averse investors. To calculate the second measure of coskewness, also an unconditional measure, we regress excess return of the *i*th asset on a constant, excess market return and its square and report the coefficient of the squared term. Like the first coskewness measure, a negative coskewness is associated with higher returns. For the third measure of coskewness, which is a conditional measure, we use rolling window regressions of 36-month observations, calculate $\hat{\beta}_{SKD}$ of each asset in each sample and rank them in ascending order with respect to their coskewness. For each 78 observations, we form two value-weighted portfolios: S^- consists of 30% of the stocks with the lowest coskewness and S^+includes 30% of the stocks with the highest coskewness. The spread for the 37th-month returns on S- and S+is our hedge portfolio henceforth, SKS which mimics ex ante conditional coskewness. Note that the higher its factor loading is, the higher is the risk premium. This methodology is much in the same way Fama and French (1993: 3-56, 1996: 55-84) form SMB and HML to investigate size and book-to-market effects.

Table 1 reports skewness, the three measures of coskewness, average excess returns, CAPM beta and standard deviations of the three portfolios.

Based on descriptive statistics of portfolio returns from ISE presented in Table 1, the most striking result is the significance of skewness and coskewness in explaining excess returns of industry and size portfolios. For size portfolios, standardized unconditional skewness coefficients are all positive and significant while the coefficients of two unconditional coskewness measures are all negative and a majority of them are significant. For industry portfolios, standardized unconditional skewness coefficients are all positive and significant while a majority of the two unconditional coskewness measures' coefficients, are negative and significant. Hence, both industry and size portfolios have significant negative contributions to the skewness of the market portfolio; therefore, an asset pricing model which ignores the coskewness factor would underestimate their expected return. We would like to also emphasize that the sign and magnitude of the correlation coefficient between average excess returns and each coskewness measure are consistent with a priori expectations. Harvey and Siddique (2000: 1263-1295) provide similar evidence of the relation between coskewness and excess returns in the case of industry and size portfolios in the US market. Furthermore, Hung (2004) finds that the coefficients for squared excess market return, the second coskewness measure, are highly significant for small- and big-size portfolios formed from stocks across 20 international markets. In contrast to the evidence on the US market in Harvey and Siddique (2000: 1263-1295), we find little evidence of a relation between average excess returns and coskewness for 16 Fama-French portfolios in ISE. As for previous evidence from emerging markets, Lin and Wang (2003: 1877-1887) also form these three portfolios for Taiwanese stock market. Although they find skewness and coskewness measures highly significant, majority of the correlations are inconsistent with the expectations. They attribute this inconsistency to sampling bias.

Based on Panel A in Table 1, for industry portfolios, all skewness measures and almost all $\hat{\beta}_{SKD}$'s are highly significant. Furthermore, the correlation coefficient between $\hat{\beta}_{SKD}$ and average excess returns is -0.718. Specifically, paper, printing and publishing industry which has the most negative coskewness of -0.897 demands an excess return of 2.4% while the chemicals, rubber and plastics industry which has the most positive coskewness of 0.352 demands the lowest excess return of 0.2%. Similarly, there is a negative (positive) correlation between the beta of the squared market excess return (factor loadings of the hedge portfolio) and average excess returns - which provide further evidence on the impact of coskewness on excess returns of industry portfolios.

The impact of coskewness is further emphasized when we consider size portfolios. Based on Panel B, almost all skewness measures and $\hat{\beta}_{SKD}$'s are significant; moreover, skewness measures are all positive while coskewness measures are all negative. This evidence implies that size portfolios have significant negative contributions to the skewness of the market portfolio; therefore, an asset pricing model which ignores the coskewness factor would underestimate their expected return. Lin and Wang (2003: 1877-1887) find similar results and reach the same conclusion for the Taiwanese stock market. Additionally, Panel B indicates the strong relation between coskewness measures and average excess returns: beta of the squared market return and beta of the hedge portfolio have -0.720 and 0.806 correlations with the average excess returns, respectively. Specifically, the lowest size decile with the highest average excess return has the highest beta coefficient for the coskewness hedge portfolio. Our findings confirm the evidence in the literature that small stocks require higher returns than big stocks;10 furthermore, it reveals that a significant portion of this return differential can be attributed to coskewness. Similarly, there is a negative relationship between $\hat{\beta}_{SKD}$'s and mean excess returns.

Average excess returns of size and book-to-market value sorted 16 portfolios presented in Panel C reveal that higher book-to-market portfolios outperform lower ones for all size groupings.11 Additionally, most of the unconditional skewness measures and the direct coskewness measures, $\hat{\beta}_{SKD}$, within each of the 16 portfolios are significantly different than zero. However, based on cross-sectional correlations among the 16 portfolios, there is no evidence of a negative and significant relationship between these measures and average excess returns. One explanation for this inconsistency would be trading behaviour of the investors in ISE. As pointed out by Gonenc and Karan (2003: 1-25), stocks that are larger in terms of market capitalization and stronger in terms of fundamentals are preferred by investors in ISE due to unstable economic environment in Turkey during 1990s and the resulting high systematic risk in ISE. Therefore, when we exclude eight portfolios with low size, the correlation between standardized unconditional coskewness and average excess returns become -0.39. Nevertheless, there is a positive correlation of 0.364 between factor loadings of the hedge portfolio and average excess returns of 16 Fama-French size and book-to-market value portfolios emphasizing the importance of coskewness.

To sum up the evidence from descriptive statistics, coskewness plays an important role in explaining cross section of asset returns in ISE. Also, the role of coskewness is more emphasized in ISE than in the US stock markets, especially for industry and size portfolios. Next, we compare four-factor model (including the coskewness hedge portfolio) with CAPM and Fama-French factors in time series. Following the time series analysis, we run cross-sectional regressions in order to reveal whether coskewness has significant incremental ability in explaining portfolio returns in ISE.

B. Carhart's 4 Factor Model

Similar to Harvey and Siddique (2000: 1263-1295) and Lin and Wang (2003: 1877-1887), we perform two different cross-sectional tests to Carhart's 4 Factor Model and different combinations of multifactor models to investigate the incremental power of coskewness in ISE. The first test is based on the Fama-MacBeth (1973: 607-636) algorithm where we first estimate betas of various factor loadings by running time series regressions with 36 monthly observations at a time. Next, the excess returns of the 37th month are regressed on these betas. These cross-sectional regressions are run for each month in our empirical testing period from July 1996 to December 2009 and averages of adjusted R^2's are reported in Panel A of Table 3. The second testing procedure is called FIML method and differs from the first one by disallowing time series variation in betas. In other words, for each portfolio the betas are constant during the entire empirical testing period; however, they are allowed to change across portfolios. For the one-factor model as well as multifactor models, we run the following cross-sectional regressions: $\hat{\mu}_i = \lambda_0 + \sum_{j=1}^{k} \lambda_J \hat{\beta}_{ij} + e_i$ where $\hat{\mu}_i$ are $\sum_{t=1}^{T} \left(r_{i,t} / T_i \right)$, are average excess returns for *i*th portfolio, and *k* refers to the number of factors in our regressions. According to this two-step estimation method, we first estimate the betas of each portfolio through time series regressions over the whole empirical testing period and calculate average excess returns. Next, we estimate the risk premia, λ_j's, in cross-sectional regressions. The residuals are assumed to be distributed as multivariate normal, $N(0, \sum)$, where $\sum$ is $N \times N$ heteroskedasticity and autocorrelation consistent variance-covariance matrix. In Panel B of Table 2, we report adjusted $R^2$for each portfolio grouping and *k*-factor model pair.

FF stands for Fama-French factors of size premium (SMB) and value premium (HML). SKS is the coskewness mimicking portfolio. S^-consists of 30% of the stocks with the lowest coskewness, and the excess return on that portfolio is another factor. Portfolios are formed according to industry, size, size and book-to-market ratio and momentum. k denotes holding period. Momentum portfolios are formed according to their past j month performance (from t - j to t-2)

Table 2: *Results of the Cross-Sectional Analysis*

	Industry (%)	Size (%)	Size &B/M (%)	Size &B/M (%)	Momentum (%)	Momentum (%)	Momentum (%)
	$k = 1$	$k = 1$	$k = 12$	$k = 1$	$j = 6, k = 6$	$j = 12, k = 6$	$j = 12, k = 1$
Panel A: Fama-MacBeth (1973) algorithm							
CAPM	7.3	16.5	9.5	10.8	17.9	19.0	12.7
CAPM + FF	14.0	24.3	22.3	21.6	31.0	37.6	18.7
CAPM + S^-	14.2	18.3	15.4	18.0	18.0	25.3	15.4
CAPM + SKS	11.9	19.8	15.8	18.5	16.2	22.4	12.4
CAPM + FF + S^-	22.8	23.4	21.6	23.4	32.7	40.0	21.3
Panel B: Full information maximum likelihood method							
CAPM	-2.6	28.9	-7.0	-1.8	85.6	51.6	23.0
CAPM + FF	80.1	71.1	50.3	62.1	91.0	43.9	12.0
CAPM + FF + S^-	76.2	69.6	57.5	59.4	89.3	32.8	-4.7
CAPM + S^-	16.2	68.7	11.6	8.0	84.9	45.6	12.1
CAPM + FF + SKS	76.3	65.3	55.7	59.7	93.8	46.9	-5.5
CAPM + SKS	9.3	55.2	14.1	13.1	87.0	55.7	18.6

***, **, * Significant at the 1,5 and 10 percent levels, respectively

Based on the test results presented in both panels of Table 2, FIML method has more explanatory power than the Fama-MacBeth (1973: 607-636) algorithm. For the three-factor model in case of momentum strategy (j = 6, k = 6), FIML method reports an adjusted R^2 of 91%, while Fama-MacBeth algorithm's adjusted R^2 stands at 31%. Additionally, we find evidence in favour of the argument that Fama-French factors capture the same financial risks that cause the conditional skewness. Similar to Harvey and Siddique (2000), we compute adjusted R^2 of the two-factor model where the factors are excess market return and excess return on the S-portfolio, and compare its adjusted R^2 with that of the Fama-French three-factor model. After the addition of the coskewness factor to the one-factor model, adjusted R^2 may increase to a level that may make this two-factor model competitive with Fama-French three-factor model. For size portfolios in the FIML estimation, the inclusion of the S-portfolio leads to an increase in adjusted R^2 from 28.9 to 68.7%, while the three-factor model produces an adjusted R^2 of 71.1%. Likewise, for most of the portfolio groupings, the addition of the coskewness factor to the three-factor model does not cause a significant increase in the adjusted R^2; on the contrary, as shown in Rows 3 and 5 of Panel B, adjusted R^2 decreases for portfolios based on industry, size, size and book-to-market with 1-month holding period and momentum strategy (j = 12, k = 1); hence coskewness might not have a significant incremental power over Fama-French factors in explaining the cross-sectional variation of excess returns. Chung et al. (2006: 923-940) argue that Fama-French factors proxy for a set of comoments of order 3 through 10 in the US market because the inclusion of higher-order comoments make SMB and HML insignificant in cross-sectional regressions.

C. Comparison

Analysis of individual portfolio groupings also reveals interesting results. For industry portfolios coskewness has additional explanatory power, corresponding to an increase of 18.8% in adjusted R^2compared to Carhart's 4 Factor Model, consistent with our analysis based on the descriptive statistics. Even though addition of coskewness factor improves over Carhart's 4 Factor Model significantly, it does not significantly improve the three-factor model. The incremental power of coskewness over Carhart's 4 Factor Model is more evident for size portfolios. Carhart's 4 Factor Model with S^-portfolio explains 68.7% of the variation of excess returns in FIML procedure whereas CAPM alone delivers an adjusted R^2 of 28.9%. This result strengthens our argument given in the descriptive statistics section that an asset pricing model which ignores the coskewness factor would underestimate the expected return of size portfolios. Moreover, for momentum strategies, especially for (j = 6, k = 6) exhibited in the 6th column of Panel B, market beta has the highest explanatory power and other factors do not have much incremental power, if any.

VII. Conclusions

Emerging market stock returns depart significantly from normality, and display skewness; therefore, coskewness, namely the contribution of an asset to the skewness of the market portfolio, should be an important factor for asset pricing. Based on this intuition, we investigate the impact of coskewness on the variation of portfolio excess returns in ISE over the period July 1996 to December 2009. Multifactor models including the coskewness factor are compared to Carhart's 4 Factor Model and Fama-French 3 factor model through cross-sectional and time series analyses for various portfolio groupings.

Our results are intriguing. Descriptive statistics indicate the existence of expected significant trade-off between average excess returns and unconditional standardized coskewness for size portfolios. We argue that coskewness is able to account for the size premium, i.e. small stocks have higher returns than big stocks, in ISE. In short, the basic two-moment Carhart's 4 Factor Model without the coskewness factor would underestimate the expected return of size portfolios. Evidence based on industry portfolios also point out to similar characteristics.

Time series analysis rests upon the multivariate F-test of Gibbons, et al. (1989: 1121-1152) and reveals that coskewness reduces the pricing bias in ISE, albeit insignificantly. One explanation for this lack of significant contribution is the sufficiency of the one-factor model to explain the expected returns for industry, momentum and coskewness portfolios. Another explanation would be that the coskewness mimicking portfolio is an imperfect proxy for ex ante conditional coskewness.

The results get more interesting when we consider cross-sectional analysis, which reveals that coskewness has a significant contribution to the Carhart's 4 Factor Model, especially for size portfolios, which strengthens our conclusions about the descriptive statistics of size portfolios. Evidence based on industry portfolios also indicates the significant contribution of coskewness over Carhart's 4 Factor Model, but its effect is not as high in magnitude as in the case of size portfolios. Finally, coskewness does not have a significant incremental explanatory power over Fama-French factors. One possible explanation is that Fama-French factors constitute the same financial risks that cause the conditional coskewness. Future work that compares higher-order comoments with Fama-French factors would be an interesting extension, contributing to the debate of cross-sectional determinants of emerging market excess returns.

References

Bekaert, G., Erb, C.B., Harvey, C.R., Viskanta, T.E. (1998) "Distributional Characteristics of Emerging Market Returns and Asset Allocation", *Journal of Portfolio Management*, 16, pp. 47-61.

Brennan, M., Wang, A., Xia, Y. (2004), "Estimation and Test of A Simple Model of Intertemporal Asset Pricing", *Journal of Finance*, 59, pp. 1743-1775.

Carhart, M. (1997) "On Persistence of Mutual Fund Performance", *Journal of Finance*, 52, pp. 57-82.

Chung, YP , Johnson, H. and Schill, M. (2006) "Asset Pricing When Returns Are Nonnormal: Fama-French Factors Versus Higher-Order Systematic Co-Moments", *Journal of Business*, 79 , pp. 923-940.

Cohen, R.B. and Polk, C.K. (1995) "COMPUSTAT Selection Bias in Tests of the Sharpe-Lintner-Black CAPM", Manuscript, Graduate School of Business, University of Chicago, Chicago, IL.

Daniel, K. and Titman, S. (1997) " Evidence on the Characteristics of Cross

Sectional Variation in Stock Returns," *Journal of Finance*, 52(1), pp. 1-33

Davis, J.L. (1994) "The Cross-Section of Realized Stock Returns: The Pre-COMPUSTAT Evidence", *Journal of Finance*, 49(5), pp. 1579-1585.

Fama, E. and French, K.R. (1992) "The Cross-Section of Expected Stock Returns", *Journal of Finance*, 47 , pp. 427-465.

Fama, E. and French, K.R. (1993) "Common Risk Factors in the Returns on Stocks and Bonds", *Journal of Financial Economics*, 33 , pp. 3-56.

Fama, E. and French, K.R. (1995) "Size and Book to Market Factors in Earnings and Returns," *Journal of Finance*, 50, pp. 131-155.

Fama, E. and French, K.R. (1996), Multifactor Explanations of Asset Pricing Anomalies, *Journal of Finance*, 51, pp. 55-84.

Fama, E. and MacBeth, J. (1973), Risk, Return and Equilibrium: Empirical Tests, *Journal of Political Economy*, 81, pp. 607-636.

Gibbons, M.R., Ross, S.A. and Shanken, J. (1989) "A Test of Efficiency of A Given Portfolio", *Econometrica*, 57 , pp. 1121-1152.

Gonenc, H. and Karan, M.B. (2003) "Do Value Stocks Earn Higher Returns Than Growth Stocks in An Emerging Market? Evidence from Istanbul Stock Exchange", *Journal of International Financial Management and Accounting*, 14 , pp. 1-25.

Harvey, C.R. (2000) "Drivers of Expected Returns in International Markets", *Emerging Markets Quarterly,* pp. 32-49.

Harvey, C.R. and Siddique, A. (2000) "Conditional Skewness in Asset Pricing Tests", *Journal of Finance*, 55 , pp. 1263-1295.

Hung, D.C. (2004) "The Pricing of Co-Skewness and Co-Kurtosis in International Size and Momentum Strategies", Working Paper, Lancaster University

Kothari, S., Shanken, J., Sloan, R. (1995) "Another Look at the Cross-Section ofExpected Returns", *Journal of Finance*, 50, pp. 185-224.

Lakonishok, J., *Shleifer*, A., *Vishny*, R. W. (1994) "Contrarian Investment, Extrapolation and Risk", *Journal of Finance*, 49(5)., pp. 1541-1578.

Liew, J., and Vassalou, M., (2000) "Can Book-To-Market, Size and Momentum Be Risk Factors That Predict Economic Growth?", *Journal of Financial Economics*, 57, pp. 221-245.

Lin, B., and Wang, J.M. (2003) "Systematic Skewness in Asset Pricing: An Empirical Examination of The Taiwan Stock Market", *Applied Economics*, 35 , pp. 1877-1887.

Lintner, J. (1965) "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets", *Review of Economics and Statistics*, 47, pp. 13-37.

Merton, R.C. 1973. “An Intertemporal Capital Asset Pricing Model”, *Econometrica*, 41 pp. 867-887.

Moskowitz, T, J. (2003) "An Analysis of Covariance Risk and Pricing Anomalies", *Review of Financial Studies*, 16(2), pp. 417-57

Mossin, J. (1966) “Equilibrium in A Capital Asset Market., *Econometrica*, 34, pp. 768-783.

Petkova, R. and Zhang, L. (2005) "Is Value Riskier Than Growth?," *Journal of Financial Economics*, 78(1), pp. 187-202,

Petkova, R. (2006) “Do the Fama–French Factors Proxy for Innovations in Predictive Variables?”, *Journal of Finance*, 61, pp. 581–612

Sharpe, W.F. (1964) “Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk”, *Journal of Finance*, 19 , pp. 425-442.